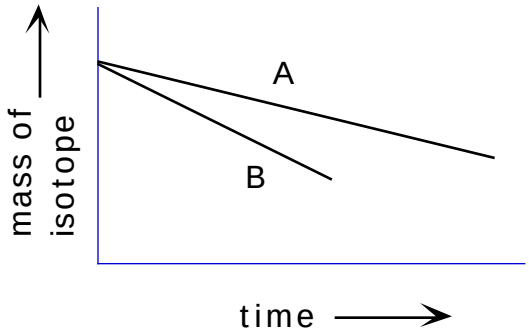
34. (Thermal conductivity; Ch. 7 "Companion") If students have a seat/desk with metal and wooden parts that are not in direct contact with their bodies, ask about the relative temperature: Which is colder? **Demonstration:** Measure the temperature of each part with a digital thermometer.
wood, metal, **both are at the same temperature**
(Tie in with thermal equilibrium and the calculated value of ambient thermal energy as RT.)

If the temperature of the room goes from 20 degrees C to 40 degrees C, the ambient thermal energy
doubles, is halved, **increases by less than 10%**

At-Seat Demonstration 7.5 "Companion": Touch the wood and metal part of the desk. Which material conducts heat better and thus has a higher thermal conductivity?
wood, **metal**, the two materials are the same

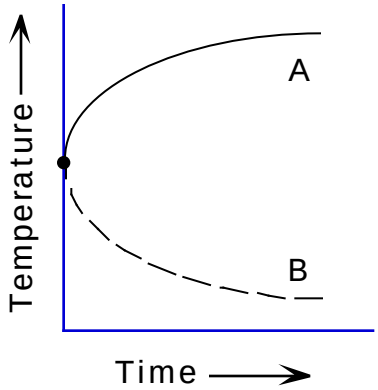
88. (Isotopes, Half-life) The half-life of ^{238}U is 4.5×10^{9} years; that of ^{235}U is 7.1×10^{8} years. If at the moment of the birth of the universe there were equal amounts of ^{238}U and ^{235}U , which is now in excess?
^{235}U, **^{238}U**, still equal amounts
Referring to the graph below, which line represents the decay of ^{238}U, as opposed to that of ^{235}U?
A, B



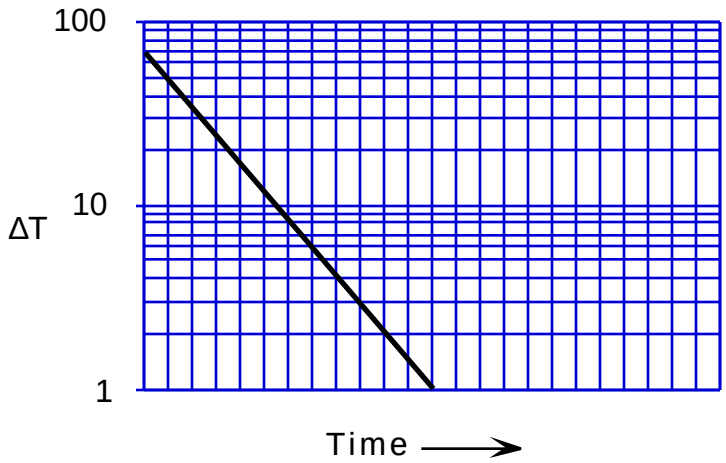
91. (Thermodynamics) **Demonstration:** Pour hot water into a room temperature vessel. What is the equilibrium temperature of the water?
> room temperature, **= room temperature**, < room temperature

108. (Radioactivity) Does $t_{1/2}$ depend on chemical composition?
yes, **no**

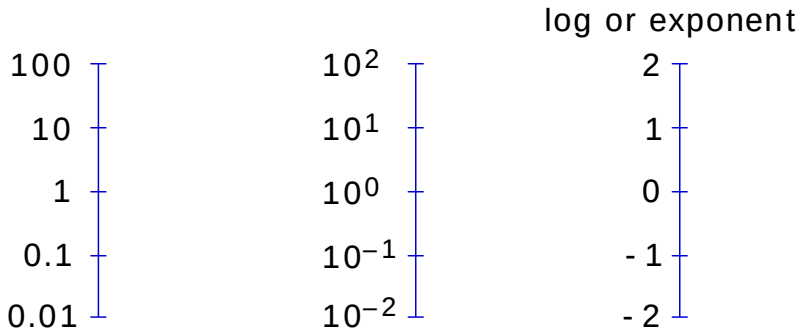
110. (Thermodynamics, logarithms) Which plot represents the temperature of a beaker of hot water left to sit out in a cool room?
A, **B**



