Predict Products for the following (Use Activity Series)

$FeO + Ba \longrightarrow$

$PbCl_2 + Zn \longrightarrow$

$NiCl + F_2 \longrightarrow$

$NaI + Cl_2 \longrightarrow$

$CaCl_2 + I_2 \longrightarrow$

$MgCl + Fe \longrightarrow$

$Ca + H_2O_{(g)} \longrightarrow$

$Fe + H_2O(l) \longrightarrow$

$Cu + HNO_3 \longrightarrow$

$Al + HC_2H_3O_2 \longrightarrow$

$Fe + O_2 \longrightarrow$
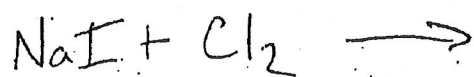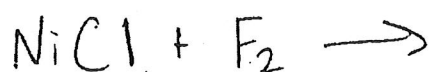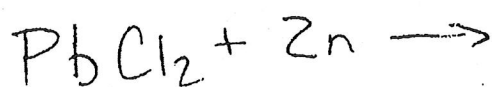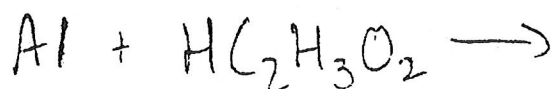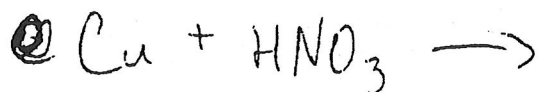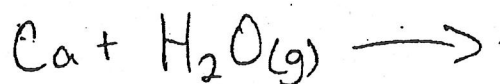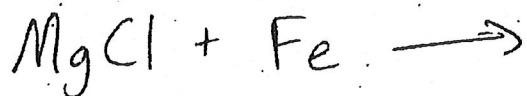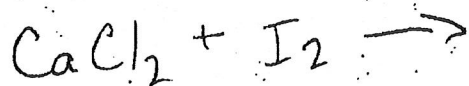
Warmup

1. What is the molecular formula of a compound that is 56.6% K, 8.7% C, and 34.7% O; and has a molar mass of 414g?

2. Find the number of molecules in 508g of methane (CH_4)
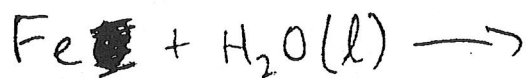
3. How many TOTAL ATOMS are in the problem above?

4. Determine the %H of Acetic Acid.

5. Determine the percent water of $BaSO_4 \cdot 5H_2O$

Net Ionic Equation Worksheet   Name _____

1. $Na_2CO_3(aq)$ $+ FeCl_2(aq)$ $\rightarrow$ $FeCO_3(s) + NaCl(aq)$

2. $Mg(OH)_2(aq) + HCl(aq)$ $\rightarrow$ $MgCl_2(aq) +$ $H_2O(l)$

3. $Zr(OH)_4(s) + HNO_3(aq) \rightarrow Zr(NO_3)_4(\quad)$ $+$ $H_2O(l)$

4. $Na_2SO_3(s) + HCl(aq) \rightarrow$ $NaCl(\quad) + H_2O(l) + SO_2(g)$

5. $BaBr_2(aq) + Na_2SO_4(aq)$ $\rightarrow$

6. $AgNO_3(aq) + MgI_2(aq)$ $\rightarrow$

7. $Ni(NO_3)_2(aq) + NaOH(aq)$ $\rightarrow$
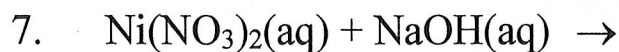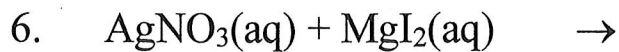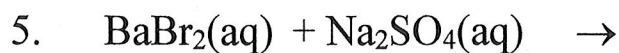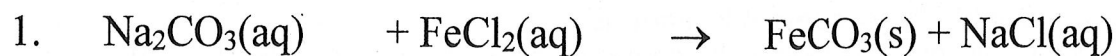
Predicting Products of Double Replacement Reactions

Worksheet #5: Double-Replacement Reactions

Name _____

In these reactions, all you do is look at the names of the reactants, and "switch partners". Just be sure that the new pairs come out with the positive ion named first, and paired with a negative ion.

1. aluminum iodide + mercury(II) chloride →

2. silver nitrate + potassium phosphate →

3. copper(II) bromide + aluminum chloride →

4. calcium acetate + sodium carbonate →

5. ammonium chloride + mercury(I) acetate →

6. calcium nitrate + hydrochloric acid →

7. iron(II) sulfide + hydrochloric acid →

8. copper(II) hydroxide + acetic acid →

9. calcium hydroxide + phosphoric acid →

10. calcium bromide + potassium hydroxide →

Examine the products of the reactions on this page, and determine in each whether a gas, water, or a precipitate is formed. Use solubility Table B.9 on page R54 at the back of your textbook to determine the solubilities of the reaction products. If there is no gas, water, or precipitate produced, put an "X" through the yield sign, because no reaction occurs.

Reactions Review: 11/6
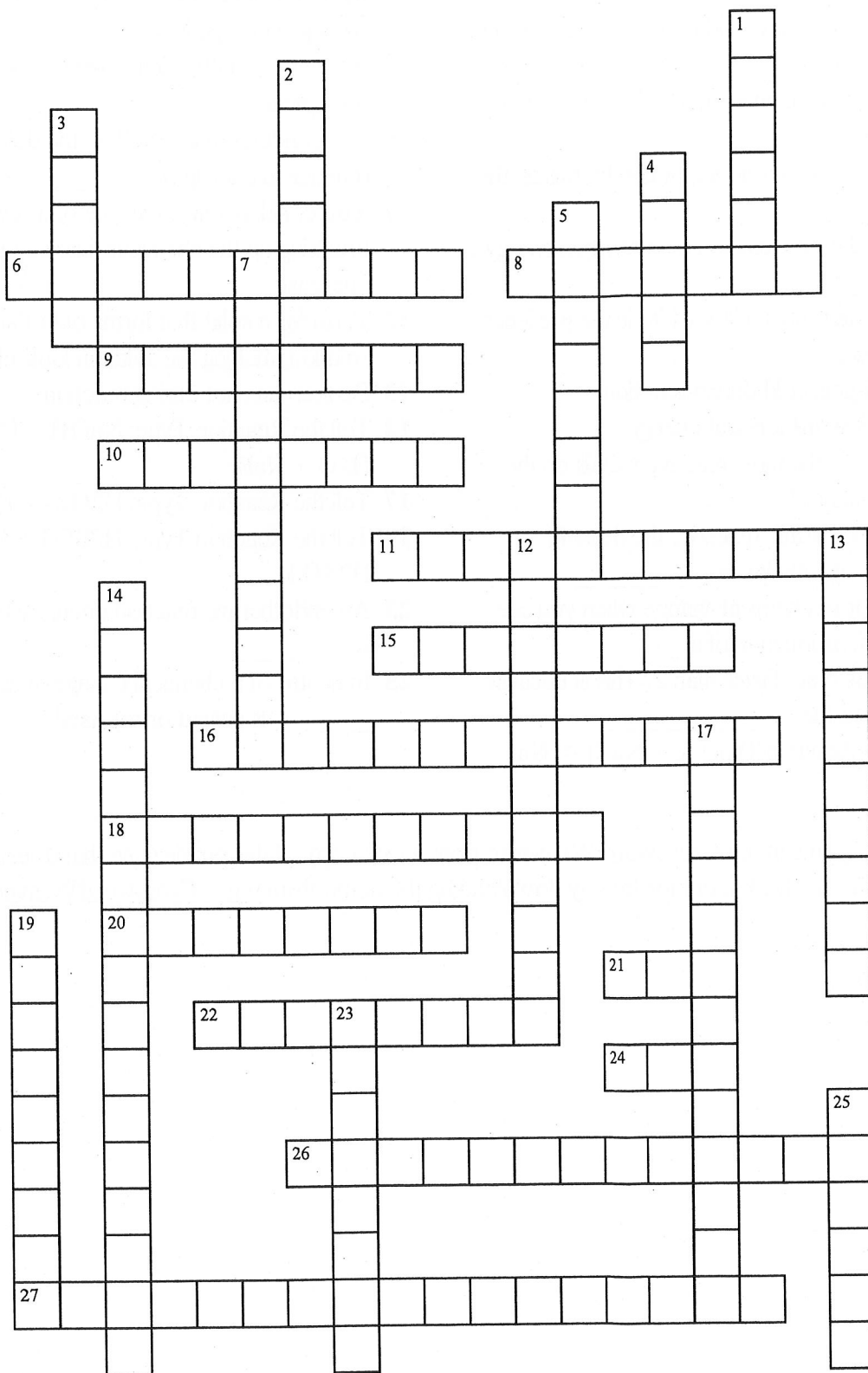
ACROSS

6 Tell the Reaction Type: C2H4 + O2 -> CO2 + H2O

DOWN

1 When you heat objects, the atoms move faster causing the object to _____

8 Reactions rates are based on the idea that for chemicals to react with each other the atoms must _____

9 A burning splint would reignite in the presence of this gas

10 Lowers activation energy to increase rate of a reaction

11 You could speed up a reaction by raising the _____

15 An exothermic reaction occurs when energy is _____

16 Lime water turns milky white in the presence of this gas

18 Beaker gets cold during reaction

20 Another word for heat energy

21 Where are the most reactive metals on the activity series?

22 In an exothermic reaction, the delta-H (change in enthalpy is _____

24 Indicator of chemical change when you see bubbles: production of a ____

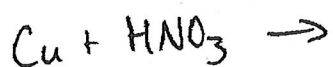26 5 mentos react faster than 2. This is because we raised the _____

27 Tell the Reaction Type: K + NaCl -> Na + KCl

2 In an exothermic reaction, heat is listed on which side of the yield sign?

3 Indicator of chemical change evident during rusting: a change in _____

4 Indicator of a chemical change when you see a precipitate

5 In an endothermic reaction, the delta-H (change in enthalpy) is _____

7 You could increase the rate of a reaction by breaking up the chemicals into smaller pieces (increase _____ _____)

12 Term for a solid that forms out of aqueous solution, making the solution look cloudy

13 Beaker gets hot during reaction

14 Tell the Reaction Type: NaOH + HBr -> H2O + NaBr

17 Tell the Reaction Type: H2O2 -> H2 + O2

19 Tell the Reaction Type: H2SO3 + O2 -> H2SO4

23 An endothermic reaction occurs when energy is _____

25 Indicator of a chemical change: when _____ is gained or released

Note: For a fee, you can use Crossword Weaver to print a nice copy of this puzzle (one that doesn't look like a web page). You can check it out for free by downloading the demo from www.CrosswordWeaver.com .

Predict Products: (No Reaction is Possible!)

$PbCl_2 + Zn \rightarrow$

$Ca + H_2O(g) \rightarrow$

$Fe + H_2O(l) \rightarrow$

$Cu + HNO_3 \rightarrow$

$Al + HC_2H_3O_2 \rightarrow$

$NaI + Cl_2 \rightarrow$
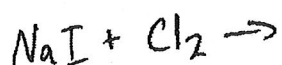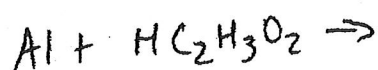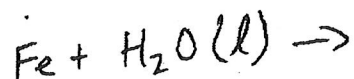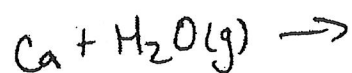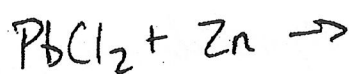
Would the following compounds precipitate out of water?

$HgSO_4$

$NaSO_4$

$LiCO_3$

NH_4OH

$Fe\,NO_3$

CaF

Write the Net Ionic Equation:

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

$Pb(s) + AgNO_3(aq) \rightarrow Ag(s) + Pb(NO_3)_2(aq)$
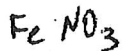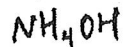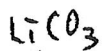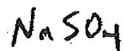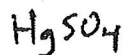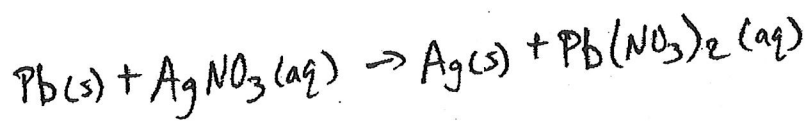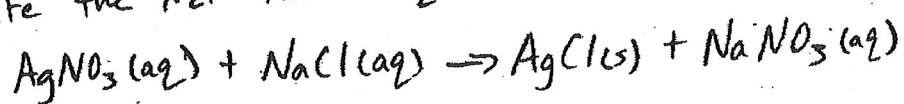
what is the most reactive metal? _____

What is a spectator ion?

Write the net ionic equation:

Aqueous solutions of Iron(III) Chloride and Potassium Hydroxide are mixed. A precipitate of Iron(III) Hydroxide forms.

Identify the reaction type:

$$H_2 + O_2 \rightarrow H_2O_2$$

$$ZnCl_2 + KBr \rightarrow ZnBr_2 + KCl$$

$$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$$

Balance:

$$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$$
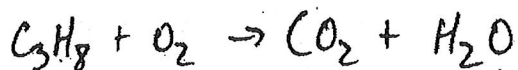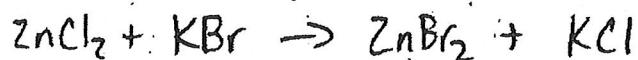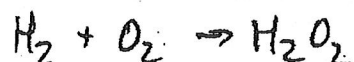
Thermochemistry Practice

How much heat, in Joules, is needed to convert 35g of ice to water at 0 Celsius?

How much heat is needed to warm a 15g block of gold 10 degrees Celsius?

How many grams of water can be vaporized at 100 degrees Celsius by 750J of heat?

How much heat, in kJ, is released when 10 moles of steam condenses?

How much heat, in Joules, is needed to convert 1.5g of water to steam?

What is the specific heat of a substance that releases 500J of heat when 15g of it are cooled from 75 to 45 degrees celsius.

An 18.0-g piece of an unidentified metal was heated from 21.5°C to 89.0°C. If 468 J of heat energy was absorbed by the metal in the heating process, what was the identity of the metal?

A student has a beaker containing 55 g of water at 100°C. How much heat is needed to convert the water to steam?

6.00 g of gold was heated from 20.0°C to 22.0°C. How much heat was applied to the gold?

Thermochemistry Problems

1. How much energy must be absorbed by 20.0 g of water to increase its temperature from 283.0 °C to 303.0 °C?

2. When 15.0 g of steam drops in temperature from 275.0 °C to 250.0 °C, how much heat energy is released?

3. How much energy is needed to melt 150g of ice?

4. How much energy is required to heat 120.0 g of water from 2.0 °C to 24.0 °C?

5. If 720.0 g of steam at 400.0 °C absorbs 800.0 kJ of heat energy, what will be its increase in temperature?

6. How much energy is needed to boil 75g of water?

7. How much heat (in kJ) is given out when 85.0 g of lead cools from 200.0 °C to 10.0 °C?

8. If it takes 41.72 joules to heat a piece of gold weighing 18.69 g from 10.0 °C to 27.0 °C, what is the specific heat of the gold?

9. It takes 333.51 joules to melt exactly 1 gram of a substance. What is the molar heat of fusion for water, from this data?

10. What mass of water can be melted using 800J of heat?
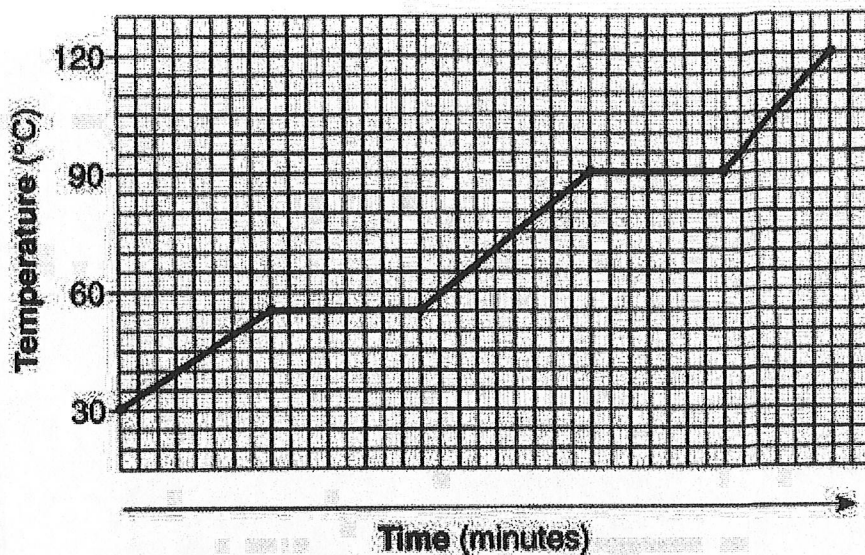
Hf=250

Hv=2000

Cp=3.0

What is the freezing point of the above substance?

