Chemistry ConcepTests
Sample Set #2

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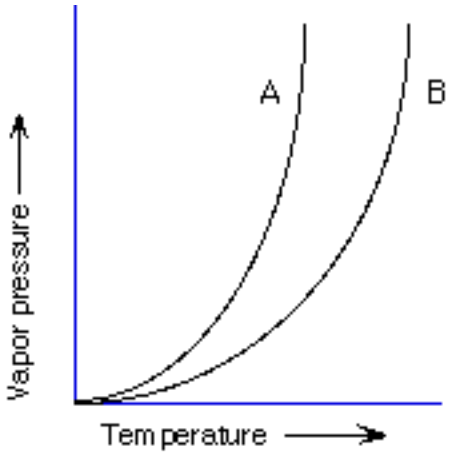
Readers may be familiar with Harvard physicist Eric Mazur's ConcepTests, which have been shown to enhance substantially the comprehension of introductory physics concepts. Briefly, conceptual questions are posed in the lecture room along with a few possible answers. Students vote on the possible answers, then try to persuade their neighbors in the lecture room that they are correct, and finally vote again. This form of peer instruction is often an effective pedagogical method, and it also provides the instructor with on-line feedback as to how well the class is following the lecture.

The ConcepTests include in parenthesis the concepts being addressed and the chapter they correspond to from the book, "Teaching General Chemistry, A Materials Science Companion," Arthur B. Ellis, et al., American Chemical Society, 1993.

Answers are in bold typeface.

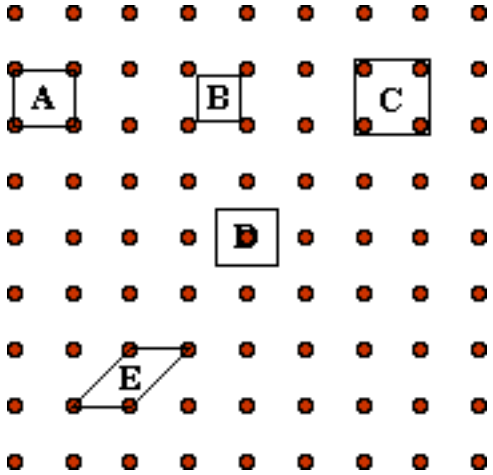
Atoms, Molecules, Extended Structures, and Stoichiometry

1. (Vapor pressure) Demonstration: Drops of water and ethanol are placed on an overhead projector and the ethanol drop is seen to evaporate more rapidly. The graph below compares the vapor pressures of ethanol and water. Which curve corresponds to ethanol?



A, B

2. (Unit cells; Ch. 3 "Companion") Which of the parallelograms in the figure below are unit cells?



A, B, C, **D**, **E**

After a unit cell is identified: What number of atoms belong to the unit cell?

1, 2, other

Equilibrium

3. (Equilibrium, concentration, competition) When people are exposed to higher than normal concentrations of CO, CO can displace O_2 from the hemeoglobia (Hb) and eventually cause death. A competition experiment involves O_2 and CO vying for hemoglobin (Hb) sites, defined by the equilibrium

$$Hb(O_2)_4 + 4\,CO \rightleftarrows Hb(CO)_4 + 4O_2$$

From Le Châtelier's principle, how is CO poisoning reversed?

decrease O_2 pressure, **increase O_2 pressure**, remove Hb

4. (Equilibrium, Le Châtelier's principle; Ch. 5 & 9 "Companion") The body-centered cubic (bcc) phase of a metal has a 68% packing efficiency, while the face-centered cubic (fcc) phase of the same metal has a 74% packing efficiency. For the equilibrium

bcc metal $\rightleftarrows$ fcc metal

as pressure increases, the equilibrium

shifts to the left, **shifts to the right**, is unaffected

5. (pH scale) Recall that $pH = -\log[H^+]$. A solution with pH = 5 is 100 times more acidic than a solution with a pH = ?

7, 3, 0.05

6. (Weak acids, Le Châtelier's principle) For the reaction, $CH_3COOH = CH_3COO^- + H^+$, $pK_a = 5$. Recall that $pK_a = -\log K_a$ and $pH = pK_a - \log\frac{[base]}{[acid]}$.

At pH = 5, what is the most prevalent species?

