The Effect of Animation on Web-based Education

By

Thomas C. Gray

B.S. Mechanical Engineering
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Submitted to the Department of Mechanical Engineering
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ABSTRACT

This study intended to show that replacing still pictures with animated pictures would improve a learner's understanding of computer-based instructional materials. The study showed no significant improvement. At the time of the study, most of the test subjects were involved in a robot design project as part of a national competition. The material presented was related to proper design of robots, which require motors and transmissions. A pretest and posttest were used to assess the improvements in understanding of torque, angular velocity, gear ratios and power in that context. One hundred and twenty participants used the specially designed tutorials. Approximately one-third used materials that included static renderings of bicycles on hills/flats. For approximately one-third, these renderings were animated. The remaining third used tutorials that did not function properly because of an unforeseen problem with software compatibility. Although the indicated improvement in understanding was impressive, the test data were remarkably insensitive to the tutorial style, even including the "broken" tutorial. While it is possible that still pictures versus animation is not an important pedagogic variable, the author believes otherwise. Several possible explanations are presented along with guidelines for more effective application of animations.

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Biography of Author

Thomas C. Gray was born in Forest Grove, Oregon in 1975. He attended Forest Grove High School and graduated with honors as Valedictorian, Boy of the Year and Recipient of the Thomas Keller Award for Leadership. He went to Oregon State University on a full-tuition Presidential Laurels Scholarship. While at Oregon State University he was an active member and eventually president of the school’s chapter of the American Society of Mechanical Engineers. He became a member of the engineering honor society Tau Beta Pi and the mechanical engineering honor society Pi Tau Sigma. The mechanical engineering department recognized him with the CH2M Hill Outstanding Senior Award. At MIT, he worked with Pappalardo Professor of Mechanical Engineering Woodie C. Flowers to develop an online community called SharingFIRST (http://sharingfirst.mit.edu) where members of the FIRST Robotics Competition could teach each other about building robots. Working with FIRST, Autodesk, The Institute for Women and Technology, Hewlett Packard and MIT, he helped high school women learn to use animation and the Internet to teach technical concepts. This work resulted in “Promoting Leadership in Girls in an Informal Education Environment: The FAIHM (“fame”) Program” which received the Best Technical Paper Award at the 2000 Society of Women Engineers National Conference. Outside of his required studies, he was part of the MIT Solar Electric Vehicle Team. Upon completion of his Masters of Science in Mechanical Engineering from Massachusetts Institute of Technology, he returned to Oregon with his wife Janelle to work at Olympic Controls as an applications engineer.
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Introduction

This study intended to show a link between the media type (animations or pictures) used in an educational web page and the amount of learning that results. The study did not return significant results indicating an advantage of animations over pictures. One hundred and twenty subjects volunteered to take the test. They completed the ten-question pretest, then looked through one of three different web-based tutorials and completed the ten-question posttest in about 30 minutes. Approximately one-third used materials that contained static renderings of bicycles on hills/flat. For another one-third, these renderings were animated. The remaining third used tutorials that did not function properly due to problems with software compatibility. A standardized grading rubric controlled the bias of the grader.

The results of the study show a significant improvement in test scores independent of the media type used to present the information. The study also showed that subjects with the lowest pretest scores improved the most. This improvement occurred independent of the media type. Neither the animations nor the pictures proved superior to the case when neither was present. This study does not eliminate animation as a useful tool for online education but it challenges intuition.

This thesis includes six sections: Motivation, Literature Review, The Study, Results, Discussion and Conclusions. The author presents several explanations for the results of this study and guidelines for effective use of animation in the discussion section.

Motivation

The author devoted a considerable portion of the time he spent at MIT promoting the use of computer animation as an education tool. FIRST and Autodesk provided educational licenses of
3-D Studio Max Version 3.0 (Current industry standard 3-D animation package in January, 2000) to more than 500 high school robotics teams competing in the FIRST Robotics Competition. Autodesk challenged the teams to create animated educational web sites teaching important robotics topics. Teams with animation, web-design and educational expertise created the best web sites. Through the course of a year, the author learned to create educational animations and tested various formats for the best presentation over the Internet. These activities lead to two questions. First, do animations improve web-based education? Second, does this improvement justify the additional effort?

**Literature Review**

An enormous number of studies show the effectiveness and value of web-based and computer-based teaching. Professor David Wallace at MIT showed that web-based lectures can disseminate information effectively when compared with typical sit-in lectures (Wallace and Mutooni, 1997). He progressed further and successfully replaced chalkboard lecture time with in-class laboratories and used on-line lectures to further leverage on-line information (Wallace and Weiner, 1998). According to Bettina Brown, “Reduced training costs, worldwide accessibility and improved technological capabilities have made web-based training (WBT) a viable alternative to classroom instruction” (Brown, 2000). Projects like Washington State University’s GenTechnique project, which teaches molecular genetics (Calza and Meade, 1998) and MIT’s TEAL project which teaches electromagnetism in a networked environment with animations and hyperlinks (MIT CAES, 2001) show that large educational institutes have embraced this new trend. The literature on the effectiveness of web-based instruction is extensive. This thesis itself confirms the ability to increase understanding using on-line
materials. However, this study specifically compares the effectiveness of media types. The rest of the authors cited narrow the focus to this specific challenge.

Animation appears to be an enticing form of communication and entertainment. Only video game sales surpass the incredible profits of Disney's animated classics. Dr. David Walsh, president of the National Institute on Media and the Family, announced the preliminary research of his colleagues Dr. Douglas Gentile and Paul Lynch who showed that 86% of all teens own video and/or computer games (Walsh, 2001). While Dr. Walsh and his colleagues studied the link between video game violence and negative behavior, they indirectly showed the educational power of these interactive, animated worlds. Amy Leh's research into adolescent web page preferences shows that "the children were especially attracted to web sites with many graphics or animations" (Leh, 1999). Melissa Dancy showed that animations used in testing could clarify questions and lead to a more accurate assessment of students' knowledge (Dancy, 2000). Sonali Pathak linked animations to increased learning when he found that an interactive CD-Rom tutorial with high bandwidth animations could teach more effectively than an interactive web-based tutorial without animations (Pathak, 1999).

Many studies caution the use of animation. A considerable amount of time and bandwidth is needed to add interactivity and animations to a basic set of pictures and instruction. Peter Riley warns, "careful consideration of content is necessary due to bandwidth and connection limitations" (Riley, 1997). Animations increase existing problems with software compatibility, download speeds and computer processing speeds. The average person on the street will tell you that animation is more effective than text and pictures, however there are reasons to suspect
otherwise. Meghan Dunn of Yale University showed animations only show effectiveness when the subject matter is difficult to visualize (Dunn, 2000). In mock-jury cases related to the familiar topic of car accidents, an animated scene by one party was not enough to sway the jury’s decision. In the case of more unfamiliar plane crashes, the mock jury sided with the party presenting the animation. This suggests that the context affects the significance of animations. Studying animation’s role in on-line sales, Yasmin Gopal at the University of Georgia showed that sound improved ratings more than animation. His subjects rated chemical companies’ web pages on retention, attitude toward the page, attitude toward the sponsor and behavioral intention. Gopal’s subjects rated the animated page lower than the control page without animations or sound in attitude toward the page (Gopal, 1996). Duane Jarc at The George Washington University compared interactive, animated, java-based courseware with an earlier non-interactive on-line courseware and produced no significant difference between the two groups except for a general perception of greater happiness (Jarc, 1999). Barbara Sauls showed that simple rotating animations of crystal lattice structures had equivalent educational value as fully interactive VRML (Virtual Reality Markup Language) simulations (Sauls, 1999). Saul’s study suggests the importance of understanding the fastest, least expensive media to use in different situations. The closest study related to the topic of animation in web-based education is that of Wolfgan Schnitz and Harriet Grzondrziel. They studied university students interacting with web pages containing pictures or animations and deduced that the “animated pictures may result in a less intensive processing, because they prevent individuals from performing relevant cognitive processes by themselves” (Schnitz and Grzondrziel, 1996).
The Study

This study used a simple experiment to add insight to the current scientific discussion on the effectiveness of animation. The study intended to reveal differences in learning performance as a function of media type. One hundred and twenty subjects took a ten-question pretest, viewed one of three versions of a web page tutorial and demonstrated learning by taking a ten-question posttest. A set rubric reduced bias when grading responses. The three tutorials included a pictorial version, an animated version and a broken version where the test subject expected animations but the computer could not display them.

A majority of the subjects in this study were participants in the FIRST Robotics Competition. The material presented in the tutorials concerned proper design of robots using motors and transmissions. The author expected the subjects would show partial familiarity with the material since many subjects recently spent six weeks designing robots. However, the robots drive train design did not intimately involve most of the test subjects and others were not involved in the competition at all. Fortunately, the tutorials explained geared, electric motor systems using a bicycle analogy to make the material more accessible.

Differences In The Three Versions

The following sections explain the unique content in each version of the tutorial. The terminology that follows occurs frequently in this thesis to differentiate between the three tutorial versions.
The Pictorial Version

In the pictorial version, a computer animated picture of a bicycle riding up or down different sloped hills with varying gear ratios and torque enforced the bicycle analogy. In each case the slope of the hill changed significantly. Two green disks showed the front and rear gear sprocket on the bicycle. The relative size of the disks varied according to the gear ratio. A red arrow on the pedals in the picture represented the amount of force needed on the pedal in the situation.

Figure 1 shows the pictorial tutorial.

Figure 1. The pictorial tutorial showed still images of bicycles riding up and down hills.
The Animated Version

In the animated version, a computer animated scene of a bicycle riding at a set speed up or down different sloped hills with varying gear ratios and torque enforced the bicycle analogy. The animated version included all of the information in the pictorial version in addition to showing the relative ground speed in different situations, the relative cadence (front crank angular velocity), and the changing force on the pedals as they go through a complete rotation. Figure 2 shows the animated tutorial.

Figure 2. In the animated tutorial, pressing play showed the bike moving up or down the hills.
**The Broken Version**

In the broken version, the Apple QuickTime plug-in on the subject’s computer either did not exist or could not to play the QuickTime movie format for some reason. (QuickTime is an animation movie format designed by Apple.) This resulted a few variations of failure like a blank player window or a simply a rectangular placeholder box displaying a browser error. The subject did not receive any picture or animation of the bicycle in the entire tutorial, even though the tutorial text referred to bicycles. Figure 3 shows the problem with the broken tutorial.

![Image of the broken tutorial](image)

**Figure 3.** In the broken tutorial, no pictures or animations of bicycles were displayed.

**Similarities In The Three Versions**

The media types provided the only differences in the three tutorials. The tutorials each attempted to teach the concepts of torque, angular velocity gear ratios and power using only standard text, formatting, layout, color and graphs. If done carefully, these tools work consistently on all browsers and are the easiest material to archive and search.
The Text

Good web authoring ensures that the page contains all of the information it intends to share in text form in addition to pictures and animations. Nothing in any of the pictures or animations was invaluable to learning the relationships between torque, angular velocity, gear ratios and power. However, the pictures and animations intended to enhance and improve the understanding of these ideas. Figure 4 shows how text, formatting, layout, color were used in one section.

![Angular Velocity](image)

**Figure 4.** The text was kept short and clear. Formatting, layout and color also aided understanding.

The Formatting

The use of bold characters to highlight the words torque, angular velocity, gear ratios and power, continuously refocused the tutorial on the understanding of the most important ideas. Section headers used larger fonts. Hyperlinks used standard blue text and with underlines. The 640 pixel tutorial width kept the web site accessible to users with older computers.
The Layout

The tutorial starts with a table of contents with hyperlinks to any specific topic in the tutorial. The tutorial included four main sections: an introduction, definitions, the relationships, and additional information. A single page, outline format organized the information and reduced the chance that the subject would get lost.

The Use of Color

The tutorial used color to show the structure of the tutorial text more clearly and to match definitions, graphical and pictorial elements together. The layout of the tutorial used dark blue blocks to show major sections, light blue blocks to show the minor sections and light gray blocks to highlight important relationship statements. As mentioned earlier, the tutorial displayed the words torque, angular velocity, gear ratios in black bold text. In addition to layout, color transferred ideas between definitions, graphs and pictures. Blue highlighted Torque in its definition picture and on the graphs. Green highlighted gear ratios in its definition picture, as a green line on the graphs and as green gears on the bicycles. Orange highlighted angular velocity and purple highlighted power in similar ways.
The Graphs

Each section of the tutorial, in all three versions, contained a graph, in picture format, that showed the current operating point on a torque-angular velocity curve. The graphs used the color-coding scheme as discussed above. Pictures or animation mapped a real life situation to the operating points shown on the graphs and provided the subject with multiple ways to view the material. The broken tutorial only displayed the graphs. Figure 5 shows one of the graphs.

Figure 5. Every tutorial type provide graphs to the test subject.
**The Pretest**

The pretest intended to test the subject’s basic vocabulary, understanding of torque, angular velocity, gear ratio and power relationships and the application of these relationships to bicycles. The subject typed a complete response into a text box on their web browser. There were no multiple choice or true/false questions to reduce the effect of guessing. Each of the three question types was intended to expose different levels of understanding. Figure 6 shows a portion of the pretest.

![Pretest: Understanding Torque, Angular Velocity, Gear Ratios and Power - Microsoft Internet Explorer](image)

**Figure 6.** The 10-question pretest without multiple choices often challenged the subjects.

**Definition Questions**

The first four questions asked the subject to define torque, angular velocity, gear ratios and power. This section shows questions in **bold** and a generally accepted answers in *italics*.

1. **What is torque?** *A twisting force*

2. **What is angular velocity?** *A turning speed***
3. **What is a gear ratio?** *How many times the output gear turns if the input gear turns once.*

4. **What is power?** *How quickly energy a machine uses energy.*

The answers to these questions helped to understand the value of later questions that used these terms.

**Relationship Questions**

The next three questions discussed three basic relationships between torque, angular velocity, gear ratios and power.

5. **When the torque load on an electric motor is increased, what happens to the angular velocity?** *(Assume the electric motor has the torque-angular velocity curve shown above.)* *The angular velocity decreases when the torque load increases for electric motors with a linear torque angular velocity curve.*

6. **When the gear ratio on an electric motor is changed to a higher gear (bigger driving gear and smaller output gear) what happens to the maximum amount of torque the system can generate?** *The maximum amount of torque decreases and the maximum angular velocity increases when the gear ratio is changes to a higher gear.*

7. **At what level of torque and angular velocity does an electric motor generate the most mechanical power?** *When the torque load is at half of the maximum torque and the angular velocity is a half of the maximum angular velocity, the electric motor generates the most mechanical power.*

The answers to these questions helped to evaluate the subject’s understanding of these terms interrelationships in the context of electric motors.
Application Questions

The last three questions used the analogy of a bicyclist on a bicycle to see if the subject could apply the ideas to a real situation.

8. When a bicyclist starts riding up a hill without shifting gears, why does he/she slow down? *The slope of the hill increases the torque on the system and thus decreases the angular velocity.*

9. When a bicyclist shifts into a lower gear (smaller driving gear and larger output gear) what happens to the maximum speed of the bicycle can go? *The maximum speed and maximum angular velocity lower when a bicyclist shifts into a lower gear.*

10. What is the main reason a bicyclist shift gears? *Bicyclists shift gears for many reasons such as maximizing power, maximizing efficiency or keeping a constant cadence (angular velocity of the crank).*

In many cases, these questions tested the subjects general understanding of bicycling and not the physics behind it.

The Web Page Tutorial

The web page tutorial refreshed the subjects’ definitions of torque, angular velocity, gear ratios and power. Then it explained the interrelationships using a bicycle as an analogy to an electric motor.
Table of Contents – The Basic Layout

The tutorial starts with a hyper linked table of contents that gives an overview of the content and provides a frame of reference for the student. The table of contents also included a brief definition of torque, angular velocity, gear ratios and power. Figure 7 shows a screenshot of the table of contents.

![Table of Contents](image)

Figure 7. The table of contents gives hyper linked access to the entire tutorial and a general overview.
Definitions

The definition section refreshed the ideas of torque, angular velocity, gear ratios. It used simple short statements, large bright pictures and friendly examples. The definitions section remained the same in all three tutorial versions. For many subjects, the definitions section introduced these terms for the first time. Figure 8 shows a screenshot of the part of the definitions section.

![Figure 8. The definitions section was the same on all three tutorials.](image)

Relationships and Applications

The relationship section was explained three aspects a gear reduced electric motor system using the bicycle and cyclist analogy. It discussed torque and angular velocity, then gear ratios and maximum torque and angular velocity and finally gear ratios and power.
**Torque and Angular Velocity**

This section explained the linear relationship between torque and angular velocity. The gear ratio stayed constant and the external torque load decreased from the stall torque, to a medium torque, to a no load condition. The angular velocity increased as the torque decreased. Figure 9 shows a screenshot of part of the relationships section.

![Graph showing the relationship between torque and angular velocity](image)

**3.1 - Relationship between Torque and Angular Velocity**

For most electric motors, when the torque increases, the angular velocity decreases and visa versa.

The point where the motor (or bicyclist) generates the max torque but no angular velocity is called the stall torque. The biker can't push hard enough to go up the hill.

**Figure 9.** Graphs and pictures of bicycles showed the tradeoff between torque and angular velocity.
**Gear Ratios, Max Torque and Max Angular Velocity**

This section explained how changing gear ratios affects the maximum torque and maximum angular velocity. A graph showed the torque-angular velocity curve and pictures or animations of stall torque and no load speed for three different gear ratios. Figure 10 shows a screenshot.

**3.2 - Relationship between Gear Ratios, Max Torque and Max Angular Velocity**

Lowering the gear ratio, increases the max torque and decreases the max angular velocity and visa-versa. The gear ratio is represented by the green line in the graph.

In a 1:2 Gear Ratio, the max torque is twice that of a 1:1 gear ratio but the max angular velocity is half as fast.

In a 1:1 Gear Ratio, the max torque and max angular velocity of the motor itself is revealed.

Figure 10. This section showed the effect of gear ratios on the max torque or angular velocity.
Power and Gear Ratios

A purple box on the graph under the torque-angular velocity curve represented power. It showed that power is the product of torque and angular velocity. Torque remained constant and the gear ratio lowered. The angular velocity and power changed. Figure 11 shows a screenshot.

If the gear ratio is too high, the system can't overcome the torque and nothing moves. Since there is no movement there is no power.

When the gear ratio allows the vehicle to operate at 1/2 of max torque and 1/2 of max angular velocity the vehicle generates max power.

Figure 11. The power section tried to explain how gear ratios affect power.
The Posttest

The Posttest intended to show that the subjects’ understanding of the material improved while looking at the web-page tutorial. The subjects defined torque, angular velocity, gear ratios and power and then answered modified versions of the original questions that tested the original concepts. Figure 12 shows a screenshot of the posttest.

![Posttest screenshot](image)

Figure 12. The posttest allowed students to show they had learned new ideas and provide feedback.

Definition Questions

The definition questions remained identical to the pretest. It was desirable for the test subject memorized the definitions. The ability to define things does not necessarily show understanding. However, knowing the definitions of a few key terms is useful for communicating ideas.
Relationship Questions

The posttest relationship questions differed slightly to reduce any effect from students who took the pretest and searched the tutorial for the specific answer without understanding the general concept that leads to the answer.

5. **When the angular velocity of an electric motor is increased, what happens to the amount of torque the motor can generate?** (Assume the electric motor has the torque-angular velocity curve shown above.) *The torque generated decreases when the angular velocity increases for an electric motor with a linear torque-angular velocity curve.*

6. **What happens to the maximum amount of torque the system can generate when the gear ratio on an electric motor is changed to a lower gear (smaller driving gear and larger output gear.)** *The maximum amount of system torque increases when the electric motor is changes to a lower gear.*

7. **What are the two operating points on a torque-angular velocity curve where an electric motor does not generate power?** *At no load speed and stall torque the system does not generate power.*
Application Questions

The posttest application questions also differed slightly to reduce chance that the subject learned only the answer to the pretest question without understanding the principals behind it.

8. **Why does a bicyclist stuck in high gear go faster on flat than on a steep hill?** *This question could be answered without understanding torque and angular velocity by saying that the body’s chemical energy is all being converted to kinetic energy on flat but must be partially converted to potential energy on the hill. However, considering the topic, the increased torque of the hill leads to a decrease in the angular velocity of the bicycle’s rear wheel and thus the bicycle’s speed.*

9. **When a bicyclist shifts into a lower gear (smaller driving gear and larger output gear) what happens to the maximum speed the bicycle can go?** *In a lower gear, the bicycle system has a lower maximum speed but can generate more torque.*

10. **What is the main reason that bicyclist shift gears?** *This is the same question as on the pretest, but it showed that many subjects could think about the answer in a more technical way. Bicyclists shift gears for many reasons such as maximizing power, maximizing efficiency or keeping a constant cadence (angular velocity of the crank).*
### Grading Rubric

The author sorted the pretest and posttest responses into categories of 100% correct answers, 67% correct answers, 33% correct answers and 0% correct answers. The entire grading rubric is in the appendices, however it aids understanding to see an example of the rubric used to judge one of the questions. Figure 13 shows the rubric for the definition of angular velocity.

#### 2. What is angular velocity?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>rotational speed</td>
<td>motor speed (infers rotation)</td>
<td>speed answers</td>
<td>everything else</td>
</tr>
<tr>
<td>&quot;the velocity of rotation&quot;</td>
<td>&quot;The rate of a motor measured in radians&quot;</td>
<td>&quot;the angle that the object is twisting&quot;</td>
<td>&quot;a unit of measure relating to an indirect application of force. An amount of torque lost in tangential direction.&quot;</td>
</tr>
<tr>
<td>&quot;Angular velocity is the rate of rotation of a body.&quot;</td>
<td>&quot;How fast a motor can potnetially move&quot;</td>
<td>&quot;the time it takes to complete one revolution (rpm)&quot;</td>
<td>&quot;The mechanical leverage you have on a gear depending on the angle.&quot;</td>
</tr>
<tr>
<td>&quot;the velocity at which a round object turns and is given in radians per second.&quot;</td>
<td>&quot;The speed in a given direction that a motor creates&quot;</td>
<td>&quot;The angle at which something moves (Speed)&quot;</td>
<td>&quot;Square&quot;</td>
</tr>
<tr>
<td>&quot;uh.......linear velocity divided by radius&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;the speed at which an angle reduces or greatens&quot;</td>
<td></td>
<td>&quot;how fast something goes at a given angle&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;angular velocity is a rotating vector represented by lower case omega and is equal to 2 times pie divided by the period&quot;</td>
<td></td>
<td>&quot;One of those triangular firework thingamajigs that spins real fast...&quot;</td>
<td>&quot;same as torque&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;As I recall... angular velocity=velocity/circumference. It describes the number of complete rotations occurring in a specific time period.&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&quot;A measure of a certain kind of speed&quot;</td>
</tr>
</tbody>
</table>

Figure 13. The grading rubric for angular velocity is a portion of the complete rubric used to grade the tests.
Results

The experiment tested 120 subjects. This section looks at the results overall, then from the perspectives of gender, education level and supervision environment. Finally, with these extra influences removed the impact of the media type on the subjects’ test scores is clear. While gender, education level and testing environment showed significant differences in test scores, the different tutorial types did not show significant variation.

The Overall Effect of Tutorial Type

Of the 120 subjects who participated in the study, 41 took the animated tutorial, 36 took the broken tutorial and 43 took the pictorial tutorial. The subjects who took the animated tutorial started off with a lower average pretest score (5.9) compared with the average pretest score on the broken tutorial (6.3) or the average score on the pictorial tutorial (6.7). The average score on the animated tutorial increased 2.2 points (5.9 to 8.1), the average score on the broken tutorial increased 2.6 points (6.3 to 8.9) and the average score on the pictorial tutorial increased 1.8 points (6.7 to 8.5). The large discrepancy in pretest scores make it impossible to compare these three cases directly. However, this relationship hints that the effect of animation in this tutorial is not significant. The subjects who took the animated tutorial did not show the expected superiority. Figures 14-16 show the data.
Figure 14. The average scores on the animated tutorial improved 2.2 points from 5.9 to 8.1.