What is the melting point?

What is the vaporization point?

Define Temperature:

When is the potential energy of the above substance changing?

How much energy was added to the substance above between t=0 and when it began to melt, assuming a 5g sample?

Answer the same question above, assuming a 10g sample.

How much energy would be required to vaporize 25g of the above substance?

How much energy would be required to vaporize 75g of the above substance?

How much energy would be released if 100g of the above substance were to freeze?

Would that process be endothermic or exothermic?

How much energy was consumed during the time this substance was a liquid, assuming a 700g sample?

How long did it take to melt the substance?
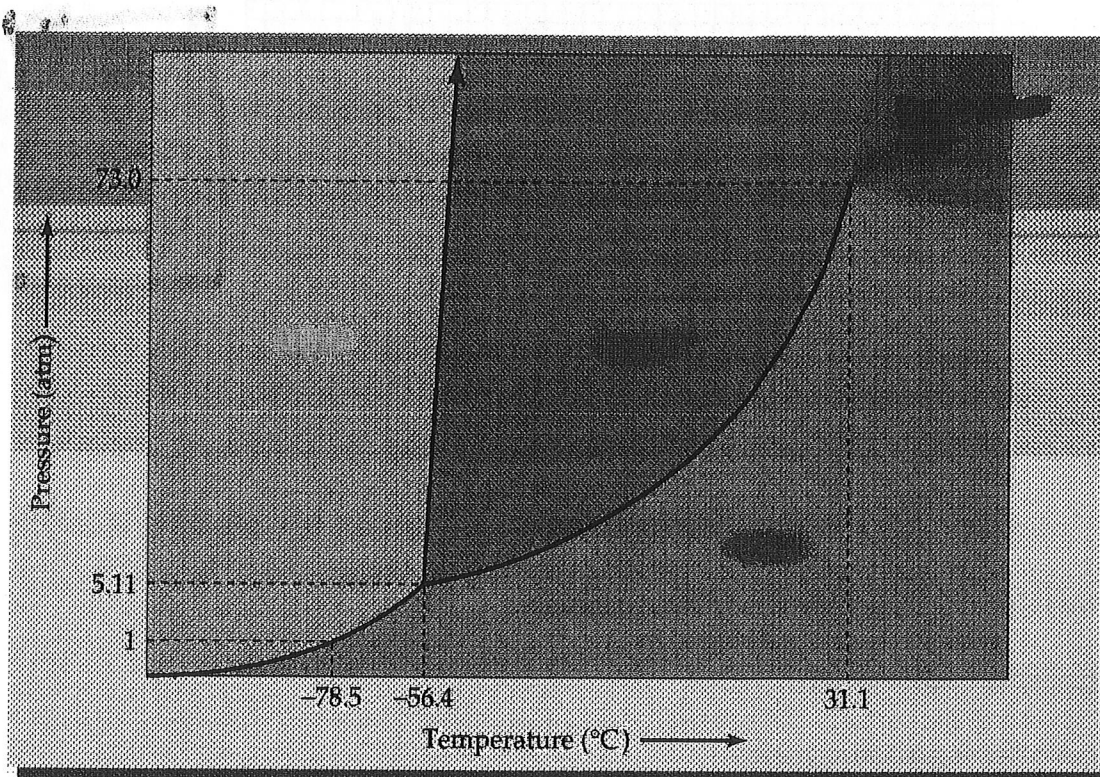
Is the above phase diagram for water?

Upon what 2 things does the state of an object depend?

Define Critical Point:

What is the critical point for this substance?

Define Triple Point:

What is the triple point of this substance?

At 70 atm, a piece of this substance is heated from 0 to 50 degrees Celsius, what change has it undergone?

At 1 atm, a piece of this substance is heated from -100 to -60 degrees Celsius, what change has it undergone?

At 0 degrees celsius, a piece of this substance is undergoes a change in pressure from 1 to 60 atm. What change has it undergone?

At 73atm, a piece of this substance is cooled from 20 to -200 degrees Celsius, what change has it undergone?

PHASE DIAGRAM

Name _____
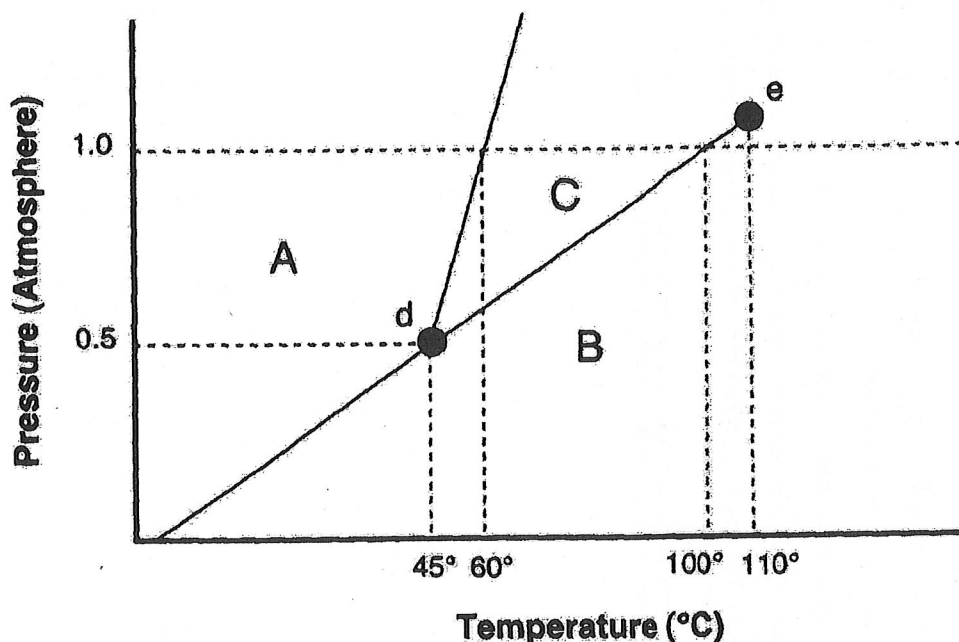
Answer the following questions using the chart above.

1. What section represents the solid phase? _____

2. What section represents the liquid phase? _____

3. What section represents the gas phase? _____

4. What letter represents the triple point? _____

5. What letter represents the critical point? _____

6. What is this substance's normal melting point? _____

7. What is this substance's normal boiling point? _____

8. Above what temperature is it impossible to liquify this substance no matter what the pressure? _____

9. At what temperature and pressure do all three phases coexist? _____

10. Is the density of the solid greater than or less than the density of the liquid? _____

11. Would an increase in pressure cause this substance to freeze or melt? _____

Phase Diagram Quiz

Refer to the phase diagram below when answering the questions on this worksheet:
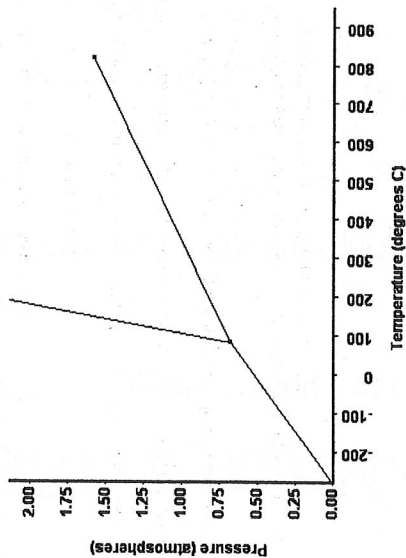
1) What is the normal (standard pressure) melting point of this substance? _____

2) What is the normal boiling point of this substance? _____

3) What is the normal freezing point of this substance? _____

4) If I had a quantity of this substance at a pressure of 1.25 atm and a temperature of 300° C and lowered the pressure to 0.25 atm, what phase transition(s) would occur?

5) At what temperature do the gas and liquid phases become indistinguishable from each other? (critical point) _____

6) If I had a quantity of this substance at a pressure of 0.75 atm and a temperature of -100° C, what phase change(s) would occur if I increased the temperature to 600° C? At what temperature(s) would they occur?

7) If I had a quantity of this substance at .5 atm and -200 Celsius and heated it to 300 degrees Celsius, what change would occur?

8) What is the term for when a gas changes to solid form?

9) What is sublimation?

10) What are the 3 units used to measure pressure?

11) What device is used to measure pressure?

12) True or False: In solids, the atoms are very loosely packed, giving solids their properties.

13) True or False: Evaporation occurs only when a substance is heated above its boiling point.

14) True or False: The Kelvin temperature of a substance is directly related to the average kinetic energy of the particles.

15) True or False: Kinetic Theory states that when in solid form, the particles that form matter are stationary, but in gaseous form are always in motion.

POTENTIAL ENERGY DIAGRAM

Name _____

A + B ↔ C + D + energy

Answer the questions using the graph above.

1. Is the above reaction endothermic or exothermic? _____

2. What letter represents the potential energy of the reactants? _____

3. What letter represents the potential energy of the products? _____

4. What letter represents the heat of reaction (ΔH)? _____

5. What letter represents the activation energy of the forward reaction? _____

6. What letter represents the activation energy of the reverse reaction? _____

7. What letter represents the potential energy of the activated complex? _____

8. Is the reverse reaction endothermic or exothermic? _____

9. If a catalyst were added, what letter(s) would change? _____

Warmup

$$\_N_2 + \_H_2 \rightarrow \_NH_3$$

1. What volume of ammonia can be produced from 100g of nitrogen gas?

2. What mass of nitrogen is needed to react with 500g of hydrogen?

3. How many moles of product can be produced using 5.8E24 molecules of nitrogen?

4. How many moles of hydrogen are needed to produce 75 mol of ammonia?

Calorimetry

Measuring quantities of heat is called calorimetry. We can measure heat energy by measuring the temperature change it produces in a reference material, which is almost always water.

One of the major uses of calorimetry is to measure specific heats of metals. Specific heats are useful for engineers and manufacturers. This use of calorimetry is based upon the **law of conservation of energy** – energy is neither created nor destroyed but can be transformed from one form to another. In this application, hot metal is added to cold water in an insulated container called a calorimeter. Heat flows from the hot metal to the cold water. Thermal equilibrium is when the two objects reach the same final temperature. The heat lost by the hot metal is gained by the cold water as they come to the same final temperature. If you measure the temperature changes you can calculate the heat gained by the water and thus the heat lost by the metal, and finally can calculate the specific heat of the metal.

1. A 175 gram sample of a metal at 93.5^0C was added to 105 grams of water at 23.5^0C in a perfectly insulated container. The final temperature of the water and metal was 33.8^0C. Calculate the specific heat of the metal in J/g^0C.

2. A 185 gram sample of copper at 98.0^0C was added to 102 grams of water at 20.0^0C in a perfectly insulated calorimeter. The final temperature of the copper-water mixture was 31.2^0C. Calculate the specific heat of copper using this data.

3. A chemistry student added 225 grams of aluminum at 85.0^0C to 115 grams of water at 23.0^0C in a perfect calorimeter. The final temperature of the aluminum-water mixture was 41.4^0C. Use the student's data to calculate the specific heat of aluminum in joules/gram^0C.

4. A student was given a sample of a silvery gray metal and told that it was either bismuth, specific heat $0.122 J/g^0C$, or cadmium, specific heat $0.232 J/g^0C$. The student measured out a 250 gram sample of the metal, heated it to 96.0^0C and then added it to 98.5 grams of water at 21.0^0C in a perfect calorimeter. The final temperature in the calorimeter was 30.3^0C. Use the student's data to calculate the specific heat of the metal sample.

HEAT AND ITS MEASUREMENT

Name _____

Heat (or energy) can be measured in units of calories or joules. When there is a temperature change (ΔT), heat (Q) can be calculated using this formula:

> **Q = mass x ΔT x specific heat capacity**
> **(ΔT = Final Temp - Initial Temp)**

During a phase change, we use this formula:

> **Q = mass x heat of fusion (or heat of vaporization)**

Solve the following problems.

1. How many joules of heat are given off when 5.0 g of water cool from 75° C to 25° C? (Specific heat of water = 4.18 j/g° C)

    _____

2. How many calories are given off by the water in Problem 1?
   (Specific heat of water = 1.0 cal/g° C)

    _____

3. How many joules does it take to melt 35 g of ice at 0° C? (heat of fusion = 333 j/g)

    _____

4. How many calories are given off when 85 g of steam condense to liquid water?
   (heat of vaporization = 539.4 cal/g)

    _____

5. How many joules of heat are necessary to raise the temperature of 25 g of water from 10° C to 60° C?

    _____

6. How many calories are given off when 50 g of water at 0° freezes?
   (heat of fusion = 79.72 cal/g)

    _____

Many times when we heat or cool a substance we produce both a temperature change and a phase change. For example, we start with a liquid and heat it to its boiling point and then convert it to a vapor; or we start with a liquid and cool it to its freezing point and then freeze it. Processes like these involve calculations with two or more steps. There are two formulas that we have already discussed and will aid you in calculating the energies required to change a substance's phase. Think in terms of the Kinetic Theory when deciding which equations to use. One equation is temperature dependent the other is not.

$$q = mC\Delta T \qquad q = m\Delta H$$

Example: Calculate the heat needed to change 3.00×10^2 grams of water at 25.0°C to steam at 100.0°C. The heat of vaporization of water is 2258 J/g.

Solution: Draw a phase diagram of this substance. Mark the starting temperature and ending temperature. Determine the number of steps involved.
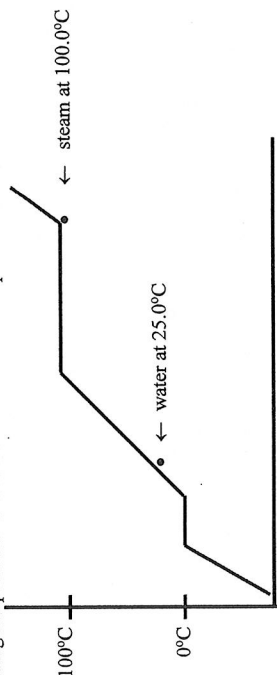
This problem involves two heat calculations:
1. Heat the water from 25°C to 100°C. $q = mC\Delta T$
2. Vaporize the water. $q = m\Delta H_v$

The total heat needed will be the sum of these two calculations.

$$q = mCp\Delta T + m\Delta H_v$$

$$q = (3.00 \times 10^2 g)(4.184\ \tfrac{J}{g°C})(75.0°C) + (3.00 \times 10^2 g)(2258\ \tfrac{J}{g}) = 7.72 \times 10^5\ J$$

Example: Calculate the heat needed to change 75.0 grams of ice at -40.0 °C to water at 20.0 °C. The specific heat of solid ice is 2.04 J/gC and the heat of fusion of ice is 333.6 J/g.

$$= (5.00 \times 10^2\ g)\left(\tfrac{333.6\ J}{g}\right) = 1.67 \times 10^5\ \text{Joules needed}$$

Calculate the heat released when 2.00×10^2 grams of steam at 100°C condenses to form water at 100°C. The heat of condensation of steam is 2258 J/g.

$$\text{steam (100°C)} \rightarrow \text{water (100°C)}$$

heat energy = mass x the heat of condensation

$$= (2.00 \times 10^2\ g)\left(\tfrac{2258\ J}{g}\right)\text{joules} = 4.52 \times 10^5\ J$$

Liquid ammonia is a common refrigerant because it absorbs so much heat energy when it turns from the liquid to a gas. The heat of vaporization of liquid ammonia is 1374 J/g. Calculate the heat needed to turn 454 grams of liquid ammonia at its boiling point to ammonia gas at the same temperature.

$$NH_3(l) \rightarrow NH_3(g)$$

heat energy = mass x the heat of vaporization

$$= (454\ g)\left(\tfrac{1374\ J}{g}\right) = 6.237 \times 10^5\ \text{joules} = 6.24 \times 10^5\ J$$

Solve the following problems on a separate sheet of paper following the method shown above.
Useful Information:
  specific heat of water, $H_2O(l)$ = 4.184 J/g °C
  specific heat of ice, $H_2O(s)$ = 2.04 J/g °C
  specific heat of steam, $H_2O(g)$ = 2.00 J/g °C
  heat of fusion of ice (0°C) = 333.6 J/g
  heat of vaporization of water (100°C) = 2260 J/g
  heat of crystallization of water = 333.6 J/g
  heat of condensation of water = 2260 J/g

1. Calculate the number of joules needed to turn 325 grams of water at 100.0°C to steam at 100.0°C.
2. Calculate the heat released when 875 grams of water at 0.0°C turns to ice at 0.0°C.
3. Calculate the number of joules needed to vaporize 2.00×10^2 grams of liquid ammonia at its boiling point and produce ammonia vapor at the same temperature. The heat of vaporization of liquid ammonia is 1374 J/g.
4. How much heat is needed to melt 25.4 g of iodine? H_f= 61.7 J/g.
5. How much heat is needed to melt 4.24 g of Pd? H_f = 162 J/g.

