16. (Kinetic energy of gases) For two gases A and B, the average kinetic energy is the same at a given temperature:

Compared to lighter atoms at the same temperature, heavier atoms on average
move faster, **move slower**, move at the same average velocity

17. (Kinetic molecular theory) Knowing that average kinetic energy of an ideal gas is directly proportional to absolute temperature, if T_1 = 273 °C, which curve represents T = 373 °C?
A, **B,** T_1

18. (Ideal gas law, kinetic molecular theory) Given the assumptions of KMT, how would the description of a real gas by the ideal gas law depend on the concentration of the gas?
best for a dilute gas, best for a concentrated gas

43. (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

Demonstration: Syringes are used to bring drops of H_2O and ethanol to the top of columns of Hg, as shown below. What will happen to the heights of the Hg columns?
both column heights will be the same, the column below H_2O is shorter, **the column below EtOH is shorter**

44. (Vapor pressure, boiling) Boiling occurs when the vapor pressure of a liquid equals the atmospheric pressure. In the high altitude city of Denver, is the boiling point of water
>100 °C, 100 °C, **<100 °C**

45. (Colligative properties, freezing point depression) The freezing point of water is lowered proportional to the number of solute species present. In identical experimental circumstances, if NaCl is replaced with $CaCl_2$ as a solute in water, how will the freezing point compare?
higher temperature with $CaCl_2$, **lower temperature with $CaCl_2$**, no difference

46. (Crystallinity, phase changes) If sea water is frozen, what is the composition of the iceberg?
pure H_2O, H_2O and salt, pure salt

47. (Ideal gas law) Consider direct and inverse relationships among ideal gas law variables.
Demonstration: A sample of gas is trapped in a J-tube Hg manometer. What will happen to each gas law variable when more Hg is added?
number of gas moles: goes up, goes down, **stays constant**
temperature: goes up, goes down, **stays constant**
volume of trapped gas: goes up, **goes down**, stays constant
pressure of trapped gas: **goes up**, goes down, stays constant

48. (Ideal gas law) Consider direct and inverse relationships among ideal gas law variables.
Demonstration: A hard-boiled egg is placed over the opening of an Erlenmeyer flask. What will happen to each gas law variable when the flask is placed in a tub of liquid nitrogen.
number of gas moles: goes up, goes down, **stays constant**
temperature: goes up, **goes down**, stays constant
volume of trapped gas: goes up, goes down, **stays constant**
pressure of trapped gas: goes up, **goes down**, stays constant
What will happen to the egg?
nothing, it will pop out of the flask, **it will be sucked into the flask**

49. (Ideal gas law) Consider direct and inverse relationships among ideal gas law variables.
Demonstration: What will happen to each gas law variable when an inflated balloon is placed in liquid nitrogen?
number of gas moles: goes up, goes down, **stays constant**
temperature: goes up, **goes down**, stays constant
volume of trapped gas: goes up, **goes down**, stays constant
pressure of trapped gas: goes up, goes down, **stays constant**

62. (Extended structures, discrete molecules, solubility) The reaction for dissolving gaseous HCl in water is HCl (g) --> H^+ (aq) + Cl^- (aq).

How many bonds are broken per HCl formula unit when a sample of gaseous HCl dissolves?

zero, **one**, many

The layer sequence of LiCl is shown below. The reaction for dissolving the extended solid in water is LiCl (s) --> Li^+ (aq) + Cl^- (aq).

How many bonds are broken per LiCl formula unit when a chunk of LiCl dissolves?

zero, one, **many**

77. (Polarity) The following figure represents soap.

Which end of the anion is hydrophobic?

left end, right end

Will a soap solution be an electrolyte? **Demonstration:** Show that a light bulb or LED with exposed leads lights up when the leads are immersed in soapy water.

yes, no

Demonstration: Gently sprinkle lycopodium powder on top of a Petri dish of water placed on an overhead projector. Take a toothpick, stick it into a bar of soap, and then poke the toothpick into the center of the vessel. The particles will be pushed to the edge by the soap molecules. Alternately, a paper clip can be shown to float and then sink when soap is added.

How will the anions on the surface of a beaker of water prefer to arrange themselves:

A, **B**, C

How does soap interact with grease (*see* below)?

A, **B**

78. (Micelles, polarity) With large enough concentrations, these compounds with polar heads and nonpolar tails arrange themselves in water to form micelles. Which figure below represents the micelle that may form, assuming the circles are polar heads?
A, **B**, C

79. (Magnetism, polarity, surfactants; Ch. 2 "Companion," **Demonstrations 2.6, 2.7**) In a ferrofluid preparation, the intent is to keep magnetic particles suspended in an oily medium. How do the surfactant molecules interact with this medium?
A, B

85. (Phase changes, Le Châtelier's principle; Ch. 9 "Companion") Nickel titanium memory metal has a symmetric cubic unit cell in its high temperature form and a less symmetric noncubic unit cell in its low temperature form. **Demonstration 9.6** "Companion"**:** By slightly changing the Ni to Ti ratio, a sample can have, at room temperature, one or the other of these phases. Two small rods, one in the symmetric structure, one in the less symmetric structure at room temperature are dropped on the floor. One produces a ringing sound, the other a soft thud. Which gives the ringing sound?
the symmetric high temperature phase, the less symmetric low temperature phase

To cause the ring-sounding sample to give a thudding sound,
heat it, **cool it**

Demonstration: cool the sample with liquid nitrogen, remove it and drop it to hear a thud. Rapid hand warming will eventually restore the ring during repeated drops.