Figure 15. The average scores on the broken tutorial improved 2.6 points from 6.3 to 8.9.
Figure 16. The average scores on the pictorial tutorial improved 1.8 points from 6.7 to 8.5.
The Effect of Gender On Test Scores

The 85 men outnumbered the 35 women who completed the experiment. Women’s average pretest scores (5.2) were lower than men’s average pretest scores (6.8). The women’s scores increased 3.3 points (5.2 to 8.5) and the men’s scores increased 1.7 points (6.8 to 8.5). This trend, where the group who started with the lowest score catches up with the group with the highest score can be seen throughout the results of this experiment. It can be understood more fully if we look at the results of the first four questions which tested definitions. On a scale from 0 to 4, the women’s average score improved 1.9 points (1.7 to 3.6) whereas the men’s average score only improved 1.0 point from 2.5 to 3.5. The ease of the test gives the lowest scoring groups the greatest opportunity to improve. Figure 17 and Figure 18 show the data.
Figure 17. The average scores of men improved 1.7 points from 6.8 to 8.5.

Figure 18. The average scores of women improved 3.25 points from 5.2 to 8.45.
The Effect of Education On Test Scores

Fifty-five high school students (or people with only high school diplomas) and 65 college students or people with college degrees completed the experiment. High school students’ pretest scores (5.6) were lower than college students’ pretest scores (6.9). The high school students’ average scores improved 2.5 points (5.6 to 8.1) and the college students’ average scores improved 1.9 points (6.9 to 8.8). In a similar way to the gender relationship, most of the improvement came in the definitions section where the high school average score improved almost 1.5 points (1.8 to 3.3). The college students who started with a higher average score in the definitions section only improved 1.1 points (2.6 to 3.7). Figure 19 and Figure 20 show the data.
Figure 19. The average score of high school students improved 2.5 points from 5.6 to 8.1.

Figure 20. The average score of college students improved 1.9 points from 6.9 to 8.8.
The supervision and setting of the testing took multiple forms but can be grouped into two main categories. The first category includes the 43 subjects who took the test with a supervisor. These subjects used laptops designed to display the animations or pictures accurately every time.

The second category includes the 77 subjects who responded to a word of mouth or email request to take the test and did so on their own personal computers or in school computer labs. The supervised subjects improved their average score 2.2 points (5.5 to 7.7). The unsupervised subjects also improved their score 2.2 points (6.8 to 9.0) although they started with a much higher pretest score. Figure 21 and Figure 22 show the data.

There was a substantial difference in the testing environment in these two cases. The supervised/unsupervised division is the only case where the group who with the lowest pretest score made the same improvement as the group with the higher pretest score. This suggests that the testing and learning environment had a significant impact on the final scores. The supervised sessions occurred at the FIRST Robotics Competition in Orlando, Florida and during Mr. Mike Fitzgibbons High School Physics classes in Forest Grove, Oregon. The FIRST Robotics Competition appears to be a poor testing environment due to the excitement level of 15,000 other students, ongoing competitions and background noise. The learning environment of the unsupervised subjects was not perfect, however it is hard to imagine situations less ideal than the blaring horns and blinking lights at the Epcot Center. The unsupervised subjects could also have cheated and used the browser’s back button to look up the answers. However, considering their high pretest scores this unlikely.
Figure 21. The average supervised subject improved 2.2 points from 5.5 to 7.7.

Figure 22. The average unsupervised student improved 2.2 points from 6.8 to 9.0
Removing the Effects of Gender, Education Level and Supervision.

A three-dimensional cross section of the data identifies the effects of the tutorial media type without the imposed effects of gender, education level and supervision environment. In each case, the tutorial types were compared with only the specific subset of the data. Many of the data sets became extremely small in this situation but this method allowed the data to be viewed with the least bias. Only the subset of male college students tested unsupervised presents significant information. The remaining subsets provide insight only. Figure 23 shows the subsections.

Figure 23. The data subsets, grouped by gender, education level and supervision environment, eliminate pretest variations.
Female College Students Tested Unsupervised

The results of the female college students tested unsupervised are typical of this study. Since anyone who studies the material thoroughly can attain the top score on the test, groups with a lower starting average score, like the broken group in this case, make larger improvements than groups who had higher pretest scores. Figure 24 shows the data.

Figure 24. Groups starting with a lower scores caught up with the groups who originally scored higher.
There were no female college students who took the supervised test, so this information is unavailable. No data is shown in Figure 25.

**Figure 25.** No supervised female college students participated in the study.
Female High School Students Tested Unsupervised

The sample of female high school students tested unsupervised is too small to draw any conclusions. The large gains made by most of the subjects in this group with the exception of the subject who took the animated tutorial are interesting. Figure 26 shows the data.

Figure 26. Not enough unsupervised female high school students took the test.
Female High School Students Tested Supervised

This group of subjects is also extremely small but it shows the same general trend as most other plots. In this case, the animated group started with a lower average score and finished with a posttest score similar to the pictorial group. There were no broken test cases in the supervised situations. Figure 27 shows the data.

![Bar chart showing test scores for female high school students tested supervised. The chart illustrates how groups starting with lower scores caught up with those who originally scored higher.]

Figure 27. Groups starting with a lower scores caught up with the groups who originally scored higher.
The male college students tested unsupervised is the most homogeneous of the eight subgroups. This is the only case where the average pretest scores started within half a point of each other. In this situation, the posttest scores ended within half a point of each other. The three different tutorial types appear to have little effect. Figure 28 shows the data.

Figure 28. The three different tutorial types can be seen to have little effect on the scores.

The bootstrap method (Efron and Tibshirani, 1993) tested the data for significance. The bootstrap method showed that on the pretest the mean animated tutorial score did not differ significantly from the mean broken tutorial score (p=0.106) or the mean pictorial tutorial score (p=0.233). The bootstrap method also showed that on the posttest the mean animated tutorial score did not differ significantly from the mean broken tutorial score (p=0.171) or the mean pictorial tutorial score (p=0.095). In all three cases the subjects made significant improvements.
The mean animated tutorial score improved 1.1 points (p<0.0005), the mean broken tutorial score improved 1.9 points (p<0.0005) and the mean pictorial score improved 1.8 points (p<0.0005). The bootstrapped distributions of the pretest and posttest scores for all three tutorial types are shown in Figure 29.

Figure 29. The bootstrap shows significant increases in test scores overall but does not show significant effects due to the media types.
There were very few male college students tested supervised. While this data shows that the subjects' test scores improved more when using the animated tutorial than the pictorial tutorial, the sample is not large enough to be considered significant. No conclusions can be drawn from this information. Figure 30 shows the data.

Figure 30. Not enough supervised male college students took the test.
Male High School Students Tested Unsupervised

No high school male tested unsupervised used a tutorial with working animations. The broken and pictorial data suggests that the pictures of bicycles were not the key to learning this material. Both groups started with similar averages and increased by similar amounts. This suggests, along with earlier data, that the pictorial content was not important to the learning process in this tutorial. Figure 31 shows the data.

![Male HS Students Tested Unsupervised](image)

Figure 31. The different tutorial types can be seen to have little effect on the scores.
Male High School Students Tested Supervised

The male high school students tested supervised had very different average pretest scores when divided by into groups by media type. While the animated tutorial group showed significantly higher improvement over the pictorial group, most of the improvement is due to learning the appropriate definitions of torque, angular velocity, gear ratios and power. Nothing can be said about the effect of animation in this situation. Figure 32 shows the data.

Figure 32. Nothing can be said about the tutorials, students with more to learn, learned more.


Discussion

The data collected showed insensitivity to the media type used in the tutorial. There are several possible explanations for this counterintuitive result. Each of these possibilities suggests guidelines for better implementations of animation. The author wishes that he had these guidelines to follow prior to the study.

The Standard Layout Crippled The Animations Capabilities

The first possible explanation contends that holding the format, content and layout consistent kept animation from exploiting its major advantages over pictures. Animations can display much more information in a given amount of screen space than pictures. An ideal animated tutorial could show torque increasing as angular velocity decreases with one animation. The ideal animation would show a bicycle slowing down as the slope of the hill increased and the position of the operating point on the graph changing accordingly. A pictorial tutorial requires two to three pictures and graphs to show the same relationship. The author decided early in the design, to keep the formatting and layout of the web site identical to make the comparison between media types clear. A web site designed around animations cannot convert to a pictorial web site without increasing its length. Therefore, the web site was designed, in lowest common denominator fashion, around text and pictures, then animations replaced the pictures. Keeping the layout constant was a mistake. The ability of animations to contain larger amounts of information should be included when comparing media types.

Guideline: The type of media used should dictate the format of the web site.
Animations Provided a False Sense of Understanding

A second possible explanation stems from the earlier cited research of Schnotz and Grzondrziel. They suggested that animations made visualization easier and removed the processing between text and pictures that normally leads to learning. A student who saw animations of a bicycle on different inclines may feel familiar with the material and not reach deeper into the text to understand the finer points, whereas still pictures demand further research in order to understand them. The animations in this experiment did not contain enough information to successfully answer the questions at the end of the tutorial if the text was avoided. Unfortunately, the resolution of the posttest did not show whether the student learned the material from the animations or the text. The subjects who only read the text did as well as those with pictures or animation. Since animations have the potential to draw a learners attention away from other materials, the animation should present all the important information. In addition, the animations should be sufficiently complex to require the learner to think hard about the subject of the animation. This usually requires that the learner replay the animation a few times to gain full understanding.

Guideline: Animations should be sufficiently complex to require increased cognitive processing from the learner.

Animations Were Overkill

A third possible explanation invokes the expression “Driving a nail with a sledge hammer.” It took a significant amount of time and effort to organize and create the clear, concise text statements made in this tutorial. In each of the three tutorial types, graphs showed the different operating points on the torque speed curve. The tutorial highlighted and repeated the main points
throughout the tutorial. Many subjects found the test rather easy and a quarter of the subjects scored above a 9.5 on the final test. The subject of torque-angular velocity curves may not need animated multimedia for effective presentation at this level of understanding. The time spent on animations for this tutorial could have increased the time programming a more interactive site and including other pedagogical techniques such as a web site that shows different content based on the test subject's responses to the pretest. The web site creator could also use the extra time to increase the depth of the current material.

**Guideline:** The decision to use animation should be weighed against the opportunity to use other pedagogical techniques or increase the existing depth of the material.

*Animating Bicycles Is Unnecessary*

A final possible explanation involves the subject matter of the animations themselves. Bicycles are a very familiar concept; this is why they make a great analogy for understanding the torque-angular velocity tradeoff in electric motors. People’s ability to mentally picture bicycles may make animations and even pictures unnecessary. As in the case of the car accident and plane crash jury cases cited earlier, animations are increasingly effective when they show events that are unusual or difficult for the subject to visualize on their own. Quite a few of the test subjects expressed confusion about torque and angular velocity even after viewing the tutorial. Perhaps using animations to enhance the definitions at the beginning of the tutorial would help the subjects apply the concepts later. Educational web site developers must decide which concepts are the most difficult to visualize and animate these concepts. The most difficult concepts to visualize are often the most challenging concepts to animate.

**Guideline:** Computer-based educators should reserve animations for difficult concepts to visualize.
A Note On Controlled Experiments

Internet experiments are difficult to control. Loosely controlled, web-based, education experiments can still teach many lessons. The population of people who find the site and go through the experiment will be the same population that can be taught using these tools. If the tools do not work with the general population, extra effort must be made on part of the educator to provide learners with the appropriate technology. Before this study, it was believed that the effect of animation was significant. A loosely controlled experiment would show this effect across a broad range of people and situations. In a more tightly controlled experiment, a group of students with the same background and average pretest score would sit in front of a laptop for a specific period of time and take the tests on computers that were guaranteed to play the multimedia correctly. The environment of this experiment was much more relaxing and realistic. Testing learning amidst other opportunities, computer failures and unsupervised testing could be said to jeopardize the results. The author disagrees and believes this makes the results more valid in the real world.

Conclusions

This study intended to show that replacing still pictures with animated pictures would improve a learner’s understanding of computer-based instructional materials. The study showed no significant improvement based on the media type. Although the indicated improvement in understanding overall was impressive, the test data were remarkably insensitive to the tutorial style, even including the broken tutorial. While it is possible that still pictures versus animation is not an important pedagogic variable, the author believes otherwise. Four guidelines have been suggested to improve the effectiveness of animation in computer-based learning. First, the
media type should dictate the format of the web site. Second, animations should be sufficiently complex to require increased cognitive processing from the learner. Third, the decision to use animation should be weighed against the opportunity to use other pedagogical techniques or increase the existing depth of the material. Fourth, computer-based educators should reserve animations for difficult concepts to visualize.
Appendix I - Bibliography


Appendix II – Tutorial Screenshots

Understanding Torque, Angular Velocity, Gear Ratios and Power

Your Workspace: I-Candy: Torque-Speed I-Candy

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   2.3 - Gear Ratio - How many times the output gear turns if the input gear turns once
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3.0 - Relationships
   3.1 - Torque and Angular Velocity
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   3.2 - Gear Ratios, Max Torque and Max Angular Velocity
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       Understanding how torque and angular velocity affect power.

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1.0 - Introduction

1.1 - Why is this important?

Devices powered by electric motors are all around us. Electric drills, screw drivers, power windows, and golf carts are some examples. While most of us won't need to design or build any of these devices in our lives, understanding their behavior will explain their benefits and limitations.

1.2 - Bike Analogy

A bicyclist on a bicycle behaves in a very similar manner to an electric motor. The torque-angular velocity curves and explanations are all based on the output torque and angular velocity of the bicycle system, not the pedals. Don't be fooled by the whirling pedals, the rotation speed of the rear wheel is the angular velocity shown on the graphs.

2.0 - Definitions

2.1 - What is Torque?
2.1 - What is Torque?

Torque is a twisting force. It is how hard you have to twist to turn an object around. You can calculate it by multiplying the force it takes to turn something by the radius to the center of rotations.

\[ T = F \times r. \]

It takes lots of torque to open a jar when the lid is on too tight.

2.2 - What is Angular Velocity?

Angular velocity is a turning speed. It is how fast an object is spinning around. You can calculate it by dividing the velocity of any point on the object by the radius to the center of rotation.

\[ w = \frac{v}{r}. \]

In-line skate wheels spin at a high angular velocity (1500 revolutions per minute.)

2.3 - What is a Gear Ratio?
2.3 - What is a Gear Ratio?

A gear ratio is the number of times the output gear turns if the input gear is turned once. A gear ratio can be measured in many ways. If there are only two gears, it is the diameter of the input gear divided by the diameter of the output gear.

\[
\text{Gear Ratio} = \frac{D_{\text{input}}}{D_{\text{output}}}.
\]

Electric drill motors have a low gear ratio like 1:150. A bicycle's highest gear ratio is about 5:1. When the gear ratio is 1:1, the torque and angular velocity of the input and output gear are the same.

2.4 What is Power?

Power is how fast energy is used. Power is also a combination of torque and angular velocity. You can calculate power by multiplying torque by angular velocity.

\[
P = T \times \omega.
\]

A hydroelectric dam creates a lot of power by using river water to create a torque on large fan-like turbines that spin at a high angular velocity.
For most electric motors, when the \textit{torque increases}, the \textit{angular velocity decreases} and visa versa.

The point where the motor (or bicyclist) generates the \textit{max torque} but \textit{no angular velocity} is called the \textit{stall torque}. The biker can't push hard enough to go up the hill.
The point where the motor runs at 1/2 of max torque and 1/2 of max angular velocity is called max power. We will discuss power later.
The point where there is no torque load and the motor spins as fast as it can is the no load speed. You feel it biking down a hill when you can't pedal any faster.

**Extra Bonus Information:**
As long as the electric motor powered system does not change gears, it is can only operate at points on the green line. This line is often called a torque-speed line but it is really a torque-angular velocity line.

$$T(w) = T_{\text{max}} - \left(\frac{T_{\text{max}}}{w_{\text{max}}}\right)w$$

is the equation for the line.

### 3.2 - Relationship between Gear Ratios, Max Torque and Max Angular Velocity

Lowering the gear ratio, increases the max torque and decreases the max angular velocity and visa-versa. The gear ratio is represented by the green line in the graph.
3.2 - Relationship between Gear Ratios, Max Torque and Max Angular Velocity

Lowering the gear ratio, increases the max torque and decreases the max angular velocity and visa-versa. The gear ratio is represented by the green line in the graph.

In a 1:2 Gear Ratio, the max torque is twice that of a 1:1 gear ratio but the max angular velocity is half as fast.
In a 1:1 Gear Ratio, the max torque and max angular velocity of the motor itself is revealed.

In a 2:1 gear ratio, max torque is cut in half and the max angular velocity is doubled compared with a 1:1 gear ratio.

Extra Bonus Information
You can use this understanding of gear ratios, torque and angular velocity to determine what gear ratio a robot needs if it has to use a specific motor. Determine how much torque your robot needs. Change the gear ratio line, according to the examples until the max torque is larger than the torque you need. You can do a similar thing if you don't need lots of torque and just want to have a fast top speed.
For any specific motor and torque load, there is only one gear ratio that will give the max power. All other gear ratios will give less than max power.

If the gear ratio is too high, the system can't overcome the torque and nothing moves. Since there is no movement there is no power.
When the gear ratio allows the vehicle to operate at 1/2 of max torque and 1/2 of max angular velocity the vehicle generates max power.

If you keep the torque the same and lower the gear ratio below the optimum level the angular velocity drops off in order to stay on the new torque-angular velocity line. This vehicle now generates a lower amount of power.

Extra Bonus Information
It's often impossible to change gears enough to be at max power all the time. If you could the green torque-angular velocity line would start vertical with infinite torque and no angular velocity. Then it would quickly change gears as the vehicle velocity increased always staying aligned with the purple max power hyperbola.
4.0 - Additional Information

4.1 - Links

- Designing with D.C. Motors - A tutorial explaining how to design devices using D.C. motors. A project of MIT Center for Innovation in Product Design Grad Student Matt Page.
- HowStuffWorks An explanation of force, power, torque and energy with animations.
- TeradynaMites Electric Motor Flyby - A look inside an electric motor by Team 97 of the US FIRST Robotics Competition at the SharingFIRST website.

4.2 - Acknowledgements

- MIT - Massachusetts Institute of Technology
- CIPD - Center for Innovation in Product Design
- Professor Woodie Flowers - Pappalardo Professor of Mechanical Engineering, MIT
- Autodesk
- Hewlett Packard
- IWT - Institute for Women and Technology
- FIRST - US FIRST Robotics Competition
- Janelle Gray
- Jim Meyer

4.3 - Click Here To Take The Posttest.

Click here to take the posttest. If you don't take the posttest, I'll be very sad because I won't have the information I need to compare before and after and it comes back to that graduating thing again.

webmaster@sharingfirst.mit.edu
## Appendix III – Grading Rubric

<table>
<thead>
<tr>
<th>1. What is torque?</th>
<th>67% Correct Answers</th>
<th>33% Correct Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correct Answers</strong></td>
<td>Twisting/turning power</td>
<td>Twisting/rotating/spinning force</td>
<td>A rotational force</td>
</tr>
<tr>
<td><strong>Force used to twist something</strong></td>
<td>Turning power</td>
<td>the amount of force a power source can deliver to a spinning object</td>
<td>Torque is the amount of mechanical power released by a motor.</td>
</tr>
<tr>
<td><strong>Rotational Force</strong></td>
<td>Torque is the rotation power of the motor.</td>
<td>rotational work done by a body -- usually in reference to motors</td>
<td>Mechanical advantage, moment of inertia</td>
</tr>
<tr>
<td><strong>tau=I*alpha</strong></td>
<td>Rotational power</td>
<td>Torque is the amount of pressure on an object while turning.</td>
<td>It lies on the y axis</td>
</tr>
<tr>
<td><strong>Force times radius</strong></td>
<td>Force times distance</td>
<td>Had force concept only</td>
<td>movement of newtons theory, and the power it takes to get momentum</td>
</tr>
<tr>
<td><strong>A Rotational force vector. (Force x radius /w rotatinal direction)</strong></td>
<td>Torque is defined as force times distance or the integral of force dotted into the distance</td>
<td>the amount of force that is generated by motors</td>
<td>torque is one of the results of momentum and newton's laws</td>
</tr>
<tr>
<td><strong>Force times the lever arm.</strong></td>
<td>the measurement of rotational force required to do work</td>
<td>how strong the motors are</td>
<td>a way to measure power</td>
</tr>
<tr>
<td><strong>force applied in a twisting fashion. The farther from the center of rotation, the more force</strong></td>
<td>ft/lbs at a point on a rotating arm</td>
<td>a measure of angular force</td>
<td>is the gear power produced by the machine</td>
</tr>
<tr>
<td><strong>Force cross distance</strong></td>
<td>Reference to the force at a distance, not both the force and distance.</td>
<td>Incorrect relationship with the right pieces</td>
<td>Torque is effort applied to move a load.</td>
</tr>
<tr>
<td><strong>Measured in ft lbs. It is the amount of force applied to an object in a rotation,</strong></td>
<td>force applied at an angle; twisting force</td>
<td>a force over a distance</td>
<td>the amount of pressure being put upon an object</td>
</tr>
</tbody>
</table>
Product of force and moment arm length. More generally, the cross product of a force vector and a radial vector. Force times perpendicular distance.

2. What is angular velocity?
Correct Answers
- rotational speed
- motor speed (infers rotational)
- the velocity of rotation
- Angular velocity is the rate of rotation of a body.
- the velocity at which a round object turns and is given in radians per second.
- uh......linear velocity divided by radius
- the speed at which an angle reduces or greatens

Incorrect Answers
- speed answers
- everything else
- The mechanical leverage you have on a gear depending on the angle.
- square
- Velocity of a line tangent to a circle in rotation.
- same as torque
- One of those triangular firework thingamajigs that spins real fast...

Correct Answers
- 67% Answers
- 33% Answers

Incorrect Answers
- 67% Answers
- 33% Answers

Torque is the amount of force put out by a motor at a certain distance for example N/m

The amount of force to rotate object(s) about a point of rotation.

A force applied on a point from a certain perpendicular distance away

The rate of a motor measured in radians

How fast a motor can potentially move

The time it takes to complete one revolution (rpm)

Angular velocity is the rate of rotation of a body.
3. What is a gear ratio?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of of torque/angular velocity between gears</td>
<td>Does not describe but probably knows.</td>
<td>Right idea bad wording</td>
<td>Everything else</td>
</tr>
<tr>
<td>Gear Ratios are used to adjust speed of motors for various applications. An example would be using a gear ratio to adjust equal speed for two different motors.</td>
<td>A gear ratio is the difference in gears. I.e. 3:4</td>
<td>The ratio that figures out power like 30 to 40 or something like that, it directly affects torque</td>
<td></td>
</tr>
<tr>
<td>the relationship between the speed (also the torque) of one gear meshing with another; equivalent to the number of teeth on one of these gears to the number of teeth on the other gear</td>
<td>A set of gears used to change the amount of torque and speed the motor generates</td>
<td>The ratio of the number of gear bits for two gears in contact with each other</td>
<td></td>
</tr>
<tr>
<td>Mechanical manipulation of torque based on the circumference of gears.</td>
<td>Gear versus tire</td>
<td>Number and size of sprockets</td>
<td></td>
</tr>
<tr>
<td>Ratio of diameters or gear teeth</td>
<td>Ratio of torque to angular velocity</td>
<td>reused the words gear and ratio in definition</td>
<td>a coefficient representing the friction between two gears</td>
</tr>
</tbody>
</table>
Using gears of different sizes to increase or reduce speed or power

The relative size of a set of gears. I usually refer to this as a fraction

A ratio (fraction) of the number of teeth of one gear to another.

Ratio of Maximum Torque to Maximum Angular Velocity
different sized gears to either get more velocity or torque
to have a better usage of a motor, it is better to use a gear ratio that will change the angular velocity of the motor

A gear ratio is a method of altering the torque/velocity output of an electric motor by adding different-sized gears.