Phase Changes

Imagine a simplified model of a solid as tiny particles bonded together by springs. The spring represents the electromagnetic forces between the particles. If the thermal energy of a solid is increased, both the potential and kinetic energy of the particles increase. The temperature is a measure of the average kinetic energy of the particles.

At higher temperatures, the forces between the particles are no longer strong enough to hold them in fixed locations. Eventually, the particles become free to slide past each other. The substance has changed from a solid to a liquid. The temperature at which this occurs is called the melting point.

When a substance is in the process of melting, added thermal energy increases the potential energy of particles, breaking the bonds holding them together. The added thermal energy does not increase the kinetic energy of the particles. Thus, the temperature does not increase.

The amount of energy needed to melt a unit mass of a substance is called the heat of fusion of that substance. For example, the heat of fusion of ice is 3336 J/g. If one gram of ice at its melting point, 0°C, absorbs 3336 J, it will become 1 gram of water at the same temperature, 0°C. The added energy causes a change in state but not in temperature.

After the substance is totally melted, a further increase in thermal energy once again increases the temperature. Added thermal energy increases both the kinetic and potential energy. As the temperature increases, some particles in the middle of the liquid obtain enough energy to break free from other particles. A tiny bubble of vapor is formed and rises to the surface. The liquid begins to boil. Any added thermal energy is used to increase the potential energy of particles and change them from the liquid to the vapor state. This temperature is known as the boiling point. The amount of thermal energy needed to vaporize a unit mass of liquid is called the heat of vaporization. For water, the heat of vaporization is 2260 J/g. Every substance has a characteristic heat of vaporization and of fusion.

When substances are condensed and frozen energy is released. These processes are exothermic. The heat of condensation is the amount of energy per gram released when condensing a gas into a liquid. The heat of crystallization (solidification) is the amount of energy per gram released when freezing a liquid into the solid phase. The amount of energy released, is the same amount as was taken in during the endothermic processes of boiling and melting. A negative sign is used to indicate the release of energy.

Example:
Calculate the heat energy required, in joules, to melt 5.00 x 10² grams of ice which is at 0.0 °C. The heat of fusion of ice is 333.6 J/g.

$$\text{ice } (0.0 \text{ °C}) \rightarrow \text{water } (0.0 \text{ °C})$$

$$q = mH_f$$

Solution: Draw a phase diagram of this substance. Mark the starting temperature and ending temperature. Determine the number of steps involved.

100°C

0°C

* ← water at 20.0°C

* ← ice at -40.0°C

This problem involves three steps:
1. heat the ice from -40°C to its melting point of 0.0°C. $q = mC\Delta T$
2. completely melt the ice. $q = mH_f$
3. heat the water from 0.0°C to 20.0°C. $q = mC\Delta T$.

The amount of heat required is equal to the sum of these three steps.

$$q = (75.0g)(2.04 \tfrac{J}{g°C})(40°C) + (75.0g)(333.6 \tfrac{J}{g}) + (75.0g)(4.184 \tfrac{J}{g°C})(20.0°C) = 3.74 \times 10^4 \text{ J}$$

Solve the following problems neatly and orderly showing all work.
Useful Information:
specific heat of water, $H_2O(l)$ = 4.184 J/g °C
specific heat of ice, $H_2O(s)$ = 2.04 J/g °C
specific heat of steam, $H_2O(g)$ = 2.00 J/g °C
heat of fusion of ice (0°C) = 333.6 J/g
heat of vaporization of water (100°C) = 2260 J/g
heat of crystallazation of water = 333.6 J/g
heat of condensation of water = 2260 J/g

6. Calculate the heat released when 454 grams of steam at 100.0°C condenses and then cools to water at 30.0°C.
7. Calculate the heat needed to change 475 grams of water at 40.0°C to steam at 100.0°C.
8. Calculate the heat needed to change 2.50 x 10² grams of ice at 0.0°C to steam at 100.0°C.
9. How much heat is needed to change 3.00 x 10² grams of ice at -30.0°C to steam at 130.0°C?
10. How much heat is removed from 60.0 g of steam at 100.0°C to change it to 60.0 g of water at 20.0°C?

3-12

1. Which of the following formulas represents an ionic compound?
   a. CS_2
   b. BaI_2
   c. N_2O_4
   d. PCl_3

2. Which element, when combined with fluorine, would most likely form an ionic compound?
   a. lithium
   b. carbon
   c. phosphorus
   d. chlorine

3. What is the correct formula for potassium sulfate?
   a. $KHSO_3$
   b. $KHSO_4$
   c. K_2SO_3
   d. K_2SO_4

4. What type of bonds are found in a $CuSO_4$ molecule?
   a. ionic
   b. covalent
   c. both
   d. neither

5. Which of the following formulas represents a molecular (covalent) compound?
   a. ZnO
   b. Xe
   c. SO_2
   d. BeF_2

6. How many valence electrons are in an atom of oxygen?
   a. 8
   b. 6
   c. 2
   d. 3

7. What is the formula unit of sodium nitride?
   a. NaN
   b. Na_2N
   c. Na_3N
   d. NaN_3

8. What is the formula unit of aluminum oxide?
   a. AlO
   b. Al_3O
   c. AlO_3
   d. Al_2O_3

9. What is the formula for sodium sulfate?
   a. $NaSO_4$
   b. Na_2SO_4
   c. $Na(SO_4)_2$
   d. $Na_2(SO_4)_2$

10. What is the formula for potassium sulfide?
    a. KS
    b. K_2S
    c. KS_2
    d. K_2S_2

11. Under what conditions can potassium bromide conduct electricity? (HINT: Potassium Bromide is an IONIC compound!)
    a. only when melted
    b. only when dissolved
    c. only when it is in crystal form
    d. only when melted or dissolved in water

12. Which of the following is NOT a characteristic of most ionic compounds?
    a. They are solids.
    b. They have low melting points.
    c. When melted, they conduct an electric current.
    d. They are composed of metallic and nonmetallic elements.

13. What characteristic of metals makes them good electrical conductors?
    a. They have mobile valence electrons.
    b. They have mobile protons.
    c. They have mobile cations.
    d. Their structures can be rearranged easily.

14. An ionic bond is a bond between _____.
    a. a cation and an anion
    b. valence electrons and cations
    c. the ions of two different metals
    d. the ions of two different nonmetals

1

POTENTIAL ENERGY DIAGRAM

Reaction Coordinate →

$$A + B \leftrightarrow C + D + energy$$

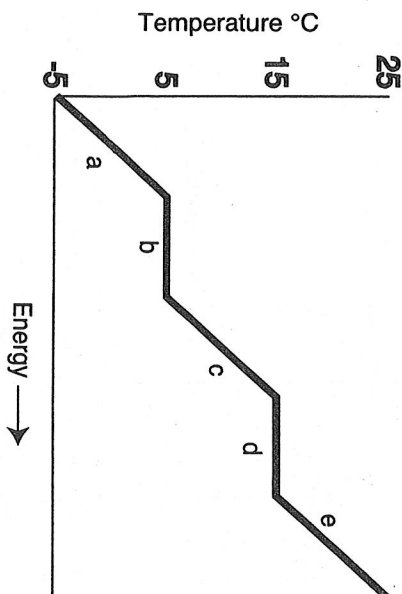Answer the questions using the graph above.

1. Is the above reaction endothermic or exothermic? _____

2. What letter represents the potential energy of the reactants? _____

3. What letter represents the potential energy of the products? _____

4. What letter represents the heat of reaction (ΔH)? _____

5. What letter represents the activation energy of the forward reaction? _____

6. What letter represents the activation energy of the reverse reaction? _____

7. What letter represents the potential energy of the activated complex? _____

8. Is the reverse reaction endothermic or exothermic? _____

9. If a catalyst were added, what letter(s) would change? _____

FREEZING AND BOILING POINT GRAPH

Name _____

Temperature °C

25

15

5

-5

a

b

c

d

e

Energy →

Answer the following questions using the chart above.

1. What is the freezing point of the substance? _____

2. What is the boiling point of the substance? _____

3. What is the melting point of the substance? _____

4. What letter represents the range where the solid is being warmed? _____

5. What letter represents the range where the liquid is being warmed? _____

6. What letter represents the range where the vapor is being warmed? _____

7. What letter represents the melting of the solid? _____

8. What letter represents the vaporization of the liquid? _____

9. What letter(s) shows a change in potential energy? _____

10. What letter(s) shows a change in kinetic energy? _____

11. What letter represents condensation? _____

12. What letter represents crystallization? _____

Reaction Types & Balancing   Name _____

Balance the following equations and indicate the type of reaction taking place:

1) ___ NaBr + ___ H_3PO_4 → ___ Na_3PO_4 + ___ HBr

Type of reaction: _____

2) ___ $Ca(OH)_2$ + ___ $Al_2(SO_4)_3$ → ___ $CaSO_4$ + ___ $Al(OH)_3$

Type of reaction: _____

3) ___ Mg + ___ Fe_2O_3 → ___ Fe + ___ MgO

Type of reaction: _____

4) ___ C_2H_4 + ___ O_2 → ___ CO_2 + ___ H_2O
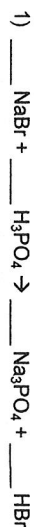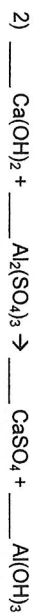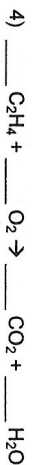
Type of reaction: _____

Combined Gas Laws   Name_____

1. You want the pressure inside a bottle to be 75.0 kPa at 23°C. At what temperature in Celsius should you seal the bottle when the pressure is 112 kPa?

2. A diver's lungs hold about 20.0 L of air underwater at a pressure of 875 mm Hg. Assuming he holds his breath and his lungs don't burst, what will be the volume of air in his lungs at standard pressure on the water's surface.

3. A soccer ball containing 12.0 mL of gas at 21°C is left outside on a cold, winter day. What is the temperature outside in Celsius if the ball shrunk to 10.5 mL?

4. What pressure is required to compress a gas that occupies 6500 L at 25°C and 1.0 atm to a volume of 40.0 L at 18°C?

5. When a canning jar is sealed at 100°C the pressure inside is 101.3 kPa. What is the pressure inside the jar when it cools to room temperature, about 21°C?

6. A gas occupies 4.78 L at 78.1 kPa and 25°C. What will the volume be at 97.5 kPa and 15°C?

7. A shampoo bottle contains 443 mL of air at 65°C. What is its volume when it cools to 22°C?

8. A sample of propane has a volume of 250.0 L at 125 kPa and 38°C. What volume will this sample have at 100.0 kPa and 95°C?

9. The pressure in a can of hairspray is 2.50 atm at 298 K. What is the pressure in the can when it is heated to 398 K?

Gases Review

Name_____

SOLVE THE PROBLEM:

1. How many moles of chloroform, $CHCl_3$, are required to fill a 253-mL flask at 100.0°C and 940 mmHg?

2. You want the pressure inside a bottle to be 75.0 kPa at 23°C. At what temperature in Celsius should you seal the bottle when the pressure is 112 kPa?

3. A diver's lungs hold about 20.0 L of air underwater at a pressure of 875 mm Hg. Assuming he holds his breath and his lungs don't burst, what will be the volume of air in his lungs at standard pressure on the water's surface.

4. A soccer ball containing 12.0 mL of gas at 21°C is left outside on a cold, winter day. What is the temperature outside in Celsius if the ball shrunk to 10.5 mL?

5. What pressure is required to compress a gas that occupies 6500 L at 25°C and 1.0 atm to a volume of 40.0 L at 18°C?

6. When a canning jar is sealed at 100°C the pressure inside is 101.3 kPa. What is the pressure inside the jar when it cools to room temperature, about 21°C?

7. What is the temperature of a 0.00893 mol sample of neon gas that has a volume of 0.302 L and a pressure of 0.941 atm?

8. A gas occupies 4.78 L at 78.1 kPa and 25°C. What will the volume be at 97.5 kPa and 15°C?

9. A shampoo bottle contains 443 mL of air at 65°C. What is its volume when it cools to 22°C?

10. A balloon is filled with helium to a volume of 12.5 liters at 25°C and 101 kPa. How many grams of helium are in the balloon?

11. A sample of propane has a volume of 250.0 L at 125 kPa and 38°C. What volume will this sample have at 100.0 kPa and 95°C?

12. The pressure in a can of hairspray is 2.50 atm at 298 K. What is the pressure in the can when it is heated to 398 K?

GAS AND HEAT REVIEW: Name_____

1. A steel canteen of constant volume is at standard pressure. What would the new pressure be, in kPa, if it were heated from 20 to 100 degrees Celsius?

2. What is the pressure on a 10 liter canister containing 450 grams of Nitrogen gas at standard temperature?

3. How many moles of gas are in a tire with a volume of 5 liters inflated to 150 kPa at 70 degrees Celsius?

4. The pressure in a car tire filled with air is 245 kPa. The partial pressure of oxygen, carbon dioxide, and other gases is 51.3kPa, 0.10 kPa, and 2.3 kPa respectively. What is the partial pressure of nitrogen in the tire?

5. What mass of ice can be melted using 10,000 Joules of heat energy?

6. What mass of hydrogen gas is contained in a 750 liter balloon at standard temperature and pressure?

7. The volume of a gas at 26 degrees Celsius and 75 kPa is 10.5L. What final temperature would be required to reduce the volume to 9.5L if the pressure were increased to 116 kPa?

8. How much heat is necessary to heat 50g of steam by 50 degrees Kelvin?

9. The pressure in a sealed plastic container is 108 kPa at 41 degrees Celsius. What is the pressure when its temperature reaches 22 degrees Celsius? Assume the volume has not changed.

10. A balloon at standard temperature and pressure is inflated to a volume of 1 liter. Assuming constant temperature, what would be the new pressure inside the ballon if 2 **more** liters of air were blown into the balloon?

11. A tire of fixed volume at standard pressure is heated from 20 to 80 degrees Celsius. If the container can withstand pressures up to 3.5 atm, would the canister rupture?

12. How much energy is needed to heat a 10g bar of nickel from 10 to 40 degrees Celsius?

Thermodynamics and Gas Laws Quiz

(Show ALL Work or NO CREDIT. NO KIDDING.)

How much energy is needed to boil 1725g of water?

What mass of ice could you melt using 3,000J of energy?

How much energy is needed to heat 500g of steam from 120 to 150 degrees Celsius?

How much energy is needed to increase the temperature of 100g of water by 40 degrees Celsius?

What is the volume of 45g of NH_3 gas at 400K and 780mmHg?

A canister of constant volume is pressurized at 200kPa at 200^{0}C. What would be the new pressure in the tank if it were heated to a temperature of 300^{0}C?

