Chemistry: Form TR8.10A Name ______________________

TEST 8 REVIEW Date ____________ Period _____

Test Review № 8

ENERGY

Calculating Joules. When you heat a solid, it's temperature generally goes up. There is a relationship between heat and temperature, but they are not the same thing. It would take a lot more energy to heat up the ocean than to warm a cup of tea. The ocean has a larger mass. It has many more molecules to share energy with. Mass is not the only thing that influences the way the temperature changes in response to heat. When the same sun beats down on the beach, the sand gets a lot hotter than the water. Water has a higher heat capacity than sand. The relationship between mass, temperature change, specific heat, and energy are shown to the right.

$$Q = m\Delta T c_p$$

Q = heat (J) m = mass in grams
ΔT = change in temperature [$\Delta T = T_f - T_i$]
T_f = final temperature
T_i = starting temperature
c_p = 4.2 J/g°C for water

Specific Heat. Some substances are more resistant to temperature change than others. They have a higher specific heat. The equation for determining specific heat is shown to the right

$$c_p = \frac{Q}{m\Delta T}$$

Q = joules; m = mass in grams
ΔT = change in temperature [$\Delta T = T_f - T_i$]
T_f = final temperature (°C)
T_i = starting temperature (°C)
c_p = specific heat (J/g°C)

Temperature scales. The Celsius scale is based on water. The freezing point of water is 0°C, while the boiling point of water is 100°C. The Kelvin scale is based on the Celsius scale with the zero at absolute zero. Absolute zero is the lowest possible temperature. It is the temperature at which particles of matter stop moving.

K = °C + 273 and **°C = K – 273**

PHASES OF MATTER

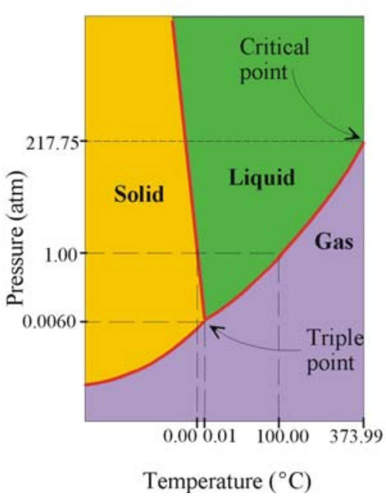
Comparing Solids, Liquids, and Gases. Solids are substances with a definite shape and volume. The particles of solids vibrate about fixed positions, held in place by large forces of attraction. Liquids have a definite volume, but their shape is determined by their container. The particles of a liquid roll and slide over each other. Both the shape and volume of a gas are determined by the container. This is because the particles move independently, and spread out to fill the container. Gases are mostly empty space, and they can be compressed.

Kinetic Molecular Theory. Matter is composed of particles that are in constant motion (kinetic energy). There are forces of attraction between particles that depend on the distance between the particles. The further apart the particles are, the smaller the forces of attraction between them are. The higher the temperature (average kinetic energy) is, the faster the particles move. The *Kinetic Molecular Theory* explains the phases. In solids the forces of attraction between particles are larger than in other phases. As a result, the particles are held relatively close together in fixed positions, vibrating back and forth. Therefor the shape and volume are not determined by the container. In liquids the forces of attraction between particles are moderate compared to other phases. The particles can move from place to place but cannot separate from each other and move independently, so they roll and slide over each other. The particles are pulled downhill by gravity causing the liquid to seek its own level, so the shape is determined by the container but the volume is not. In gases the forces of attraction between particles are weaker than in other phases. The particles can move from place to place independently of each other because they do NOT attract or repel each other. The particles are relatively far apart. The volume of the particles is small compared to the space between them. Gases tend to spread out to fill their container. Therefor both the shape and volume are determined by the container.