4. What is mechanical power?
   Correct Answers

   Energy / time
   The rate of work
   Energy per unit of time

   the rate at which mechanical work is completed?

   Gear ratio is the ratio of torque to angular velocity
   the ratio of gears on the machine to the power you get going
   the ratio that allows the gears to work

   angular velocity per torque
   the mathematical relation of output force based on input force changed by gears
   The proportion of the size of a gear to the torque that it can create

   A gear ratio is a method of altering the torque/velocity output of an electric motor by adding different-sized gears.

   67% Answers
   Energy applied to move objects
   Power is a machine’s ability to transmit its torque
   Energy generated mechanically.

   33% Answers
   Energy vs speed
   Mechanical power is what is produced when some form of potential energy is converted to kinetic energy
   how far and how fast you can move something
   the force you have over another thing

   Incorrect Answers

   0% Answers

   Energy / time
   The rate of work
   Energy per unit of time

   the rate at which mechanical work is completed?
Force x velocity

Work divided by time, i.e., the capacity to continually exert force over a distance

Work divided by time. You can also calculate it by taking force times velocity or torque times angular velocity.

Torque x angular velocity

\( p = \omega \tau \) Work done per unit time or angular velocity multiplied by torque

Mechanical power is force of motion, the product of torque and angular velocity.

5. When the torque load on an electric motor is increase, what happens to the angular velocity? (Assume the electric motor has the torque-angular velocity curves shown above.)

Correct Answers
Decreased 67% Answers

Incorrect Answers
Increased

Answered the difference in mechanical power vs electrical or thermal.

Power transferred through motion, not radiation or heat

I don't know objects in motion

Power is gear reduction

The unit of force created by torque and angular velocity

The amount of weight that torque can manipulate.

The overall output of the machine
6. When the gear ratio on an electric motor is changed to a higher gear (bigger driving gear and smaller output gear) what happens to the maximum amount of torque the system can generate?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased</td>
<td>it creates speed, thus decreasing power</td>
<td>the torque momentum increases and the maximum amount decreases Angular velocity increases, so torque decreases (this doesn't make sense to me, but I'm interpreting the graph)</td>
<td>Increased</td>
</tr>
</tbody>
</table>

7. At what level of torque and angular velocity does an electric motor generate the most mechanical power.

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 max torque, 1/2 max w</td>
<td>In the middle (no reference to curve) At mid point</td>
<td>Not an exact idea A happy medium?</td>
<td>Everything else</td>
</tr>
</tbody>
</table>

According to the graph it looks like at the center of the line where torque would = angular velocity. In the middle of the torque-angular velocity curve

<table>
<thead>
<tr>
<th>50%</th>
<th>IN the middle?</th>
<th>mechanical power is equal at all levels</th>
</tr>
</thead>
</table>
At the 50% stall torque point.

At the maximum area under the graph

8. When a bicyclist starts riding up a hill without shifting gears, why does he/she slow down?

<table>
<thead>
<tr>
<th>Correct Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque up so w down</td>
</tr>
</tbody>
</table>

The necessary torque to move the bicycle increases

Not only does air resistance and friction oppose the travel of the bicycle, but the force of gravity does now too. The additional torque needed is given by $m\cdot g\cdot \sin(\theta)$, with $\theta$ equal to the angle of the hill above the vertical.

Power need up, torque can't increase so w down
The angular velocity decreases due to the need of needing more power

Not enough power.

The kinetic energy is being transformed into potential energy, and some heat due to friction.

9. When a bicyclist shifts into a lower gear (smaller driving gear and larger output gear) what happens to the maximum speed the bicycle can go?

Correct Answers

Decreases

67% Answers

It decreases, due to the gear ratio creating power. Every turn of the small gear creates only a fraction of the big gear

33% Answers

The maximum speed should not be affected given that the cyclist can always pedal faster and then that would increase the maximum speed. (affected?) However, if you are talking about maintaining a speed the cyclist will be pedaling much faster

Incorrect Answers

Increases

10. What is the main reason a bicyclist shifts gears?

Correct Answers

optimum torque and speed

67% Answers

Unscientific torque-speed answer

To go up hills, of course

33% Answers

Right idea, can't reduce work

To maintain constant speed, reduce work

Incorrect Answers

Everything Else

to obtain maximum gear ratios

BECAUSE OF FRICITION AND STUFF
<table>
<thead>
<tr>
<th>To gain mechanical advantage.</th>
<th>the control the force you apply onto the petals</th>
<th>to save on energy by increasing speed using less energy</th>
<th>predomin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed changes</td>
<td>To go faster, or to go up steep hills/on grass.</td>
<td>to regulate the amount of energy needed to maintain a constant velocity</td>
<td>to gain more momentum</td>
</tr>
<tr>
<td>maximum power</td>
<td>Unclear idea right direction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To keep maximum power</td>
<td>To optimize the constant weight (torque) to mechanical advantage to produce optimum power=speed by switching gears</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The main reason is to change the gear ratio to increase the power that you get out of your legs</td>
<td>the amount of force you need to move a given distance is spread over a larger or smaller time interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>So that he can stay in his peak power band.</td>
<td>when less force is required to speed up, and down shifts to get more power</td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum efficiency</td>
<td>Non-scientific efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To make best use of energy. Downshift to go up hills, upshift to go down hills</td>
<td>To allow them to use less effort when it is not needed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant angular velocity</td>
<td>Non-scientific constant cadence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To maximize linear velocity while maintaining a constant W.</td>
<td>so they have a constant amount of peddlening</td>
<td>to keep their rpms and max velocity the same</td>
<td>to keep at the same pace</td>
</tr>
</tbody>
</table>

Posttest
1. What is torque?
<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisting/Rotating/Spinning force</td>
<td>Twisting/turning power</td>
<td>Had rotational concept only</td>
<td>Everything else</td>
</tr>
<tr>
<td>A rotational force</td>
<td>Turning power</td>
<td>the amount of force a power source can deliver to a spinning object</td>
<td>Torque is the amount of mechanical power released by a motor.</td>
</tr>
<tr>
<td>Force used to twist something</td>
<td>Torque is the rotation power of the motor.</td>
<td>torque is the rotational work done by a body -- usually in reference to motors</td>
<td>Mechanical advantage, moment of inertia</td>
</tr>
<tr>
<td>Rotational Force</td>
<td>rotational power</td>
<td>Torque is the amount of pressure on an object while turning.</td>
<td>It lies on the y axis</td>
</tr>
<tr>
<td>tau=I*alpha</td>
<td>Force times distance</td>
<td>Had force concept only</td>
<td>movement of newtons theory, and the power it takes to get momentum</td>
</tr>
<tr>
<td>Force times radius</td>
<td>A Rotational force vector. (Force x radius /w rotational direction)</td>
<td>Torque is defined as force times distance or the integral of force dotted into the distance</td>
<td>torque is one of the results of momentum and newton's laws</td>
</tr>
<tr>
<td>Force times the lever arm.</td>
<td>the measurement of rotational force required to do do work</td>
<td>how strong the motors are</td>
<td>a way to measure power</td>
</tr>
<tr>
<td>force applied in a twisting fashion. The farther from the center of rotation, the more force</td>
<td>ft/lbs at a point on a rotating arm</td>
<td>a measure of angular force</td>
<td>is the gear power produced by the machine</td>
</tr>
<tr>
<td>Force cross distance</td>
<td>Reference to the force at a distance, not both the force and distance.</td>
<td>Incorrect relationship with the right pieces</td>
<td>Torque is effort applied to move a load.</td>
</tr>
<tr>
<td>Measured in ft lbs. It is the amount of force applied to an object in a rotation, Product of force and moment arm length. More generally, the cross product of a force vector and a radial vector.</td>
<td>force applied at an angle; twisting force</td>
<td>a force over a distance</td>
<td>the amount of pressure being put upon an object</td>
</tr>
<tr>
<td></td>
<td>A force applied on a point from a certain perpendicular distance away</td>
<td>Torque is the amount of force put out by a motor at a certain distance for example N/m</td>
<td>Torque is kinetic energy generated from the production of power</td>
</tr>
</tbody>
</table>
2. What is angular velocity?

Correct Answers

<table>
<thead>
<tr>
<th>Force times perpendicular distance</th>
<th>The amount of force to rotate object(s) about a point of rotation.</th>
<th>a vector with direction determined by the cross product of two other vectors</th>
<th>the amount of power, or traction (friction), that a moving object has with a sedentary object.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational speed</td>
<td>motor speed (infers rotation)</td>
<td>speed answers</td>
<td>everything else</td>
</tr>
<tr>
<td>the velocity of rotation</td>
<td>The rate of a motor measured in radians</td>
<td>the angle that the object is twisting</td>
<td>a unit of measure relating to an indirect application of force. An amount of torque lost in tangential direction.</td>
</tr>
<tr>
<td>Angular velocity is the rate of rotation of a body.</td>
<td>How fast a motor can potnetially move</td>
<td>the time it takes to complete one revolution (rpm)</td>
<td>The mechanical leverage you have on a gear depending on the angle. square</td>
</tr>
<tr>
<td>the velocity at which a round object turns and is given in radians per second.</td>
<td>The speed in a given direction that a motor creates</td>
<td>The angle at which something moves (Speed)</td>
<td></td>
</tr>
<tr>
<td>uh.......linear velocity divided by radius</td>
<td>Right description wrong equation</td>
<td>how fast something goes at a given angle</td>
<td>Velocity of a line tangent to a circle in rotation.</td>
</tr>
<tr>
<td>the speed at which an angle reduces or greatens</td>
<td>It is how fast the objet is spinning around something its found by the velocity devided by the rotation of the gear</td>
<td>One of those triangular firework thingamajigs that spins real fast...</td>
<td></td>
</tr>
<tr>
<td>angular velocity is a rotating vector represented by lower case omega and is equal to 2 times pie divided by the period</td>
<td>Angular velocity is the speed at which an object rotates and is = Forward velocity x Radius</td>
<td>As I recall... angular velocity=velocity/circumference. It describes the number of complete rotations occurring in a specific time period.</td>
<td>A measure of a certain kind of speed</td>
</tr>
</tbody>
</table>
3. **What is a gear ratio?**

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of of torque/angular velocity between gears</td>
<td>Does not describe but probably knows.</td>
<td>Right idea bad wording</td>
<td>Everything else</td>
</tr>
<tr>
<td>Gear Ratios are used to adjust speed of motors for various applications. An example would be using a gear ratio to adjust equal speed for two different motors.</td>
<td>A gear ratio is the difference in gears, i.e. 3:4</td>
<td>the change of speed and power as gear teeth mesh</td>
<td>The ratio that figures out power like 30 to 40 or something like that, it directly effects torque</td>
</tr>
<tr>
<td>the relationship between the speed (also the torque) of one gear meshing with another; equivalent to the number of teeth on one of these gears to the number of teeth on the other gear</td>
<td>A set of gears used to change the amount of torque and speed the motor generates</td>
<td>its gear ratings it can be for power or speed</td>
<td>number and size of sprockets</td>
</tr>
<tr>
<td>Mechanical manipulation of torque based on the circumference of gears.</td>
<td>Usually is a reduction such as 2:1</td>
<td>gear verses tire</td>
<td>The ratio of the number of gear bits for two gears in contact with each other</td>
</tr>
<tr>
<td>Ratio of diameters or gear teeth</td>
<td>Ratio of torque to angular velocity</td>
<td>Reused the words gear and ratio in definition</td>
<td>a coefficient representing the friction between two gears</td>
</tr>
<tr>
<td>Using gears of different sizes to increase or reduce speed or power</td>
<td>Gear ratio is the ratio of torque to angular velocity</td>
<td>the ratio of gears on the machine to the power you get going</td>
<td>the ratio that allows the gears to work</td>
</tr>
<tr>
<td>The relative size of a set of gears. I usually refer to this as a fraction</td>
<td>angular velocity per torque</td>
<td>the mathematical relation of output force based on input force changed by gears</td>
<td>The proportion of the size of a gear to the torque that it can create</td>
</tr>
</tbody>
</table>
A ratio (fraction) of the number of teeth of one gear to another.

**Ratio of Maximum Torque to Maximum Angular Velocity**
- different sized gears to either get more velocity or torque
- to have a better usage of a motor, it is better to use a gear ratio that will change the angular velocity of the motor

A gear ratio is a method of altering the torque/velocity output of an electric motor by adding different-sized gears.

4. What is mechanical power?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy / time</strong></td>
<td>The rate of work</td>
<td>Energy applied to move objects</td>
<td>Energy generated mechanically,</td>
</tr>
<tr>
<td><strong>Energy per unit of time</strong></td>
<td>Mechanical power is what is produced when some form of potential energy is converted to kinetic energy</td>
<td>Power is a machine's ability to transmit its torque</td>
<td>Energy vs speed</td>
</tr>
<tr>
<td><strong>the rate at which mechanical work is completed</strong></td>
<td>Force x velocity</td>
<td>how far and how fast you can move something</td>
<td>the force you have over another thing</td>
</tr>
<tr>
<td><strong>Work divided by time, i.e., the capacity to continually exert force over a distance</strong></td>
<td>Right Definition, wrong equation</td>
<td>Answered the difference in mechanical power vs electrical or thermal,</td>
<td>VI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It's how fast energy is used. Power = Torque X Work</td>
<td>I don't know</td>
</tr>
</tbody>
</table>

79
Work divided by time. You can also calculate it by taking force times velocity or torque times angular velocity.

**Torque x angular velocity**

- **p=omega*tau** Work done per unit time or angular velocity multiplied by torque

Mechanical power is force of motion, the product of torque and angular velocity.

5. When the angular velocity of an electric motor is increased, what happens to the amount of torque the motor can generate? (Assume the electric motor has the torque-angular velocity curve shown above.)

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased</td>
<td></td>
<td></td>
<td>Increased</td>
</tr>
</tbody>
</table>

6. What happens to the maximum amount of torque the system can generate when the gear ratio on an electric motor is changed to a lower gear (smaller driving gear and larger output gear.)

- **objects in motion**
- **power is gear reduction**
- The unit of force created by torque and angular velocity
- The amount of weight that torque can manipulate.
- The overall output of the machine
7. What are the two operating points on a torque-angular velocity curve where an electric motor does not generate power?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stall torque and no load speed</td>
<td>Stall torque and something wrong</td>
<td>Personal Description of only stall torque or no load speed. The two operating points on the torque-angular velocity curve are where the slope of the gear ratio intersects the torque level of the hill, and where the slope of the gear ratio intersects the max power line.</td>
<td>Everything else</td>
</tr>
<tr>
<td>x=0 and y=0</td>
<td>No load speed and something wrong</td>
<td>Personal Description of at the minimum or maximum there is no power, either because there is an infinite torque that can not be overcome, or because there is an infinite angular velocity and no force</td>
<td></td>
</tr>
</tbody>
</table>

8. Why does a bicyclist stuck in high gear go faster on flat than on a steep hill?
<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque down so w up</td>
<td>High gear is good for flat</td>
<td>A good guess</td>
<td>Everything Else</td>
</tr>
<tr>
<td></td>
<td>On flat ground, little to no power is needed, so the bicyclist makes use of the high angular velocity provided. While on a steep hill, a low gear is necessary to have enough power and still maintain some angular velocity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power needed down so w can go up</td>
<td>Not exact answer but knows what is going on. because the gear ratio is at a higher level all the, meaning that the amount of torque needed to create maximum power is greater. It's much harder for a biker to create the necessary torque going uphill than on a flat surface.</td>
<td></td>
<td>He needs more torque than angular velocity.</td>
</tr>
<tr>
<td></td>
<td>Answered reverse question but provided good explanation more torque is needed so angular velocity decreases</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. When a bicyclist shifts into a lower gear (smaller driving gear and larger output gear) what happens to the maximum speed the bicycle can go?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The max speed of the bike is greatly increased, and thus increases the max torque provided.</td>
<td>A correct answer to a different question max torque without angular velocity gives you the stall torque.</td>
<td></td>
</tr>
</tbody>
</table>

10. What is the main reason bicyclists shift gears?

<table>
<thead>
<tr>
<th>Correct Answers</th>
<th>67% Answers</th>
<th>33% Answers</th>
<th>Incorrect Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>optimum torque and speed</td>
<td>Unscientific torque-speed answer</td>
<td>Right Idea, can't reduce work</td>
<td>Everything Else</td>
</tr>
<tr>
<td>Low gears on hills to keep on going High gears on flat roads to go fast</td>
<td>To go up hills, of course</td>
<td>To maintain constant speed, reduce work</td>
<td>to obtain maximum gear ratios</td>
</tr>
<tr>
<td>To gain mechanical advantage.</td>
<td>constant effort</td>
<td>to save on energy by increasing speed using less energy</td>
<td>boredom</td>
</tr>
<tr>
<td>Speed changes</td>
<td>To go faster, or to go up steep hills/on grass.</td>
<td>to regulate the amount of energy needed to maintain a constant velocity</td>
<td>to gain more momentum</td>
</tr>
<tr>
<td>maximum power</td>
<td>Unclear idea right direction to try to reach the point of max-torque and max-angular velocity</td>
<td>Right Idea, really should say efficiency</td>
<td>to create maximum angular velocity</td>
</tr>
<tr>
<td>To keep maximum power</td>
<td></td>
<td>To keep the bicycle moving while using the least amount of power.</td>
<td></td>
</tr>
</tbody>
</table>
The main reason is to change the gear ratio to increase the power that you get out of your legs by switching gears the amount of force you need to move a given distance is spread over a larger or smaller time interval when less force is required to speed up, and down shifts to get more power

So that he can stay in his peak power band.

maximum efficiency

To make best use of energy. Downshift to go up hills, upshift to go down hills

Non-scientific efficiency

To allow them to use less effort when it is not needed
to save energy

Right idea, should say torque not power

To decrease the amount of power they need to turn the wheels when the torque on the wheels changes because of hills.

To use only the amount of power necessary.
Appendix IV – Test Responses

Animated Tutorial Subjects

User 596

Pretest Response on 2001-04-06 at 17:18
force applied to an angle
I dont know
ratio of gears
power that is not electric
I dont know
i dont know
medium level
there's more pressure
your increasing he intensity
change the different speeds
Freshman Jefferson High School (Lafayette IN)

Posttest Response on 2001-04-06 at 17:28
twisted force
turing speed
how many times the inputs turns if the output turns once
how fast power is used
decreases
more pressure is used
loses pressure
pressure force
loses pressure
fastness
yes
thanks as well
User 811

Pretest Response on 2001-04-20 at 14:27
A measure of a turning object.
A measure of a certain kind of speed
The ratio of gears.
The force of a mechanical action.
It will also increase.
The amount of possible torque will increase
The lowest.
The gravity will push you downwards.
The bicycle will slow and but can go faster.
To change the amount of power and speed they can produce.
15 2001

Posttest Response on 2001-04-20 at 14:38
Torque is a twisting force
The speed of an object as it turns.
The difference between gears.
The force of mechanical actions
Torque will decrease.
The torque would decrease.
I don't know.
because it would be harder to move the wheels on a hill, but be decent on flat ground.
The maximum speed decreases.
To make it easier to pedal or to gain more speed.
yes. they were nifty.
There is a flaw, the one being tested can hit back on there browser to view the answer, then hit forward to
go to the test with the right answer. This defeats the purpose.
User 604

Pretest Response on 2001-04-07 at 11:34
objective pressure
?????????????
ammount of teeth on a geer
?????????????????
it drops
it is increased
???????????????????
slows down
it increased
to make it easier to ride
14years 9th grade

Posttest Response on 2001-04-07 at 11:57
the amount of pressure it takes to turn something
??????????????/the size between 2 geers
tork output
it decreases
it decreeses
????????????
f
it decreases
f
f
f
Pretest Response on 2001-04-06 at 10:42

Torque is one of the results of momentum and Newton's laws.

\[ v = \frac{d}{t} \]

This formula is used to find velocity with the different angles of a 45-45-90 triangle.

The ratio of the resulting vectors determines the motor power that controls the engine's velocity, force, and control.

The angular velocity decreases because of the division of the time and distance ratio. It increases because of the use of the engine controls the torque momentum and ratio denominator.

The lower the level of generation, the higher the mechanical power.

The force projected on the bicycle's wheels and the control you have over the bike's petals...this makes you slow down forcing you to increase the power you apply onto the pedals.

The force on the petals makes the bike go faster providing slower gears and higher max. speed.

The control the force you apply onto the petals.

11th grade

Posttest Response on 2001-04-06 at 10:51

A twisting force

A turning speed

The ratio that determines whether the gears are the same or not. 1:2 different. 1:1 - same.

\[ t + av = p \]

The turning power is increased and the torque twist to create greater momentum.

The torque is twisted and the power is increased.

Torque and angular velocity create power, so if there was none then there would be no power.

The power is affected and makes the bike go faster.

The max speed increases.

To control velocity and force applied.

Yea.