A 1.5L balloon at 25^{0}C contains air at 1.5atm. If the balloon expanded to a volume of 5L while warming up to 30^{0}C, what would then be the pressure of the gas inside?

$$N_2 + H_2 \rightarrow NH_3$$
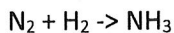
According to the unbalanced equation above, what mass of nitrogen gas at STP would be needed in order to produce 85L of ammonia?

Using the same equation, what volume of hydrogen gas would need to be reacted with 5.47 x 10^{19} molecules of nitrogen?

MOLARITY (M)

Molarity = $\dfrac{\text{moles of solute}}{\text{liter of solution}}$

Solve the problems below.

1. What is the molarity of a solution in which 58 g of NaCl are dissolved in 1.0 L of solution?

   _____

2. What is the molarity of a solution in which 10.0 g of AgNO$_3$ is dissolved in 500. mL of solution?

   _____

3. How many grams of KNO$_3$ should be used to prepare 2.00 L of a 0.500 M solution?

   _____

4. To what volume should 5.0 g of KCl be diluted in order to prepare a 0.25 M solution?

   _____

5. How many grams of CuSO$_4$•5H$_2$O are needed to prepare 100. mL of a 0.10 M solution?

   _____

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MOLARITY BY DILUTION

Name _____.

Acids are usually acquired from chemical supply houses in concentrated form. These acids are diluted to the desired concentration by adding water. Since moles of acid before dilution = moles of acid after dilution, and moles of acid = M x V then, $M_1 \times V_1 = M_2 \times V_2$. Solve the following problems.

1. How much concentrated 18 M sulfuric acid is needed to prepare 250 mL of a 6.0 M solution?

   _____

2. How much concentrated 12 M hydrochloric acid is needed to prepare 100 mL of a 2.0 M solution?

   _____

3. To what volume should 25 mL of 15 M nitric acid be diluted to prepare a 3.0 M solution?

   _____

4. To how much water should 50. mL of 12 M hydrochloric acid be added to produce a 4.0 M solution?

   _____

5. To how much water should 100. mL of 18 M sulfuric acid be added to prepare a 1.5 M solution?

   _____

Molarity Quiz

What is the molarity of a solution containing 250g of NaCl in 35ml of water?

What is the molarity of a solution containg 15mol of sugar in 30L of solution?

How many grams of HCl are needed to produce 2L of 1.7 Molar solution?

What volume of 6M HNO3 would be required in order to make 200ml of 0.2 Molar acid?

How much water would you add to the acid used above?

A 0.7L solution with a molarity of 1.5 mol/L is diluted down to create 3L of solution. What would the concentration of this new solution be?

You add 800ml of water to 500 ml of 0.6M HC2H3O2. What is the concentration of the new solution?

Molarity Quiz

What is the molarity of a solution containing 100g of NaCl in 25ml of water?

What is the molarity of a solution containg 25mol of sugar in 10L of solution?

How many grams of HCl are needed to produce 2L of 0.7 Molar solution?

What volume of 8M HNO_3 would be required in order to make 200ml of 0.1 Molar acid?

How much water would you add to the acid used above?

A 0.5L solution with a molarity of 2 mol/L is diluted down to create 3L of solution. What would the concentration of this new solution be?

You add 1200ml of water to 300 ml of 0.8M $HC_2H_3O_2$. What is the concentration of the new solution?

Page 1

1a) What is the molarity of a 10L solution containing 75g of NaCl?

1b) What is the molarity of a 65L solution containing 220g of HCl?

2a) What mass of nitric acid is needed to make 100L of 0.5M acid?

2b) How many grams of NaCl are needed to make 20L of 2M solution?

3a) What volume of stock 8M HCl is needed to prepare 200L of 1M acid?

3b) What volume of 0.2M HCl could be prepared using 4L of stock 5M acid?

Page 2

A solution involves a solute being dissolved in a solvent.

We calculated Molarity, or the concentration, of various solutions previously.
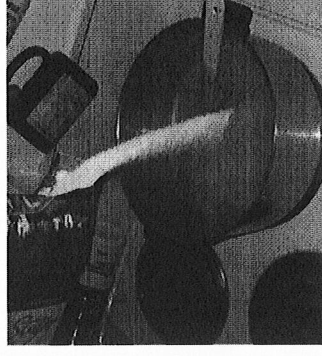
Why is the pot on the stove?

There are limits as to how concentrated a solution can become. Once a solution reaches its Saturation Point, it cannot hold (dissolve) any more solute.

Page 3

Solubility is a measure of how much solute can be dissolved in a given amount of solvent.
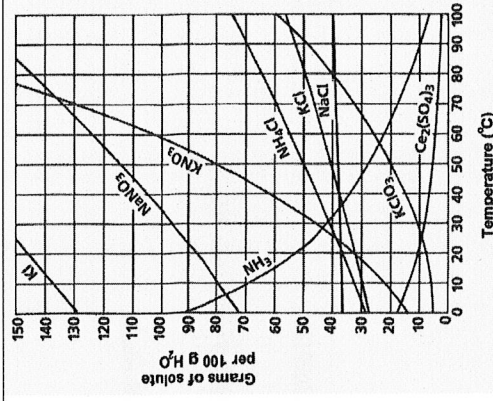

Some liquids can dissolve in each other at any proportion. Such liquids are said to be miscible.

Liquids that are insoluble in each other are said to be immiscible. (oil & water)

Page 4

What affects solubility?
1) Temperature
2) Pressure (for gases in liquids)

A Solubility Curve shows the amount of solute that can be dissolved in a given amount of solvent, at various Temperatures.

How do you make a supersaturated solution?

http://www.youtube.com/watch?v=GTi8Zq901xM

supersaturated

http://www.youtube.com/watch?v=gGpNhBPYNfs&feature=related

supercooled 1

http://www.youtube.com/watch?v=fSP2Mva9_CE

supercooled 2

3 Types of Solutions:

Saturated Solution: *Contains the maximum amount of solute possible for a given amount of solvent at that temperature and pressure.*

Unsaturated: *Contains less than the maximum amount.*

Supersaturated: *Contains MORE solute than it should be able to hold.*

(Rare! Unstable!)

Page 10 slide:
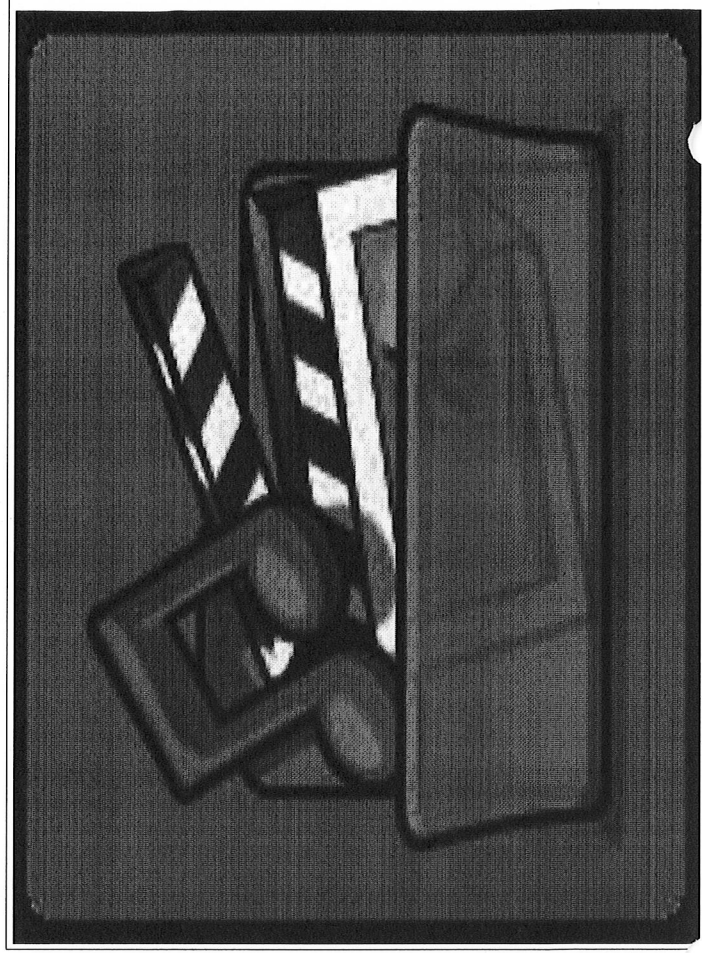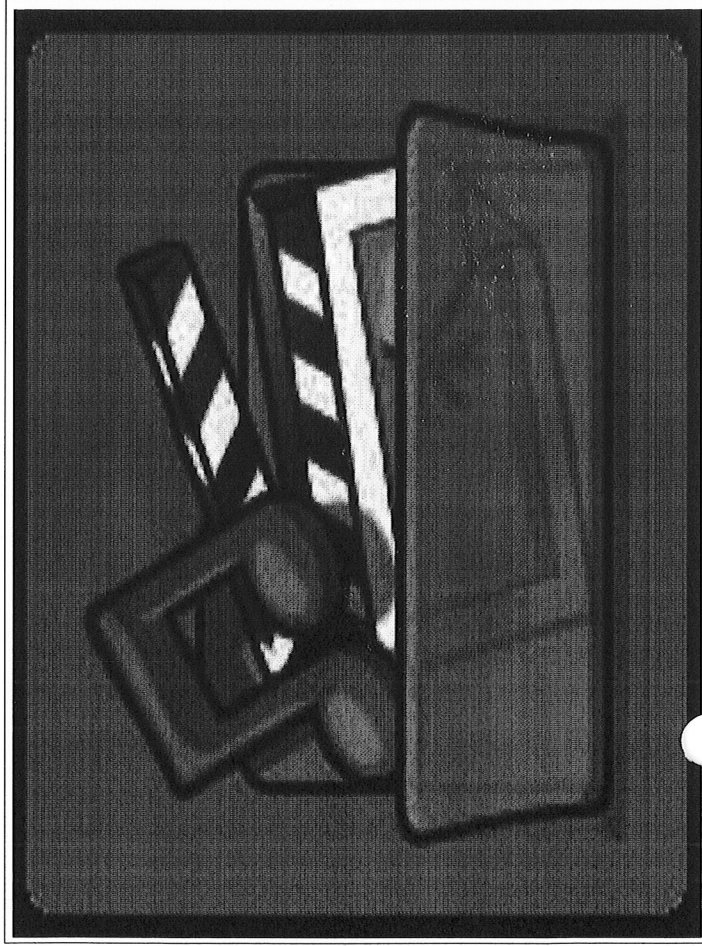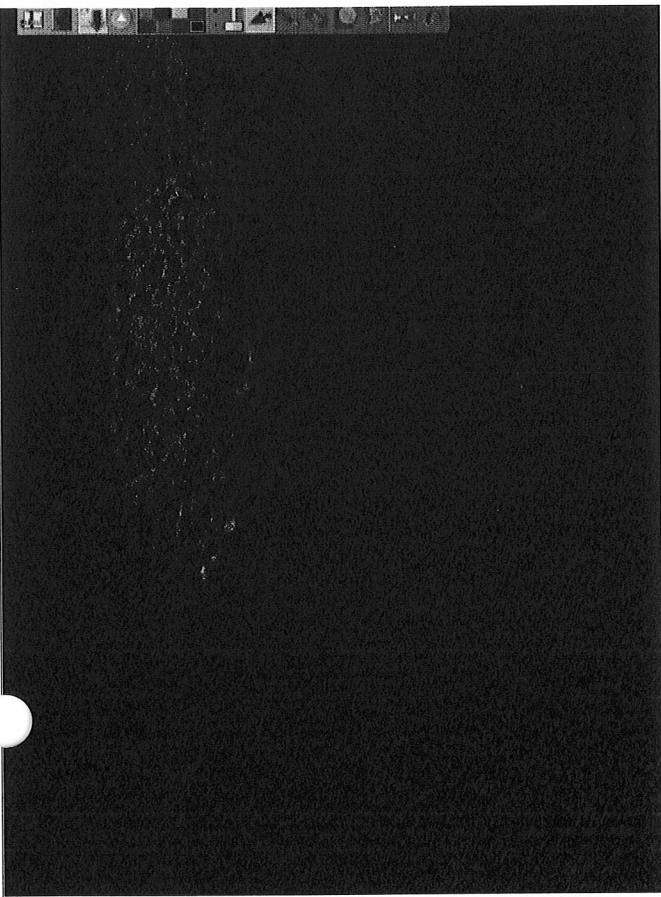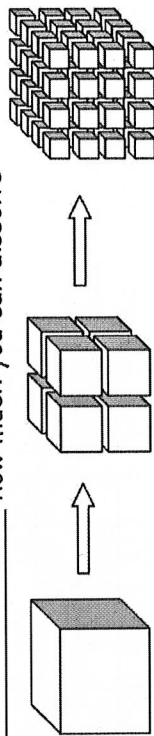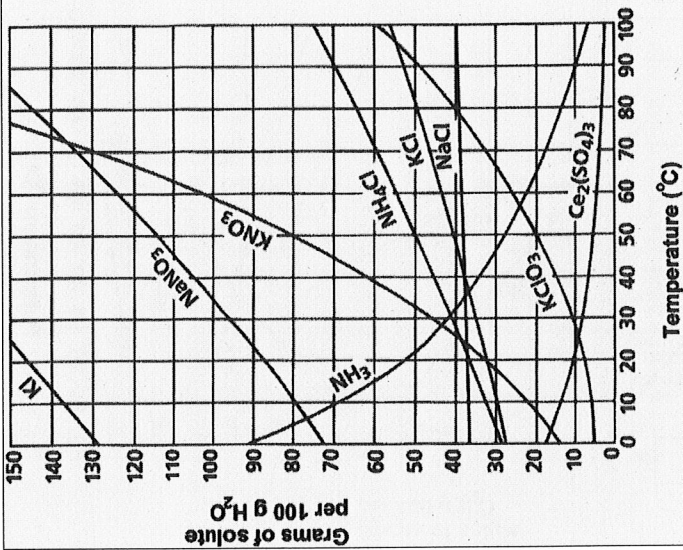
Factors Affecting Rate of Solution

1. Stirring
   - stirring _____ the rate of solution.

2. Surface Area
   - Breaking up the chunks (_____ surface area)
   _____ how much you can dissolve

This affects the rate, NOT the amount that can be absorbed!

Page 9 slide:

Page 11 slide:
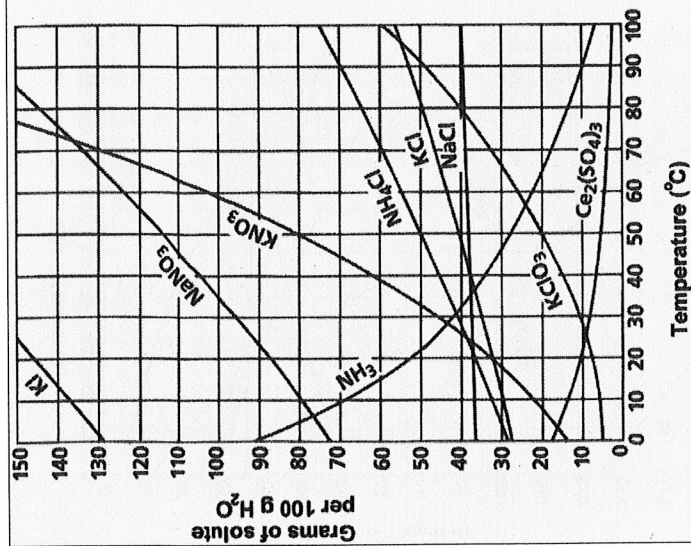
How much Ammonium Chloride can be dissolved in 100g of H2O at 90C?

How much Sodium Nitrate can be dissolved in 100g of H2O at 20C?

How much Potassium Chloride can be dissolved in 100g of H2O at 50C?

Page 12 slide:

How warm would you need to heat 100g of water in order to dissolve 50g of KCl?

At what temperature is the solubility of KCl the same as NaCl?

Which is more soluble in water, Sodium Nitrate or Ammonium Chloride?

Which substance is most soluble in water at 20C?

