Name: KEY

Balancing and Reaction Types Station

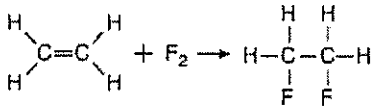
1.) Given the balanced equation representing a reaction:
$H^+(aq) + OH^-(aq) \rightarrow H_2O(l) + 55.8\ kJ$
In this reaction there is conservation of
(1) mass, only
(2) mass and charge, only
(3) mass and energy, only
(4) mass, charge, and energy

2.) Which equation shows conservation of atoms?
(1) $H_2 + O_2 \rightarrow H_2O$
(2) $H_2 + O_2 \rightarrow 2H_2O$
(3) $2H_2 + O_2 \rightarrow 2H_2O$
(4) $2H_2 + 2O_2 \rightarrow 2H_2O$

3.) In a chemical reaction, there is conservation of
(1) energy, volume, and mass
(2) energy, volume, and charge
(3) mass, charge, and energy
(4) mass, charge, and volume

4.) Given the balanced equation representing a reaction:
$2H_2 + O_2 \rightarrow 2H_2O$
What is the total mass of water formed when 8 grams of hydrogen reacts completely with 64 grams of oxygen?
(1) 18 g
(2) 36 g
(3) 56 g
(4) 72 g

5.) Given the balanced equation representing a reaction:



Which type of reaction is represented by this equation?
(1) addition
(2) fermentation
(3) polymerization
(4) substitution

6.) Given the balanced equation representing a reaction:
$K_2CO_3(aq) + BaCl_2(aq) \rightarrow 2KCl(aq) + BaCO_3(s)$
Which type of reaction is represented by this equation?
(1) synthesis
(2) decomposition
(3) single replacement
(4) double replacement

7.) Given the reaction:
$Mg(s) + 2\ AgNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + 2\ Ag(s)$
Which type of reaction is represented?
(1) single replacement
(2) double replacement
(3) synthesis
(4) decomposition

8.) Given the balanced equation representing a reaction:
$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$
Which type of reaction is represented by this equation?
(1) decomposition
(2) neutralization
(3) single replacement
(4) synthesis

9.) Given the incomplete equation representing a reaction:

$2C_6H_{14} + \_\_\_\_\_ O_2 \rightarrow 12CO_2 + 14H_2O$

What is the coefficient of O_2 when the equation is completely balanced using the smallest whole number coefficients?

(1) 13
(2) 14
(3) 19
(4) 26

10.) Balance the equation below, using the smallest whole-number coefficients.

2 $Al(s)$ + 3 $CuSO_4(aq) \rightarrow$ _____ $Al_2(SO_4)_3(aq)$ + 3 $Cu(s)$

Base your answers to questions 11 and 12 on the balanced chemical equation below.

$$N_2 + 3\ H_2 \rightarrow 2\ NH_3$$

11.) What type of reaction does this equation represent? Synthesis

12.) How does the balanced chemical equation show the Law of Conservation of Mass?

There are the same number + type of atoms in the reactants and products (2 N + 6 H on both sides of equation)

Base your answers to questions 13 and 14 on the information below.

Given the unbalanced equation:

$$\_\_\_\ C_6H_{12}O_6 \xrightarrow{\text{enzyme}} 2\ C_2H_5OH + 2\ CO_2$$

13.) Balance the equation provided *above* using the lowest whole-number coefficients.

14.) Identify the type of reaction represented. fermentation

Name: KEY

Gas Law Station

1.) Under which conditions does a real gas behave most like an ideal gas?

4

(1) at low temperatures and high pressures
(2) at low temperatures and low pressures
(3) at high temperatures and high pressures
(4) at high temperatures and low pressures

2.) The kinetic molecular theory assumes that the particles of an ideal gas

1

(1) are in random, constant, straight-line motion
(2) are arranged in a regular geometric pattern
(3) have strong attractive forces between them
(4) have collisions that result in the system losing energy

3.) A sample of a gas is contained in a closed rigid cylinder. According to kinetic molecular theory, what occurs when the gas inside the cylinder is heated?

3

(1) The number of gas molecules increases.
(2) The number of collisions between gas molecules per unit time decreases.
(3) The average velocity of the gas molecules increases.
(4) The volume of the gas decreases.

4.) According to the kinetic molecular theory, the molecules of an ideal gas

3

(1) have a strong attraction for each other
(2) have significant volume
(3) move in random, constant, straight-line motion
(4) are closely packed in a regular repeating pattern

5.) According to the kinetic molecular theory, which statement describes the particles in a sample of an ideal gas?