No problem... this was just so much fun... good experience!
User 808

Pretest Response on 2001-04-20 at 13:23
i don't know
i don't know
i don't know
i don't know
i don't know
i don't know
i don't know
i don't know
slower
to reduce rpm
18, senior

Posttest Response on 2001-04-20 at 13:34
i don't know
i don't know
i don't know
i don't know
less torque
more torque
too much torque
angular velocity decreases
can't go as fast
to reduce rpm
yes
i don't know
User 563

Pretest Response on 2001-04-06 at 10:39
movement of newtons theory, and the power it takes to get momentum.
the power (velocity) you get when you come down at a angle
the ratio of gears on the machine to the power you get going
the power that advances within the machine
the angular velocity increases and turns into power
the torque momentum increases and the maximum amount decreases
at the middle in the most generating level
yes
it goes more powerfully, but slower
to gain more momentum
15yrs, 10th grade

Posttest Response on 2001-04-06 at 10:50
a twisting force
turning speed
the ratio that determines whether the gears are the same or not 1:2 -different 1:1- same
torque + angular velocity = power
the turning power is increased and the torque twist to create greater momentum.
the torque is twisted and the power is increased
torque and angular velocity create power, so if there was none, then there would be no power
the power is effected, and makes the bicyclist goes faster
it increases
to gain angular velocity against decreasing pwer and momentum
yes
youre very welcome!
User 805

Pretest Response on 2001-04-20 at 12:16
str.
how fast something goes at a given angle
idk
the energy of a moving object
it decreases
it increases
idk
because his angular velocity increases without raising his level of torque
less than it could in a high gear
in order to keep a constant speed without slowing down
17, Junior

Posttest Response on 2001-04-20 at 12:36
T=Fxr the amount of power in order to turn something
the speed at which something turns
the ratio in cycles of the output gear in relation to the amount of cycles from the input gear
The amount of energy given by a moving object
torque is increase
It decreases
idk
because the amount of torque is greater than the angular velocity
it decreases
in order to maintain a constant gear ratio.....that will keep you at a constant speed.....making it easier to
ride up and down hills......an stuff
Yes indeed it did
Good amount of information, however while some bits of the information stick pretty easily in my
mind,however once I got down to the examples of torque-angular velocity my memory became a bit	fuzzy and I don't think I retained quite as much of the information.
User 809

Pretest Response on 2001-04-20 at 13:41
amount of pulling power
I have no clue
a ratio involving gears
a form of energy
the angular velocity decreases
it decreases
when the are equal
he is not in the right gear
it increases
so they can maintain speed
18 senior

Posttest Response on 2001-04-20 at 13:57
it is a turning force
is the speed something rotates at
a ratio between the in gear and the out gear
power is a way to use energy
the torque decreases
gain more torque
all torque - no angular velocity, all angular velocity - no torque
he can only produce a small amount of torque, and therefore has not as much power
the speed decreases
so they can have the most power at all times
yes
i liked the drawings the best
Pretest Response on 2001-04-16 at 12:04
Torque is how fast an object is moving
What happens to the speed when the object is on an angle
How big one gear is in comparison to another
When gears are moved to move something else
It increases
no idea
right in the middle
because the angular velocity has increased
it decreases
to be able to get more power to move
26-BA in Psych

Posttest Response on 2001-04-16 at 12:12
torque is the angle at which you need to be to move something
it is how fast something spins
the gear ratio is how many times the smaller one goes around versus how many times the big one goes around
What it takes to make something move
The torque is increased
it increases
at the top and the bottom--going too fast or not moving
because you do not need as much power to move it in high gear
it increases
to get more power to go up hills
yes
I am not a physics wiz, that is for sure!
User 81

Pretest Response on 2001-04-20 at 14:53
if you had a object and wanted to turn it the torque is the measurement of the movement
same as torque
the ratio of torque to angular velocity
work x gear ratio
decrease in angular velocity
increases
center of the line
torque decreases
decreases
so they don't have to work as hard at higher speeds
18 four

Posttest Response on 2001-04-20 at 15:18
T = f x r
w = f/r
the rate at which one gear moves compared to the other gear(s) in the system
P = T x w
angular velocity decreases
decrease
center of the line and the top of the line
because he can't produce enough torque
decreases
to decrease his work
yes
graphs hard to understand sometimes
Pretest Response on 2001-04-20 at 12:17
strength of something to withstand friction as it spins
speed at an angle
How many times one gear revolves around another-the relation between revolutions
the amount of work you need to apply for motion?
it decreases at a linear rate
it becomes greater
90 degrees or 270-when the motor is pointed straight up or down
because they do not shift to higher/larger gears and therefore they lose torque and it takes more power to
achieve same result
increases
to continue going at the same speed with the same amount of effort
17, senior

Posttest Response on 2001-04-20 at 12:39
a twisting force
turning speed
how many times the output gear turns when the input gear is turned once
combination between torque and angular velocity
decreases
increases
when angular velocity is at its max or when torque is at its mx
angular rotation is higher because you don't need as much torque on flat surfaces
decreases-more torque
same answer as before
yep
very informative cool things to know. I wish I could have paid more attention to it but I've got to go.
Thanks. I have learned some stuff
User 603

Pretest Response on 2001-04-07 at 11:34
the amount of pressure being put upon an object
????????????
the ratio of the amount of teeth of one gear to another
????????????
the angular velocity decreases
it increases
????????????
because they lose strength because the angle is increased which increases the torque
it decreases
to save on energy by increasing speed using less energy
16 sophomore

Posttest Response on 2001-04-07 at 11:49
the amount of energy it takes to turn something
foregut
the difference between the size of your gears
the output produced by the torque angular velocity
it decreases
it decreases
stall point where max torque is reached and the point where max angular velocity is reached
because on a the higher on a hill he goes the more torque it takes to move and with a higher gear the torque is increased also so the biker has to use more strength
it decreases
to increase maximum output
yes
the angular velocity confused me a bit if you have a more in-depth tutorial I would like to see it
Pretest Response on 2001-04-20 at 02:31

twisting force
the speed of something moving at a slanted direction
the difference between one size gear and another one of different size
the energy used to move an object
it increases
it increases
when they are the same
it becomes more difficult to pedal
it increases
when it is difficult or easy it tailors itself to the conditions
53 and master degree

Posttest Response on 2001-04-22 at 03:16

Twisting force. How hard you have to twist to turn an object around.
Turning speed. How fast something is turning around.
The relationship between the number of times the output gear turns while the input gear only turns once.
The diameter of the input gear is divided by the diameter of the output gear to get the gear ratio.
Power is how fast energy is used. Multiply torque times angular velocity to get power.
The torque decreases
Max torque is increased. I'm guessing.
No torque load and max power.
The max angular velocity is up and the max torque is down.
The maximum speed decreases because you spin a lot but it's great for going up hill.
To take strain off my knees! The high gear makes the bicycles stop halfway up the hill and then I might fall over in the road and get run over and life flighted to the hospital. Shifting makes the bike easier to pedal.
Well, sort of. I saw animations then would get an error message that the program had performed an illegal operation and would be shut down. This happened four times. This whole process took me three hours but I wanted to learn about torque and angular velocity so it was worth it. I did not know what input and output gears are on a bike. I mean which one is the driving gear and which was the output gear. So I found it hard to mentally picture myself riding the bike. Which is a very nice bike by the way.
You are welcome. The colors helped me a lot on the graphs. It's nice to know what you spend your time thinking about and how this relates to robot motors. Have a blessed day!
User 554

Pretest Response on 2001-04-06 at 09:36
twisting force
inverse relationship with torque
the ratio that allows the gears to work
Force time distance
it decreases
it decreases
at the middle or balance - when there even
?
it goes up
to change the distance pedalled and force difference
17 junior high school

Posttest Response on 2001-04-06 at 09:53
force of rotation
speed of rotation
the output for one rotation of input
how fast energy is used
decreases
decreases
stall point and no load speed
?
goes up
to create maximum angular velocity
yes
a
User 505

Pretest Response on 2001-04-16 at 15:42
I'm not sure.
I am not familiar with this term.
The relative size of a set of gears. I usually refer to this as a fraction.
I usually refer to this in Horse power.
It would decrease.
It would increase.
According to the graph it looks like at the center of the line where torque would = angular velocity.
The angular velocity is decreasing so the torque is increased? Just a guess.
The maximum speed should not be effected given that the cyclist can always pedal faster and then that would increase the maximum speed. (affected?) However, if you are talking about maintaining a speed the cyclist will be pedeling much faster.
To gain mechanical advantage.
45 BA Special Education 1978. Non-technical Parent of a team member. I drive a team to the compitition and mentor my son. Team 411, which is in danger of loosing their program due to lack of funds.

Posttest Response on 2001-04-16 at 16:04
Torque is twisting force
the measure of angular speed
the ratio of turns between the drive gear and the driven gear
\[ P = \text{torque times angular velocity} \]
the torque decreases
it will decrease
the motor stall point, and the maximum torque point
this is due to hitting the maximum torque point
it is decreased
to maximize velocity
yes
I hope I didn't fail too bad. I wanted to spend more time to try and understand the material before I took the test. Thanks.
User 547

Pretest Response on 2001-04-05 at 16:21
The amount of power output.
The amount of speed output.
The amount of reduction of either torque or angular velocity in substitution for the other.
Unknown
It decreases.
It increases.
Unknown
They slow down because they need to produce more torque to go up the hill so the energy is taken away from angular velocity
It decreases.
To change the amount of torque and angular velocity.
14 Freshman

Posttest Response on 2001-04-05 at 16:36
Torque is a twisting force upon an object
Angular velocity is the amount of rotational speed that a fixed point observes.
A gear ratio is to distribute torque and angular velocity to obtain an optimal power
Power is the amount of torque multiplied by angular velocity.
It decreases.
It increases.
The point which there is no torque and the point where there is no angular velocity.
Because the bicyclist does not need to generate as much power on the flat terrain than on the steep hill so the extra energy is converted to angular velocity
It decreases.
The main reason is that the bicyclist needs to have max power for the most efficient ride.
Yes it had animations
No feedback
Mark McGwire’s key to hitting 500 foot homeruns after making contact with a 100 mph pitch. Amount of speed required to keep some object in rotation. No idea. No idea. Angular Velocity decreases. Torque increases. High torque, low angular velocity. Angular velocity decreases not enough torque. max speed decreases. to make pedaling easier on uphill, downhill changes shift to lower gears to make going uphill easier, shift to higher gears to go faster downhill 25, 7th year in college

A twisting force, how hard Mark McGwire has to turn ie rotate his bat around to pull a 100 mph pitch into the left field stands. Or how hard a lab assistant has to work in order to twist off the caps from a pap bottle. Torque = Force x radius. The speed of an object moving in a circle. Angular Velocity equals Velocity/radius Gear Ratio is D input/D output ie the amount of power a mountain biker has to pedal in order to get his/her wheel’s turning. It’s how fast energy is used. Power = Torque X Work Torque decreases. maximum torque increases 1. Stall Torque 2. ? On a steep hill a bicyclist is increasing torque, pedaling harder in order to get his/her wheels spinning in order to climb. He/she goes faster on flat because less torque required for greater angular velocity. maximum speed decreases Either to increase torque, so that you can move uphill, or ease up on torque as you go down. It’s easier to climb uphill on the lower gears, it saves the knees and back trust me. Yes. Maybe a quick Q and A after each section for review, where it will correct each answer as you go, so you can check.
User 594

Pretest Response on 2001-04-07 at 11:58
Torque is the ratio of something to something.
I can't even think of a random word to use... so.
Angular velocity is the speed and direction that... torque.. applies.
Gear ratio is the ratio of torque to angular velocity
mechanical power is a measure of the force exerted... against gravity.
The angular velocity drops.
It.. increases.
50-50
Ah. geez. Because his gear ratio causes torque.. too low to compensate for the angular velocity needed.
It.. decreases.
To increase/decrease torque to compensate for.. necessary angular velocity.
15 - sophomore

Posttest Response on 2001-04-07 at 12:17
Twisting force
The speed at which things turn
The number of times the output gear turns in comparison to the number of times the input gear turns.
The rate at which energy is used.
Decreases.
Decreases.
No load speed and stall torque
A higher speed increases the torque but decreases the angular velocity and therefore... the output gear spins fewer times
It increases.
To change torque:angular velocity.
Yeah. but I liked the graphics for torque, power, and gear ratio better.
All right. Well. Here are my thoughts. I thought the explanation of angular velocity was vague. I still don't really, truly understand exactly what it means, physically, when you change the angular velocity (and therefore torque).

The bicycle analogy was good... except my bicycle was stolen in 7th grade and I barely remember what it's like.

But I'm just weird.
User 676

Pretest Response on 2001-04-12 at 11:28
power measurement
speed in a circle
the ratio of the size of gears
power produced by an engine
decreases
decreases
middle
he's not peddlin fast enough
it deceases
to decrease to strain of peddling the bike
23-sr

Posttest Response on 2001-04-12 at 11:30
a force that produces or tends to produce rotation or torsion (an automobile engine delivers torque to the drive shaft);
also: a measure of the effectiveness of such a force that consists of the product of the force and the perpendicular distance from the line of action of the force to the axis of rotation
the rate of rotation around an axis usually expressed in radians or revolutions per second or per minute
A gear ratio is the number of times the output gear turns if the input gear is turned once
the time rate at which work is done or energy emitted or transferred by a mechanical device
as angular vel increases, torque decreases
increases
zero load point and stall torque
cause less torque is need on a flat surface
decreases
decrease torque or increase speed
yes
make sure dr boys knows that i took this. craig hamilton thanks
Pretest Response on 2001-04-06 at 10:28
rotational power
velocity at an angle (not moving in a straight line)
THE ratio of one gear to another, determines mechanical advantage of the gears
how far and how fast you can move something
it will decrease
less torque (higher speed)
the best one
because they must supply more force, and force and velocity are inversely related
it goes down
so they can move their legs at a comfortable speed
17 junior

Posttest Response on 2001-04-06 at 10:46
twisting force
rotational speed
the ratio of the size of the gears
how fast energy is used
there is less
it can generate more torque, at the cost of slower angular velocity
stall point and the vertical asymptote (can't overcome initial torque)
because he can't supply enough torque on the way up hill to deep the angular velocity up.
the maximum speed is less
to supply maximum power (1/2 max angular velocity, 1/2 torque)
yes
looked pretty cool
User 708

Pretest Response on 2001-04-14 at 14:28
The moment of a force; the measure of a force's tendency to produce torsion and rotation about an axis, equal to the vector product of the radius vector from the axis of rotation to the point of application of the force
The rate of change of angular displacement with respect to time
The ratio of the speed of rotation of the powered gear of a gear train to that of the final or driven gear
The rate at which mechanical energy is exerted or mechanical work performed, as by an engine or other machine, or an animal, working continuously; as, an engine of twenty horse power
it goes down
it rises
right in the middle
angular velocity
it goes up
to have more power
16 junior

Posttest Response on 2001-04-14 at 14:41
a twisting force
a turning speed
the number of times the output gear turns if the input gear is turned once
how fast energy is used
it goes down
it goes down
the max torque and the max angular velocity
the angular velocity and the gear ratio
goes down
angular velocity
yes
dont force people to take the damn test
User 797

Pretest Response on 2001-04-19 at 16:57
A "twisting" force.
The velocity at which something move around an angle.
The ratio between the size of gears that are used in a mechanism.
The amount of work per unit time a machine can accomplish.
Decreases.
Increases.
When they are equal.
She/He must apply more force to increase the torque of the bicycle wheel.
Increases.
To make the work the bicyclist do less work.
20. End of sophomore year in college. (major Chemistry)

Posttest Response on 2001-04-19 at 17:15
A twisting Force.
Turning Speed.
D input / D output
P = T*w
Decreases
decreased
Stall speed and No-load Speed.
More work is required to go fast on the steep hill. Less on the flat one.
increases.
To work less.
Yes it did.
Very nice. I am a physics student of Dr. Boyz at U of M- Flint, in Flint Michigan. My name again is Michael Scanello. Very neat site here!
torque is power. Power is defined by gear ratio. Torque, to me, defines how well a machinery is geared, small to big gear ratio creating torque, which is, as said earlier, power.

Angular velocity is the velocity at which the gears rotate, which can be derived by taking the first or second delivative.

Gear ratio is what determines if the moving joint is fast or slow (slow and powerful, or fast and weak). It is determined by counting how many teeth there are on the beginning teeth all the way to the end. For example, if the initial gear has 8 teeth, and the next one has 10, and the last one has 20- the gear ratio is 8:10:20, which can be broken down to 4:5:10.

There are 2 things which result from gear ratio. Slow and power, or fast and weak. To get a slow and powerful ratio, the gears must go from small to big. To get a fast and weak joint, or whatever, the gears must go from big to small.

Power is defined by work times force. The error in this is that if nothing is moved, then there is no power resulted.

It slows down, as shown in the graph.

It creates speed, thus decreasing power.

In the middle

Because gear ratio is needed to go up, and the type is power, for more power is needed to go up.

It decreases, due to the gear ratio creating power. Every turn of the small gear creates only a fraction of the big gear.

To go faster, or to go up steep hills/on grass.

16; 11th Grade

Posttest Response on 2001-04-06 at 11:26

it is the twisting power, like how hard it takes you to turn an object, such as using a monkey wrench to turn a nut.

It is how fast the object is spinning around something. Its found by the velocity divided by the rotation of the gear.

Gear ratio is amount of teeth on each gear.

Power is gear reduction = small to big.

It decreases because speed has increased.

It increases because speed decreased because of the gears = when the first small gear spins it takes the second gear longer to complete a full rotation.

When there is total angular speed only and no torque

More power is needed to go onto a steep hill than flat ground

It decreases because of gear ratio properties""

to go faster, or to go on steep hills.

Yes

Ok, let me know the results
User 791

Pretest Response on 2001-04-19 at 14:22
force that act in a rotational manner created by a force on the handle
rate of rotation around the axis
ratio comparing the circumference of gears
Force times distance
decreases
increases
At the maximum area under the graph
Angular velocity is lower so torque has to be higher and if it is too high, he will slow.
angular velocity increases and torque decreases
To maintain high velocity at a lower torque
21

Posttest Response on 2001-04-19 at 14:36
Force *Radius
Velocity/Radius
D input/D output
torque*angular velocity
decreases
increases
stall torque and no load speed
He needs less torque to overcome gravity
increases
to maintain max power
yes
no problem, My name is Chris Kus, please tell my teacher this. He will give me extra credit.
Pretest Response on 2001-04-12 at 13:12
Torque is the amount of force at a distance from a rotational point.
Angular velocity is a rate at which something is moving around a point. Angular velocity has a magnitude and direction.
Gear Ratio is a ratio describing the size of 2 gears that are connected.
Power is the amount of work done.
As the Torque increases, the Angular Velocity Decreases
Maximum Amount of Torque decreases
The most power is generated when the product of Torque and Angular velocity are maximized.
More force is needed to move the bicyclist up a hill.
The bicycle's maximum speed increases.
Bicyclists shift gears to make it easier to go up hills.
Steven Shade 19
Sophomore at University of Maryland: College Park

Posttest Response on 2001-04-12 at 13:34
Torque is a rotational quantity that is the product of a force at some radius from the point of rotation.
Angular velocity is a quantity that describes the magnitude and direction of rotation.
Gear Ratio is a number that describes the relationship between 2 gears.
Power is the product of Torque and Angular velocity.
As angular velocity increases, Torque Decreases.
The maximum amount of torque decreases proportional to the gear ratio.
The motor does not produce power when at Stall Torque or at maximum angular velocity.
On a flat hill, the bicyclist can reach the maximum angular velocity.
The maximum speed decreases.
Bicyclists shift gears because it allows them to stay close to the point on the Torque-angular velocity curve where maximum power occurs.
yes
User 680

Pretest Response on 2001-04-12 at 11:49
Is the cross product of the force applied to a point and the lever arm.
Is the velocity of a object rotating or spinning on its axis. Angular velocity is measured in radians per second.
Is the ratio of torque to angular velocity
It is the amount of work done in a given amount of time. The power withdrawn from a mechanical battery is the product of the current times the voltage drop across the circuit containing the battery (or motor).
It decreases (because they're indirectly proportional to each other).
It increases
At the maximum amount of torque and minimum angular velocity
Because as he goes up he needs more torque so the force opposing both the friction force and the horizontal component of gravity is bigger and thus can keep riding up the hill.
It decreases
To increase the torque to supply more power
20 years old. I'm a junior.

Posttest Response on 2001-04-12 at 12:19
It is the amount of force necessary to make an object turn times the lever arm which is the distance from the center of the object to the point where the force is applied
It is the velocity of a turning object. It can be found by dividing the linear velocity by the radius (Distance from point where linear velocity is taken to the center of the object).
It is the number of turns the output gear would turn when the input gear is turned once
Power is how much energy (or work) is used in a given time. Also in terms of torque and angular velocity it is just the product of these two.
It decreases
It increases
If there is no power it is because nothing moves. If nothing moves is because the gear ratio is too high (w is too high and torque is too low)
Because on flat land the angular velocity does not decrease as fast as it does going up a hill
It decreases
To obtain the maximum power given a gear ratio
Yes
I liked the graphs very much; they definitely caught my attention. I think after reading the tutorial what I remember is the bold words.
User 583

Pretest Response on 2001-04-06 at 15:51
Torque is a measure of twisting force.
A speed in a circular trajectory.
A rate of turning input speed to output speed.
The ability to use a force to perform mechanical work.
Angular velocity decreases.
Torque decreases.
Maximum torque.
He/she does not have enough torque to continue in with the current gear ratio.
Maximum speed decreases.
So that they can create more output torque.
22, college junior

Posttest Response on 2001-04-06 at 16:05
A twisting force.
Rotational speed.
The number of times the output turns for one turn of the input.
The rate at which energy is used.
Torque decreases.
Torque increases.
Zero torque and zero angular velocity.
Because he does not have to produce much torque on the flat.
Maximum speed decreases.
To produce more torque.
Yes.
Your welcome.
User 556

Pretest Response on 2001-04-06 at 09:54
force ofrottATION
degrees/radians traversed in an amount of time
ratio of the circumferences of gears
amount of work done in an amount of time
decreases
increases
WHEN THEY ARE BOTH AT THE MIDDLE OF THEIR EXTENTS
not enough torque to accommodate for having to defeat more gravity
no maximum speed, requires more pedaling to reach the same speed
to reduce the amount of work they have to do to get the bike to do work
18, 12TH

Posttest Response on 2001-04-06 at 10:18
rotational force
revolutions per minute, radians per second
ratio of the diameters of two gears
torque * angular velocity
it decreases
increase
maximum and minimum
no need to overcome incline
it is reduced
to maximize power
mine tutorial had animations
ok.
User 822

Pretest Response on 2001-04-20 at 21:06
The product of a force times the distance it is away from the pivot point.
The speed at which an object rotates around a central axis.
The ratio of the size of one gear (i.e. the gear connected to the motor shaft) to another (i.e. the gear around the wheel axle).
The amount of driving power put out by the motor.
As the torque increases, the angular velocity decreases.
As the gear ratio is changed to a higher gear with a larger driving gear and a smaller output gear, the amount of torque is decreased, increasing the angular velocity.
An electric motor generates the most amount of mechanical power when the motor is going at it's maximum angular velocity.
In order to go up a hill easier, you must shift into a lower gear. This gives you more torque, yet less angular velocity.
The max speed is greatly reduced inorder to increase the amount of torque to the desired amount.
Bicyclist shift gears to provide them with the appropriate power/speed needed at whatever incline/decline they may be at without changing the speed in which they are pedaling.
Age-19, freshman in college

Posttest Response on 2001-04-20 at 21:55
Torque is a twisting force determined by multiplying the applied force by the radius to the center of rotation.
Angular velocity is the speed at which something is spinning around. This can be found by dividing the speed of any point on the spinning object and dividing it by the radius to the center of rotation.
A gear ratio is the number of times an output gear turns if the input gear is turned only once.
Mechanical power is the resulting product of the torque times the angular velocity.
When the angular velocity of an electric motor is increased, the torque decreases.
Changing the gear ratio to a lower gear increases the maximum amount of provided torque while decreasing the maximum amount of possible angular velocity.
The two operating points on the torque-angular velocity curve are where the slope of the gear ratio intersects the torque level of the hill, and where the slope of the gear ratio intersects the max power line.
On flat ground, little to no power is needed, so the bicyclist makes use of the high angular velocity provided. While on a steep hill, a low gear is necessary to have enough power and still maintain some angular velocity.
The max speed of the bike is greatly increased, and thus increases the max torque provided.
Bicyclist shift gears to provide them with the proper and necessary amount of torque/angular velocity needed to ride on the incline/decline with enough power and speed.
Yes, there were animations of the torque being applied to the pedals, showing how it increases on the down stroke and decreases on the return stroke.
This was a very good tutorial giving basic concepts and ideas of torque and angular velocity that even someone not familiar with basic physics could understand thanks to visual aids (graphs and animations) and examples of formulas and calculations.
User 849

Pretest Response on 2001-04-28 at 00:54
The strength of rotation
the velocity of rotation
size of gear to output
the overall output of the machine
it decreases
it decreases
medium
the torque is high and the gear ratio is large
it increases
the maximize energy consumption to output
21, junior

Posttest Response on 2001-04-28 at 01:03
force needed to turn an object
speed of rotation
number of revolutions of of input gear to one revolution of output gears
the total output of the machine
it decreases
it increases
1:1 ratio and larger input than output.
it takes less torque, which the higher gear requires.
it increases.
to maximize output.
yes
good show
User 821

Pretest Response on 2001-04-20 at 19:16
A twisting force
The velocity of a rotating object
The ratio between angular velocity and torque
The amount of energy spent in a certain amount of time
angular velocity decreases
The amount of torque increases
When the torque equals the angular velocity (right in the middle)
The torque necessary to get up the hill is increased
The amount of torque decreases
To increase the torque so that he/she must do less work
21; 3rd year in college

Posttest Response on 2001-04-20 at 19:28
The twisting force
The velocity of an object that is spinning
The number of turns that the output gear does for one input gear turn
The amount of energy spent in a period of time
The torque decreases
The amount of torque increases
Stall torque and no load speed
Because in high gear, there is low torque and on a flat surface, torque is kept constant
The maximum speed decreases
To increase the torque when needed
Yes
I felt that the animated pictures were extra helpful and a fun way to involve the student in understanding the concepts
Pretest Response on 2001-04-20 at 19:16

- twisting force
- the velocity of a rotating object
- the ratio between the angular velocity and the torque
- the energy output in a certain amount of time
- angular velocity decreases
- torque increases
- right in the middle, when the torque=angular velocity
- because the bike needs more torque to go up the hill, thus created from a lower gear.
- it decreases
- so the amount of energy required is limited
- I'm 21 and in my third year of college

Posttest Response on 2001-04-20 at 19:29

- twisting force
- the velocity of a spinning object
- the number of turns it takes the output gear, for one turn of an input gear
- the amount of energy spent in a period of time
- the torque decrease
- the torque increases
- stall torque and no load speed
- because in high gear there is low torque, and to go faster on the hill you must increase the torque
- the max speed decreases
- to reduce the amount of energy needed to produce the torque to go up the hill or wherever
- yes
- the graphs and pictures were very helpful to picture the problem, and to get the basic idea.
User 793