Page 14

Describe the following solutions:

90g NaNO₃ at 20C

80g KNO₃ at 50C

90g KNO₃ at 70C
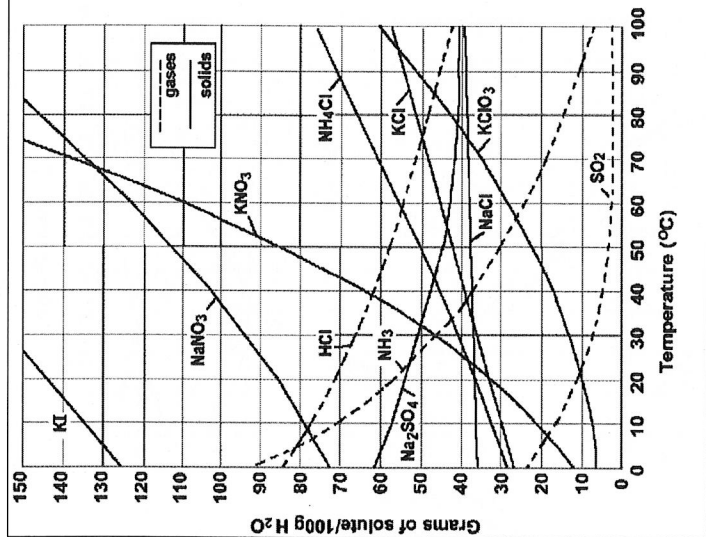
60g NH₃ at 10C

70g NH₄Cl at 90C

115g NaNO₃ at 50C

65g NH₄Cl at 70C

Page 13

Using the graph, what is the general rule concerning solubility and temperature?

What substance becomes less soluble as the temperature increases?
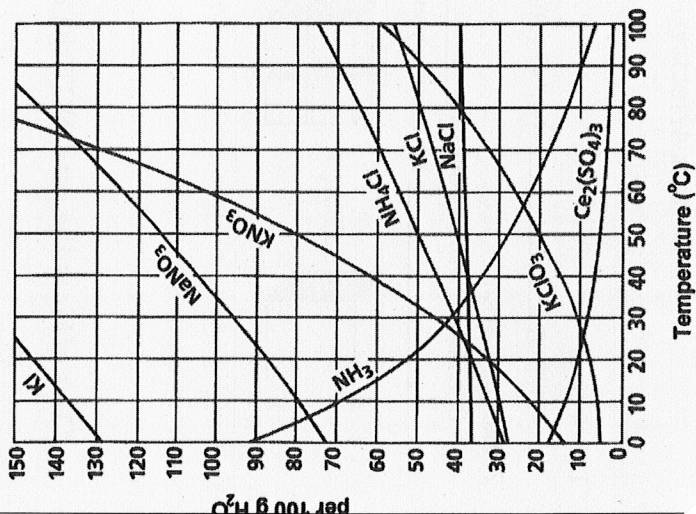
Page 16

Which substances solubility is least responsive to a change in temperature?

Which substances solubility is most responsive to a change in temperature?

At 50C I am able to dissolve 80g of an unknown substance in 100g of water. What is the substance?

Page 15

Determine Solubility:

KNO3 at 50C in 100g water

KNO3 at 50C in 200g water

KI at 0C in 100g of water

NH4Cl at 50C in 100g water

KCl at 80C in 100g water

KCl at 80C in 50g water

Chem Test Review

Solutions, Molarity, Dilutions, Solubility Curves,
Phase Diagrams, Gas Laws, Thermochemistry

* Please Take Out *
Green Sheets
Calculator

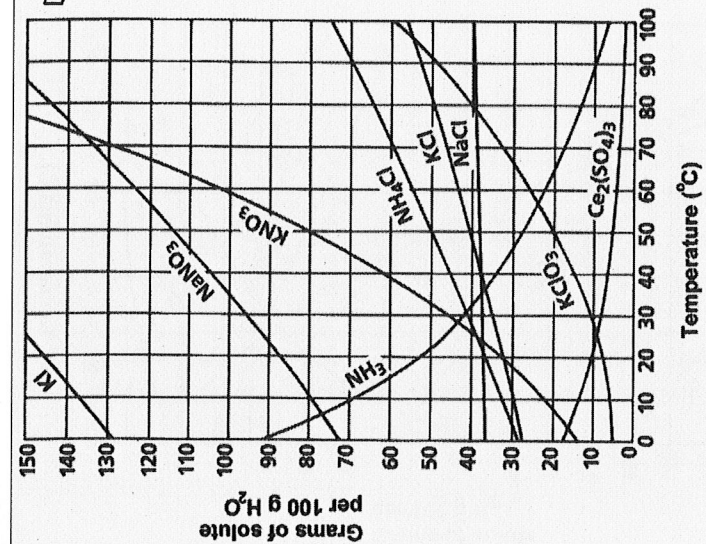How many moles of nitrogen gas are in 135 L of nitrogen gas at Standard Temperature and Pressure (STP)?

A   4.82 moles of N_2

B   5.53 moles of N_2

C   6.02 moles of N_2

D   9.64 moles of N_2

A mixture of gases (NO_2, CO_2, SO_2) is collected in a bottle. The partial pressure of NO_2 is 1.25 atm, and the partial pressure of CO_2 is 2.63 atm. If the total pressure of the gases is 11.20 atm, what is the partial pressure of SO_2?

A   2.89 atm

B   7.32 atm

C   9.23 atm

     11.20 atm

The graph below shows the solubility of various compounds.

Solubility of Various Compounds

A   48°C

B   54°C

C   60°C

D   66°C
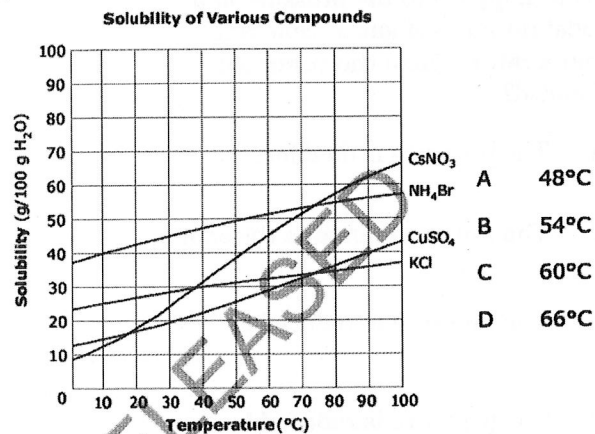
At what temperature will 50 g of NH_4Br produce a saturated solution when dissolved in 100 g of water?

The graph below shows the solubility of various compounds.

Solubility of Various Compounds

A   a saturated solution of KCl

B   a saturated solution of KNO_3

C   an unsaturated solution of NaCl

D   a supersaturated solution of NH_4Cl
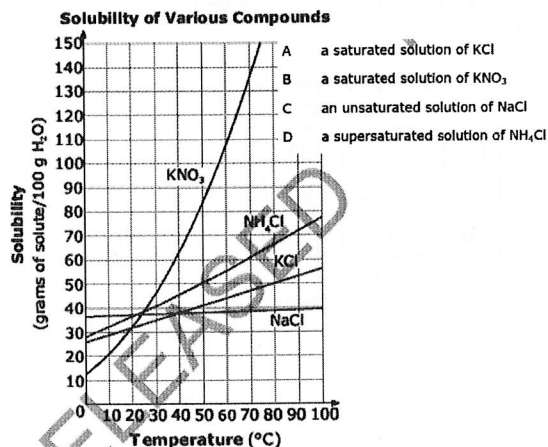
Which salt solution could contain *approximately* 50 g of solute per 100 g of H_2O at 80°C?

To increase the temperature of 100.0 g of H_2O (s) from −50.0°C to −10.0°C, how much energy is required?

A 1.67×10^4 J

B 8.20×10^3 J

C 8.08×10^3 J

D 1.95×10^3 J

What is the pressure, in atmospheres, exerted by a 0.100-mol sample of oxygen in a 2.00-L container at 273°C?

A 4.48×10^{-1} atm

B 2.24×10^{0} atm

C 1.12×10^{3} atm

D 2.24×10^{3} atm

Page 7

Consider this phase diagram:

At what temperature does the normal boiling point occur?

A   45°C

B   60°C

C   100°C

D   110°C

Page 8

What happens to the pressure of a constant mass of gas at constant temperature when the volume is doubled?

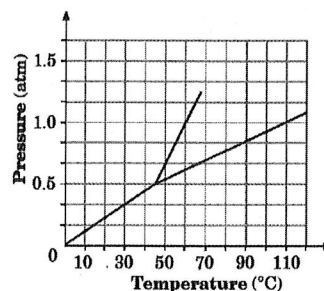A   The pressure is doubled.

B   The pressure remains the same.

C   The pressure is reduced by $\frac{1}{2}$.

D   The pressure is reduced by $\frac{1}{4}$.

Page 9

In a flexible container, 15.9 L of gas is under 589 kPa of pressure at a temperature of 56.5°C. If the pressure and temperature change to STP, what is the new volume?

A   10.2 L

B   76.6 L

C   92.4 L

D   112 L

Page 10

Consider this phrase diagram.

What process is occurring when a substance changes from point X (−130°C and 50 kPa) to point Y (30°C and 100 kPa)?

A   boiling

B   freezing

C   melting

D   sublimation

Page 11

Which substance listed in the table is a liquid at 27°C?

	Melting Point	Boiling Point
I	28°C	140°C
II	−10°C	25°C
III	20°C	140°C
IV	−90°C	14°C

A   I

B   II

C   III

D   IV

Page 12

How many grams of ice will melt at
0°C if the ice absorbs 420. J of energy?

A   0.186 g

B   0.795 g

C   1.26 g

D 5.38×10^4 g

For the reaction

$A^+ (aq) + B^- (aq) \rightarrow AB (s)$

increasing the temperature increases
the rate of the reaction. Which is the
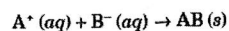*best* explanation for this happening?

A   The pressure increases, which in
turn increases the production of
products.

B   The concentration of reactants
increases with an increase in
temperature.

C   The average kinetic energy
increases, so the likelihood of
more effective collisions between
ions increases.

D   Systems are more stable at high
temperatures.

How many grams of KCl are necessary
to prepare 1.50 liters of a 0.500-*M*
solution of KCl?

A   224 g

B   74.6 g

C   56.0 g

D   24.9 g

6.00 g of gold was heated from 20.0°C
to 22.0°C. How much heat was
applied to the gold?

A   1.55 J

B   15.5 J

C   17.0 J

D   32.5 J

What is the molarity of a solution
containing 20.0 g of sodium hydroxide
dissolved in 1.00 L of solution?

A   0.500 *M*

B   0.400 *M*

) 0.300 *M*

D   0.200 *M*

A gas under a pressure of 74 mmHg
and at a temperature of 75°C occupies
a 500.0-L container. How many moles
of gas are in the container?

A   1.7 moles

B   7.9 moles

C   13 moles

D   59 moles
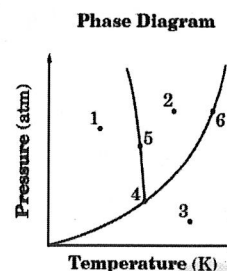
Neutralization occurs when 15.0 mL of KOH react with 25.0 mL of HNO_3. If the molarity of HNO_3 is 0.750 M, what is the molarity of the KOH?

A   1.67 M

B   1.25 M

C   0.600 M

D   0.450 M

This diagram represents a phase diagram for a substance.

Phase Diagram

At which point do solid, liquid, and gas phases exist in equilibrium?

A   1

B   2

C   3

D   4
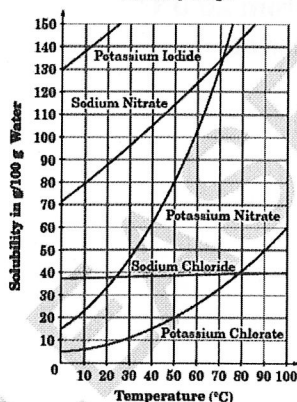
What is the identity of the substance?

A   Sodium Nitrate

B   Potassium Nitrate

C   Sodium Chloride

D   Potassium Chlorate

Student Data

Trial	Temperature(°C) of Water	Salt in 100 g of water(g)
1	25	40
2	68	126

When combined, two gases have a pressure of 4.0 atm. If one gas has a pressure of 1.5 atm, what is the pressure of the second gas?

A   1.5 atm

B   2.0 atm

C   2.5 atm

D   5.5 atm

This graph represents a phase diagram for a substance.

Phase Diagram
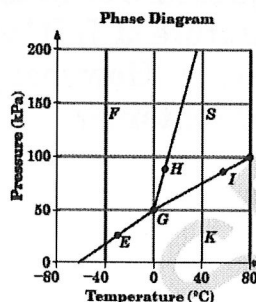
What is the state of the substance at point I?

A   gas

B   liquid

C   liquid and gas

D   solid and liquid

What is the molarity of 28.9 g of $CaCl_2$ dissolved in water to make 0.78 L of solution?

A   0.33 M

B   0.69 M

C   1.5 M

D   3.0 M

Chemistry Test: Solutions, Thermochemistry, Gas Laws

1. The graph below represents a chemical reaction.

This reaction is best described as

A) endothermic, because energy is absorbed

B) endothermic, because energy is released

C) exothermic, because energy is absorbed

D) exothermic, because energy is released

2. How many kiloJoules of heat energy are absorbed when 100 grams of water is heated from 20°C to 30°C?

A) 4.2 kJ   C) 420 kJ
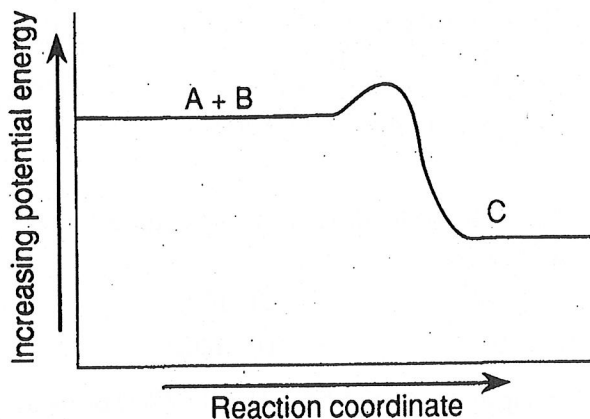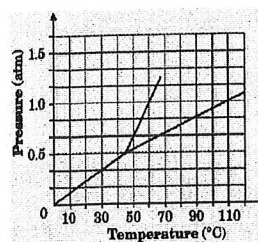
B) 42 kJ   D) 0.42 kJ

3. A gas has a pressure of 120 kPa, a temperature of 400. K, and a volume of 50.0 milliliters. What volume will the gas have at a pressure of 60 kPa and a temperature of 200. K?

A) 200. ml   C) 50.0 ml

B) 12.5 ml   D) 100. ml

4. At a temperature of 273 K, a 400.-milliliter gas sample has a pressure of 760. millimeters of mercury. If the pressure is changed to 380. millimeters of mercury, at which temperature will this gas sample have a volume of 551 milliliters?

A) 273 K   C) 188 K

B) 100 K   D) 546 K

5.

What is the normal melting point for the susbtance?

A) 110   D) 100

B) 45   E) 60

C) 50

6. What is the total number of moles of solute contained in 0.50 liter of 3.0 M HCl?

A) 1.0   C) 3.0

B) 1.5   D) 3.5

7. A sample of gas has a volume of 12 liters at 0°C and 380 torr. What will be its volume when the pressure is changed to 760 torr at constant temperature?

A) 6.0 L   C) 24 L

B) 18 L   D) 12 L

8. When the pressure exerted on a confined gas at constant temperature is doubled, the volume of the gas is

A) halved   C) tripled

B) doubled   D) quartered

9. Given the reaction:

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

How many grams of H_2SO_4 are needed to produce exactly 11.2 liters of H_2, measured at STP?

