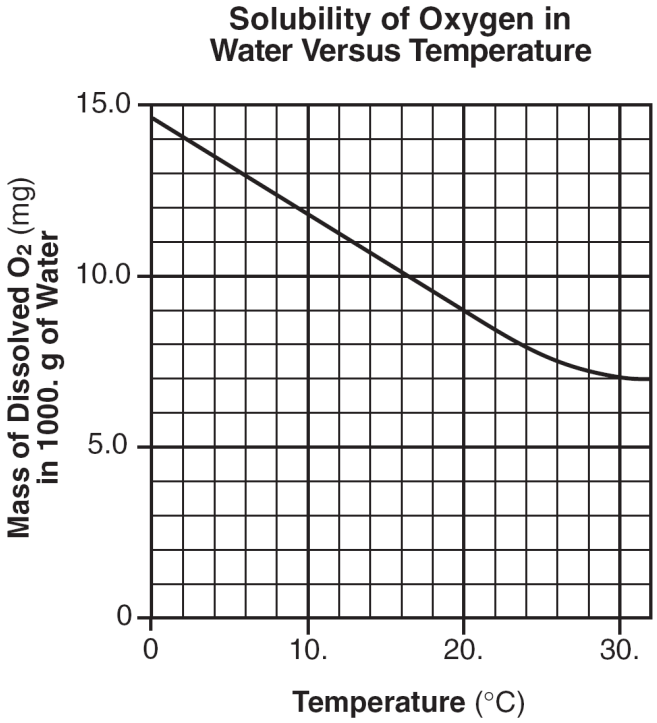
Base your answers to questions **1** through **3** on the information below

Scientists who study aquatic ecosystems are often interested in the concentration of dissolved oxygen in water. Oxygen, O2, has a very low solubility in water, and therefore its solubility is usually expressed in units of milligrams per 1000. grams of water at 1.0 atmosphere. The graph below shows a solubility curve of oxygen in water.



1. An aqueous solution has 0.0070 gram of oxygen dissolved in 1000. grams of water. Calculate the dissolved oxygen concentration of this solution in parts per million. Your response must include *both* a correct numerical setup and the calculated result.

2. Explain, in terms of molecular polarity, why oxygen gas has low solubility in water. Your response must include *both* oxygen and water.

3. A student determines that 8.2 milligrams of oxygen is dissolved in a 1000.-gram sample of water at 15°C and 1.0 atmosphere. In terms of saturation, what type of solution is this sample?

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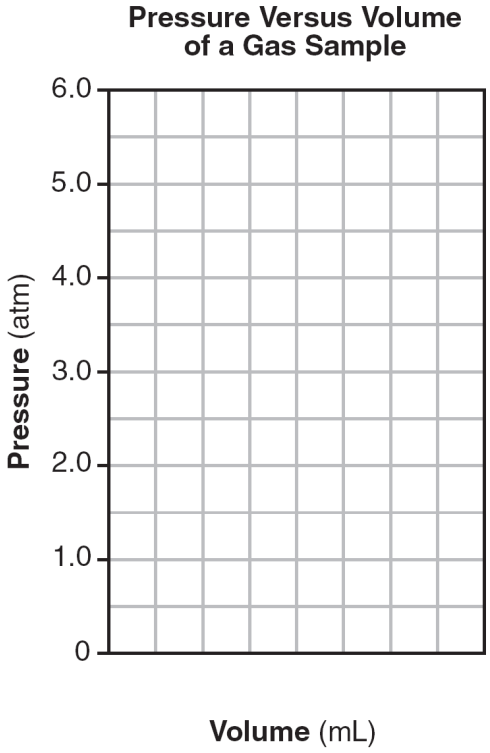
4. A 1.00-mole sample of neon gas occupies a volume of 24.4 liters at 298 K and 101.3 kilopascals. Calculate the density of this sample. Your response must include *both* a correct numerical setup and the calculated result.

Base your answers to questions **5** through **7** on the information below

A gas sample is held at constant temperature in a closed system. The volume of the gas is changed, which causes the pressure of the gas to change. Volume and pressure data are shown in the table below.