Pretest Response on 2001-04-19 at 15:39
a twisting force
the time it takes to complete one revolution (rpm)
the ratio of the radius of one gear to another
energy used to make something move
it decreases
less torque
medium torque and medium angular
He has to put more torque on the pedals
it increases
to maximize output power
20, college sophomore

Posttest Response on 2001-04-19 at 16:02
a twisting force, T=Fxr
v=rxw
the amount revolutions a gear makes when the gear connected to it turns once
energy consumed
torque decrease
maximum torque decrease
stall torque and no load speed
he does not need to generate as much torque on a flat surface so he increases his output
it increases
to maximize power
yes
thanks
User 72

Pretest Response on 2001-04-12 at 08:38
a turning force
the ratio of the number of times a gear turns related to the number of times a turned gear turns
force / time
it slows
goes down
near the center of the torque angular velocity curve
gravity is causing them to slow down and more torque is needed to maintain the speed
more force is applied to the wheels and the maximum speed slows
to change torque and or speed
55 MA

Posttest Response on 2001-04-12 at 09:22
a twisting force
turning speed
the number of times an output gear turns if the input is turned once
how fast energy is used P=t* w
decreases
increases
at stall torque and when the motor is spinning as fast as it can or max no load speed
they have a constant torque with a gear ratio conducive to speed
it is reduced
to change gear ratio for speed or torque
yes
good job I will direct students here
User 783

Pretest Response on 2001-04-18 at 20:31
angular force
speed around an axis
ratio between two gears' #of teeth or radius
work over time
decreases
increases
midpoint of t-s curve
working harder
decreases
put in same work in varying conditions
21, MIT Senior (hopefully i will be an
outlying datapoint--woodie directed me
here because my sr thesis is a similar
thing)

Posttest Response on 2001-04-18 at 20:37
FR
velocity about an axis
ratio of #teeth/radius
work over time
decreases
increases
stall torque, no-load speed
generate more P
decreases
constant effort
yes
nice website =)
User 807

Pretest Response on 2001-04-20 at 13:09
Torque is a twisting force.
Angular Velocity is rotational motion
The number of times the motor spins compared to the output gear
the amount of work per unit time
the angular velocity will decrease
the maximum torque output of the system will be decreased
when the torque and angular velocity are equal.
more work needs to be done because the rider is fighting the earth's gravity
the maximum speed of the bicycle is decreased
to make it easier to pedal
age 19, u of m flint end of sophomore year

Posttest Response on 2001-04-20 at 13:16
Torque is a twisting force.
rotational speed
the number of turns of the output gear if the input gear is turned once
power is how fast energy is used
if the angular velocity of the motor is increased the amount of torque is decreased
the maximum amount of torque increases
the ends of the curve
a bicyclist going up a hill can't push hard enough to climb the hill because of the high gear ratio
the maximum speed of the bicycle is decreased
to make it too easier to push the pedals
yes
I am a u of m flint physics student.
Forces that act in a rotational manner and created by a vertical force applied at the end of the handle. (N-m)
The rate of rotation around an axis. (RPM)
Ratio involving angular velocity and torque
Ability to act or produce an effect. Rate at which work is done
Angular velocity decreases
Torque decreases
At the maximum area under the graph
Angular velocity is lower so the torque has to increase. Therefore, the bicycler will slow down and apply more force
Angular velocity will increases so the torque decreases
To make peddling easier

Posttest Response on 2001-04-19 at 14:38
twisting force
turning speed
number of times the output gear turns if the input gear in turned once
how fast energy is used
torque decrease
increase
when gear ratio is too high there is no power: Stall point and no load speed
because he needs less torque to overcome gravity
increase
to maintain max power
yes
your welcome!!!
User 675

Pretest Response on 2001-04-12 at 11:23
force that produces rotation
velocity of a rotating object
Ratio of the size of different gears, like in a car
the time at which mechanical energy is transferred
Angular velocity decreases
Torque decreases
Torque at half stall torque and angular velocity at half no load speed
Because the gear ratio is large and more load on gear
The speed decreases
for different elevation changes, so there is less load on the bicyclist.
20 Sophomore

Posttest Response on 2001-04-12 at 11:41
Its a twisting force. its how hard you have to twist to turn an object around.
Its turning speed that tells us how fast an object is spinning
A gear ratio is the number of times its take for the output gear to turn, each time the input is turned
The amount it take for power to be used
Decreases
increases
stall torque and no load speed
Because there is less torque
Higher speed
so there is no load on the body, and to pick up speed
yes
It was a good tutorial, learned a lot, and make sure DR Boys gets this hahahahaha....
User 248

Pretest Response on 2001-04-06 at 15:09
product of force and perpendicular distance
angular distance divided by time interval
ratio of number of teeth on one gear to that on another
rate of doing work
decreases
decreases
50%
force increases so torque applied must also increase
it goes down
to keep your speed at 50% of maximum, and thus your torque also
60 PhD

Posttest Response on 2001-04-06 at 15:26
force times distance
angular displacement divided by time interval
ratio of angular displacement of one gear to that of the other
force time velocity or torque times angular velocity
decreases
increases
no load speed and stall torque
operates closer to maximum power
decreases
to operate nearest maximum power
yes
I had difficulty knowing too many ways I could respond to the question, and wonder if your program can recognize the different possibilities. Sometimes I wondered if you wanted a rule on how to calculate it.
Pretest Response on 2001-04-16 at 04:56
Torque is the angular equivalent to force and represents the amount of weight that can be moved a certain distance from the pivot point. Angular velocity is the speed with which something is spinning. What's this question supposed to mean? Not sure I can explain a gear ratio, unless you mean the ratio of how much you turn one gear for the amount of motion of the other gear. Power is the amount that can be moved at a certain velocity. Angular velocity decreases. The area underneath the torque-velocity curve represents power, so when that area is maximized. In the graph above, it is halfway between the maximum torque and the maximum angular velocity. The same answer as 5, the load increases and so the angular velocity decreases. Decreases to change gear ratio's and make the ride easier, more torque when going up hill, and more angular velocity when going straight.
19, sophomore in college.

Posttest Response on 2001-04-16 at 05:40
torque is a turning force and measures how hard you are turning something. Angular velocity is the speed with which something rotates. The ratio of the input gear to the output gear. Power is the rate at which energy is used. Decreases. Increases. Stall torque, and maximum angular velocity. The hill requires more torque and the high gear can't provide that much torque. It decreases. To try to always have the maximum power. Not the first time that I tried it, but then I tried the middle link and they worked. I hope you learned something from me. :)

I took about 2 hours to do this, mostly spent on the pre test trying to figure out what some of the questions meant.
Force times the lever arm.  
Speed of rotation usually measured in revolutions per minute or radians per second.  
The ratio of input speed to output speed for a gear set or gearbox.  
Work divided by time. You can also calculate it by taking force times velocity or torqu times angular velocity.  
It decreases.  
It goes down.  
Please don't confuse people further about gears being higher or lower. A higher gear ratio seems to be the opposite of what you describe. Please use the term lower gear ratio. Further the motor doesn't change gear ratios the gear box connected to a motor does.  
For the curve above the peake power is at 1/2 of the free speed.  
Because the torque load went up along with the power load.  
It decreases. Again confusing as this is actually a higher gear ratio.  
So that he can stay in his peak power band.  
26 - Bachelors of Engineering

Your definition of a gear ratio is wrong. It appears you have them backwards. Your drawing shows an input gear that is smaller than the output gear. This is a gear ratio of greater than one. The answer should be 2:1 not 1:2. A common example would be an axle in a car having a gear ratio of 4.10:1. For every revolution the tire makes the driveshaft makes 4.10. My American Heritage Dictionary confirms this.  
Drill motors have a very high gear ratio (that which you would describe as low gears.) I have found the students find this very confusing, so I try to stick with talking about gear ratios, not gears. When you downshift in you car you actually get a higher gear ratio.  
I find an explanation of power without a discussion of work goes against classical teaching. If you want people to understand power they should also understand work.  
The colorful diagrams are great. I think they go a long ways toward teaching the principas you intend to. I think most people are used to looking at an available power vs. angular velocity which is a parabola. Your plots actually confused me a little.
Broken Tutorial Subjects

User 716

Pretest Response on 2001-04-13 at 10:16
I have no idea.
I have no idea.
Again, I have no idea.
No idea...
It becomes bigger?
I don't know
I don't know
Because it becomes harder to pedal...
I don't know
So it is easier for their legs to pedal
I'm 15 and a sophomore in high school.

Posttest Response on 2001-04-13 at 10:26
how hard you have to twist to turn an object
the turning speed of an object
the number of times an output gear changes when the input gear is turned once
how fast energy is used
it decreases
I don't know
I don't know
I dont remember
it decreases
to make it easier to pedal
I think so but my computer didn't play them when i pressed the play button
I'm not too bright on this gear ratio stuff but I hope it helped :-}
Pretest Response on 2001-04-25 at 09:06
How much power the engine has
Something to do with speed, but I am not sure what
How many times the gears turn in relation to the speed
Power generated by mechanical means (machine made)
It increases
It increases
Highest, I guess--not sure what you mean by level
It is harder to push the pedals at the same rate because of the incline
The speed decreases
It takes fewer rotations (pedal power) to go the same speed
44--returning to college this summer--been out of school for 16 years

Posttest Response on 2001-04-25 at 09:25
A twisting force
turning speed
relationship of input gear to output gear
power generated by gears turning
it decreases
it decreases
max torque; max angular velocity
torque is increased; angular velocity is increased--when either is greater, power (speed) is decreased
it decreases
to improve the gear ratio, getting it closer to 1:1
No, my computer has serious limitations that I can't control. I am part of a network.
It is a very informative and interesting site. This will come in handy next year on the robotics team. I hope
that you be leaving it up in some format. It is quite obvious that I didn't understand any of this before.
User 776

Pretest Response on 2001-04-19 at 13:01
gets harder to pedal
decreases
to make pedaling up/down hills more efficient.
24 - Batchelors Degree (the last time I studied physics, I was a junior in high school)

Posttest Response on 2001-04-19 at 13:34
Torque is a twisting force
Angular velocity is turning speed
Gear ration is the # of times the output gear turns for one turn of the input gear
Power is how fast energy is used P=T*ω
The amount of torque generated is reduced
the max torque is increased when the gear ration is lowered.
Where torque=0 or where angular velocity=0
There is a more angular velocity and less torque
The max speed is decreased
to decrease/increase the torque when going up/down hills
no
hope this balances out the smart people a little bit.
User 748

Pretest Response on 2001-04-15 at 14:45
The thrust of an object.
Speed.
The proportion of the size of a gear to the torque that it can create.
Power that is generated by something mechanical rather than chemical, for example.
The angular velocity also increases.
It decreases.
Low.
He/she can no longer produce enough torque on the gears (because of the resistance on the hill) to keep the same level of angular velocity.
It increases.
To input the least amount of energy to attain the most speed and distance.
22, BS in Liberal Studies

Posttest Response on 2001-04-15 at 15:30
Twisting force.
Turning speed.
The number of times that an output gear turns if the input gear is turned once.
How fast energy is used. It is the combination of torque and angular velocity.
It decreases.
It increases.
When the gear ratio is too high, and when there is max torque and no angular velocity.
On a steep hill, the bicyclist cannot overcome the torque as easily because the gear ratio is too high.
It increases.
To be able to input the least amount of power to create the most amount of angular velocity.
Yes, but I couldn't get them to play. (My computer is having issues.)
The initial concept of torque and angular velocity wasn't too hard to understand, but after that, it became a little more difficult for me (being a Liberal Arts major!).
User 740

Pretest Response on 2001-04-15 at 01:18
Something to do with motion.
Something to do with motion.
Difference between the gears.
Is it power generated by some kind of motion?
Angular velocity decreases (I think that's how you read the pretty graph.)
My instinct tell me that the maximum increases, but I don't understand engines, so I could have that backwards.
IN the middle?
He/she needs to shift into another gear. I don't know if it's up or down.
Slower.
To help them move more efficiently.
Sad to say; I'm 27; I have a master's degree in an arts field and I don't understand this stuff!

Posttest Response on 2001-04-15 at 01:37
a twisting force
a turning speed
It is the ratio between input and output.
how quickly energy is expended
torque decreases
the torque is smaller. This part was confusing to me. I didn't understand which drawings represented "smaller" or "larger" outputs. Maybe a better picture for us physics-deprived people would help.
When the torque is at max and angular velocity is at the minimum.
Because of the gear ratio. The bicyclist needs to change to a different gear. If he/she was at 1:1, he/she needs to change to a gear like a 5:1.
This is where I'm confused. Please see statement above.
So that they do not hit a stage where they are creating all the torque but not the angular velocity.
No, I could not get them to work.
No matter how badly I scored, please know that I really tried! I wish I could learn more about this; it's very interesting, but I'm afraid my brain doesn't quite grasp the concepts.
User 730

Pretest Response on 2001-04-14 at 16:02
The amount of work put into a system
the increase in speed in a circle
torque:angular velocity
the amount of work put into the system
it decreases
it goes up
50%
because not enough work goes into maintaining angular momentum
the spoke spins faster, meaning that bike can go
to make it easier to pedal
22; Senior

Posttest Response on 2001-04-14 at 16:29
twisting force
turning speed
ratio of gears;
diameter in: Diameter out
Power= torque x angular velocity
torque decreases
max torque decreases
No load speed (torque= 0)
stall torque (angular velocity=0)
because the gear ratio is at a higher level all the, meaning that the amount of torque needed to create
maximum power is greater. It's much harder for a biker to create the necessary torque going uphill than on
a flat surface.
it decreases
to adjust the possible angular velocity and torque for the biking conditions
no.
It's a really easy-to-understand tutorial. The one thing is a vocab list that we could jump to at different
points in the tutorial. It's hard to remember a whole bunch of new terms at once.
User 810

Pretest Response on 2001-04-20 at 14:22
A force that causes rotation
The speed of rotation
torque over angular velocity
energy generated
The angular velocity decreases
It increases
high torque, low angular velocity
angular velocity decreases
It decreases
Increase power output generated by power input
25, BS

Posttest Response on 2001-04-20 at 14:28
force that causes rotation
turning speed
number of input turns required for one output turns
how much energy used
decreases
decreases
low torque, high angular velocity
torque
decreases
change torque
no
good tutorial
User 696

Pretest Response on 2001-04-12 at 19:35
Power
speed given over an angle
teeth to teeth ratio
leverage
decreases
increases
equal levels
because the gears are not at the correct ratio, and there is not enough torque
increases
to increase the speed they are traveling at and to increase the torque of the bike so they can take inclines easier
19 years old, Freshman in college

Posttest Response on 2001-04-12 at 19:49
turning power
how fast an object spins
teeth to teeth ratio, how fast one gear pins in relation to the other
how fast the energy is used
it decreases
stall torque
stall torque and no load
because the angular speed is higher not the torque speed and therefore not much power is being used or created
the speed decreases
in order to increase their speed
no, the animations would not pop up
nice work Tom, I hope my info and many others can help you out a lot, and don't worry we will steal you again next time :)
User 727

Pretest Response on 2001-04-14 at 12:02
Not sure of the official definition.
Speed measured in a circle
The ratio of the number of teeth of two mating gears.
Not sure of the official definition.
Angular velocity decreases.
Max torque increases.
Max torque.
Runs out of power.
Max speed goes down.
To obtain more torque.
age:29 BS:EE

Posttest Response on 2001-04-14 at 11:57
How hard you have to twist to turn an object around.
How fast an object is spinning around.
The number of times an output gear turns if the input gear is turned once.
How fast energy is used.
Torque output decreases as angular velocity increases.
Torque increases.
Zero torque and zero angular velocity.
Because the torque required to spin the tires decreases on a flat causing the angular velocity to increase.
Maximum speed decreases due to the reduction in gear ratio.
To obtain max power as the terrain changes.
No
This is a nice tutorial. I needed the brush up since I have not had any classes or reason to use this material in a long time. Thanks.
User 774

Pretest Response on 2001-04-17 at 12:05
power to do work; something to do with friction.
How fast something goes. Perhaps at an angle?:)
the ratio of gear sizes used. big:small
how much work a machine can do. A car with a strong motor has more power than a car with a weak engine.
it decreases
it decreases. smaller gears have more torque.
at the higher torque levels, lower velocity levels.
ot in good enough shape...less donuts, more protein. Ie: smaller overall output in the larger gears with
increase in work potential
velocity decreases
increase/decrease torque to maximize velocity
23, year 21 in school. (B.S. degree, 2 weeks away from master's comps)

Posttest Response on 2001-04-17 at 12:43
twisting force
how fast the wheels turn
the input: output gears
amount of force
how fast energy is used
decreases
when there is zero torque, or zero velocity
less torque on a flat surface
decreases
to decrease torque
not moving ones
Nice drawings, Tom. Glad to see you got something out of MIT.:) Hate to say it though, but this webpage
is just like Physics or something. You learn the stuff for a few minutes while you take the exam and then
you forget it all. Anyway, hope it works out well. Good luck on getting out of there!
User 436

Pretest Response on 2001-04-12 at 12:52
Turning power
A ratio of time, distance, and friction.
Mechanical manipulation of torque based on the circumference of gears.
Energy generated mechanically.
Angular velocity increases
Decreases
not sure
Not enough power.
It decreases.
Speed changes
44 years old 14 years of school

Posttest Response on 2001-04-12 at 13:30
Torque is turning force represented by the formula $T=FxR$
T is Torque, F is Force, and R is Radius of object
Angular velocity is how often something turns in relation to its radius.
$W= \frac{V}{R}$ Angular velocity is the relationship of the speed of rotation of a point to the radius. Velocity divided by the radius of the pivot point.
The ratio of two or more gears. Diameter of the input gear divided by the output gear.
Power is torque times angular velocity. $TxW= \text{Power}$
Decreases, and the inverse is true. If the angular velocity decreases the amount of torque increases.
The torque increases.
The stall point is when angular velocity reaches zero and torque is at its maximum and the other is no load speed. That's when there is no torque but maximum angular velocity. No power is generated it just spins.
More torque is required on a steep hill which reduces the angular velocity reducing the maximum power.
Maximum power is achieved more on a flat terrain than on a steep hill. Maximum power is when the ratio of torque and angular velocity are 1/2.
The torque is increased allowing greater potential for higher speeds.
To try and maintain maximum power.
no
Overall an enjoyable exercise. I did have to go back a few times to review but I did learn something even without the animations. Good job!!
User 770

Pretest Response on 2001-04-17 at 00:11
Force that runs parallel to the center of a spinning body?
speed at which at object going round in a circle would go at if could stop going round but go straight?
Ratio between a bigger gear and a smaller gear
work done by physical force
it increases
it decreases
Highest torque, lowest angular velocity
He can't apply enough force to keep up the velocity
He can't go as fast.
So he doesn't have to apply as much force to move the bike forward up a hill
30, MBA

Posttest Response on 2001-04-17 at 00:33
turning force
spinning velocity
number of times one gear spins another
how fast energy is used
decreases
lower torque
don't remember
The cyclist can't over come the torque so he moves slower on a steep hill.
it goes down
To make it easier for him to pedal
none that worked for me
Interesting idea. Would have been more interesting if the videos had worked.
User 313

Pretest Response on 2001-04-18 at 02:11
force with a lever arm, the centripetal / angular power or force (causing things to rotate about an axis)
rotational speed
a way to convert torque to angular velocity and vice versa (through use of different gears)
the ability to apply a force
when torque load is increased, the angular velocity decreases
in this scenario, the maximum amount of torque a system can generate is increased
high level of torque, low level angular velocity
he has to apply the torque singlehandedly (without changing the gear ratio) thus the angular velocity decreases
max speed is increased
to adjust for a given situation (to go faster, or to go uphill)
16, Junior in high school

Posttest Response on 2001-04-18 at 02:42
a twisting force: force multiplied by the lever arm (max at low angular velocity) T as convention symbol
a turning speed: tangential velocity (linear) divided by the radius (max at low torque) w as a convention symbol
the number of times it takes an input gear to turn an output gear once
1 : 2 would mean that it would take two input gear rotations to rotate the output gear once
how fast energy is used up: torque multiplied by angular velocity. Max at 1/2 of max torque and 1/2 of max angular velocity
the amount of torque the motor can generate is decreased
btw: T(w) = T_max - (T_max / w_max)w
the amount of torque is increased
the stall torque (angular velocity is zero) and when the torque is zero (no-load angular velocity or "typically" no-load speed)
he does not need as much torque to move on flat ground, thus the angular velocity is greater (making the tangential velocity greater as well)
the maximum speed decreases
to maximize power!
nope, none that i saw
on the graphs, i didn't notice the x and y axis labels (T for torque and W for angular velocity) because they were a different color, and easily overlooked. if they were the same color as the graph, they would better compliment each other. I liked the lesson overall (although there were no links in the end)
Torque is the amount of mechanical power released by a motor. The speed at which a motor operates, relative to its torque. The higher the torque, the lower the angular velocity, or speed, and vice-versa.

Gear Ratios are used to adjust speed of motors for various applications. An example would be using a gear ratio to adjust equal speed for two different motors.

The amount of energy needed to move something, or energy released by a motor to move a load. Angular velocity decreases as the torque load increases. As the load increases, more torque is required to move the load, and as a result the angular velocity decreases to compensate for the increase in torque.

On a lower gear, the maximum torque is increased. On a higher gear, the maximum torque is decreased. The smaller the output gear, the more revolutions per second it can do. This means it moves faster, but with less power. The reverse is true for a larger output gear.

With minimal angular velocity and higher torque, more energy is produced. This is because the torque enables one to move more massive loads.

The load of the bicycle uphill increases as kinetic energy increases. Shifting gears compensates for this increase.

The maximum speed decreases.

To conserve the energy of the bicyclist.

17, Nonnewaug High School

Posttest Response on 2001-04-12 at 19:09
Torque is how much force is required to rotate something.
Angular velocity is how fast something rotates.
A gear ratio is how far an output gear will turn when an input gear is rotated 360 degrees.
Power is the rate at which energy is consumed.
Torque decreases as angular velocity increases.

The lower the gear ratio, the more torque is produced.
With zero torque, there is no power, nor is there with no angular velocity.

With a higher gear the angular velocity increases, as there is less torque. The input gear is larger than the output gear, producing more speed.

The maximum speed decreases. Speed is based on angular velocity, and angular velocity decreases with increasing torque. Torque is increased with a lower gear.

To conserve the maximum amount of power, to go farther distances with less wasted energy.

No, only blank windows media player applets.