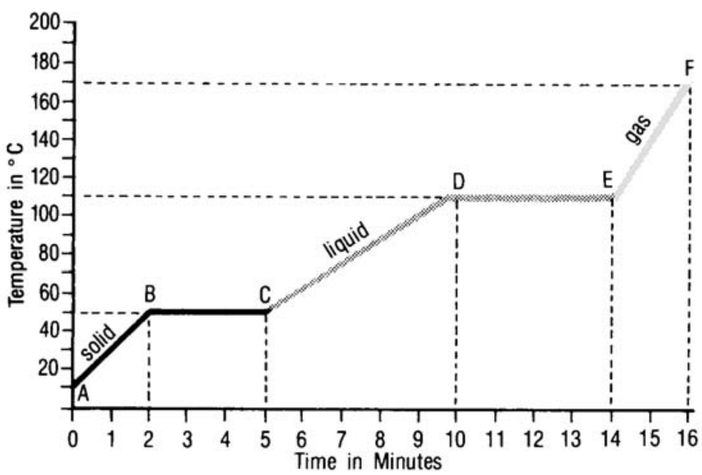
PHASE CHANGES

Heating a substance in a given phase causes the temperature to increase. Increasing the temperature causes particles to move faster and collide harder. This causes the particles to rebound harder moving them further apart. Larger distances between particles weakens the forces of attraction between them. When the forces of attraction are weak enough, the distance between the particles increases markedly and the phase changes. As a result, a solid melts, and a liquid evaporates. The reverse happens when a substance cools, so a gas condenses, and a liquid freezes.

Phase Diagram. A phase diagram shows phases of a substance in a closed system as a function of temperature and pressure. The points on the phase diagram are [a] the *triple point* where all three phases of mater coexist; [b] the *critical temperature* above which vapor cannot be liquefied no matter what pressure is applied; [c] the *critical pressure*, the pressure required to form a liquid at the critical temperature; and [d] the *critical point* defined by the critical temperature and pressure.



Phase diagram for water



Heating/Cooling Curve

Heating/Cooling Curve The temperature does not change during a phase change. The heat energy absorbed or lost does not result in a change in kinetic energy. Instead, there is a change in potential energy due to the change in distance between the particles. The *Freezing/Melting point* is the temperature at which the solid and liquid phase exist in equilibrium. The *heat of fusion* is the amount of heat needed to change a unit mass of a substance from a solid to a liquid at a constant temperature and 1 atm of pressure. For water it is 333.6 J/g. The *boiling point* is the temperature at which the vapor pressure is equal to the surrounding pressure. The *heat of vaporization* is the amount of heat needed to change a unit mass of a substance from a liquid to a gas at a constant temperature and 1 atm of pressure. For water it is 2259 J/g.

Vapor Pressure. When water evaporates, it changes from a liquid to a gas called water vapor. Water vapor takes up more space than an equal mass of liquid water. As a result, in a closed container, the vapor that forms can exert a significant amount of pressure. This pressure is known as vapor pressure. Even in an open container, the vapor is confined by the air pressing down on it. Some of it collects at the surface and exerts pressure. Occasional high energy molecules at the water's surface escape. That is why the water eventually evaporates. But for a water to expand and form vapor bubbles throughout the liquid as it does when it boils, the vapor has to exert as much pressure as the blanket of air confining it. As a liquid is heated, more of it turns into vapor, and the vapor pressure increases. When the vapor pressure reaches atmospheric pressure, the liquid boils. Under greater external pressure, the liquid boils at a higher temperature.

Gas Laws. The volume of a gas is inversely proportional to the pressure at a constant temperature. At a constant pressure, the volume of a gas is directly proportional to its Kelvin temperature. These two ideas together result in the combined gas law.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Answer the questions below by circling the number of the correct response

1. Which temperature represents absolute zero? (1) 0 K (2) 0°C (3) 273 K (4) 273°C

2. At which temperature does a water sample have the highest average kinetic energy (1) 0°C, (2) 100°C, (3) 0 K, (4) 100 K

3. When 84 joules of heat is added to 2.0 gram of water at 15°C, the temperature of the water increases to (1) 5.0°C, (2) 15°C, (3) 25°C, (4) 50. 0 C

4. Which Kelvin temperatures represent, respectively, the normal freezing point and the normal boiling point of water? (1) 0 K and 273 K (2) 0 K and 100 K (3) 100 K and 273 K (4) 273 K and 373 K

5. How many joules of heat energy are released when 50 grams of water are cooled from 70°C to 60°C? (1) 42 joules (2) 210 joules (3) 2100 joules (4) 4,200 joules

6. The number of joules needed to raise the temperature of 10 grams of' water from 20°C to 30°C is (1) 42, (2) 84, (3) 420, (4) 168

7. A 5-gram sample of water is heated and the temperature rises from 10°C to 15°C. The total amount of heat energy absorbed by the water is (1) 105 J, (2) 84 J, (3) 63 J, (4) 21 J

8. At which temperature would the molecules in a one gram sample of water have the lowest average kinetic energy? (1) 5°C (2) –100°C (3) 5 K (4) 100 K

9. How many kilojoules of heat energy are absorbed when 100 grams of water is heated from 20°C to 30°C? (1) 4.2 kJ (2) 42 kJ (3) 420 kJ (4) 0.42 kJ