Volume and Pressure of a Gas Sample

Volume (mL)	**Pressure** (atm)
1200	0.5
600	1.0
300	2.0
150	4.0
100	6.0



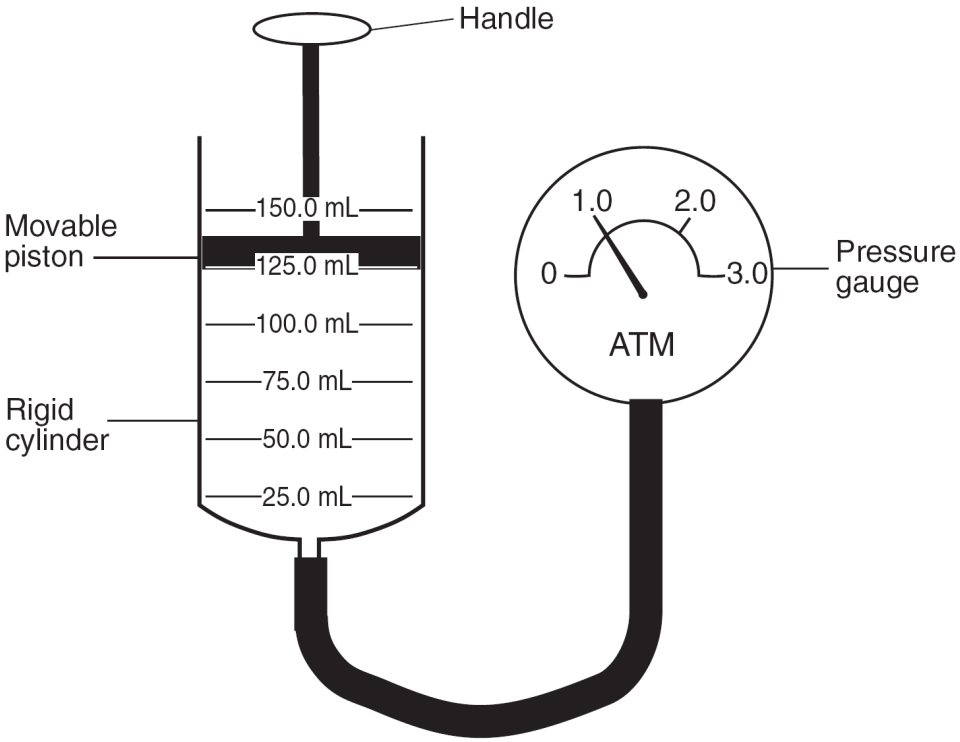
5. On the grid above, mark an appropriate scale on the axis labeled "Volume (mL)."

6. On the same grid, plot the data from the table. Circle and connect the points.

7. Based on your graph, what is the pressure of the gas when the volume of the gas is 200. milliliters?

Base your answers to questions **8** through **10** on the information below.

A rigid cylinder is fitted with a movable piston. The cylinder contains a sample of helium gas, He(g), which has an initial volume of 125.0 milliliters and an initial pressure of 1.0 atmosphere, as shown below. The temperature of the helium gas sample is 20.0°C.



8. Helium gas is removed from the cylinder and a sample of nitrogen gas, $N_2(g)$, is added to the cylinder. The nitrogen gas has a volume of 125.0 milliliters and a pressure of 1.0 atmosphere at 20.0°C. Compare the number of particles in this nitrogen gas sample to the number of particles in the original helium gas sample.

9. The piston is pushed further into the cylinder. In the space below, show a correct numerical setup for calculating the volume of the helium gas that is anticipated when the reading on the pressure gauge is 1.5 atmospheres. The temperature of the helium gas remains constant.

10. Express the initial volume of the helium gas sample, in liters.

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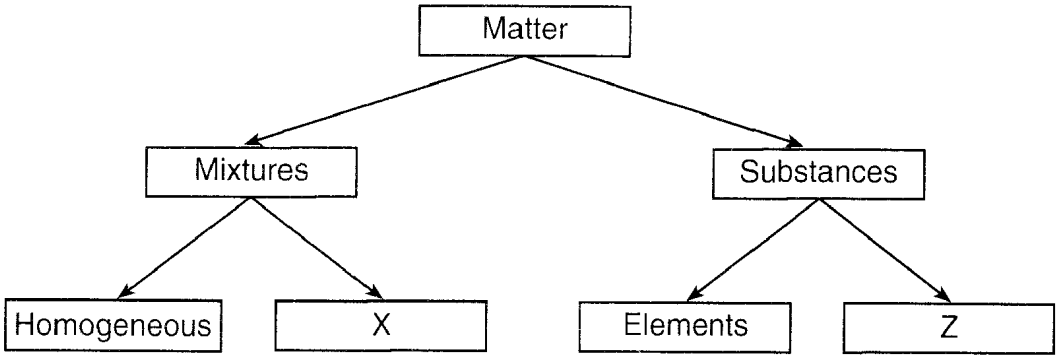
11. A liquid boils when the vapor pressure of the liquid equals the atmospheric pressure on the surface of the liquid. Using Reference Table *H*, determine the boiling point of water when the atmospheric pressure is 90. kPa.