This seems an interesting and creative way to teach, I know I learned much about everything covered, the visuals and simple explanations really help. Great job, and good luck with graduation. You should have no trouble with a theses such as this.
Pretest Response on 2001-04-16 at 17:32
Rotational force
The rate and direction at which an object rotates
A proportional measure of the force transmitted from one gear to another
The rate at which work can be done
According to the curve, angular velocity decreases as torque increases.
It increases
Higher torque, lower angular velocity
The bicyclist is experiencing an unfavorable gear ratio; he/she needs to pedal a lot to move a short
distance.
The maximum speed of the bicycle decreases.
To change the balance between exerting a lot of torque (more desirable when riding up a hill) or acquiring
a high speed.
26, last diploma was a B.S. in biological engineering, currently in grad school

Posttest Response on 2001-04-16 at 17:46
Torque is rotational force \( T = F*r \)
Angular velocity is rotational speed.
The ratio of one gear diameter to another.
The rate at which energy is produced.
As the angular velocity increases, the amount of torque decreases.
When the gear ratio is lowered, the maximum amount of torque increases.
At maximum torque, the angular velocity is zero, so there's no power. At max angular velocity, the torque
is zero, so again there's no power.
In high gear, angular velocity is maximized at the cost of torque, but you need more torque to climb a hill
than to cycle on a flat surface.
The maximum speed decreases at the lower gear.
To choose between maximum speed and maximum torque, in order to adjust to the terrain.
No. I saw play/pause bars, but no animations.
This is a cool project, and the graphs and info are excellent. There are a few grammatical errors in the
text, though...
User 796

Pretest Response on 2001-04-19 at 16:50
circular force
speed traveling in a circular motion
gear verses tire
I^2(R) conventional current squared times the resistance
decreases
increases
when the torque and the angular v. are equal
becuase the torque is increacing which causes the velocity to decxreace
decreases
to increase their maximum speed
29, 15

Posttest Response on 2001-04-19 at 17:00
twisting force
turning speed
Number of times the output gear turns compared to the input gear turnig once
how fast the energy is used
decreases
the torque increases
stall
doesn't need as much torque to go on a flat surface
increases
to have less torque needed and increace the speed
no
Ithought your pixs where great
User 780

Pretest Response on 2001-04-17 at 19:34
Resistance
One of those triangular firework thingamajigs that spins real fast...
It's the ratio of two or more gears to one another
Potential Energy
Angular velocity decreases
decreased
the "sweet spot" right in the middle.
He's out of shape.
decreases
To prove their smarter than the average bmx kid. (More efficient use of energy)
24 High School Graduate

Posttest Response on 2001-04-17 at 20:00
Torque is a twisting force.
Angular velocity is a turning speed.
ratio of different input and output gear sizes
Mechanical Power is defined as torque X angular velocity.
Decreases...
Increases...
When either torque or angular velocity equals zero.
steep hill requires a greater amount of torque which decreases angular velocity and in turn, speed of bicycle.
Decreases
to achieve max power
no.
you're cool.
User 801

Pretest Response on 2001-04-23 at 11:51
A force causing a twisting motion on an object.
The rate of a motor measured in radians
The max speed per gear
The amount of work done in a fixed amount of time
The angular velocity will decrease
When the torque is at a maximum and the angular velocity is at a minimum
Because as the bike climbs the hill more torque is generated and the angular velocity decreases causing the bike to slow down.
The maximum speed of the bike increases
To reduce the amount of power needed to operate the bike efficiently
22 5th year student

Posttest Response on 2001-04-23 at 12:02
A force that creates a twisting motion.
The speed at which an object spins.
The number of times an output gear is turned by turning an input gear once.
Power is how fast energy is used up.
The torque will decrease as the angular velocity is increased.
The maximum amount of torque will decrease.
The stall point and the no load point.
Because on flat ground less power is needed to keep the bicycle moving. On a hill more power is needed and a lot more torque is needed to keep the bicycle moving because of the gear ratio.
The maximum speed of the bicycle will decrease when it is shifted into a lower gear.
To keep the bicycle moving while using the least amount of power.
No.
This was a good test.
Pretest Response on 2001-04-14 at 15:58

As I recall... angular velocity=velocity/circumference. It describes the number of complete rotations occurring in a specific time period.

ratio of circumferences of gears.

as torque increases the angular velocity decreases

The maximum amount of torque is decreased as gear ratio increases.

More torque is required to make it up the hill. If the gear ratio doesn't change then a reduced speed is required to generate the greater amount of torque.

Maximum speed of bicycle is decreased.

Bicyclists shift gears to change the torque-speed curve. This is done when a greater speed or more torque is needed.

age = 23.

Senior is CpE.

Posttest Response on 2001-04-14 at 17:00

Torque = Force * Radius. It is the rotational force applied to a system.

w = Velocity / Radius. It is the rotational velocity, or the rate that revolutions occur.

Ratio between gear circumferences.

Torque * w. It is the rate at which energy generated.

The max generatable amount of torque decreases.

Max torque increases as gear ratio decreases.

At max torque and max angular velocity the system doesn't generate power.

On a hill, the amount of torque required to bike at a constant velocity is attainable at a low angular velocity. In the flat, the amount of torque required to bike at a constant velocity is attainable at a high angular velocity. This is all described by the torque-angular velocity curve and is determined by gear ratio.

Max speed decreases as gear ratio decreases.

Shifting gears changes the gear ratio and effects the torque-angular velocity curve. This allows a greater max torque and greater max velocity.

no.

The tutorial was well explained. I thought that the tutorial was too squished space-wise. The pictures in particular could have been less confusing by taking up more space.
Pretest Response on 2001-04-24 at 15:23
Torque is the amount of force needed to move a certain object a given amount of distance in circular motion. the velocity at which a round object turns and is given in radians per second. Tells the reduction or enhancement of the the gears Example 14.7:1
THE AMOUNT OF OUTPUT.
IT SLOWS DOWN
IT WILL BE DECREASED
AT THE PEAK OF THE CURVE
HE/SHE DOES NOT HAVE THE POWER TO GET UP THE HILL
IT IS DECREASED BUT THE AMOUNT OF EFFORT REQUIRED IS DECREASED
MAKES IT EASIER
25 JUNIOR IN COLLEGE

Posttest Response on 2001-04-24 at 15:32
TORQUE IS HOW MUCH ENERGY IS REQUIRED TO TURN SOMETHING
HOW FAST SOMETHING TURNS AROUND YOU IN RAD/S
USUALLY IS A REDUCTION SUCH AS 2:1
IS HOW FAST ENERGY IS USED
IT IS DECREASED
TORQUE IS INCREASED
THE X AND Y AXIS
BECAUSE THE BICYCLIST DOES NOT HAVE THE POWER TO PEDAL AS FAST GOING UP HILL.
IT IS GREATLY DECREASED
TO MAKE IT EASIER TO CLIMB HILLS THEREFORE HE CHANGES THE GEAR RATIO
NO
HAVE NO EXTRA FEEDBACK
User 749

Pretest Response on 2001-04-15 at 15:06
Force trying to turn an object.
Velocity of an object turning
Rate at which one gear turns another (ie One gear makes two revolutions for every one of a larger gear)
Energy applied to move objects
Decreases.
Lowers
Highest torque, no velocity
Bicyclist has to apply more force to go up hill, thus more torque and less velocity
Goes up.
To make best use of energy. Downshift to go up hills, upshift to go down hills
22, Junior in college

Posttest Response on 2001-04-15 at 15:15
Twisting force
Turning speed
Comparitive diameter of gears
Torque times angular velocity
Decreases
Increases
x=0 and y=0
Need less torque for flat surfaces, which is harder to generate in a higher gear
Lowers (assuming due to pedaling power, and not coasting down a hill)
To achieve a better use of Energy by finding the optimal power point.
Nope
Nil
Torque is effort applied to move a load.
Angular velocity is the rate of change of a given angle measure over a certain space of time.
Gear ratio is a way of measuring drive reduction. Changing a gear ratio trades angular velocity for torque
or vise-versa or neither. However, any gearing system has frictional loss.
Mechanical power is motive force, or, the power to move.
Assuming current to the motor is constant, the angular velocity of the motor should decrease.
torque would decrease in this situation.
The higher the torque, the higher the mechanical power regardless of how much angular velocity is
present. Because he/she can't must provide more power to get up the steeper incline, and must usually work harder
to do so.
it lowers. Low gearing provides extremely high torque with a loss of angular velocity.
To start out moving, a bicyclist usually uses a low gear to given them the high torque necessary to
facilitate initial acceleration. However, as speed increases this high torque becomes unnecessary as
momentum can keep the vehicle moving for the most part. At this point (cruising) a higher gear is desired
so that the bicyclist can supply the high angular velocity and lower torque effort needed to keep the
vehicle moving.
18, 12th (senior in high school)

The explanations of torque, angular velocity, gear ratios, etc. were much better than anything presented
in my Principles of Technology class! I think I learned more here in half an hour total than in the three
weeks spent on the these topics in class! Great job.
User 704

Pretest Response on 2001-04-12 at 21:42
How much force the motor is able to generate.
The amount of speed the motor puts out.
A set of gears used to change the amount of torque and speed the motor generates
The combination of torque and power the motor is generating.
The angular velocity goes down
The amount of torque is reduced
When at half of total torque and half of maximum angular velocity
He/She doesn't have as much torque as needed.
The maximum speed drops
To allow them to use less effort when it is not needed.
Age: 16 10th grade in high school

Posttest Response on 2001-04-12 at 21:57
Torque is the amount of force needed to turn an object.
Angular velocity is how fast the object turns
The ratio of output gear to input gear.
The combination of torque and angular velocity. It is found by multiplying the torque and angular velocity
The amount of torque decreases.
The amount of torque increases.
The stall torque and the no load speed.
He needs more torque than angular velocity.
The maximum speed is reduced.
To use only the amount of power necessary.
No.
A good tutorial. It helped me to better understand how to apply the concepts.
Pretest Response on 2001-04-21 at 02:41
the strength at which a motor can turn something
uh........linear velocity divided by radius
when you put 2+ gears together of different sizes the gears will turn at different rates. The ratio of these
rates is a gear ratio
?
it lowers
decreases
?
gravity is pulling him down the hill
lowers
so he won't have to work as hard pedaling
16
10th grade

Posttest Response on 2001-04-21 at 02:54
It is how hard you have to twist to turn an object around.
It is how fast an object is spinning around
A gear ratio is the number of times the output gear turns if the input gear is turned once.
Power is how fast energy is used.
decreases
increases
no w and max w
because there is less torque
increases
to not pedal as much
no
none
User 732

Pretest Response on 2001-04-14 at 18:08
Force x Lever arm at which the force is applied
change in position as something moves in an arc.
size of one gear compared to the size of one it is adjact to.
torque x angular velocity
it decreases
it increases
0.5T x 0.5AV
T remains the same, but the AV decreases. Therefore, power decreases and the rider slows down.
it increases
to generate the most power with the least amount of effort

Posttest Response on 2001-04-14 at 18:32
twisting force: T=Fxr
turning speed: w=v/r
number of times the input gear
how fast energy is used: P=Txw
T decreases
max T increases
Tmax and Wmax
when the angular velocity decreases biker can't get enough power to keep the bike going up hill.
increases
to get the most ideal gear ratio that will allow them to get the most power with the least amount of torque.
no
I wanted to see the animations! :o) Hi TOM!
Torque is the amount of pressure about a fixed point when a force is applied to a bar extending from that point.
Angular velocity is the velocity of something that is spinning.
Gear ratio is the ratio of two gears. The number of turns of one compared to the turns of the other.
Power is a measure of the amount of work that is done over a distance.
The angular velocity will decrease.
The torque will increase.
The maximum power is generated at the midpoint of torque and angular velocity.
He/she slows down because the grade of the hill requires more output from the bicycle which can only be attained by shifting to a lower gear.
The maximum speed will decrease.
To get a greater speed without having to pedal as much.
23, 6th year

Torque is a twisting force. It is how hard you have to twist to turn an object.
Angular velocity is how fast an object is spinning.
Gear ratio is the number of times the output gear turns if the input gear turns once.
Power is how fast energy is used.
The torque will decrease.
The torque will increase.
The stall torque and the no load speed.
The amount of torque required on the flat ground is less than that on the steep hill to produce the same angular velocity.
The maximum speed will decrease.
So they put in less torque to get a greater angular velocity.
Yes, but only the tool bar to show them appeared the actual animations did not.
I found the tutorial to be very simple but extremely helpful.
Pretest Response on 2001-04-11 at 15:59
force acting through an angle
revolutions per unit time
radius of 1 gear compared to another radius of a gear
work per unit time
decreases
increases
at the mid point of torque and angular velocity
torque has to increase to stay at a constant velocity, since the same gear is used
the max speed decreases and torque increases
so that the same amount of work can be done by a person by using simple physics
22, junior in college

Posttest Response on 2001-04-11 at 16:23
applied force through an angle
revolutions per unit time
when 1 gear is completely revolved, compared to the number of turn the the other revolves
work accomplished per unit time
decreases, since they are inversely proportional
since there is a smaller gear ratio (1:0.25), the torque will decrease or else become 0.
point 1 torque = 0
point 2 angular velocity = 0
there is little torque and a lot of angular velocity produced. (high gear ratio) but on a steep hill, more
torque has to be produced, and so gears have to be switched
the speed decreases and torque increases
so that less work has to be done
no
you made several difficult topics in physics seem extremely easy
Torque is an angular force, or twist.
Angular velocity is the rate of rotation of a body.
Gear ratio is the comparison of size of one gear to another. The gear ratio determines the effect the gears will have on torque and angular velocity fed into the gear system.
Power is force over time. Mechanical power is kinetic force over time.
The torque load and angular velocity on an electric motor are inversely proportional. If the torque load increases, the angular velocity will decrease.
Output torque is reduced
Generally at about 70 percent of potential torque and velocity.
Increased torque requirements, reduce angular velocity.
the max speed is reduced
to adjust to torque requirements for max efficiency.
27, BSME

most electric motors actually have a power curve, not a flat line. They are most efficient at around 70 percent power.
User 759

Pretest Response on 2001-04-16 at 14:09
Twisting Force
Rotational Speed
Speed difference
Force that can be applied
Proportionally decreases
Lowered
50%
Runs out of power
Lowered
To get more power
27 Purdue

Posttest Response on 2001-04-16 at 14:15
Twisting Force
Rotational Speed
Difference between two (or more) rotating speeds
A force you can work with
Lowered
Decreased
No speed stall torque and full speed no load
Since he has only a little power to work with he uses it on flat but he doesn't have enough to use on the hill
Decreased
To gain power or speed
No
THanks
User 741

Pretest Response on 2001-04-15 at 01:42
power time the radius
time rate of change by some angle
the difference between two sprokets
amount of work performed per unit of time
decreases
decreases
mid torque and mid angular velocity
gear ratio is not small enough
decreases
mechanical advantage
30 BS Forest Engineering

Posttest Response on 2001-04-15 at 01:59
force times some radius
speed of a spinning object at some distance from the center
how many times 1 turn of the input drive gear turns the output drive gear.
torque times the angular velocity
decreases
increases
at max Angular velocity, max torque
the steep hills requires more torque, but the high gear has limited torque because of the higher gear ratio.
decreases
maximize power output
no
Nice graphics in the icandy section. This was a nice refresher course
User 534

Pretest Response on 2001-04-04 at 16:19
Rotational Force
tau=I*alpha
Rotational velocity
The velocity at which something rotates
omega=v*r
A gear ration is a ratio of the number of times the motor's output shaft rotates compared with the main output shaft.
p=omega*tau
Work done per unit time or angular velocity multiplied by torque
The angular velocity decreases
Angular velocity increases, which is inversely proportional to torque, therefore torque decreases for a constant power.
When both torque and angular velocity are maximized relevant to each other.
Not only does air resistance and friction oppose the travel of the bicycle, but the force of gravity does now too m*g*sin(theta), with theta equal to the angle of the hill above the vertical.
Torque increases, while angular velocity of the wheel decreases, therefore linear velocity decreases
To maximize linear velocity while maintaining a constant W. 
19 years-old
Freshman in college who took a Physics I: Mechanics exam yesterday

Posttest Response on 2001-04-04 at 16:37
T=F*r
Rotational force
w=v/r
rotational velocity
The ratio for in to out
P=T*w
T decreases
T increases
T=0, w=0
A low amount of opposition forces allow for a small torque, maximizing w and v.
The maximum speed decreases
To maximize speed/minimize T to only what is required.
No, I was not able to view any...
My biggest problem with internet learning as well as simply reading a text book, is that I like to be able to hear the material. Visual and Aural learning is best for me.
Pretest Response on 2001-04-12 at 22:01
a vector with direction determined by the cross product of two other vectors.
the speed of the rotation measured in radians per seconds.
the ratio of the power of one gear measured against another gear -- output in comparison to input of gears.
the amount of mechanical work done divided by the amount of time it takes to get it done.
The angular velocity decreases as the torque load increases.
the torque maxs out and then starts to decrease.
at the very top of the bell-shaped curve -- midway between the stall torque and the no load speed.
you slow down due to the gravitational force pushing against them, they're riding up hill, and the change in the plane that they were on at the start of the ride. In other words, their angular speed is decreasing.
the maximum speed reaches it's peak and cannot go any faster.
to control how fast they would like to go as the angular speed changes. Also, to be able to go against the force of gravity when it is very difficult to peddle.
37, 4 1/2 years.

Posttest Response on 2001-04-12 at 22:23

\[ T = F \times r, \] a twisting force.
\[ w = \frac{v}{r}, \] a turning speed.
the number of input vs. output of a gear rotation.
\[ P = T \times W, \] how fast energy is used.
when the torque increases the angular velocity decreases and vice versa.
when there is a max torque the angular speed decreases and the gear ratio decreases.
at the stall torque and at the load speed point.
there is no torque load and because of this the will spins as fast as it can which = the no load speed.
max torque without angular velocity gives you the stall torque,
because the rotation speed of the rear wheel is the average velocity and this is as fast as he/she can go.
I don't think so.
Good luck with putting your thesis together. Like myself, I hope you graduate, soon. Good luck in your endeavors.

P.S. It was easy read as well as informative. Thanks.
Pretest Response on 2001-04-14 at 23:40
rotational power
The speed of rotation
Using gears of different sizes to increase or reduce speed or power
The rate of work
Angular speed decreases
max torque is reduced
At half of full speed
Although the angular speed is low, the gearing gives less torque.
The maximum speed declines
Low gears on hills to keep on going
High gears on flat roads to go fast
16, 11th grade

Posttest Response on 2001-04-15 at 00:07
a twisting force
formula: torque = radius * Force
The rotating force
formula: angular velocity = radius * velocity at one point of rotation
Ratio of output revolutions per input revolution.
formula: gear ratio = output revolutions / input revolutions
How fast energy is used.
power = torque * angular velocity
torque decreases
torque increases because angular velocity decreases
stall torque and max angular velocity
It takes more power to climb a steep hill. Additionally, on a high gear, it takes even more power because one has less torque on the tires. On a flat road the max torque requirement is less and the cyclist can afford to lose more torque by switching to a higer gear.
it decreases
to have the perfect amount of torque so that he can overcome the stall torque while obtaining the maximum angular velocity.
nope, no one, unless I didn't notice. But i'm pretty sure there wasn't one.
I had some enjoyment out of this experience. I feel I learned something along the way. Hope you get that what ever you're looking for. It's somewhere under there. This study looks interesting. I hope I get to know how it turns out. And lastly, for all the thank you's that are smeared on you web site, "You're Welcome."
Pretest Response on 2001-04-12 at 11:23
A force that produces a rotation or torsion.
The velocity of a rotating object around an axis.
The ratio of the size of the different gears, for example in a car.
The time rate that mechanical energy or work is transferred.
The angular velocity decreases.
Torque decreases.
At torque that is half of the stall torque, and angular velocity that is half of the no load speed.
Because the gear ratio is large and there is more load, as well as bigger torque.
The maximum speed decreases.
Because for different purpose different gears are needed.
Age 21, Junior

Posttest Response on 2001-04-12 at 11:44
Torque is a twisting (rotating) force.
Angular velocity is a turning speed of a rotating object.
The number of times the output gear turns if the input gear turns once.
The rate that the energy is used.
Torque decreases.
Torque increases.
A stall torque or max torque, and no load speed or maximum angular velocity.
Because lower torque.
The maximum speed increases.
Lower load and torque and increase speed.
No.
Congratulations with your academic endeavors and Thank you for this great information. Tell Dr. Boys I said "HI", and e-mail me if you want to talk about science sometimes. Just Kidding.:)))
User 722

Pretest Response on 2001-04-14 at 03:01
A measure of the strength of a twisting force. The product of a force times the length of the lever-arm on which it is acting
A measure of rotational speed
The ratio of the rotational speeds of two shafts, which are connected by one or more gears.
Work exerted per unit of time.
It decreases.
It decreases
At about 50% of it's maximum speed (or torque).
Well, for a gentle hill, I don't suppose he necessarily HAS to slow down, just increase his power output. But at some level of increased resistance, he will have reached the limits of the available muscle power, and speed will drop, regardless of WHAT gear he's in. It will decrease roughly in proportion to the change in gear ratio. Presumably, there's a certain maximum rpm at which the cyclist can spin the crank, even in the face of zero resistance.
To maintain an optimum cadence speed. Power output from the cyclist is maximum at something like 60 rpm for the pedals.
Keeping the human body within its "power band" is the objective.
BSEE

Posttest Response on 2001-04-14 at 03:36
A measure of twisting force, the product of a force time the radius through which it acts.
rotational speed.
The ratio of the rotational speeds of two shafts, linked by 2 or more gears.
Energy expended per unit time
It decreases
It Increases
No load speed and Stall torque.
Well, there's probably couple of ways to look at it. For almost ANY system, increased resistance (the hill) is going to produce decreased speed. You may get more POWER if your gearing is optimized for the hill, but I can't see that you'd ever get more speed. Now you might say that if you were in a high gear, you'd be operating near your maximum power point on the flat, and very far from max-power when on the hill.
The maximum attainable speed goes up. Probably about in proportion to the change in gear ratio.
To ensure that he is putting out nearly maximum power at all times, by adjusting his torque-speed line, so that it intersects the max-power hyperbola at something near his current road-speed. Nah. That may sound good, or fit the theory, but he's STILL trying to keep a 60 rpm cadence, or whatever works best for him. THAT defines his personal maximum power output point. You just adjust the gearing until your legs are moving at that speed.
Yes. Did they work? No.
Um, OK. The system won't accept my response unless I type SOMETHING here. But I can't really think of anything I'd like to add.
Torque is the force of rotation.
Angular velocity is a velocity of rotation.
A gear ratio is a method of altering the torque/velocity output of an electric motor by adding different-sized gears.
Mechanical power is the product of torque and angular velocity.
When the torque load on an electric motor is increased, the angular velocity decreases.
When the gear ratio on an electric motor is changed to a higher gear, the amount of torque the system can generate decreases.
An electric motor generates the most mechanical power when the torque and angular velocity are running at 50% maximum capacity (ie: Halfway up the torque-angular velocity curve).
When a bicyclist starts riding up a hill without shifting gears, he/she slows down because more torque is required to ride uphill than is required to ride on a level ground.
When a bicyclist shifts into a lower gear, the maximum speed of the bicycle decreases.
The main reason bicyclist shift gears is to provide more torque to go up hills and over some terrain.
16 years old, 12th grade (High School Senior)

Torque is a twisting force.
Angular velocity is a turning speed.
A gear ratio is the number of times an output gear spins when connected to an input gear that spins once.
Power is how fast energy is consumed.
When the angular velocity of an electric motor is increased, the amount of torque the motor can generate decreases.
When the gear ratio on an electric motor is changed to a lower gear, the amount of torque increases.
When an electric motor does not generate power, the two operating points on a torque-angular velocity curve are called "stall torque" and "no load".
When the bicyclist begins to ascend a hill, the required amount of torque increases. If he/she is stuck in the same gear ratio as compared to a flat, the power output of the bicycle will decrease, causing the cyclist to move slower than on a flat.
When a bicyclist shifts into a lower gear, the maximum speed of the bicycle decreases.
The main reason bicyclist shift gears is to generate enough power with respect to the required amount of torque of their terrain.
No, my tutorial did not contain any animations.
After you get the required number of people to take this tutorial, will it still be available online? In the future, I may need to do such explanations to any FIRST team I mentor, and such a reference as this would definitely be helpful.
Pictorial Tutorial Subjects

User 539

Pretest Response on 2001-04-05 at 10:22
a creMY PASTRY
how fast you wake up when it's 7:30
the size of two gears
amount of effort needed to do something
goes down, as per the little graph
I dunno, no graph
5 high balls
Haven't done any physical activity in 20 years
Will go up until they hit A passing truck
boredom
16, Junior

Posttest Response on 2001-04-05 at 10:31
a spinning force
a turning force
ratios of size between gears
movement forward
down
smaller
high gear, drunk
less, uh, lets say resitatnce
down
to go to max speed
no, and I feel lesser because of it
Your keyboard sticks, it was an impairment to my education
User 551

Pretest Response on 2001-04-06 at 09:11
It lies on the y axis
It lies on the x axis
the ratio between gears.
power that is mechanical
it will increase
it will decrease
12
because they are tired little girly men who cant handle any real work so they give up and quit and go slower
it stays the same. He may not be able to pedal the bike as fast however, the bike max speed remains the same
to go faster and make the work load lighter
17.6, BC High, Junior

Posttest Response on 2001-04-06 at 09:18
Twisting Force
turning speed
ratio of small gear turn to big gear turn
energy used
decreases
It rose to the pressure
top NS BOTTOM OB DRAGF
The angular velocity is less, and so is the torque
it stays the same
to make the work load easier
no
I took note of the bold faced answers, and if i ever take a course on this i will be sure to come back to this site. LIVE THE FOURTH!!!!!!
User 607

Pretest Response on 2001-04-07 at 11:50
force on a motor
the higher the angle the greater the velocity
how much force is put on one gear compared to another
how much power a machine gives
it's higher
less torque
low
force from the angle
it's greater
to keep at the same pace
17 3rd(Junior in High School)

Posttest Response on 2001-04-07 at 12:09
twisting
turning
how much the output gear turns when the input gear is turned once
how fast energy is used
little
goes higher
stall torque and max power
the force is less
lower
to go in a new torque-angular velocity line
no
good job! I learned more than in class!
User 573

Pretest Response on 2001-04-06 at 13:53
power
turn inj a dirtion
the ratio of one gear to another
able to do work
goes down
goes up
closes to the torque side
he is in a low gear and does not have enough power
goes up
to maximis proferce
17,2002

Posttest Response on 2001-04-06 at 13:59
forces on a lever
power in a circle
the ration if the output shafted to the input shafted
how fast energy is used
it goes up
is going down
in the middle were the forces are the same
the gear ratio is lower
it goes down
to maxius profeasces
no
like the pic's
User 605

Pretest Response on 2001-04-07 at 11:33
Torque is the amount of pressure on an object while turning.
The speed over distance of how fast an object is accelerating up.
A gear ratio is the difference in gears. i.e. 3:4
The amount of power from a motor.
The angular velocity increases.
Less
i don't know
he needs more driving power.
the maximum is brought up.
to save energy
15 and i am in 9th grade.