A) 196   C) 49.0

B) 24.5   D) 98.0

10. How many grams of ammonium chloride (gram formula mass = 53.5 g) are contained in 0.500 L of a 2.00 M solution?

A) 53.5 g   C) 26.5 g

B) 10.0 g   D) 107 g

11. The potential energy diagram below represents the reaction

$$2 KClO_3 \rightarrow 2 KCl + 3 O_2.$$
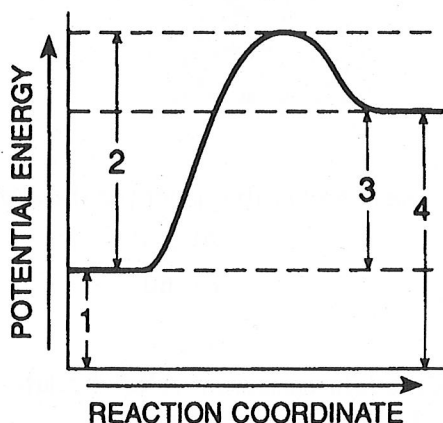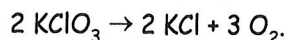
Which numbered interval on the diagram would change when a catalyst is added?

A) 1   C) 3
B) 2   D) 4

12. What is the total number of grams of NaI(s) needed to make 1.0 liter of a 0.010 M solution?

A) 1.5   C) 0.15
B) 15   D) 0.015

13. Which statement explains why the speed of some chemical reactions is increased when the surface area of the reactant is increased?

A) This change alters the electrical conductivity of the reactant particles.
B) This change exposes more reactant particles to a possible collision.
C) This change increases the density of the reactant particles.
D) This change increases the concentration of the reactant.

14. In an experiment using a calorimeter, the following data were obtained:

Mass of calorimeter + water . . . . .150. g
Mass of calorimeter . . . . .100. g
Final temperature of water . . . . 55°C
Initial temperature of water . . . . 25°C

What is the total number of Joules absorbed by the water?

A) 12600   C) 18900
B) 6300   D) 4200

15. A compound contains 53% Al and 47% O by mass. What is the empirical formula of this compound?

A) Al_2O_3 C) AlO
B) Al_3O_2 D) AlO_2

16. When ammonium chloride crystals are dissolved in water, the temperature of the water decreases. What does this temperature change indicate about the dissolving of ammonium chloride in water?

A) It is an exothermic reaction because it absorbs heat.
B) It is an endothermic reaction because it releases heat.
C) It is an endothermic reaction because it absorbs heat.
D) It is an exothermic reaction because it releases heat.

17. The graph below represents the relationship between temperature and time for a substance that was heated uniformly starting at t_0. The substance was in the solid phase at t_0.
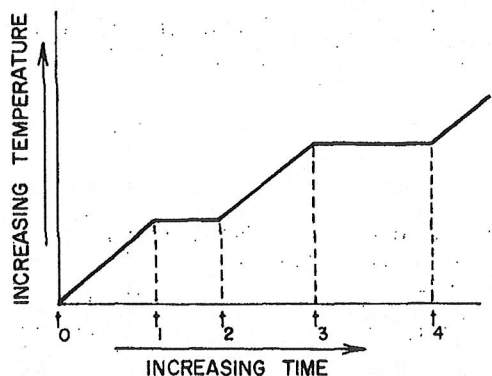

During which time interval does the heat absorbed by the substance represent the heat of fusion of the substance?

A) t_0 to t_1 C) t_2 to t_3

B) t_1 to t_2 D) t_3 to t_4

18. A mixture of oxygen, nitrogen, and hydrogen gases exerts a total pressure of 74 kPa at 0°C. The partial pressure of the oxygen is 20 kPa and the partial pressure of the nitrogen is 40 kPa. What is the partial pressure of the hydrogen gas in this mixture?

A) 40 kPa   C) 20 kPa

B) 14 kPa   D) 74 kPa

19. When 20.0 grams of water is cooled from 20.0°C to 10.0°C, the number of Joules of heat released is

A) 42.0   C) 126

B) 84.0   D) 840.

20. According to the potential energy diagram below, what is the reaction $A + B \rightarrow C$?
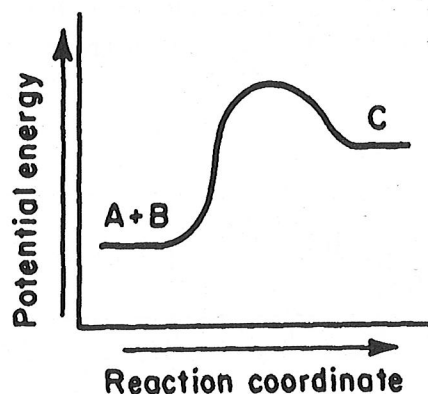
A) exothermic and ΔH is negative
B) endothermic and ΔH is positive
C) endothermic and ΔH is negative
D) exothermic and ΔH is positive

21. How many liters of a 0.5 M sodium hydroxide solution would contain 2 moles of solute?

A) 1 L   C) 3 L

B) 2 L   D) 4 L

22. What mass of N_2 is needed to pressurize a 7L balloon to 150kPa at standard temperature?

A) 0.017g   C) 12.95g

B) 0.46g   D) 6.45g

23. Given the following reaction, predict the products:
$AlCl_3 + F_2 \rightarrow$

A) $AlF + Cl$ D) No Reaction

B) $AlF_3 + Cl_2$ E) $AlF_2 + Cl_2$

C) $ClF_2 + Al$

24. What is the molarity of a solution that contains 30. grams of NaOH in 500. milliliters of solution?

A) 0.75 M   C) 1.3 M

B) 2.6 M   D) 1.5 M

25. The graph below represents the relationship between temperature and time as heat is added uniformly to a substance, starting when the substance is a solid below its melting point.
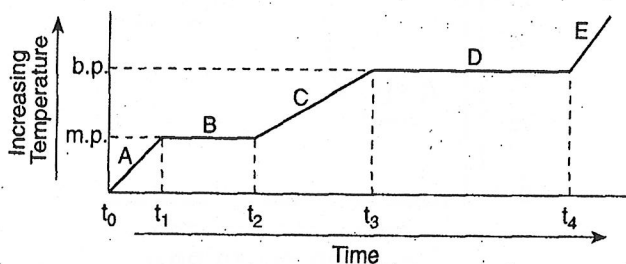
Which portions of the graph represent times when heat is absorbed and potential energy increases while kinetic energy remains constant?

A) A and B   C) A and C

B) B and D   D) C and D

26. A sealed container of nitrogen gas contains 6×10^{23} molecules at STP. As the temperature increases, the mass of the nitrogen will

A) decrease   C) remain the same

B) increase

27. As a liquid boils at its normal boiling point, its temperature

A) decreases   C) remains the same

B) increases

28. At which temperature would the molecules in a one gram sample of water have the *lowest* average kinetic energy?

A) 5 K   C) 5°C

B) –100°C   D) 100 K

29. Base your answer to the following question on the table below, which represents the production of 50 milliliters of CO_2 in the reaction of HCl with $NaHCO_3$. Five trials were performed under different conditions as shown. (The same mass of $NaHCO_3$ was used in each trial.)

Trial	Particle Size of $NaHCO_3$	Concentration of HCl	Temperature (°C) of HCl
A	small	1 M	20
B	large	1 M	20
C	large	1 M	40
D	small	2 M	40
E	large	2 M	40

Which two trials could be used to measure the effect of surface area?

A) trials A and B   C) trials A and D

B) trials A and C   D) trials B and D

30. Which interval on the potential energy diagram shown below represents the ΔH of the reaction

$a + b \rightarrow c + d$?
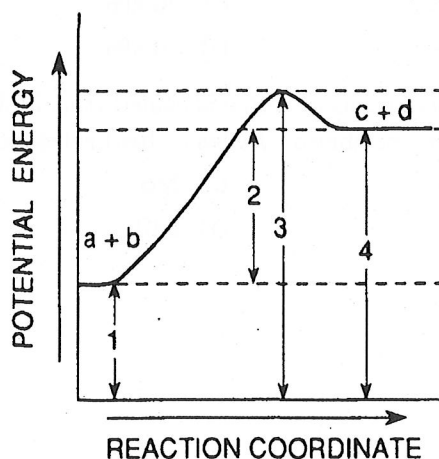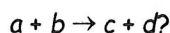
A) 1   C) 3

B) 2   D) 4

31. What is the minimum number of kiloJoules needed to change 40.0 grams of water at 100°C to steam at the same temperature and pressure?

    A) 2.26
    B) 90.4
    C) .400
    D) 1,810

32. At constant pressure, what temperature must be reached to increase a 100.-milliliter sample of a gas initially at 300. K to a volume of 200. milliliters?

    A) 150. K
    B) 600. K
    C) 200. K
    D) 300. K

33. If the pressure on 36.0 milliliters of a gas at STP is changed to a pressure of 25.3 kPa at constant temperature, the new volume of the gas is

    A) 126 ml
    B) 226 ml
    C) 9.00 ml
    D) 144 ml

34. Which conditions will increase the rate of a chemical reaction?

    A) decreased temperature and increased concentration of reactants
    B) increased temperature and increased concentration of reactants
    C) increased temperature and decreased concentration of reactants
    D) decreased temperature and decreased concentration of reactants

35. Which of these compounds is soluble in water?

    A) Iron(III) Oxide
    B) Potassium Sulfate
    C) Aluminum Sulfide
    D) Calcium Carbonate

36. Determine if the following reaction will occur. If so, predict products.
    $Zn(s) + HCl(aq) \rightarrow$

    A) $ZnCl_2 + H_2$
    B) $Zn + Cl_2 + H_2$
    C) $ZnCl + H_2$
    D) No Reaction

37. When 20.0 grams of a substance is completely melted at its melting point, 820. Joules are absorbed. What is the heat of fusion of this substance?

    A) 41.0 J/g
    B) 840. J/g
    C) 800. J/g
    D) 16,400 J/g

38. The graph below represents changes of state for an unknown substance.
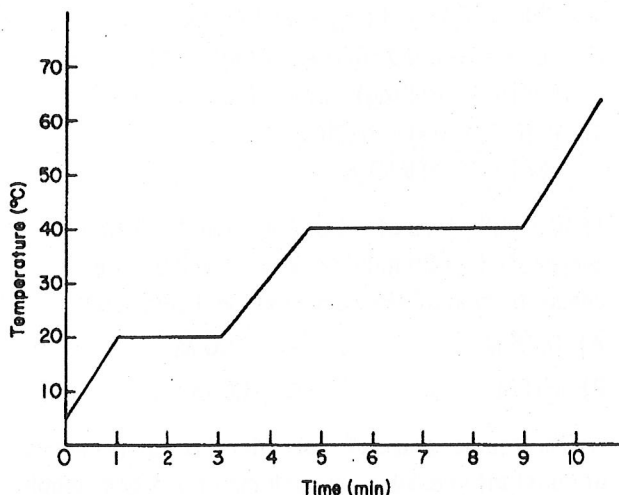
    What is the boiling temperature of the substance?

    A) 0°C
    B) 20°C
    C) 70°C
    D) 40°C

39. What is the molarity of a solution that contains 20. grams of $CaBr_2$ in 0.50 liter of solution?

    A) 0.20 M
    B) 10. M
    C) 5.0 M
    D) 0.50 M

40. What is the pressure, in atm, of a 20L tire at 20 degrees Celsius that contains 12 moles of Nitrogen gas (N_2)?

    A) 3.7atm
    B) 12.5atm
    C) 14.4atm
    D) 1461atm

41. When 20. milliliters of 1.0 M HCl is diluted to a total volume of 60. milliliters, the concentration of the resulting solution is

    A) 1.0 M
    B) 0.50 M
    C) 0.33 M
    D) 0.25 M

42. A sample of gas has a volume of 2.0 liters at a pressure of 1.0 atmosphere. When the volume increases to 4.0 liters, at constant temperature, the pressure will be

A) 1.0 atm   C) 0.50 atm

B) 2.0 atm   D) 0.25 atm

43. What is the net ionic equation in the reaction between $Pb(NO_3)_2$ and HCl?

A) $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$

B) $2NO_3^-(aq) + 2H^+(aq) \rightarrow 2HNO_3(aq)$

C) $Pb^{2+}(aq) + 2NO_3^{3-}(aq) + 2H^+(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s) + 2H^+(aq) + 2NO_3^-(aq)$

D) $Pb(NO_3)_2(aq) + 2HCl(aq) \rightarrow PbCl_2(s) + 2HNO_3(aq)$

44. If 100. milliliters of a 1.0-molar NaCl solution is evaporated to 25 milliliters, what will be the concentration of the resulting NaCl solution?

A) 0.25 M   C) 0.50 M

B) 2.0 M   D) 4.0 M

45. As the temperature of a sample of a gas increases at constant pressure, the volume of the gas sample

A) decreases   C) remains the same

B) increases

46. As the pressure on a sample of a gas increases at constant temperature, the volume of the gas

A) decreases   C) remains the same

B) increases

47. Given the reaction:

$$Fe + S \rightarrow FeS + energy$$

Which statement about this reaction is true?

A) It is exothermic.

B) It is endothermic.

C) The potential energy of the reactants is lower than the potential energy of the product.

D) The potential energy of the reactants is the same as the potential energy of the product.

48. The graph below was constructed by a student to show the relationship between temperature and time as heat was uniformly added to a solid below its melting point.
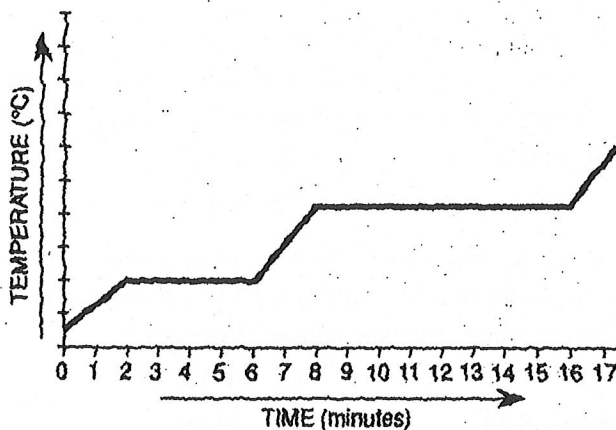
What is the total length of time that the solid phase existed with the liquid phase?

A) 6 min   C) 8 min

B) 10 min   D) 4 min

49. The number of Joules needed to raise the temperature of 10 grams of water from 20°C to 30°C is

A) 42   C) 420

B) 84   D) 1680

50. A student wants to prepare a 1.0-liter solution of a specific molarity. The student determines that the mass of the solute needs to be 30. grams. What is the proper procedure to follow?

A) Add 30. g of solute to 970. mL of solvent to make 1.0 L of solution.

B) Add enough solvent to 30. g of solute to make 1.0 L of solution.

C) Add 1000. g of solvent to 30. g of solute.

D) Add 30. g of solute to 1.0 L of solvent.