A semilog plot of log [(Temp. of hot water) - (Room temperature)] vs. time is linear. Can the equilibrium temperature difference of zero be shown on such a plot?
yes, **no**

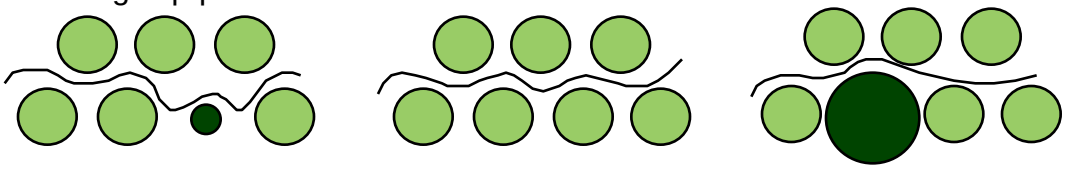


111. (Logarithms) Omit some numbers from any of the indicated logarithmic number lines and ask what they are.



113. (Thermal energy, work hardening; Ch. 6 “Companion”) **Demonstration 6.4** “Companion”: After work hardening a piece of copper metal, it can be made soft again by
heating, cooling

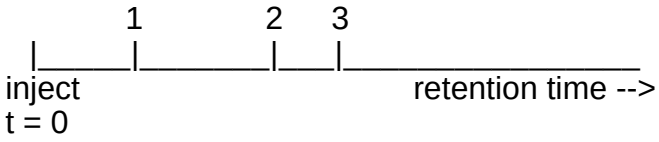
114. (Plastic deformation, slip planes; Ch. 6 “Companion”) Which situation allows easiest slippage of planes of atoms past one another, as sketched below?
identical spheres in both layers, a layer with a large impurity atom, a layer with a small impurity atom
Which of the two impurities acts like a "speed bump" and which like a "pothole," in impeding movement along slip planes?



125. (Chromatography) **Demonstration:** Simultaneously drop marbles and ping pong balls down the ICE model chromatography column. Which balls will get to the bottom first?
marbles, ping pong balls

126. (Chromatography, equilibrium) The chromatographic equilibrium for a species A can be described as A in mobile phase <==> A in stationary phase
A mixture of two volatile compounds is injected onto a column with air, which doesn't interact with the column. Which of the three peaks below is air?
1, 2, 3

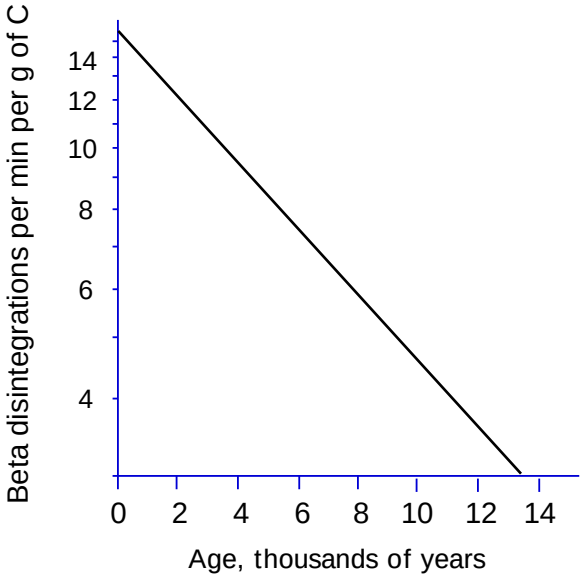
Which of the other two peaks corresponds to the larger equilibrium constant K?
1, 2, **3**



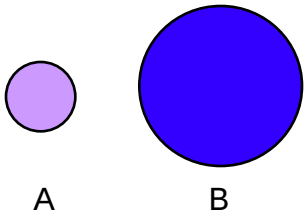
130. (Nuclear chemistry) Can a chemical reaction transform lead to gold?
yes, **no**

131. (Nuclear chemistry) A proton would be denoted
$^{1}_{0}$p , **$^{1}_{1}$p**

132. (Nuclear chemistry, half lives) From the semilog plot of log(disintegration rate) vs. time (below), the approximate half life of ^{14}C is
2000 years, **6000 years**, 10,000 years