Which phase is more mechanically flexible?
the symmetric high temperature phase, **the less symmetric low temperature phase**

When nickel titanium memory metal interconverts between the symmetric high temperature form and the less symmetric low temperature form, which of the following changes?
elemental analysis, **X-ray diffraction pattern**, **hardness**

When a sample of nickel-titanium in the high temperature phase is bent, as pictured, the atoms that are under compression and thus favored by Le Châtelier's principle to convert to the denser low-temperature phase are those
at the bottom of the bend, in the middle of the bend, at the top of the bend

Demonstration 9.5 "Companion": Bend memory metal eyeglass frames and show that they return to their original shape. Then cool with liquid nitrogen to show that when the eyeglass frames are in the more flexible low temperature phase they stay bent until they return to room temperature, where they regain their original shape.

90. (Phase changes) If the graph below represents temperature vs. time with a constant rate of heat input, which phase transition requires more energy?
ice melting, **water boiling**

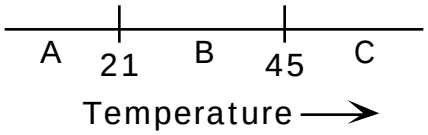
122. (Vapor pressure, equilibrium) **Demonstration:** The same amount of solid iodine is added to two identical glass tubes, which are then stoppered and heated to the same temperature. The color in the two tubes is seen to be the same and solid iodine is still present in the bottom of the tubes. When a lot of additional iodine crystals are added to one of the tubes
the color of the vapor in that tube will become darker, **there is no change in the color of the vapor**, the color of the vapor in that tube will become lighter

128. (Liquid crystals, phase changes) How many hydrogen atoms are present in the structure of the liquid crystal shown below?

13, 17, **2 1**

Which part of the molecule is more rigid?
left box, right box

Schematically, the solid liquid crystal has molecules aligned in a repeating pattern. In the liquid, order is lost. In the liquid crystal, there is still orientational order. Phase transitions are observed at 21 and 45 degrees C.



In which region would the liquid crystal be the stable phase?
A, **B**, C

142. (Colligative properties, boiling point elevation, freezing point depression, phase changes) **Demonstrations:** A digital thermometer is used to monitor temperature in each of these experiments.
What will the boiling point do when lots of salt is dissolved in the water?
increase, decrease, stay the same
What will the freezing point do when lots of salt is dissolved in the water?
increase, **decrease**, stay the same

143. (Concentration, moles) To a solution of 10 mL of 6 M NaOH is added enough water to make 100 mL of solution. The number of moles of NaOH present is
increased by a factor of 10, decreased by a factor of 10, **unchanged**
The concentration of NaOH is
increased by a factor of 10, **decreased by a factor of 10**, unchanged

144. (Concentration, moles) **Demonstration:** A mass of 0.02 moles of copper sulfate is to be dissolved in 200 mL of water to make solution A. A mass of 0.04 moles of copper sulfate is to be dissolved in 400 mL of water to make solution B. Will the two solutions have the same concentration?
yes no
Will they have the same intensity of color in a given pathlength?
yes no

146. (Ions) Solutions of $NaNO_3$ and K_2SO_4 are dissolved in water and the water then allowed to evaporate. How many possible salts could be recovered?
2, 3, **4**

158. (Solid solutions; Ch. 3 “Companion”) The following trio of metals all form the BCC structure.

Metal	Atomic Radius
V	1.31 Angstroms
Mo	1.36 Angstroms
Na	1.86 Angstroms

Which two metals are most likely to form a solid solution?
V and Mo, V and Na, Mo and Na

Additional example:

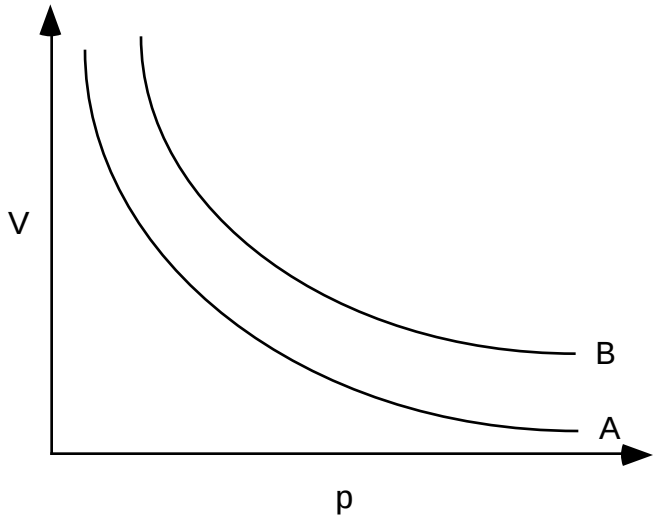
Group 14 Element	Unit Cell Length
C	3.57 Angstroms
Si	5.43 Angstroms
Ge	5.66 Angstroms

Which two elements are most likely to form a solid solution?
C and Si, C and Ge, **Si and Ge**

219. (Ideal Gas Law) The following volume-temperature plots were made at different constant pressures (and constant number of moles of gas). Which plot represents the higher pressure?

A, B

221. (Ideal Gas Law) Which of the following pV curves obtained at different constant temperatures ("isotherms") represents the lower temperature?



A, B

240. DEMONSTRATION Two samples of liquid Br_2 are placed in each of two ampules that are then sealed. One ampule will be dropped so as to break in a transparent tube filled with air. The other will be dropped so as to break in an evacuated tube. Compare the relative rates of diffusion, which are made visible as the red-brown Br_2 vapor fills each tube. The rate of diffusion will be:

The same in both tubes
Faster in the air-filled tube
Faster in the evacuated tube