Posttest Response on 2001-04-07 at 11:39
The amount of twisting power.
The amount an object turns.
The amount of times a second gear turns when the first is turned.
The amount of energy used.
Less
less torque
flat and something else.
because the driving gear turns less while the moving gear turns more.
slower
to help conserve power
nope.
No problem and I am glad to help.
User 679

Pretest Response on 2001-04-12 at 11:26
a force over a distance
speed relative to location on a circle
angular velocity per torque
torque
it decreases
it can produce more torque
half the maximum torque
their angular velocity doesn't produce the required torque to maintain velocity.
it increases
decrease the amount of angular momentum required to maintain a speed.
20 and junior year.

Posttest Response on 2001-04-12 at 11:46
a rotating force multiplied by the distance from the center of rotation.
the velocity at any point on a rotation divided by the distance from the center of rotation.
the amount of times the output gear turns if the input gear is turned.
the torque multiplied by the angular velocity.
the amount of torque decreases.
the system can have higher maximum torque
Stall torque, and no load speed.
there is less torque to overcome.
it is decreased.
decrease the torque they need to overcome.
no
the tutorial helped a lot with trying to understand relationships between the different concepts.
Torque is kinetic energy generated from the production of power.
Angular Velocity is the amount force generated by the production of torque.
Gear Ratio is the difference created between one revolution of one shaft or gear and another.
Mechanical power is what is produced when some form of potential energy is converted to kinetic energy.
This will also increase.
The amount of torque decreases.
At the initial point of start up or increase, when power or more power is supplied
increase in frictional or gravitational forces as appoased to power and or torque
opposing forces are reduced, hence better torque, but not necessarily better speed (gear Ratio not best for speed).
Better Torque to overcome frictional forces (ie easier pedaling).
39 years
Completed year 12 high school in Australia (did not go on to University).

A Twisting force
The spinning Speed
The difference between an input and output shaft
Power is how fast Energy is consumed.
Torque is reduced in proportion till zero torque is achieved.
Torque is increased.
At the point where the gear ratio is too high and at the point where the gear ratio is too low
this is the point where the gear ratio used provides the best possible tradeoff relationship.
torque is increased but angular velocity is decreased hence the bike will slow down
to increase torque.
No
Interesting!! started to make me think again. I hope you finish up at MIT doing well.
Pretest Response on 2001-04-12 at 19:24
the amount of power, or traction (friction), that a moving object has with a sedentary object.
the amount of speed that a moving object has with a sedentary object
the ratio between two separate gears. On a FIRST robot, teams are always looking for the best possible
gear ratio - enough to give the most possible traction & speed simultaneously.
the amount of power waiting to be used by the object
the velocity decreases.
the max amount of torque lessens.
the highest level of torque, the lowest level of velocity
because the traction stays the same, and gravity is pulling the cyclist down.
the max speed lessens.
to increase the max amount of speed or traction depending on the type of ground they are on.
17, senior in high school

Posttest Response on 2001-04-12 at 19:40
a twisting force
how fast the wheel turns
how many times the output wheel turns when the input wheel is turned once
the amount of stored energy for the object
the amount of torque lessens
torque increases
at max amount of torque and max amount of angular velocity
because there is less torque needed to go fast on flat land
it lessens
to get the max amount of speed & power out of the bicycle depending on the conditions of the road
no
Make sure the links in the links section work next time. Great job!
User 695

Pretest Response on 2001-04-12 at 19:25
Force multiplied by the angle it turns radians per second
an amount of rotations per time period
a coefficient representing the friction between two gears
Energy per second. Watts. Work per time
Angular speed decreases
torque increases near the middle value of torque
because they are doing more work moving uphill, less force is applied
the amount of teeth turning the gears increases creating more torque, which creates more power.
to ease their bodies, so they do not have to use as much energy.
20 junior High school graduate

Posttest Response on 2001-04-12 at 20:07
T=F x R R is radius. A twisting force. Creating friction to do more work or power
W=V x R The number of revolutions per period of time. How fast something turns.
The ratio of torque:angular velocity.
P=T x W The amount of energy needed or used per sec.
Torque decreases
The torque stall or max is lowered
Torque stall and the no load speed
high gears create more angular velocity and less torque, creating low power. It takes less power to go on flat land.
It decreases
to change the amount of power used. To adjust torque and angular velocity. Allowing to speed up, go slow, up or down hills
no
I think I have a better understanding
User 565

Pretest Response on 2001-04-06 at 10:58
a way to measure power
the speed of the gears
a number used to compare the sizes of the gears
objects in motion
it decreases
in the middle
gravity, and he is in the wrong gear
it decreases
to keep their rpms and max velocity the same
17, HS Senior

Posttest Response on 2001-04-06 at 11:06
power times radius
speed
gear sizes
torque
decreases
increases
?
gravity
drops
to maintain constant rpms and keep a high max velocity
no
you have a cool outfit
User 67

Pretest Response on 2001-04-05 at 13:48
power
the rate of change of speed at an angle
the change of speed and power as gear teeth mesh
force
the angular velocity decreases
the maximum amount of torque decreases
at a high level of torque and low level of angular velocity
because it takes more power to move up at an angle.
the speed decreases
to get more torque and less speed to get up the hill
age: 16 grade: 10

Posttest Response on 2001-04-05 at 14:03
Torque = Force * radius
turning speed
Gear Ratio = diameter of input gear / diameter of output gear
hmm...I guess i wasn't paying attention for that part
the torque decreases
the torque can increase
the maximum torque and the minimum angular velocity and the maximum angular velocity and minimu
torque
it takes more torque to go up a steep hill than it takes to traverse flat terrain.
the maximum speed that the bicycle can go decreases
the bicyclist needs more power to get up the hill
no
:-)
User 681

Pretest Response on 2001-04-12 at 11:52

torque is the rotational work done by a body -- usually in reference to motors.
angular velocity is the inverse of torque...when it increases torque decreases
a gear ratio is used to balance speed and torque. it is written like 3:2 and is calculated by counting the
number of teeth on the gears.
mech power is the amount of force output and the work done by a body
angular velocity will decrease proportionally
it will be decreased (torque)
at the midpoint
the amount of torque needed to maintain a constant velocity against the incline is increased
decreases as the torque output increases
to regulate the amount of energy needed to maintain a constant velocity
18 - HS Senior

Posttest Response on 2001-04-12 at 12:06

torque is a twisting force
angular velocity is rotational speed
a gear ratio is the number of times the input gear turns divided by the number of times the output gear
turns for one revolution of the input gear (I know what I want to say but that seems so much more
complicated than I needed)
power is how fast energy is used by a system
torque will decrease
the torque generated will increase
at zero power when the system cannot overcome the torque
he is generating less torque that is needed to move up the incline
decreases
to try to reach the point of max-torque and max-angular velocity
no
Good luck Tom -- I promised I'd do it! Your graphs in some places were a little difficult to decipher --
took me a while puzzling over them. And this format, well -- it was a little boring to read, but very
informative! ~ lora
Pretest Response on 2001-04-14 at 11:10
The power of the revolutions per minute that an electric motor puts out. It is inversely related to angular velocity, as shown in the graph.
The speed in a given direction that a motor creates
The ratio of torque vs velocity which is dependent on the size of a gear is represented in a gear ratio
The unit of force created by torque and angular velocity
Velocity decreases
it increases
equilibrium between the two
because the work load created by gravity and friction is increased, while torque and angular velocity remained the same
decreases
increase rpm by deacreasing torque, making each revolution easier
17
11th

Posttest Response on 2001-04-14 at 11:11
Torque is the turning power of a gear
The speed in a given direction of a gear
The amount of times the output gear will turn if the input gear is turned one time. Its a ratio of the distance input over the distance output.
It also represents Ideal Mechanical Advantage, whereas M.A. is the ratio of power input over power output
Power is angular velocity times torque. Its the rate at which energy is consumed. Power is the practical output of velocity and torque factors
Torque decreases
Torque increases, alot
Approaching either assymtote where the torque of overcomes the system and speed is infinitesimal, or vice versa
Because on the hill torque created by the angle (grabbity grabs ya down)
the angular velocity created on the flat
It decreases
So as to maintain the 1/2 max balance for both Torque and angular velocity
I have no idea. There was a gif I think, but there may have been an ad. I don't think so.
Hi. I don't hablo physics particularly well, I'm a chem. engineer.
Errr, I went ahead and checked the page after getting you e-mail, but everything seems to be squared away...
at heart I think. Ah well, nice project. Good work soldier
User 657

Pretest Response on 2001-04-10 at 15:54
a turning, twisting motion of power?
velocity at a angle?
the ratio at which gears change from one gear to another gear?
the rate at which mechanical work is completed?
it is decreased
torque is increased
at equal levels of torque and angular velocity
because the torque is to low and the angular velocty to high
it is decreased
to make it easier for the bicyclist to continue riding on different terrains and on inclines
17, Senior (12th grade)

Posttest Response on 2001-04-10 at 17:09
a twisting force
a turning speed
the number of times the output gear turns if the input gear turns once.
how fast energy is used. A combination of torque and angular velocity
it decreases
it is increased
at the stall torque and the stall angular velocity
because the incline requires more torque and less angular velocity on a steep hill than on the flat ground
it decreases
to give more speed/less torque or less speed/more torque as required
it had pictures, but no moving doodles
I enjoyed you tutorial very much. It refreshed my memory about torque, angular velocity, mechanical power, etc. and taught me a little more about our robot’s drive system for US FIRST.
Pretest Response on 2001-04-06 at 17:28
ratio of force to distance (in work)
number of degrees turned in a single Period (T)
Comparison of the number of teeth on one gear to the number of teeth of the same size on another gear
power transferred through motion, not radiation or heat
It decreases.
It increases
When they are both the same (closest to a square)
Less force is created per rotation in lower gears so it takes more force to rotate the pedals once.
It increases.
To adjust to varying levels of ease of pedaling resulting from environmental factors such as inclines or friction.
15. 9th grade (freshman)

Posttest Response on 2001-04-06 at 17:40
The force that must be overcome to move an object (power/angular velocity)
The number of degrees an object turns in a given amount of time (Velocity/radius)
The comparison of the torque on the input and output ends of a system.
torque * angular velocity
decreases
increases
When the gear is too low to have angular velocity, or too high to overcome the forces of friction
The force needed to overcome torque is greater on a steep hill because of gravity than on a level plane
where you don't have to act against gravity (as much).
decreases
to change speed or torque to deal with changing levels of inclination.
no
The explanations were concise and easy to understand
User 61

Pretest Response on 2001-04-12 at 22:08
the amount of force a power source can deliver to a spinning object
Rotational velocity of a spinning object
Ratio of the Pitch Diameters of the two gears
Don't know
Decreases
Decreases
Midpoint
Low Torque
Decreases
To change torque/speed
41 BSEE

Posttest Response on 2001-04-12 at 22:27
A twisting force
The rotational speed of a spinning object
The Ratio of the Input Gear of a system to the Output gear
Torque X Angular Velocity
Decreases
Increases
Where Torque = 0 and Angular Velocity = Max
Where Torque = Max and Angular Velocity = 0
When climbing, the potential energy of the system is changing and power must be applied to compensate.
Decreases
To change how power is applied to the bike. To change positions on the torque/angular velocity curve
Pictures only - No animations
Good Luck Tom!
User 552

Pretest Response on 2001-04-06 at 09:25
the amount of force that is generated by motors
the speed of a vehicle
the difference output gear and driving gear
forces created by by a mechanical means
decreases
decreases
when in equilibrium
because more mechanical force is needed to stay as this also increase the amount needed to go
decreases
so they have a constant amount of peddleing
14 freshmen

Posttest Response on 2001-04-06 at 09:38
twisting force the amount of energy needed to turn something
the turning speed of an object
the number of times the output gear turns for each turn of the
how fast power is used by mechanical means
decreases
decreases
max torque max power
more torque is needed so angular velocity decreases
decreases
to make something easier to do
no
good job
User 802

Pretest Response on 2001-04-19 at 23:59
angular force
rotational speed
a variation in gear size that allows constant power output with variable input of power
An outside force acting upon the motor
the angular velocity decreases
torque decreases
high torque and low angular velocity
torque decreases
it decreases
to maintain cadence
55 20

Posttest Response on 2001-04-20 at 00:14
a twisting force
rotational speed
the number of rotations at the output wheel with one rotation at the input wheel
the ratio between torque and angular velocity
torque decreases
torque decreases
angular velocity and torque equal zero
higher angular velocity
it decreases
maintain a constant angular velocity
no
It takes a long time to sign on as the program doesn't take the information the first or second time. We
think you are wonderful.
Pretest Response on 2001-04-09 at 13:22
a measure of angular force
a measure of angular speed and direction
the comparison of power to torque
linear force
it decreases
it decreases
an equal level of torque and angular velocity
the load on the torque increases so the angular velocity decreases
it increases
to increase potential speed
28, undergrad (but it was an arts thing :)

Posttest Response on 2001-04-09 at 13:30
the force needed to turn an object
turning speed
the number of output turns compared to input turns in a gear
the energy needed
it decreases
it decreases
max torque and max angular velocity
load on steep hill increases
it increases
to increase potential speed
no
i think one of the gear diagrams (the ratio one) has the numbers reversed as compared to the bike gears.
Turning the big wheel once would make the little one go around twice right? or maybe not ...not sure.
maybe explaining that part would help. could break it out by the speed and circumference of the two gears.
good luck on the thesis
User 537

Pretest Response on 2001-04-05 at 02:13
Mechanical advantage, moment of inertia
Rate of change in direction
Description of mechanical advantage in numerical function.
Energy vs speed
It decreases
It is reduced.
At mid point
The mechanical advantage decreases.
It is reduced
To optimize the constant weight (torque) to mechanical advantage to produce optimum power=speed 58, (going on 17), 3 years college. Many devices today are archaic in design=raisin bran package, boat hulls, anti-gravity devices=mass movement. In the absence of truth things become what we (others) want them to be

Posttest Response on 2001-04-05 at 02:36
Turning motion/advantage to do so.
rotational movement= to agree with your reading= but not accurate because it only accounts for one dimensional=angular Velocity is a "rate of change in direction term"
relationship of mechanical advantage based of size of gears expressed in numeric expression.
Ability to produce speed.
It is increased.
It is increased.
Stall point (top of curve) and lowest where there would be no speed
The hill induces the stall point, i.e. loss of torque/
It is reduced
To vary torque to match work load
no= by definition animation means showing of movement I saw none of this. Pretty pictures, yes. (Correct the wording the question #11, or you might flunk the exam).
This project seems to be awkwardly presented in scope for the sophisticated site it is presented. Hope you appreciate my time to further your project. Good luck.
User 555

Pretest Response on 2001-04-06 at 09:47
Torque is the force of rotation
Angular velocity is measured in radians per second and it is the amount of radians you go per second.
The ratio of the driving gear to the output gear
Power is work over time
the angular velocity decreases
increase
at the middle
God sure knows
I am sure you can ask God
To increase the power you can put in
17 and am a senior

Posttest Response on 2001-04-06 at 10:03
Torque is force applied in radians
Angular velocity is velocity measured in radians
Gear ratio is the ratio of if the drive wheel turns once how many times the output wheel turns
Force times time
The torque of the motor will decrease since it is a linear relationship
decreases because as the angular velocity increases the force must decrease
at 0 angular velocity of 0 torque
Because there is no friction and he doesn't have to push up a steep hill.
The angular velocity max. would be smaller because there is less torque to apply
to get the max. ang. velocity
no
Have fun with life
User 593

Pretest Response on 2001-04-07 at 12:02
force applied at an angle; twisting force
movement that is not in a straight line/vector
window motor had to be geared down from to one, it ran 4x too fast- input to output?
"ability to do work" Mechanically- I'd say it moves things
vel goes down
lessens (higher ang velocity)
one half torque, one-half vel
more torque is applied
(more force required to turn)
thing? just have to apply more force
to make it easier on their legs- less force required per second
18, 12th grade

Posttest Response on 2001-04-07 at 12:10
twisting force
motion at an angle
input to output power
ability to move stuff
decreases
less torque
zeroing either torque or vel
more ang vel because more input is converted to the bike's linear motion : effort is wasted on friction on hill, must slow down to be able to apply enough torque to bike on hill
harder to attain- bicyclist must pedal much faster
they're lazy, don't like pedaling hard all the time
don't know - a gauge of how well we paid attention?
cool. anything for pooh
User 557

Pretest Response on 2001-04-06 at 10:16
the amount of power something can exert
the speed an object moves at a certain angle
the ratio of number of teeth on two gears
the power a machine has
it decreases
it decreases
half the maximum
there is more torque required so it slows down the speed of the bike
it decreases because it increases the amount of torque
to increase torque
14, Astronaut High School

Posttest Response on 2001-04-06 at 10:27
a twisting force
a turning speed
the diameter of the input gear over the diameter of the output gear
the combination of torque and angular velocity
it decreases
it increases
max torque, max angular velocity
because he uses less torque
it decreases
to increase torque or angular velocity
no
A Twisting force
the speed of an object based on an angel of decent
the mathematical relation of output force based on input force changed by geers
the energy produced by a machine
As torque increces, angular volicity decreaces.
the torque decreces
when torque and angular velocity are equal
because the bicyclist is exerting the same force while the force needed to move is increced.
Maximum speed drops
To controll the amount of torque/speed they need in diffrent conditions.
16, 11th grade

Torque is twisting force
Angular Velocity is the speed a geer spins
the number of rotations from the input geer to the output geer
the energy tranferd
the amount of torque that can be produced is lowered
the torque is increced
no load point and the torque overload point
because the force needed to move of a flat surface is lower than when you are trying to go uphill
The max speed drops
to controll the torque/speed needed in a specific situation
No
Don't take candy from strangers.
Pretest Response on 2001-04-06 at 10:27

Torque is the force exerted by rotational motion.
Angular velocity is the speed at which something changes direction.
A gear ratio is the ratio between two gears, in which you can increase/decrease power and speed by changing the RPMs of a motor.
Mechanical power is the amount of work something can do in a given time.
Angular velocity would decrease when the torque increases.
In this situation, torque would decrease.
Mechanical power is equal at all levels.
They slow down because it puts more stress on their muscles.
The speed decreases when this happens.
By switching gears, the amount of force you need to move a given distance is spread over a larger or smaller time interval.
18 Senior (High School)

Posttest Response on 2001-04-06 at 10:43

Torque is a "twisting force" when rotating something around a center point.
Angular velocity is how fast something revolves around something.
Gear ratio is the number of times a gear will rotate in relation to another gear.
Power is the measure of force of time.
As angular velocity is increased, the torque of the motor decreases.
As the gear ratio lowers, the torque of the motor increases.
At the minimum or maximum there is no power, either because there is an infinite torque that cannot be overcome, or because there is an infinite angular velocity and no force.
On a steep hill, the torque needed to go at a decent speed is much too high.
The maximum speed drops but the torque increases.
They switch gears to try to keep as close to the maximum power as the can in all situations.
No, but this question contains a typo.
I hope that you are able to graduate with my help.... if not you can still do children's birthday parties....
Good Luck (convince Woody to give team #271 some sort of award)
Pretest Response on 2001-04-06 at 11:23
Torque is defined as force times distance or the integral of force dotted into the distance.
Angular velocity is the change in distance with respect to time while the object in question is moving on an angular path.
Gear ratio is the amount of teeth on one gear to the amount of teeth on the other. It is used for the increasing or reducing speed or power.
Power is defined as the change in work vs time.
The angular velocity decreases in a linear fashion.
The max torque of the system goes down when the angular velocity is slowed. The torque increases thus causing an increase in the power output of the motor.
He slows down because he is now working against a component of gravity that is parallel to the plane of the surface he is riding up.
The max speed of the bicycle drops.
The cyclist uses the different combinations of gears to either maintain a certain speed or if he is going up a hill to provide more power to the drive wheels.
Senior at Kettering University Majors: Mechanical Engineering and Applied Physics

Posttest Response on 2001-04-06 at 11:25
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
See the pretest for answers
No
Your welcome
Pretest Response on 2001-04-06 at 16:53
the amount of force generated by the motor per X revolutions
the speed at which the motor turns, usually in RPM (I think)
the ratio of sizes between the gear that is physically attached to the motor and the gear that is attached to whatever the motor is turning
the force exerted on whatever is being turned (i.e., the force exerted on a bike wheel when the rider pedals)
it goes down
it goes down
high torque, low angular velocity
because in order to maintain their speed they would have to maintain their angular velocity while increasing their torque to compensate for the hill. Not very likely (ever see a bicyclist shift from 21st gear to 1st gear really quickly?)
it goes down
to get the right match of torque and angular velocity, or the right gear ratio to match the road conditions, and its bicyclists
I am 16 years old and am in my junior year at Lyme-Old Lyme High School (joy)

Posttest Response on 2001-04-06 at 17:18
torque is the twisting force
the speed at which the object being turned actually turns (i.e., the speed of the rear bicycle wheel)
the ratio of power input to power output
mechanical power is the speed at which energy is used
it goes down
it goes up
the no-load speed and the stall point or speed (no torque and full angular velocity and full torque and no angular velocity, respectively)
because going up a hill requires more torque, and so if the bicyclist is at, or at least near the max power point when they are on a level surface, when they hit the hill it will require more power input by the rider to maintain the angular velocity, and since in most cases the rider is already at or near the maximum amount of power they can put out, they slow down
it goes down
to get the max power point as close to that hill line on the graph on the previous page (to increase the torque so that they can get up the hill without killing their legs)
no
you might want to check your page for errors a little more thoroughly, but I know that no matter how much you check, at least one error is guaranteed to slip through (the little bastards)
Pretest Response on 2001-04-09 at 18:43
Torque is the strength with which a motor rotates.
Angular velocity is the speed at which motion along a curved path is moving.
A gear ratio is the difference between the number of teeth between different gears, as are used to increase the torque of an electric motor by decreasing the angular velocity.
Mechanical power is force of motion, the product of torque and angular velocity.
Angular velocity decreases as torque increases.
The maximum amount of torque is reduced.
Mechanical power is constant.
They do not have enough torque to force against the increased angle of the hill with the same amount of angular velocity.
The maximum speed decreases.
The shift in gears increases the torque which the bicyclist can produce, making it easier to cycle with the same amount of effort.
16 years old
10th grade