Base your answers to questions **12** through **15** on the diagram below concerning the classification of matter.

Classification of Matter



12. Given a mixture of sand and water, state *one* process that can be used to separate water from the sand.

13. Explain, in terms of particle arrangement, why NaCl(aq) is a homogeneous mixture.

14. What type of substance is represented by *Z*?

15. What type of mixture is represented by *X*?

Base your answers to questions **16** and **17** on the information below.

Air bags are an important safety feature in modern automobiles. An air bag is inflated in milliseconds by the explosive decomposition of $NaN_3(s)$. The decomposition reaction produces $N_2(g)$, as well as Na(s), according to the unbalanced equation below.

$$NaN_3(s) \rightarrow Na(s) + N_2(g)$$

16. When the air bag inflates, the nitrogen gas is at a pressure of 1.30 atmospheres, a temperature of 301 K, and has a volume of 40.0 liters. Calculate the volume of the nitrogen gas at STP. Your response must include *both* a correct numerical setup and the calculated volume

17. Balance the equation for the decomposition of NaN_3, using the smallest whole-number coefficients.

---

18. Base your answer to the following question on the information below.

A lightbulb contains argon gas at a temperature of 295 K and at a pressure of 75 kilopascals. The lightbulb is switched on, and after 30 minutes its temperature is 418 K.

Show a correct numerical setup for calculating the pressure of the gas inside the lightbulb at 418 K. Assume the volume of the lightbulb remains constant.

19. A sample of oxygen gas in one container has a volume of 20.0 milliliters at 297 K and 101.3 kPa. The entire sample is transferred to another container where the temperature is 283 K and the pressure is 94.6 kPa. Show a correct numerical setup for calculating the new volume of this sample of oxygen gas.

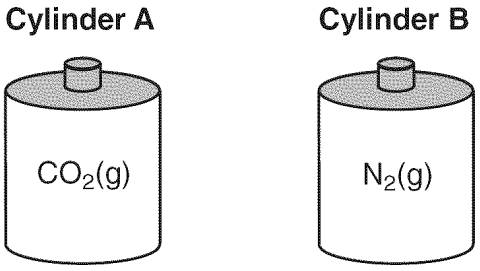
Base your answers to questions **20** and **21** on the properties of propanone.

20. A liquid's boiling point is the temperature at which its vapor pressure is equal to the atmospheric pressure. Using Reference Table *H,* what is the boiling point of propanone at an atmospheric pressure of 70 kPa?

21. Explain, in terms of molecular energy, why the vapor pressure of propanone increases when its temperature increases.

Base your answers to questions **22** and **23** on the information and diagrams below.

Cylinder Acontains 22.0 grams of $CO_2(g)$ and cylinder Bcontains $N_2(g)$. The volumes, pressures, and temperatures of the two gases are indicated under each cylinder.

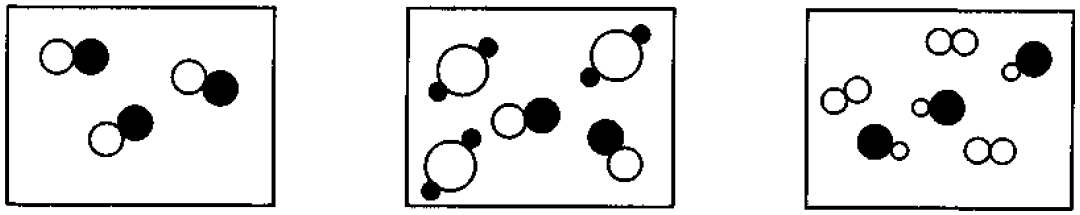


Cylinder A	Cylinder B
V = 12.3 L	V = 12.3 L
P = 1.0 atm	P = 1.0 atm
T = 300. K	T = 300. K

22. The temperature of the $CO_2(g)$ is increased to 450. K and the volume of cylinder A remains constant. Show a correct numerical setup for calculating the new pressure of the $CO_2(g)$ in cylinder A.