10. The temperature of a substance changes from -173°C to 0°C. How many Kelvin degrees does this change represent? (1) 100. (2) 173 (3) 273 (4) 446

11. How many kilojoules of heat are needed to raise the temperature of 500. grams of water from 10.0°C to 30.0°C? (1) 42 kJ (2) 105kJ (3) 210. kJ (4) 168 kJ

12. When 5 grams of water at 20°C absorbs 10 joules of heat, the temperature of the water will be increased by a total of (1) 0. 5 C° (2) 2 C° (3) 10 C° (4) 50 C°

13. Which Kelvin temperature is equal to –33°C? (1) –33 K (2) 33 K (3) 240 K (4) 306 K

14. If 4 grams of water at 1°C absorbs 33.6 joules of heat, the temperature of the water will change by (1) 1 C° 2) 2 C° (3) 3 C° (4) 4 C°

15. The molecules of which substance have the highest average kinetic energy? (1) He(g) at 0°C (2) CO_2(g) at 20°C (3) HCl(g) at 40°C (4) N_2(g) at 60°C

16. Which 5.0-milliliter sample of NH_3 will take the shape of and completely fill a closed 100.0-milliliter container? (1) NH_3(s) (2) $NH_3(\ell)$ (3) NH_3(g) (4) NH_3(aq)

17. Which of the following has the strongest forces of attraction? (1) CO_2(s) (2) $CO_2(\ell)$ (3) CO_2(g) (4) CO_2(aq)

18. Which of the following can be compressed under pressure? (1) I_2(s) (2) $I_2(\ell)$ (3) I_2(g) (4) I_2(aq)

19. Which 1.5-liter sample of salt does *NOT* take the shape of its container? (1) NaCl(s) (2) NaCl(ℓ) (3) NaCl(g) (4) NaCl(aq)

20. A 25.0 mL sample of water is poured from a 50.0 mL graduated cylinder to a 100.0 mL graduated cylinder. The volume of the water (1) increases, (2) decreases, (3) remains the same.

21. As ice melts at standard pressure, its temperature remains at 0°C until it has completely melted. Its potential energy (1) decreases (2) increases (3) remains the same

22. When water freezes, each gram loses an amount of heat equal to its heat of (1) fusion (2) vaporization (3) sublimation (4) reaction

23. As the temperature of a liquid increases, its vapor pressure (1) decreases (2) increases (3) remains the same

24. Which change of phase represents fusion? (1) gas to liquid (2) gas to solid (3) solid to liquid (4) liquid to gas

25. Which substance readily sublimes at room temperature? (1) $H_2O(\ell)$ (2) O_2(g) (3) Fe(s) (4) CO_2(s)

26. Which change of phase represents sublimation? (1) $H_2O(g) \rightarrow H_2O(\ell)$ (2) $H_2O(\ell) \rightarrow H_2O(s)$ (3) $CO_2(s) \rightarrow CO_2(g)$ (4) $CO_2(s) \rightarrow CO_2(\ell)$

27. Which change of phase is exothermic? (1) gas to liquid (2) solid to liquid (3) solid to gas (4) liquid to gas

28. The heat of fusion for ice is 333.6 joules per gram. Adding 333.6 joules of heat to one gram of ice at STP will cause the ice to (1) increase in temperature (2) decrease in temperature (3) change to water at a higher temperature (4) change to water at the same temperature

29. Which term represents the change of a substance from the solid phase to the liquid phase? (1) condensation (2) vaporization (3) evaporation (4) fusion

30. When the vapor pressure of a liquid in an open container equals the atmospheric pressure, the liquid will (1) freeze (2) crystallize (3) melt (4) boil

31. The energy required to change a unit mass of a gas to a liquid at constant temperature is called its heat of (1) formation (2) vaporization (3) combustion (4) fusion

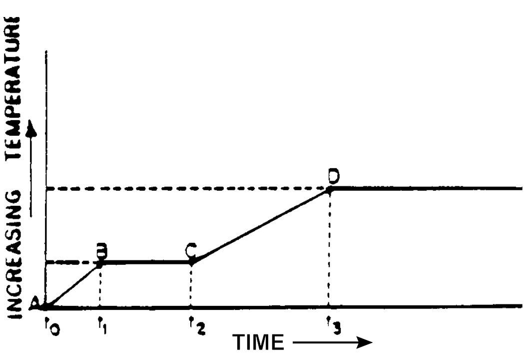
32. Which sample contains particles arranged in regular geometric pattern? (1) $CO_2(\ell)$ (2) CO_2(s) (3) CO_2(g) (4) CO_2(aq)

33. The heat of fusion of a substance is the energy measured during a (1) phase change (2) temperature change (3) chemical change (4) pressure change

34. A substance sublimes at standard temperature and pressure. What could be done to cause the substance to melt? (1) increase the temperature (2) decrease the temperature (3) increase the pressure (4) decrease the pressure.