Posttest Response on 2001-04-09 at 19:22
Torque is the force required to rotate an object.
Angular velocity is the speed with which an object rotates.
A gear ratio is the difference in size between two gears. It relates the number of rotations of the output gear per rotation of the input gear.
Mechanical power is the amount of energy used, the product of angular velocity and torque.
As angular velocity increases, torque decreases.
The maximum amount of torque is increased.
The stall torque point is where there is high torque but no angular velocity at which to move. The no load point is where there is high angular velocity but no torque to drive it.
The amount of torque required to pedal on a hill is greater, which reduces the amount of angular velocity which the bicyclist can produce.
The maximum speed is decreased.
The shift in gears allows the bicyclist so that the level of torque on the surface they are pedalling on coincides approximately with the point of maximum power, at half maximum speed and torque.
No.
Cool. This clarifies some of the stuff we were doing on our robot. ;)
The graphics were such that it was hard to keep track of the gear ratios and torque arrows on them. The text explanations were good.
User 586

Pretest Response on 2001-04-06 at 16:30
Torque is defined as twisting force.
The velocity of something as it moves in a circular path.
A gear ratio is the ratio between the number of teeth on the input gear vs. the number of teeth on the output gear.
Power is a machine's ability to transmit its torque.
The angular velocity decreases.
It is reduced.
When the two are equal.
Because their angular velocity is decreasing
The maximum speed is decreased.
To change their gear ratio and thus affect their output torque to account for different terrains.
18 Senior in High School

Posttest Response on 2001-04-06 at 16:45
Torque is a twisting force.
Angular velocity is the speed something travels in a circular path.
A gear ratio is the diameter of the output gear divided by the diameter of the input gear. It determines how many times the output gear turns if the input gear is turned once.
The amount of force used.
The amount of torque decreases.
The maximum torque is increased.
At the point of max torque and at the point of max angular velocity.
He has a lot of angular velocity, but not much torque to use to go up the hill.
It is decreased.
The keep the balance between torque and angular velocity he needs to keep providing the power he needs to travel over differing angles of terrain.
YES. I didn't use them but they were there.
Your page was a great help in understanding these terms and their relationships to each other.
User 709

Pretest Response on 2001-04-12 at 23:22
T = F x d. It's the cross product of the force and distance. Expressed in newton-meters.
omega = theta / second. The rate at which something rotates. Expressed in radians per second.
The ratio of the radius of two gears.
P = W / s = F d /s = F v. It is the rate at which work is done.
It decreases.
It increases.
Since power is work per second or rate times force, probably where torque and angular velocity are in the middle.
It increases the necessary work.
It decreases.
To compensate for terrain by modifying the required amount of work.
17 High School Senior

Posttest Response on 2001-04-12 at 23:37
Cross product of force and radius.
Radians of rotation per second, or translational motion divided by the radius.
The ratio of the radii of two gears.
The rate at which work is done.
The torque decreases.
The torque decreases.
When it is at max torque with minimum angular velocity, and when it is at max angular velocity with minimum torque.
Because there is no rotational resistance when gravitational force is perpendicular to the rider.
It increases.
To change the amount of work for certain types of terrain in order to prevent max torque with no angular velocity.
No.
Pretty basic.
User 689

Pretest Response on 2001-04-12 at 17:55
Torque is the measure of the turning force of a rotational element. Angular velocity is the speed of which a rotational element (like a wheel) is moving. A gear ratio is the relation between the angular velocity of the driving gear in a gear train to the final driven gear. The output of a mechanical machine?
The angular velocity decreases. The maximum amount of torque is decreased. A happy medium?
Going up a grade requires more energy, but the same amount of torque is present. A larger load reduces the speed of the wheels, and consequently, the bicycle. The maximum speed goes down. To reduce the amount of force required to pedal, increasing the distance (pedal rotations) required. 16 - sophomore, high school

Posttest Response on 2001-04-12 at 18:06
Torque is a twisting force. Angular velocity is rotational speed. A gear ratio is the comparison between the input and output gears. Power is how fast energy is used. The torque decreases. The torque is increased. The stall torque and the no load speed. The full energy of the bicyclist is directed to moving in a level plane, rather than increasing his altitude as well. The maximum speed is decreased. To best regulate the amount of torque required to maintain a certain velocity. No. I think I met you at the Radisson when the flight to Boston was canceled. I might be wrong though. Good luck.
User 711

Pretest Response on 2001-04-12 at 23:46
The force a motor exerts.
The speed at which something rotates.
The ratio of one sprocket to another in a gear system.
The amount of forward movement exerted by a mechanism.
The angular velocity decreases in a linear fashion.
The torque is lessened.
When both are at half their maximum capacity.
Because torque is increased so angular velocity is decreased.
The maximum speed lowers because the gear ratio lowers.
A bicyclist shifts gears to either lessen the torque on hard paths or increase the torque on easy paths.
14
Freshman in high school

Posttest Response on 2001-04-13 at 00:05
Torque is the amount of rotational force exerted on an object. Torque = Radius from center of rotation to force x Force
Angular velocity is the speed at which an object rotates and is = Forward velocity x Radius
Gear ratio is the ratio of the diameter of one gear to the next and is = Diameter of first gear / Diameter of second gear
Mechanical power is the amount of force a system outputs. Mechanical power = Torque x Angular velocity
The torque decreases.
The maximum amount of torque increases.
At full torque and full angular velocity.
The torque increases on a steep hill and so the angular velocity decreases.
The maximum speed decreases.
To increase the amount of mechanical power.
No.
I liked all the drawings and they helped me understand the idea.
User 541

Pretest Response on 2001-04-05 at 12:25
Force used to twist something
Angle over time
different sized gears to either get more velocity or torque
I don't know
slows down
decreased
middle of line
more torque is needed
decreases
when less force is required to speed up, and down shifts to get more power
17, 2001

Posttest Response on 2001-04-05 at 12:38
Force times radius
Velocity divided by radius
number of times output gear spins when the drive gear spins once
I forgot
decreases
increases
asymptotes on hyperbola
less torque more velocity
decreases
get either more torque or velocity
no
is question 11 supposed to read "your" instead of "you" right?
Pretest Response on 2001-04-12 at 18:51
The propensity for something to turn based on forces exerted on it.
The speed in angles per measurement of time that something is revolving.
When you put gears of various sizes together with a chain, it reduces or increases the revolutions per second. The gear ratio has to do with the ratio of the areas of the circles (gears).
Work done (work = distance times force over which it was applied ) over time.
Angular velocity decreases.
Angular velocity increases, so torque decreases (this doesn't make sense to me, but I'm interpreting the graph)
When torque and angular velocity are equal (both having medium values), the most power is generated.
The direction in which the work is being done changes though the direction of gravity stays the same (down), so the new force causes the torque on the wheels to go in the opposite direction (down the hill). I just made that up, but it sounds logical to me.
It slows. I think.
To accommodate changes in the torque applied by gravity on the wheels.
17, 12th grade

Posttest Response on 2001-04-12 at 19:19
Twisting force. High torque means you need more force to twist it.
Rotation speed.
Ratio between number of times input gear turns to number of times output gear turns in the same amount of time when connected by a chain.
Angular velocity times torque
Torque decreases.
Max torque increases
At max torque, there is no angular velocity, so there is no power (stall torque). At max angular velocity, there is no torque and all that is working is gravity, so there is no power.
Because the output gear turns more often which increases angular velocity, so when torque is increased by the incline of a hill, the max angular velocity decreases, whereas on a flat surface, there is less torque, so the cyclist goes faster.
Half as fast as it could go on a one-to-one gear ratio.
To decrease the amount of power they need to turn the wheels when the torque on the wheels changes because of hills.
No.
Being able to see things turn might help. I need a clearer explanation of torque (it still seems backwards to me, with the torque-angular velocity tradeoff). It might also help if there were a better way of breaking the material into chunks. In general, it was very helpful (better than any of the teachers at my school, anyway). Thank you, and good luck!
User 677

Pretest Response on 2001-04-12 at 11:13
The force of rotation
The speed of rotation
The ratio of the number of teeth of two gears meshing
The ability to do a task, in Newtons
The angular velocity decreases, it is in a linear relationship.
It decreases
In the middle of both
Increase in load on the motor, more torque.
It decrease, but going up the hill is easier.
To go up hills, lower gears enable more revolutions per minute. Less work when more torque is applied
21, Junior in College

Posttest Response on 2001-04-12 at 11:28
The force need to cause rotation
The speed of rotation
It is ratio of the diameters of the two gears
Torque times Angular velocity
It is decreased by a ratio equal to the amount you increased the angular velocity by.
The amount of torque is increased
Stall Torque, and no load speed
Because the load is increased on a hill and thus it requires more torque to move forward so angular speed is decreased.
It decreased
To try to stay at there maximum torque speed point, in the middle of the graph.
No
Thanks for giving us extra credit towards our physics final
Pretest Response on 2001-04-06 at 10:29

A force applied on a point from a certain perpendicular distance away
The speed at which a wheel, or a point on that wheel, rotates. Measured typically in radians per second
The number of turns one gear will make for every one rotation of another gear to which it is connected.
Often obtained by dividing the number of teeth of the one gear by the number of teeth of the other
Work divided by time, i.e., the capacity to continually exert force over a distance
It decreases, in this case at a flat rate proportional to the increase in torque
It becomes smaller, although the maximum angular velocity does go up
Maximum torque, minimum angular velocity
He/she is generating a continual force forward, which is counteracted only by the force of friction with the road. When he/she begins climbing the hill, the force of gravity begins to act on the bicyclist, which slows him/her down. However, if the bicyclist shifts to a lower gear ratio and pedals faster, the same speed (angular velocity of the wheels) can be generated with less force (hence less effort) on the pedals
That becomes smaller, just as the maximum angular velocity does
To go up hills, of course
18, high school senior

Posttest Response on 2001-04-06 at 12:12

A twisting force, F X R
A turning speed, v/r
The number of times an output gear turns if an input gear is turned once
The rate at which energy is used, torque times angular velocity, T x w
It decreases
It increases
Max torque/zero angular velocity, max angular velocity/zero torque - the points at which the graph of said curve leave Quadrant I
High gear means a lower maximum torque, which equates to less capability to push the bike up the slope of the hill against that evil old gravity
It decreases
To change from hill-climbing to flat riding, or vice versa
No

Your simple definitions of these mechanical concepts seem quite appropriate for the broad audience I assume you intend to reach. Also, your visual aids provided a comprehensible frame of reference for the text. You may consider yourself praised for those aspects of your tutorial. However, I would like to recommend you add a section, if a small one, where you apply the details of electric motor operation that you just taught, through the bicycle analogy, to electric motors. I would, I think, be able to think through the ramifications of the power tradeoff, the max-power curve, etc., more readily if I could see them applied to motors like the ones in my team’s robot. Besides which, a summary/application section could serve as a final review of the material taught. Oh, and type your axioms of electric-motor operation in capital letters. Then even a glance will serve to teach a little bit. Thanks for reading.
User 155

Pretest Response on 2001-04-06 at 11:59
A Rotational force vector. (Force x radius /w rotational direction)
A rotational velocity vector. (Speed /w rotational direction)
The ratio of the radi of two or more sets of gears
The amount of mechanical work performed per unit time
It is reduced linearly
It is increased
At the mid-point of the line
The torque load is too high for the legs
It is reduced
The reduce the torque load on the legs
36, Master's in Progress (Chemical Education)

Posttest Response on 2001-04-06 at 12:08
T=Fxr A twisting force. How hard one has to twist to rotate and object
w=Vxr The speed of rotation is the linear velocity times the radius
The ratio of the diameter of a set of gears
How fast one uses energy
It is reduced
It is increased
Stall torque, no angular velocity
No load speed, max w but no T
One is approaching the stall torque and cannot keep the pedals moving.
It is reduced
reduce the torque load to keep it below the stall torque level
I did not notice any
It seems useful. I need more time to browse the pages to tell you more.
a force acting on a moment arm
rotational speed
ratio of the diameters of connected gears
rate of energy output
decreases
decreases
1/2 stall torque & 1/2 free speed
a greater force is required on the peddles
decreases
to reduce the amount of force necessary on the peddles
43, 1979

(assuming the steep hill is up-hill) torque increases up hill reducing speed
decreases
to maintain a gear ratio near max power
no

nice tutorial
User 119

Pretest Response on 2001-04-05 at 02:27
Force times perpendicular distance.
The number of turns per unit of time.
A ratio (fraction) of the number of teeth of one gear to another.
Energy per unit of time.
It decreases linearly.
It decreases.
At the midpoint.
The kinetic energy is being transformed into potential energy, and some heat due to friction.
It decreases.
To hit the comfortable energy output range (force per stroke)
48, Master's in Teaching 1990

Posttest Response on 2001-04-05 at 02:35
How much twist is being applied or is required.
How fast something is turning.
How many turns the output shaft turns for each turn of the input shaft.
How fast energy is being used.
It decreases.
It decreases by a factor of the gear ratio.
Either at No torque or at no angular velocity.
The power s/he can put into each stroke is limited by the amount of power to go the distance required by each stroke. (Headwinds not counting. ;-) )
It decreases.
To match the torque/ angular velocity balance point.
Some were partially done.
Nice pre-post test. Being a mechanical engineer, before becoming a teacher, I can appreciate the balance of info you're giving to the readers.
Pretest Response on 2001-04-12 at 07:30
Torque is a force which tends to produce rotation about a point.
The speed of the rotation.
Gear ratio is the relationship between the size of the driven gear and the size of the drive gear.
Power is the product of torque and speed.
Decreases.
Output torque is reduced.
Half torque, half velocity.
It takes more power to maintain a constant speed when the load increases.
The maximum speed is reduced.
To maintain a comfortable pedaling speed for the current load and desired speed.
47 BS

Posttest Response on 2001-04-12 at 08:00
A twisting force.
The speed of a point on a rotating object divided by the radius.
The number of times one gear rotates for one full rotation of the other.
Torque times speed.
Decreases.
Increases.
Stall and free speed.
The torque requirements are lower on the flat.
Decreases.
To match the torque and speed to the current conditions.
No.
Sorry it took so long. I'm at work with plenty of distractions.
User 543

Pretest Response on 2001-04-05 at 12:51
the measurement of rotational force required to do work
the speed and direction for which an object is rotating
the ratio of two axles rotating...ie 2:1 first rotates twice for ever one rotation of the second
power is the amount of work that be done in a given amount of time
it decreases
it decreases
usually right in the middle
the ratio is too high, and the rider can not provide enough torque to overcome the increase in grade
it is decreased, but it is easier to pedal
to obtain the best compromise between the two to get the most power possible at any given time
16...junior (highschool)

Posttest Response on 2001-04-05 at 12:57
twisting force
rotational speed...rpm
ratio between the motor and output
amount of work done in given time
decrease
increases
in middle
because he is generating maximum power
decreases
to stay in the middle of that graph...to give maximum power output
negative
I wish u the best of luck on your project...nice tiger suit. Have fun at First...Jay Krushinski
User 663

Pretest Response on 2001-04-11 at 12:28
Product of force and moment arm length. More generally, the cross product of a force vector and a radial vector.
A vector quantity measuring the rate of rotation of an object in space.
Ratio of radii of two gears in mesh.
Product of torque and angular velocity. A scaler quantity measuring the rate of energy transfer.
It slows down.
It decreases.
At the 50% stall torque point.
The load increases the torque stays the same so the net result is a negative torque applied which causes deceleration.
It decreases.
To increase maximum speed capability.
26 / MSME

Posttest Response on 2001-04-11 at 12:41
Product of force and moment arm length.
Rate of rotation.
Ratio of input gear radius to output gear radius.
Product of torque and angular velocity
Decreases
It increases.
Stall torque and max angular velocity
The torque load on the bicycle is lower on flat ground thus increasing max speed capability.
It decreases.
To maximize speed capability while allowing for low-end torque to bring the bicycle up to speed.
No.
Good explanations. Cool graphs too.
User 355

Pretest Response on 2001-04-04 at 14:16
A rotational force
The speed something is spinning
the relationship between the speed (also the torque) of one gear meshing with another; equivalent to the
number of teeth on one of these gears to the the number of teeth on the other gear
The rate at which work is done
The angular velocity decreases
Less torque can be generated
In the middle of the torque-angular velocity curve
The necessary torque to move the bicycle increases
The maximum speed is decreased
To keep maximum power
24; BS in 1998

Posttest Response on 2001-04-04 at 14:37
A twisting force
A twisting speed
The number of times the output shaft turns if the input shaft is turned once; diameter of the output gear
divided by the diameter of the input gear for a two gear system
The rate at which work is done
The amount of torque the motor can generate is less
The maximum amount of torque the system can generate is increased
Where the torque-speed curve meets the vertical and horizontal axes (stall torque and no-load speed)
The no-load speed is higher on a flat.
It is reduced
To keep near to maximum power, and avoid stall torque and no-load speed. In other words, to keep the
constant torque and speed available for input usable for varying output speeds and torques
No
I hope Tigger gets a diploma, and I'm still jealous you get to do this stuff for you thesis! See you at
nationals.
Will
### Appendix V – Test Scores

**Animated Tutorial**

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207
### Animated Tutorial

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Appendix VI – The Bootstrap Method

1. Count the N Data Points
2. Randomly select N Data Points from the Sample
3. Calculate and Store the Mean of the new samples
4. Repeat 1000 times

Display the distribution of the means.

\[
\begin{align*}
\end{align*}
\]
Trials := 1000 k := 1..Trials
index1 := floor(runif(L1 - Trials, 0, L1 - 0.001))
index3 := floor(runif(L3 - Trials, 0, L3 - 0.001))
index2 := floor(runif(L2 - Trials, 0, L2 - 0.001))
i1 := 0..(L1 - Trials) - 1 i2 := 0..(L2 - Trials) - 1 i3 := 0..(L3 - Trials) - 1

AnimDataSample_{i1} := AnimatedData_{index1} PictorialDataSample_{i3} := PictorialData_{index3}
BrokenDataSample_{i2} := BrokenData_{index2}

mean(AnimDataSample) = 7.618 mean(PictorialDataSample) = 7.332
mean(BrokenDataSample) = 7.111

AnimBootstrap_{k-1} := mean(submatrix(AnimDataSample, k - L1 - L1, k - L1 - 1, 0, 0))
BrokenBootstrap_{k-1} := mean(submatrix(BrokenDataSample, k - L2 - L2, k - L2 - 1, 0, 0))
PictorialBootstrap_{k-1} := mean(submatrix(PictorialDataSample, k - L3 - L3, k - L3 - 1, 0, 0))

μ1 := mean(AnimBootstrap) μ2 := mean(BrokenBootstrap) μ3 := mean(PictorialBootstrap)
σ1 := stdev(AnimBootstrap) σ2 := stdev(BrokenBootstrap) σ3 := stdev(PictorialBootstrap)

μ1 = 7.618 σ1 = 0.406 μ2 = 7.111 σ2 = 0.35 μ3 = 7.332 σ3 = 0.75
\[
\begin{align*}
\mu_1 &= 7.618 & \sigma_1 &= 0.406 \\
\mu_2 &= 7.111 & \sigma_2 &= 0.35 \\
\mu_3 &= 7.332 & \sigma_3 &= 0.75 \\
\end{align*}
\]

\[
p_1(x) := \frac{1}{\sqrt{2 \pi \sigma_1^2}} e^{-\frac{(x-\mu_1)^2}{2 \sigma_1^2}} \\
p_2(x) := \frac{1}{\sqrt{2 \pi \sigma_2^2}} e^{-\frac{(x-\mu_2)^2}{2 \sigma_2^2}} \\
p_3(x) := \frac{1}{\sqrt{2 \pi \sigma_3^2}} e^{-\frac{(x-\mu_3)^2}{2 \sigma_3^2}} \\
\]

\[
x := 5, 5.01 \ldots 10
\]
Now for the Posttest Data:
1. Count the N Data Points
2. Randomly select N Data Points from the Sample
3. Calculate and Store the Mean of the new samples
4. Repeat 500 times
4. Display the distribution of the means.

$\text{AnimatedData := [8.01, 9.01, 10, 7.33, 9, 8.67, 8.33, 6.34, 9.33, 7.33, 10, 9.67, 8.33, 10, 10, 10]}$

$\text{BrokenData := [8.01, 10, 7.67, 10, 8, 10, 8.67, 10, 9.33, 7.97, 9, 8, 10, 10, 9]}$

$\text{PictorialData := [6.34, 9.33, 7.33, 10, 9.67, 8.33, 10, 10, 9]}$

$\text{L1 := length(AnimatedData)}$

$\text{L2 := length(BrokenData)}$

$\text{L3 := length(PictorialData)}$

$\text{L1 = 15}$

$\text{L2 = 15}$

$\text{L3 = 7}$

$\text{mean(AnimatedData) = 8.757}$

$\text{mean(BrokenData) = 9.043}$

$\text{mean(PictorialData) = 9.144}$
Trials := 1000  k := 1..Trials

index1 := floor(runif(L1-Trails, 0, L1-.001))
index2 := floor(runif(L2-Trails, 0, L2-.001))
index3 := floor(runif(L3-Trails, 0, L3-.001))

i1 := 0..(L1-Trails) - 1  i2 := 0..(L2-Trails) - 1  i3 := 0..(L3-Trails) - 1

AnimDataSample1 := AnimatedData(index1)
PictorialDataSample3 := PictorialData(index3)
BrokenDataSample2 := BrokenData(index2)

\[ \text{mean}(\text{AnimDataSample}) = 8.764 \]
\[ \text{mean}(\text{PictorialDataSample}) = 9.146 \]
\[ \text{mean}(\text{BrokenDataSample}) = 9.04 \]

\[ \text{AnimBootstrap}_k := \text{mean}(\text{submatrix}(\text{AnimDataSample}, k \cdot L1 - L1, k \cdot L1 - 1, 0, 0)) \]
\[ \text{BrokenBootstrap}_k := \text{mean}(\text{submatrix}(\text{BrokenDataSample}, k \cdot L2 - L2, k \cdot L2 - 1, 0, 0)) \]
\[ \text{PictorialBootstrap}_k := \text{mean}(\text{submatrix}(\text{PictorialDataSample}, k \cdot L3 - L3, k \cdot L3 - 1, 0, 0)) \]

\[ \mu_1 := \text{mean}(\text{AnimBootstrap}) \quad \mu_2 := \text{mean}(\text{BrokenBootstrap}) \quad \mu_3 := \text{mean}(\text{PictorialBootstrap}) \]
\[ \sigma_1 := \text{stdev}(\text{AnimBootstrap}) \quad \sigma_2 := \text{stdev}(\text{BrokenBootstrap}) \quad \sigma_3 := \text{stdev}(\text{PictorialBootstrap}) \]

\[ \mu_1 = 8.764 \quad \sigma_1 = 0.291 \quad \mu_2 = 9.04 \quad \sigma_2 = 0.233 \quad \mu_3 = 9.146 \quad \sigma_3 = 0.488 \]
\[
\begin{aligned}
\mu_1 &= 8.764, & \sigma_1 &= 0.291, & \mu_2 &= 9.04, & \sigma_2 &= 0.233, & \mu_3 &= 9.146, & \sigma_3 &= 0.488 \\
p_1(x) &:= \frac{1}{\sqrt{2\pi \sigma_1^2}} e^{-\frac{(x-\mu_1)^2}{2\sigma_1^2}} \\
p_2(x) &:= \frac{1}{\sqrt{2\pi \sigma_2^2}} e^{-\frac{(x-\mu_2)^2}{2\sigma_2^2}} \\
p_3(x) &:= \frac{1}{\sqrt{2\pi \sigma_3^2}} e^{-\frac{(x-\mu_3)^2}{2\sigma_3^2}} \\
x &:= 5, 5.01, \ldots 10
\end{aligned}
\]