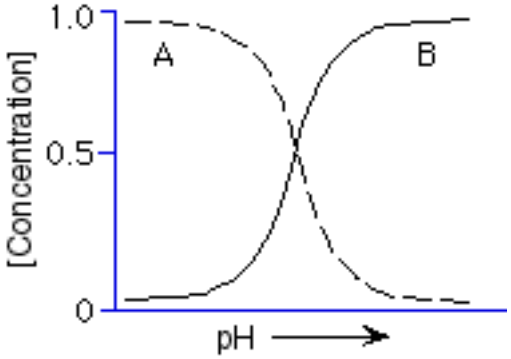
CH_3COOH, CH_3COO^-, **equal amounts of the acid and its conjugate base**

At pH = 2, what is the most prevalent species?

CH_3COOH, CH_3COO^-, equal amounts of the acid and its conjugate base

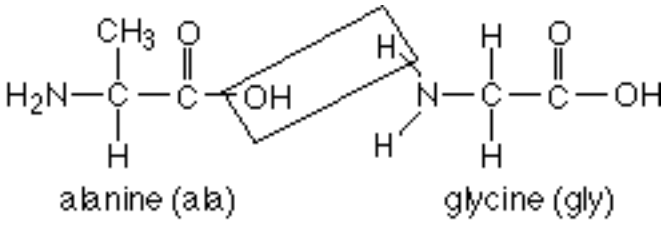
The plot below show the concentrations of CH_3COOH and CH_3COO^- as a function of pH. Which plot corresponds to the concentration of acetic acid, CH_3COOH, as a function of pH?

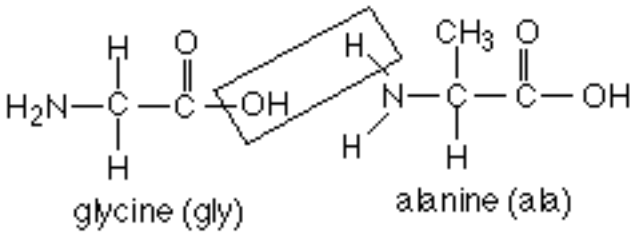
A, B



Chemical Reactions, Acid-Base, Redox, Precipitation

7. (Amino acid sequences) Amino acids are joined by peptide bonds formed through condensation reactions. Is the compound gly-ala the same as ala-gly?





yes, **no**

Electrochemistry

8. (Galvanic cells, redox, Le Châtelier's principle)

$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ $E^{\circ} = 0.80$ V

$Cu^{+2}(aq) + 2e^{-} \rightarrow Cu(s)$ $E^{\circ} = 0.34$ V

Will Ag(s) react with $Cu^{+2}(aq)$?

yes, **no**

Will Cu(s) react with $Ag^{+}(aq)$?

yes, no

Demonstration: $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{+2}(aq) + 2Ag(s)$ Place a sheet of copper into a $AgNO_3$ solution. The submerged copper electrode will be plated with silver at the end of the reaction.

Demonstration: Construct a galvanic cell: $Cu(s)|Cu^{+2}(aq)||Ag^{+}(aq)|Ag(s)$ Measure the voltage.

If water is added to the $Cu^{+2}(aq)$ cell, how will the voltage be affected?

voltage will increase, voltage will decrease, no change

If a Cl^{-} solution is added to the $Ag^{+}(aq)$ half cell to precipitate AgCl(s), how will the voltage be affected?

voltage will increase, **voltage will decrease**, no change

As current passes, the voltage

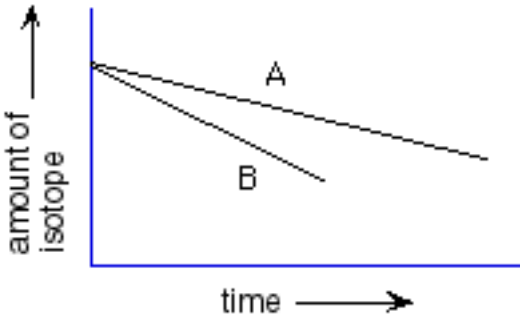
increases, **decreases**, stays constant

Other

9. (Isotopes, Half-life) The half-life of ^{238}U is 4.5×10^{9} years; that of ^{235}U is 7.1×10^{8} years. If at the moment of the birth of the universe there were equal amounts of ^{238}U and ^{235}U, which isotope is now in excess?

^{235}U, ^{238}**U**, still equal amounts

Referring to the graph below, which line represents the decay of ^{238}U, as opposed to that of ^{235}U?



A, B