23. What is the total number of moles of $CO_2(g)$ in cylinder *A*?

24. Base your answer to the following question on the pictures below:



A B C

Explain how the average kinetic energy of sample *B* can be equal to the average kinetic energy of sample *C*.

Base your answers to questions **25** through **28** on the information below.

A weather balloon has a volume of 52.5 liters at a temperature of 295 K. The balloon is released and rises to an altitude where the temperature is 252 K.

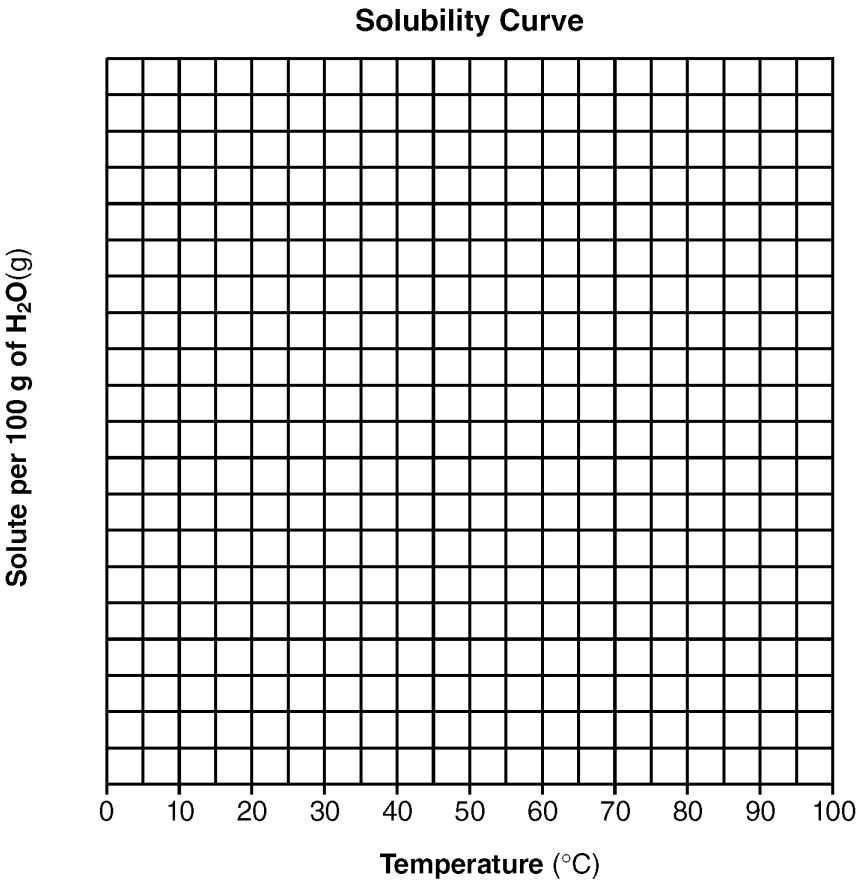
25. What pressure, in atmospheres (atm), is equal to 45.6 kPa?

26. What Celsius temperature is equal to 252 K?

27. The original pressure at 295 K was 100.8 kPa and the pressure at the higher altitude at 252 K is 45.6 kPa. Assume the balloon does not burst. Show a correct numerical setup for calculating the volume of the balloon at the higher altitude.

28. How does this temperature change affect the gas particle motion?

Base your answers to questions **29** through **32** on the data table below, which shows the solubility of a solid solute.



The Solubility of the Solute at Various Temperatures

Temperature (°C)	Solute per 100 g of H_2O(g)
0	18
20	20
40	24
60	29
80	36
100	49

29. On the grid provided, mark an appropriate scale on the axis labeled "Solute per 100 g of H_2O(g)." An appropriate scale is one that allows a trend to be seen.

30. On the same grid, plot the data from the data table. Circle and connect the points.

31. Based on the data table, if 15 grams of solute is dissolved in 100 grams of water at 40°C, how many *more* grams of solute can be dissolved in this solution to make it saturated at 40°C?

32. According to Reference Table *G*, how many grams of $KClO_3$ must be dissolved in 100 grams of H_2O at 10°C to produce a saturated solution?

Base your answers to questions **33** and **34** on the information below.