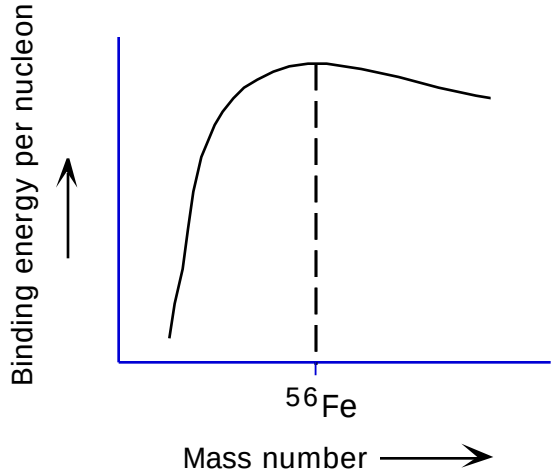
133. (Nuclear chemistry, critical mass) Consider a small sphere A and a larger sphere B. Which has a larger surface-to-volume ratio?
A, B



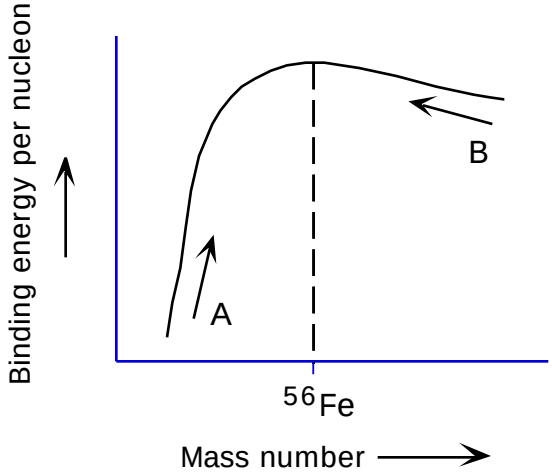
In order to sustain a nuclear chain reaction, is a large or small surface-to-volume ratio desired?
large, **small** (large sphere having at least the so-called critical mass)

134. (Nuclear chemistry) From the plot of binding energy as a function of nucleon, more stable nuclei are made by

moving toward the maximum in the plot at ^{56}Fe, moving away from the maximum in ^{4} the plot at ^{56}Fe



Which direction is fusion of nuclei and which is fission (*see* plot below)?
A is fusion and B is fission, A is fission and B is fusion



153. (Nuclear chemistry) To balance the equation

$$^{230}\text{Th} \rightarrow {}^{4}\text{He} + {}^{226}?$$

the other element produced is
Ra, Rn, Po

154. (Logarithms, nuclear chemistry, half-lives) **Demonstration:** Pass out semilog paper and have students plot the following data for decay of a Tc isotope. What is the approximate half life in hours?
4, **6**, 8

time, hr	disintegrations/min
0	180
2.5	130
5.0	104
7.5	77
10.0	59
12.5	46

173. Demonstration: Draw or obtain a rectangle. Measure one side of the rectangle carefully to 3 significant figures, and measure the other side of the rectangle to only 1 significant figure. Ask the class what the area of the rectangle is based on your measurements.

What is the area of a rectangle that is 3 m by 1.11 m?

3.33 m^2, **3 m^2**

174. The following columns of substances are listed as a combination of pure substances and mixtures. Which column represents mostly pure substances and which mostly mixtures?

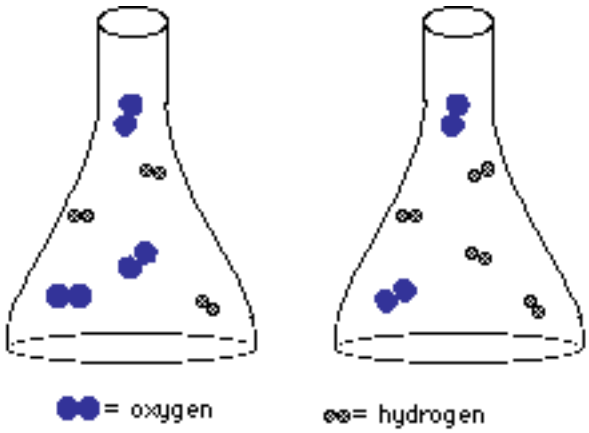
A	B
milk	raisin bran
table salt	muddy water
colorless diamond	air
graphite	gold

column A is mostly pure substances and column B is mostly mixtures
column A is mostly mixtures and column B is mostly pure substances

