Answer 9.6

Chemical 1 is a conservative tracer that does not react or degrade.
The peak of the non-adsorbing, non-degrading chemical will arrive soonest and with the highest concentration. This corresponds to the red curve. From the peak arrival time we can estimate the velocity, $u = 8m/4day = 2\ md^{-1}$.

Chemical 2 does not adsorb, but is degraded by microbes living in the aquifer.
This chemical does not adsorb, and so has no retardation. Its peak will arrive with that of chemical 1, but with a diminished concentration. This corresponds to the green curve. Specifically, $C2(t) = C1(t)\exp(-kt)$. Using the peak values at $T_{1,2} = 4$ days, $C2_{peak}/C1_{peak} = (10.5/15.8) = \exp(-kt)$, from which

$$k2 = -\ln(C2/C1)/t = -\ln(10.5/15.8) / (4\ \text{days}) = 0.1\ d^{-1}.$$

Both Chemical 3 and 4 adsorb to the soil matrix, and so experience some retardation, as seen in the orange and blue curves. However, Chemical 4 has a slow adsorption process, and so will not be in equilibrium. Slow sorption leads to additional dispersion. This is consistent with the orange curve. Chemical 3 therefor corresponds to the blue curve.

Chemical 3 adsorbs rapidly and the partitioning is always at equilibrium.
Blue Curve. The transport of this plume is slowed because at any time only the fraction f of the mass is in the dissolved phase and subject to fluid transport. Specifically, the plume advects at the speed fu rather than u. We can estimate f by comparing the peak arrival time with that of the non-adsorbing chemical. Specifically, $T_{1,2} = L/u$ and $T_3 = L/(fu)$, so that $f = T_{1,2} / T_3 = 4\ d / 8\ d = 0.5$.

Chemical 4 adsorbs so that the partitioning is not at equilibrium.
From the discussion above, this corresponds to the orange curve. The rate of sorption/desorption must be slow compared to the transport time scales. Using the observed transport scale, $k4^{-1} >> 5$ d, or $k4 << 0.2\ d^{-1}$.