51. Which graph best represents a change of phase from a gas to a solid?

A)

PRESSURE vs TIME

C)
TEMPERATURE vs TIME

B)
PRESSURE vs TIME

D)
TEMPERATURE vs TIME
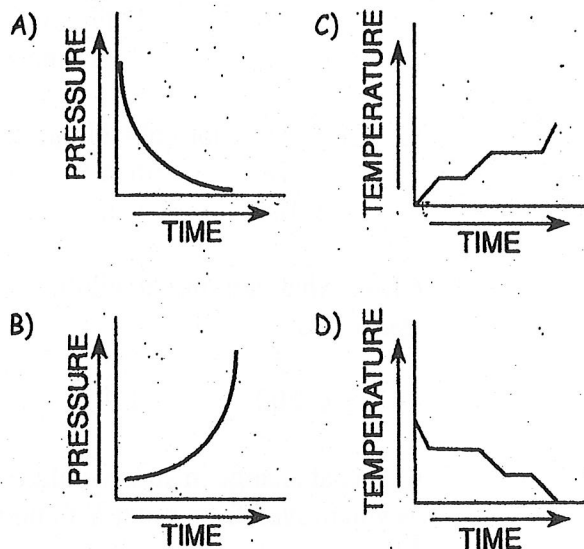
52. Gas samples A, B, and C are contained in a system at STP. The partial pressure of sample A is 38.0 kPa and the partial pressure of sample B is 19.0 kPa. What is the partial pressure of sample C?
   A) 38.0 kPa   C) 63.3 kPa
   B) 44.3 kPa   D) 19.0 kPa

53. If 420 Joules are added to 20 grams of water at 30°C, what will be the final temperature of the water?
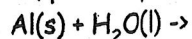   A) 35°C   C) 40°C
   B) 25°C   D) 50°C

54. The temperature of a sample of water in the liquid phase is changed from 15°C to 25°C by the addition of 2.1 kilojoules. What is the mass of the water?
   A) 10 g   C) 50 g
   B) 5,000 g   D) 100 g

55. How many Joules of heat would be required to completely melt 5.00 grams of $H_2O(s)$ at 0°C to H$_2$O(l) at 0°C?
   A) 167   C) 1,670
   B) 5.00   D) 334

56. Determine if the following reaction will occur. If so, predict products:
   $Al(s) + H_2O(l) \rightarrow$
   A) No Reaction   C) $Al + O_2 + H_2$
   B) $Al(OH)_3 + H_2$ D) $Al_2O_3 + H_2$

57. A sample of gas occupies 15.0 liters at a pressure of 2.00 atmospheres and a temperature of 300. K. If the pressure is lowered to 1.00 atmosphere and the temperature is raised to 400. K, the volume of the gas sample would be
   A) 22.5 L   C) 40.0 L
   B) 5.63 L   D) 10.0 L

58. The volume of a sample of a gas at 0°C is 100 liters. If the volume of the gas is increased to 200 liters at constant pressure, what is the new temperature of the gas in degrees Kelvin?
   A) 273 K   C) 100 K
   B) 546 K   D) 0 K

59. Which solution is most concentrated?
   A) 0.1 mole of solute dissolved in 400 ml of solvent
   B) 0.2 mole of solute dissolved in 300 ml of solvent
   C) 0.3 mole of solute dissolved in 200 ml of solvent
   D) 0.4 mole of solute dissolved in 100 ml of solvent

60. Base your answer to the following question on the reaction coordinate shown below:
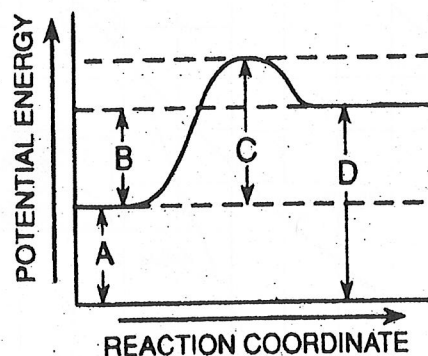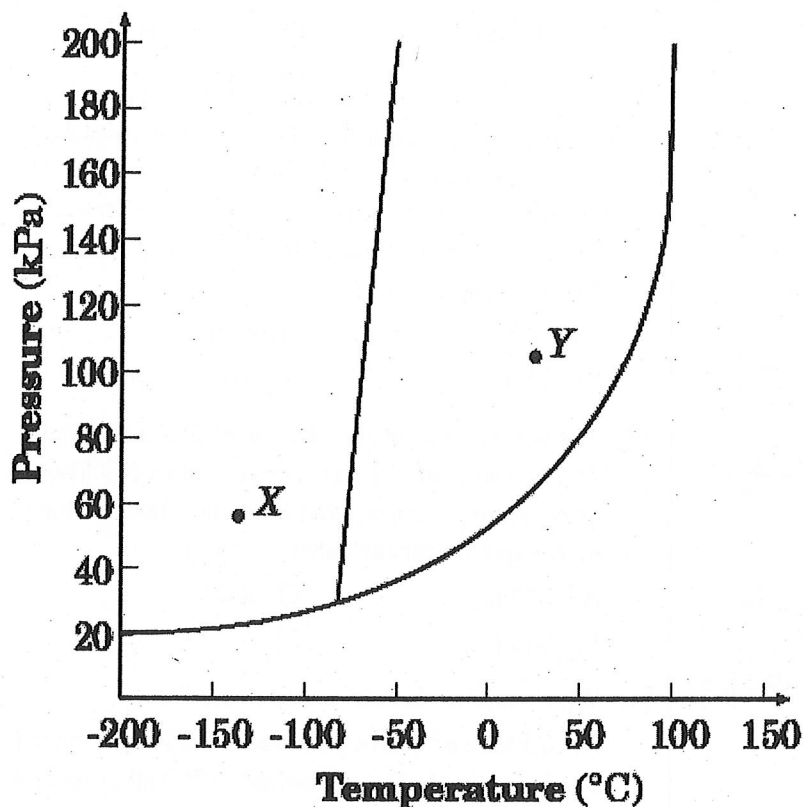

Which interval represents the activation energy of the forward reaction?
   A) A   C) C
   B) B   D) D

61. The temperature of 50.0 grams of water was raised to 50.0°C by the addition of 4200 Joules of heat energy. What was the initial temperature of the water?
   A) 10.0°C   C) 30.0°C
   B) 20.0°C   D) 60.0°C

Phase Diagram

62. What phase is the substance at point X?
    a. solid   b. liquid
    c. gas   d. plasma

63. What is the normal melting point?
    a. -78   b. 60
    c. 101   d. 0

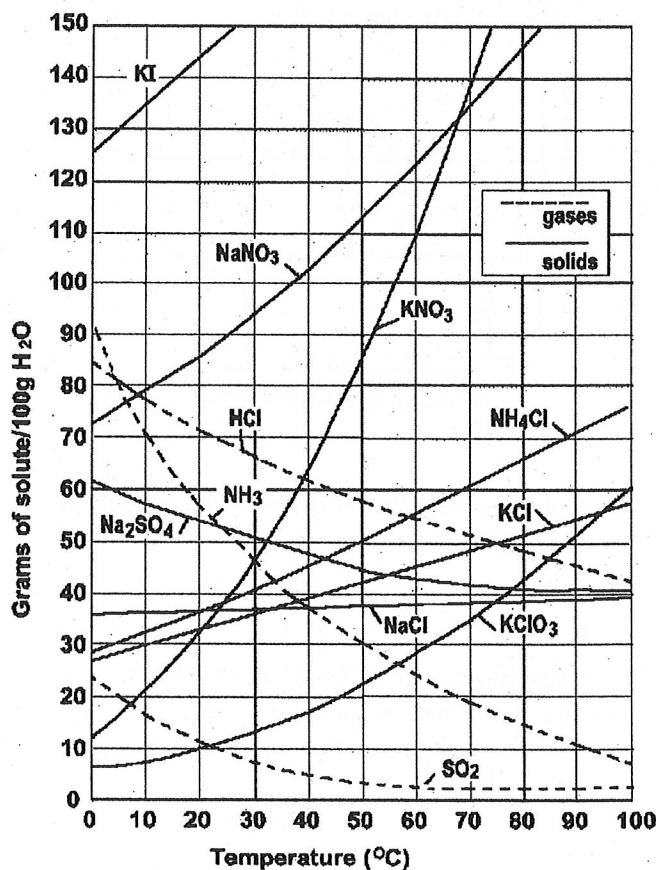**64.** At what pressure do all three states exist?
    a. 25   b. 1
    c. 200   d. 140

65. What change in state would occur as you moved from point Y to point X?
    a. melting   b. boiling
    c. sublimation d. freezing

66. Which of the following does not indicate a chemical change?
    a. absorb/release heat
    b. production of precipitate
    c. change in state
    d. production of a gas

67. How would you describe a solution of 20g of NH_4Cl in 100g of water at 70 Celsius?

    a. Saturated   c. Unsaturated
    b. Supersaturated d. Concentrated

68. How would you describe a solution of 110g of KNO_3 in 100g of water at 60 Celsius?

    a. Saturated   c. Unsaturated
    b. Supersaturated d. Concentrated

69. What is the solubility of hydrochloric acid at 40 Celsius in 50g of water?

    a. 62g   c. 31g
    b. 124g   d. 75g

70. How would you describe a solution of 110g of sodium nitrate at 40 Celsius in 200g of water?

    a. Saturated   c. Unsaturated
    b. Supersaturated d. Concentrated

Chemistry Test: Solutions, Thermochemistry, Gas Laws

1. A sample of gas occupies 15.0 liters at a pressure of 2.00 atmospheres and a temperature of 300. K. If the pressure is lowered to 1.00 atmosphere and the temperature is raised to 400. K, the volume of the gas sample would be

   A) 40.0 L   C) 10.0 L

   B) 22.5 L   D) 5.63 L

2. The graph below was constructed by a student to show the relationship between temperature and time as heat was uniformly added to a solid below its melting point.
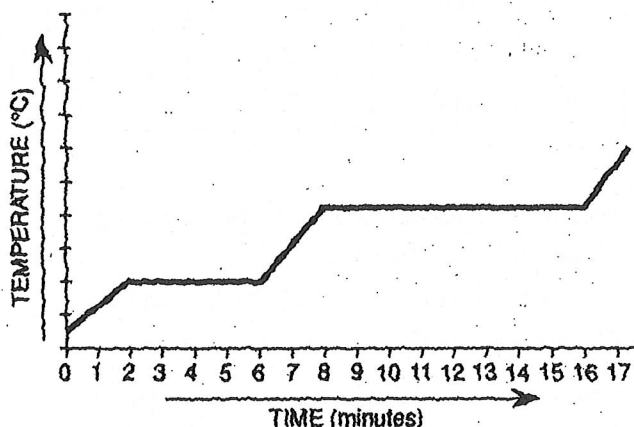

   What is the total length of time that the solid phase existed with the liquid phase?

   A) 6 min   C) 8 min

   B) 10 min   D) 4 min

3. A sample of gas has a volume of 12 liters at 0°C and 380 torr. What will be its volume when the pressure is changed to 760 torr at constant temperature?

   A) 12 L   C) 24 L

   B) 6.0 L   D) 18 L

4. What is the minimum number of kiloJoules needed to change 40.0 grams of water at 100°C to steam at the same temperature and pressure?

   A) .400   C) 1,810

   B) 2.26   D) 90.4

5. At constant pressure, what temperature must be reached to increase a 100.-milliliter sample of a gas initially at 300. K to a volume of 200. milliliters?

   A) 150. K   C) 300. K

   B) 200. K   D) 600. K

6. What is the molarity of a solution that contains 20. grams of $CaBr_2$ in 0.50 liter of solution?

   A) 0.50 M   C) 0.20 M

   B) 10. M   D) 5.0 M

7. How many kiloJoules of heat energy are absorbed when 100 grams of water is heated from 20°C to 30°C?

   A) 4.2 kJ   C) 420 kJ

   B) 42 kJ   D) 0.42 kJ

8. Determine if the following reaction will occur. If so, predict products:
   $Al(s) + H_2O(l)$ ->

   A) $Al(OH)_3 + H_2$ C) No Reaction

   B) $Al + O_2 + H_2$ D) $Al_2O_3 + H_2$

9. When ammonium chloride crystals are dissolved in water, the temperature of the water decreases. What does this temperature change indicate about the dissolving of ammonium chloride in water?

   A) It is an exothermic reaction because it releases heat.

   B) It is an exothermic reaction because it absorbs heat.

   C) It is an endothermic reaction because it releases heat.

   D) It is an endothermic reaction because it absorbs heat.

10. A compound contains 53% Al and 47% O by mass. What is the empirical formula of this compound?

    A) AlO   C) AlO_2

    B) Al_3O_2 D) Al_2O_3

11. Given the following reaction, predict the products:
    $AlCl_3 + F_2$ ->

    A) $AlF_2 + Cl_2$ D) $AlF + Cl$

    B) $AlF_3 + Cl_2$ E) $ClF_2 + Al$

    C) No Reaction

12. Base your answer to the following question on the reaction coordinate shown below:
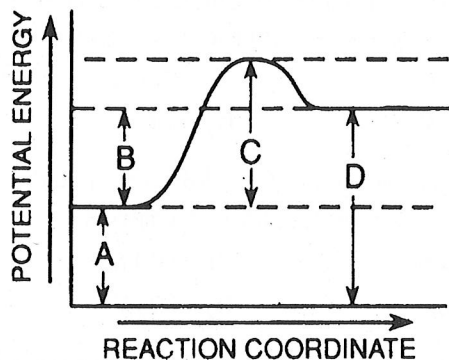
Which interval represents the activation energy of the forward reaction?

A) A

B) B

C) C

D) D

13. Gas samples A, B, and C are contained in a system at STP. The partial pressure of sample A is 38.0 kPa and the partial pressure of sample B is 19.0 kPa. What is the partial pressure of sample C?

A) 38.0 kPa

B) 19.0 kPa

C) 44.3 kPa

D) 63.3 kPa

14. A gas has a pressure of 120 kPa, a temperature of 400. K, and a volume of 50.0 milliliters. What volume will the gas have at a pressure of 60 kPa and a temperature of 200. K?

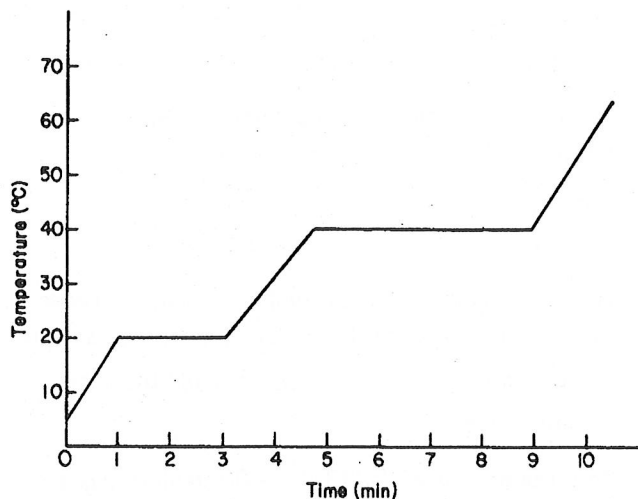A) 12.5 ml

B) 200. ml

C) 100. ml

D) 50.0 ml

15. Base your answer to the following question on the table below, which represents the production of 50 milliliters of CO_2 in the reaction of HCl with $NaHCO_3$. Five trials were performed under different conditions as shown. (The same mass of $NaHCO_3$ was used in each trial.)

Trial	Particle Size of $NaHCO_3$	Concentration of HCl	Temperature (°C) of HCl
A	small	1 M	20
B	large	1 M	20
C	large	1 M	40
D	small	2 M	40
E	large	2 M	40

Which two trials could be used to measure the effect of surface area?

A) trials A and B

B) trials A and C

C) trials A and D

D) trials B and D

16. How many grams of ammonium chloride (gram formula mass = 53.5 g) are contained in 0.500 L of a 2.00 M solution?

A) 10.0 g

B) 107 g

C) 53.5 g

D) 26.5 g

17. The graph below represents changes of state for an unknown substance.

What is the boiling temperature of the substance?
A) 70°C
C) 0°C
B) 40°C
D) 20°C

18. A mixture of oxygen, nitrogen, and hydrogen gases exerts a total pressure of 74 kPa at 0°C. The partial pressure of the oxygen is 20 kPa and the partial pressure of the nitrogen is 40 kPa. What is the partial pressure of the hydrogen gas in this mixture?
A) 20 kPa
C) 14 kPa
B) 40 kPa
D) 74 kPa

19. How many liters of a 0.5 M sodium hydroxide solution would contain 2 moles of solute?
A) 1 L
C) 3 L
B) 2 L
D) 4 L

20. How many Joules of heat would be required to completely melt 5.00 grams of $H_2O(s)$ at 0°C to $H_2O(\ell)$ at 0°C?
A) 5.00
C) 167
B) 334
D) 1,670

21. What is the pressure, in atm, of a 20L tire at 20 degrees Celsius that contains 12 moles of Nitrogen gas (N_2)?
A) 1461atm
C) 12.5atm
B) 3.7atm
D) 14.4atm

22. What is the net ionic equation in the reaction between $Pb(NO_3)_2$ and HCl?
A) $Pb(NO_3)_2(aq) + 2HCl(aq) \rightarrow PbCl_2(s) + 2HNO_3(aq)$
B) $Pb^{2+}(aq) + 2NO_3^-(aq) + 2H^+(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s) + 2H^+(aq) + 2NO_3^-(aq)$
C) $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$
D) $2NO_3^-(aq) + 2H^+(aq) \rightarrow 2HNO_3(aq)$

23. At which temperature would the molecules in a one gram sample of water have the *lowest* average kinetic energy?
A) 5°C
C) −100°C
B) 5 K
D) 100 K

24. The volume of a sample of a gas at 0°C is 100 liters. If the volume of the gas is increased to 200 liters at constant pressure, what is the new temperature of the gas in degrees Kelvin?
A) 546 K
C) 100 K
B) 273 K
D) 0 K

25. Given the reaction:

Fe + S → FeS + energy

Which statement about this reaction is true?
A) It is endothermic.
B) The potential energy of the reactants is lower than the potential energy of the product.
C) The potential energy of the reactants is the same as the potential energy of the product.
D) It is exothermic.