Which substances are in the wrong column?

milk, graphite, raisin bran, **gold**

185. Which of the flasks below will contain a mixture when all the hydrogen reacts with oxygen to give water?



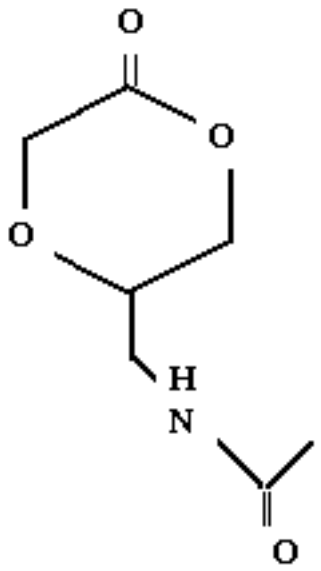
Flask A, Flask B

194. For the amino acid glycine (H2N-CH2-CO2H), the pKa of the -NH3+ group is about 10 and pKa of the -CO2H group is about 2. At pH 0, what form of these groups is primarily present?

NH3+ and CO2H, NH3+ and CO2-, NH2 and CO2H, NH2 and CO2-

195. The pKa of the weak acid, HF, is about 3. The pKb of the weak base F- is about:
-11, 3, **11**, 13

197. The molecule shown below contains which functional groups?



amide, amine, alcohol
ester, amide, ether
ester, amine, ether
carboxylic acid, amide, alcohol

How many hydrogens are present in the structure?

8, **9**, 10, 11

207. Which particle is emitted in the following nuclear reaction?

$$^{11}_{6}C \longrightarrow {}^{11}_{5}B + ?$$

A. $^{0}_{-1}e$

B. $^{0}_{+1}e$

C. $^{1}_{0}n$

A, **B**, C

208. What is the formula of bis(ethylenediamine)dichlorocobalt (III)?

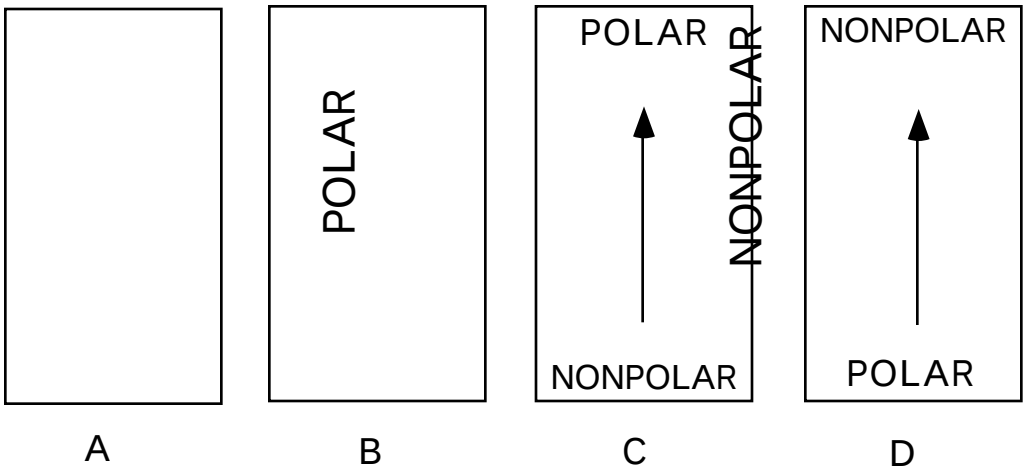
A. $[Co(en)_3Cl_2]^+$

B. $[Co(en)_2Cl_2]^+$

C. $[Co(en)_2Cl_2]^{3+}$

A, **B**, C

215. Water droplets were recently made to perform the astonishing feat of climbing uphill against gravity on a coated microscope slide. To make this process occur, the slide would have to be coated in which of the following ways?



A. Uniformly coated with a polar film
B. Uniformly coated with a nonpolar film
C. Coated with a film that gradually increased in polarity from the bottom of the slide to the top
D. Coated with a film that gradually decreased in polarity from the bottom of the slide to the top

A, B, **C**, D

(Adapted from M. K. Chaudhury and G. M. Whitesides, *Science*, 256, 1539 (1992).)