35. The temperature at which a substance can exist as a solid, liquid, and gas simultaneously is the (1) melting point, (2) triple point, (3) boiling point, (4) critical point.

Base your answers to questions 36 and 37 on the diagram below which represents a substance being from a solid to a gas, the pressure remaining constant



36. The substance begins to boil at point (1) E (2) B (3) C (4) D

37. Between points B and C the substance exists in (1) the solid state, only (2) the liquid state, only (3) both the solid and liquid states (4) neither the solid nor the liquid state

Answer questions 38-40 by referring to Table H on the reference tables.

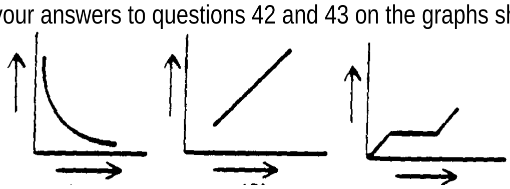
38. At what pressure will ethanol boil at 90°C? (1) 75 kPa (2) 150 kPa (3) 101.3 kPa (4) 200 kPa

39. At what temperature will water boil at a pressure of 10 kPa? (1) 25°C (2) 10°C (3) 101.3°C (4) 45°C

40. Which of the following has the highest boiling point at a pressure of 40 kPa? (1) propanone (2) ethanoic acid (3) ethanol (4) water

41. A sample of a gas is at STP. As the pressure decreases and the temperature increases, the volume of the gas (1) decreases (2) increases (3) remains the same

Base your answers to questions 42 and 43 on the graphs shown below.



(1) (2) (3)

Note that questions 42 and 43 have only three choices.

42. Which graph best represents how the volume of a given mass of a gas varies with the Kelvin temperature at constant pressure?

43. Which graph best represents how the volume of a given mass of a gas varies with the pressure on it at constant temperature.

44. A 100. milliliter sample of a gas at a pressure of 50.8 kPa is reduced to 25.4 kPa at constant temperature. What is the new volume of the gas? (1) 50.0 mL (2) 90.0 mL (3) 200. mL (4) 290. mL

45. Pure water will boil at 24°C in a closed system when the pressure in the system is (see vapor pressure graph) (1) 13.3 kPa (2) 101.3 kPa (3) 3.0 kPa (4) 36.4 kPa

46. At constant temperature the pressure on 8.0 liters of a gas is increased from 1 atmosphere to 4 atmospheres. What will be the new volume of the gas? (1) 1.0 ℓ (2) 2.0 ℓ (3) 32 ℓ (4) 4.0 ℓ

47. As the temperature of a sample of gas decreases at constant pressure, the volume of the gas (1) decreases (2) increases (3) remains the same

48. A 100 milliliter sample of a gas is enclosed in cylinder under a pressure of 101.3 kPa. What volume would the gas sample occupy at a pressure of 202.6 kPa, temperature remaining constant? (1) 50 mL (2) 100 mL (3) 200 mL (4) 380 mL

49. The volume of a sample of hydrogen gas at STP is 1.00 liter. As the temperature decreases, pressure remaining constant, the volume of the sample (1) decreases (2) increases (3) remains the same

50. The pressure on 200. milliliters of a gas at constant temperature is changed from 0.500 atm to 1.00 atm. The new volume of the gas is (1) 100. mL (2) 200. mL (3) 400. mL (4) 600. mL

51. As the pressure on a given sample of a gas increases at constant temperature, the mass of the sample (1) decreases (2) increases (3) remains the same

52. A gas sample is at 10.0°C. If pressure remains constant, the volume will increase when the temperature is changed to (1) 263 K (2) 283 K (3) 273 K (4) 293 K

Answers

1. 1	12. 1	23. 2	33. 1	43. 1
2. 2	13. 3	24. 3	34. 3	44. 3
3. 3	14. 2	25. 4	35. 2	45. 3
4. 4	15. 4	26. 3	36. 4	46. 2
5. 3	16. 3	27. 1	37. 3	47. 1
6. 3	17. 1	28. 4	38. 2	48. 1
7. 1	18. 3	29. 4	39. 4	49. 1
8. 3	19. 1	30. 4	40. 2	50. 1
9. 1	20. 3	31. 2	41. 2	51. 3
10. 2	21. 2	32. 2	42. 2	52. 4
11. 1	22. 1			