26. When 20.0 grams of water is cooled from 20.0°C to 10.0°C, the number of Joules of heat released is
A) 42.0
C) 126
B) 84.0
D) 840.

27. The graph below represents the relationship between temperature and time for a substance that was heated uniformly starting at t_0. The substance was in the solid phase at t_0.
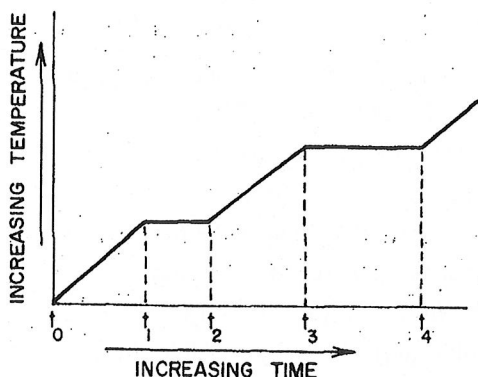

During which time interval does the heat absorbed by the substance represent the heat of fusion of the substance?

A) t_0 to t_1

C) t_2 to t_3

B) t_1 to t_2

D) t_3 to t_4

28. Which solution is most concentrated?

A) 0.1 mole of solute dissolved in 400 ml of solvent

B) 0.2 mole of solute dissolved in 300 ml of solvent

C) 0.3 mole of solute dissolved in 200 ml of solvent

D) 0.4 mole of solute dissolved in 100 ml of solvent

29. Which graph best represents a change of phase from a gas to a solid?
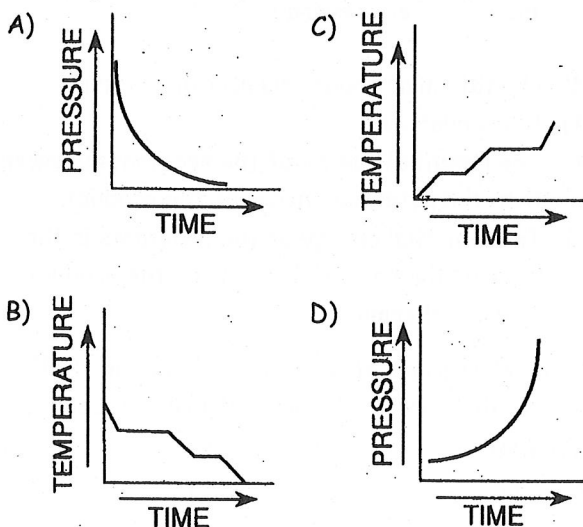
30. A sealed container of nitrogen gas contains 6×10^{23} molecules at STP. As the temperature increases, the mass of the nitrogen will

A) decrease

C) remain the same

B) increase

31. What is the total number of moles of solute contained in 0.50 liter of 3.0 M HCl?

A) 1.0

C) 3.0

B) 1.5

D) 3.5

32. As the temperature of a sample of a gas increases at constant pressure, the volume of the gas sample

A) decreases

C) remains the same

B) increases

33. At a temperature of 273 K, a 400.-milliliter gas sample has a pressure of 760. millimeters of mercury. If the pressure is changed to 380. millimeters of mercury, at which temperature will this gas sample have a volume of 551 milliliters?

A) 188 K

C) 100 K

B) 546 K

D) 273 K

34. When 20. milliliters of 1.0 M HCl is diluted to a total volume of 60. milliliters, the concentration of the resulting solution is

A) 1.0 M

C) 0.33 M

B) 0.50 M

D) 0.25 M

35. If 100. milliliters of a 1.0-molar NaCl solution is evaporated to 25 milliliters, what will be the concentration of the resulting NaCl solution?

A) 0.25 M

C) 0.50 M

B) 2.0 M

D) 4.0 M

36. Which conditions will increase the rate of a chemical reaction?

A) increased temperature and decreased concentration of reactants

B) decreased temperature and increased concentration of reactants

C) decreased temperature and decreased concentration of reactants

D) increased temperature and increased concentration of reactants

37. Which interval on the potential energy diagram shown below represents the ΔH of the reaction

$$a + b \rightarrow c + d?$$
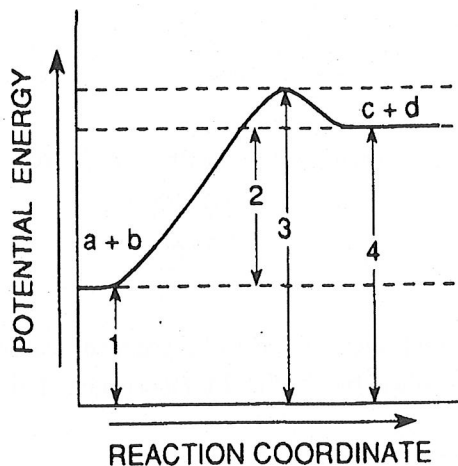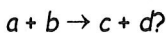
A) 1 C) 3
B) 2 D) 4

38. As the pressure on a sample of a gas increases at constant temperature, the volume of the gas
   A) decreases   C) remains the same
   B) increases

39. As a liquid boils at its normal boiling point, its temperature
   A) decreases   C) remains the same
   B) increases

40. The temperature of 50.0 grams of water was raised to 50.0°C by the addition of 4200 Joules of heat energy. What was the initial temperature of the water?
   A) 10.0°C   C) 30.0°C
   B) 20.0°C   D) 60.0°C

41. Which of these compounds is soluble in water?
   A) Aluminum Sulfide   C) Calcium Carbonate
   B) Potassium Sulfate D) Iron(III) Oxide

42. The number of Joules needed to raise the temperature of 10 grams of water from 20°C to 30°C is
   A) 42   C) 420
   B) 84   D) 1680

43. The graph below represents a chemical reaction.
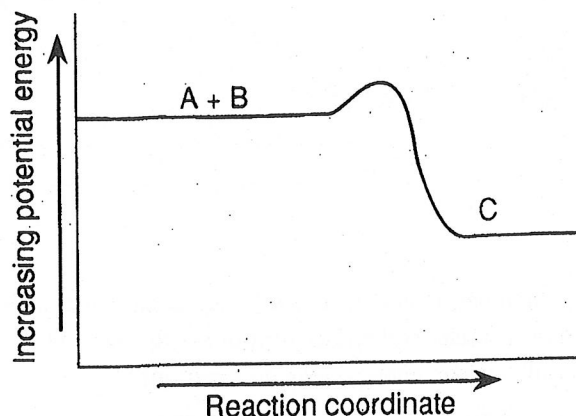

This reaction is best described as
   A) exothermic, because energy is released
   B) endothermic, because energy is released
   C) exothermic, because energy is absorbed
   D) endothermic, because energy is absorbed

44. Given the reaction:

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$
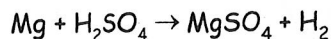
How many grams of H_2SO_4 are needed to produce exactly 11.2 liters of H_2, measured at STP?
   A) 98.0   C) 49.0
   B) 24.5   D) 196

45. A sample of gas has a volume of 2.0 liters at a pressure of 1.0 atmosphere. When the volume increases to 4.0 liters, at constant temperature, the pressure will be
   A) 1.0 atm   C) 0.50 atm
   B) 2.0 atm   D) 0.25 atm

46. The graph below represents the relationship between temperature and time as heat is added uniformly to a substance, starting when the substance is a solid below its melting point.
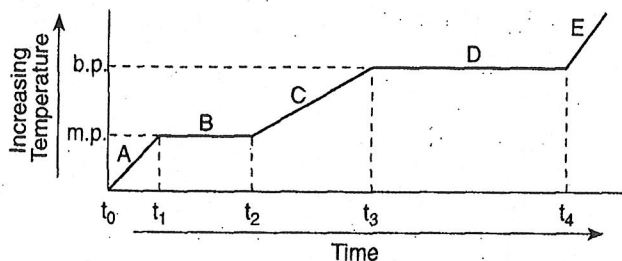

Which portions of the graph represent times when heat is absorbed and potential energy increases while kinetic energy remains constant?

A) C and D   C) A and C
B) A and B   D) B and D

47. According to the potential energy diagram below, what is the reaction A + B → C?
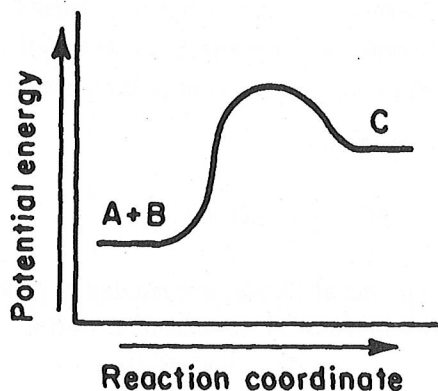
A) exothermic and ΔH is positive
B) endothermic and ΔH is negative
C) exothermic and ΔH is negative
D) endothermic and ΔH is positive

48.
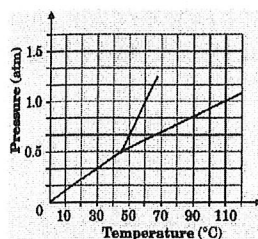
What is the normal melting point for the susbtance?

A) 45   D) 100
B) 110   E) 60
C) 50

49. If 420 Joules are added to 20 grams of water at 30°C, what will be the final temperature of the water?

A) 35°C   C) 40°C
B) 25°C   D) 50°C

50. What mass of N_2 is needed to pressurize a 7L balloon to 150kPa at standard temperature?

A) 12.95g   C) 0.46g
B) 6.45g   D) 0.017g

51. When 20.0 grams of a substance is completely melted at its melting point, 820. Joules are absorbed. What is the heat of fusion of this substance?

A) 16,400 J/g   C) 41.0 J/g
B) 800. J/g   D) 840. J/g

52. When the pressure exerted on a confined gas at constant temperature is doubled, the volume of the gas is

A) halved   C) tripled
B) doubled   D) quartered

53. In an experiment using a calorimeter, the following data were obtained:

Mass of calorimeter + water . . . . 150. g
Mass of calorimeter . . . . 100. g
Final temperature of water . . . . 55°C
Initial temperature of water . . . . 25°C

What is the total number of Joules absorbed by the water?

A) 6300   C) 18900
B) 4200   D) 12600

54. What is the molarity of a solution that contains 30. grams of NaOH in 500. milliliters of solution?

A) 0.75 M C) 2.6 M

B) 1.5 M D) 1.3 M

55. A student wants to prepare a 1.0-liter solution of a specific molarity. The student determines that the mass of the solute needs to be 30. grams. What is the proper procedure to follow?

A) Add 30. g of solute to 1.0 L of solvent.

B) Add enough solvent to 30. g of solute to make 1.0 L of solution.

C) Add 30. g of solute to 970. mL of solvent to make 1.0 L of solution.

D) Add 1000. g of solvent to 30. g of solute.

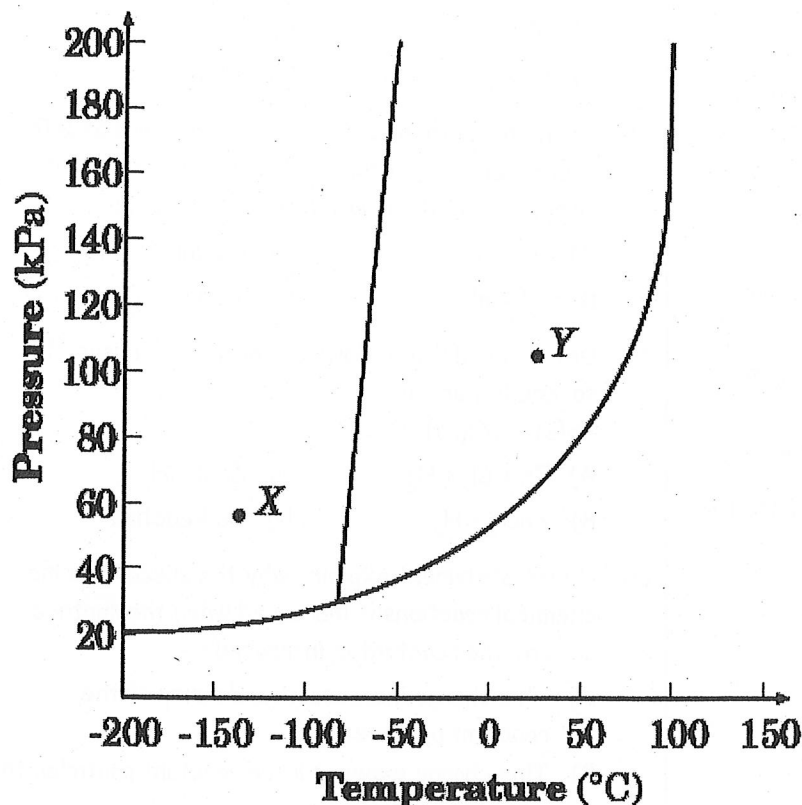56. The potential energy diagram below represents the reaction

$$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2.$$
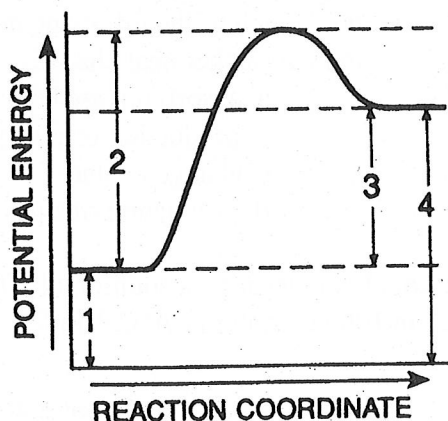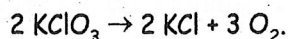
Which numbered interval on the diagram would change when a catalyst is added?

A) 1 C) 3

B) 2 D) 4

57. The temperature of a sample of water in the liquid phase is changed from 15°C to 25°C by the addition of 2.1 kilojoules. What is the mass of the water?

A) 10 g C) 5,000 g

B) 50 g D) 100 g

58. If the pressure on 36.0 milliliters of a gas at STP is changed to a pressure of 25.3 kPa at constant temperature, the new volume of the gas is

A) 144 ml C) 126 ml

B) 226 ml D) 9.00 ml

59. Determine if the following reaction will occur. If so, predict products.

$Zn(s) + HCl(aq) \rightarrow$

A) $Zn + Cl_2 + H_2$ C) $ZnCl + H_2$

B) $ZnCl_2 + H_2$ D) No Reaction

60. Which statement explains why the speed of some chemical reactions is increased when the surface area of the reactant is increased?

A) This change increases the density of the reactant particles.

B) This change exposes more reactant particles to a possible collision.

C) This change increases the concentration of the reactant.

D) This change alters the electrical conductivity of the reactant particles.

61. What is the total number of grams of NaI(s) needed to make 1.0 liter of a 0.010 M solution?

A) 0.015 C) 15

B) 1.5 D) 0.15

Phase Diagram

62. What phase is the substance at point X?
      a. solid   b. liquid
      c. gas   d. plasma

63. What is the normal melting point?
      a. -78   b. 60
      c. 101   d. 0

64. At what pressure do all three states exist?
      a. 25   b. 1
      c. 200   d. 140

65. What change in state would occur as you moved from point Y to point X?
      a. melting   b. boiling
      c. sublimation d. freezing

66. Which of the following does not indicate a chemical change?
      a. absorb/release heat
      b. production of precipitate
      c. change in state
      d. production of a gas

67. How would you describe a solution of 20g of NH_4Cl in 100g of water at 70 Celsius?

      a. Saturated   c. Unsaturated
      b. Supersaturated d. Concentrated

68. How would you describe a solution of 110g of KNO_3 in 100g of water at 60 Celsius?

      a. Saturated   c. Unsaturated
      b. Supersaturated d. Concentrated

69. What is the solubility of hydrochloric acid at 40 Celsius in 50g of water?

      a. 62g   c. 31g
      b. 124g   d. 75g

70. How would you describe a solution of 110g of sodium nitrate at 40 Celsius in 200g of water?

      a. Saturated   c. Unsaturated
      b. Supersaturated d. Concentrated