Naphthalene, a nonpolar substance that sublimes at room temperature, can be used to protect wool clothing from being eaten by moths.

33. Explain why naphthalene is *not* expected to dissolve in water.

34. Explain, in terms of *intermolecular forces*, why naphthalene sublimes.

Base your answers to questions **35** through **37** on the information below.

A student uses 200 grams of water at a temperature of 60°C to prepare a saturated solution of potassium chloride, KCl.

35. This solution is cooled to 10°C and the excess KCl precipitates (settles out). The resulting solution is saturated at 10°C. How many grams of KCl precipitated out of the original solution?

36. According to Reference Table *G*, how many grams of KCl must be used to create this saturated solution?

37. Identify the solute in this solution.

Base your answers to questions **38** and **39** on the diagram below, which shows a piston confining a gas in a cylinder.

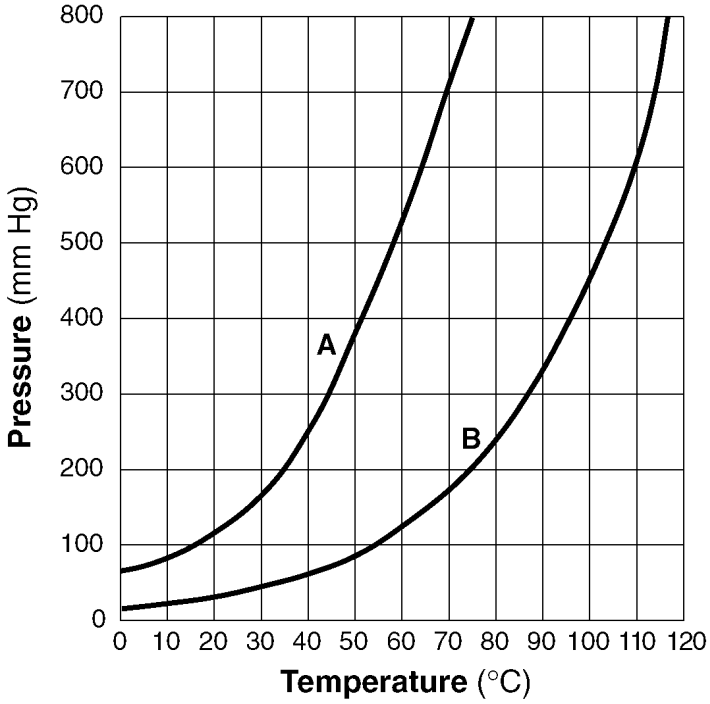
38. The gas volume in the cylinder is 6.2 milliliters and its pressure is 1.4 atmospheres. The piston is then pushed in until the gas volume is 3.1 milliliters while the temperature remains constant.

a Calculate the pressure, in atmospheres, after the change in volume. Show all work.

b Record your answer.

39. Sketch the general relationship between the pressure and the volume of an ideal gas at constant temperature.

Base your answers to questions **40** through **42** on the graph below, which shows the vapor pressure curves for liquids *A* and *B*.



40. Which liquid will evaporate more rapidly? Explain your answer in terms of intermolecular forces.

41. At what temperature does liquid *B* have the same vapor pressure as liquid *A* at 70°C? Your answer must include correct units.

42. What is the vapor pressure of liquid *A* at 70°C? Your answer must include correct units.

Base your answers to questions **43** and **44** on the information below.

When cola, a type of soda pop, is manufactured, $CO_2(g)$ is dissolved in it.

43. *a* Draw a set of axes and label one of them "Solubility" and the other "Temperature."
b Draw a line to indicate the solubility of $CO_2(g)$ versus temperature on the axes drawn in part *a*.

44. A capped bottle of cola contains $CO_2(g)$ under high pressure. When the cap is removed, how does pressure affect the solubility of the dissolved $CO_2(g)$?

Answer Key
Unit 7 and 8 SA Review

1. $\text{ppm} = \frac{0.0070 \text{ gram } O_2}{(1000. \text{ grams of water} + 0.0070 \text{ gram of } O_2)} \times 1\,000\,000$

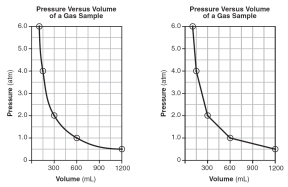
   $(0.0070 / 1000.0070) \times 1\,000\,000$

2. Oxygen molecules are nonpolar and water molecules are polar.

3. The sample is an unsaturated solution.

4. $D = \frac{m}{v} = \frac{20.179g}{24.4L}$
   0.827 g/L

5. An appropriate scale is linear and allows a trend to be seen.

6. 

7. 3.0 atm *or* for a response consistent with the student's graph ± 0.3 grid space

8. *Examples:* —Both samples have the same number of particles. —Equal volumes of gases at the same temperature and pressure contain the same number of particles.

9. *Examples:*
   —$V_2 = \frac{(1.0atm)(125.0mL)}{1.5atm}$
   —(1.0)(125) = (1.50)(V_2)

10. *Examples:* —0.1250 L —0.125 L —1.25 × 10^{-1} L

11. 97°C ± 1°C.

12. Examples: – Evaporate the water. – Decant the water. -filtration

13. Examples: – The water molecules, sodium ions, and chloride ions are uniformly mixed together.
    – All particles distribute evenly.

14. compound or compounds

15. Examples: – heterogeneous – nonuniform

16. 47.2 L
    V_2 = (273 K)(1.30 atm)(40.0 L) / (301 K)(1.00 atm)
    $\frac{(273)(1.30)(40.0)}{(301)(1.00)}$

17. 2 $NaN_3(s) \rightarrow$ 2 Na(s) + 3 $N_2(g)$

18. $\frac{75 \text{ kPa}}{295 \text{ K}} = \frac{x}{418 \text{ K}}$

    $P_2 = \frac{(75)(418}{295}$

19. Acceptable responses include, but are not limited to:
    $V_2 = \frac{(20.0 \text{ mL})(101.3 \text{ kPa})(283 \text{ K})}{(94.6 \text{ kPa})(297 \text{ K})}$

    $\frac{(101.3)(20.0)}{297.283} = (94.6)V_2$

20. 45°C (±2).

21. Acceptable responses include, but are not limited to:
    As the temperature increases, more molecules have enough energy to escape the liquid phase.

22. $\frac{450}{300}$

23. 0.500 mol

24. If both samples are at the same temperature *or* Samples *B* and *C* could both be at 273 K (or at 0ºC) *or* both at STP

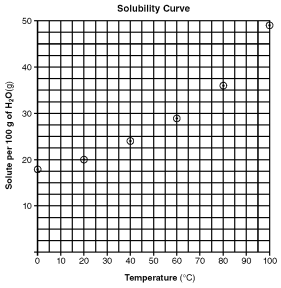
25. .45 or 0.45

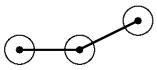
26. –21°C

27. $\frac{(100.8 \text{ kPa})(52.5 \text{ L})}{295 \text{ K}} = \frac{(45.6 \text{ kPa})(X)}{(252 \text{ K})}$

    $52.5 \times \frac{252}{295} \times \frac{100.8}{45.6}$

28. Acceptable responses: Particles move slower; The molecules will slow down as the temperature decreases; The average kinetic energy of the particles decreases; decreases.

29. 

30. Example: 

31. 9

32. 7; ±1

33. Acceptable responses: Naphthalene is nonpolar and water is polar; Nonpolar won't dissolve in polar; Like dissolves like.

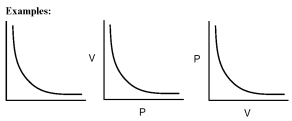
34. Acceptable responses: Naphthalene has weak intermolecular forces; They are weak.

35. Allow credit for **30** (±2). *or* Allow credit for a response consistent with the student's answer to previous question.

36. Allow credit for **90** (±2).

37. Allow credit for **KCl** or **potassium chloride**.

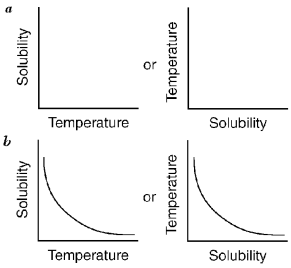
38. *a* Example: (6.2 mL)(1.4 atm) = (3.1 mL)(P_2)
    b 2.8

39. 

40. liquid *A*
    Example:
    The higher vapor pressure of liquid *A* indicates that the intermolecular forces between its molecules are weaker, allowing the molecules to escape more readily to the vapor phase.

41. 114 (±2) °C

42. 710 (±10) mm Hg

43. 

44. Solubility of $CO_2(g)$ decreases with a decrease in pressure