2

(1) The force of attraction between the gas particles is strong.
(2) The motion of the gas particles is random and straight-line.
(3) The collisions between the gas particles cannot result in a transfer of energy between the particles.
(4) The separation between the gas particles is smaller than the size of the gas particles themselves.

6.) Which gas sample at STP has the same total number of molecules as 2.0 liters of $CO_2(g)$ at STP?

2

(1) 5.0 L of $CO_2(g)$
(2) 2.0 L of $Cl_2(g)$
(3) 3.0 L of $H_2S(g)$
(4) 6.0 L of He(g)

7.) At 25°C, gas in a rigid cylinder with a movable piston has a volume of 145 mL and a pressure of 125 kPa. Then the gas is compressed to a volume of 80. mL. What is the new pressure of the gas if the temperature is held at 25°C?

4

(1) 69 kPa
(2) 93 kPa
(3) 160 kPa
(4) 230 kPa

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \qquad \frac{125\,kPa \times 145mL}{298K} = \frac{x \cdot 80mL}{298K}$$

$P_1 = 125\,kPa$ $\quad P_2 = x$

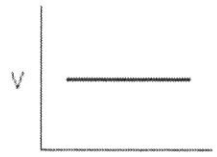
$V_1 = 145mL$ $\quad V_2 = 80mL$

$T_1 = 25°C \rightarrow 298K$ $\quad T_2 = 298K$

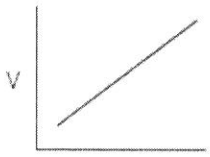
OVER

8.) Which graph best represents the pressurevolume relationship for an ideal gas at constant temperature?

4



(1)



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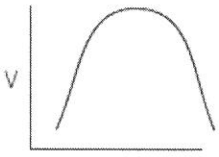
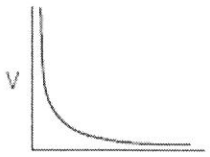


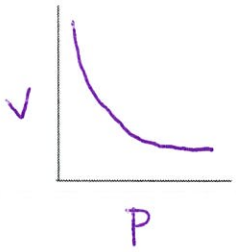
(3)



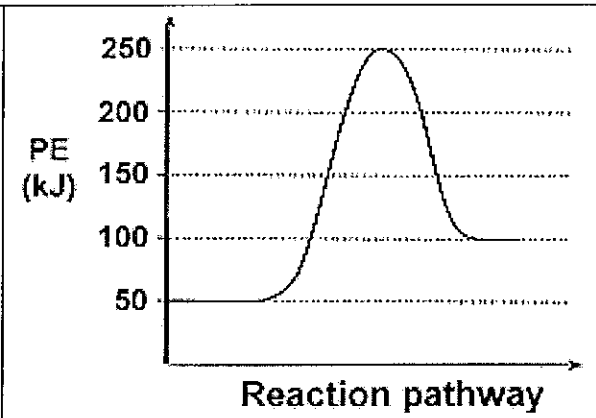
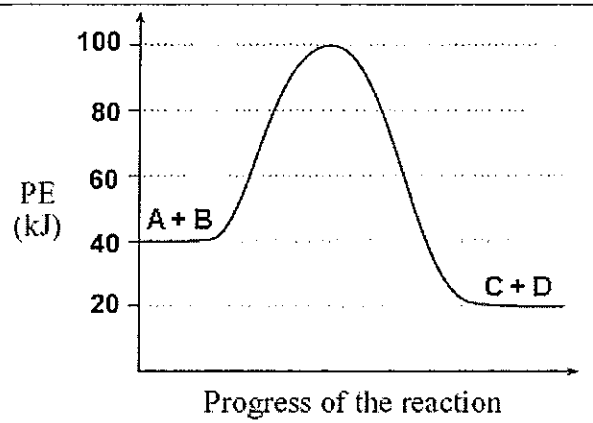
(4)

Base your answers to question 9 on the diagram below, which shows a piston confining a gas in a cylinder.

9.) Using the set of axes provided *below,* sketch the general relationship between the pressure and the volume of an ideal gas at constant temperature.



Regents Chemistry: PE Diagrams & Ref. Table I Name: KEY

		
Does the diagram represent an exothermic or endothermic process?	endothermic	exothermic
Determine the potential energy of the reactants	50 kJ	40 kJ
Determine the potential energy of the products	100 kJ	20 kJ
Determine the heat of reaction, including the sign and magnitude	+50 kJ	-20 kJ
Determine the activation energy of the forward reaction	200 kJ	60 kJ
Are the reactants or products more stable?	reactants	products
Describe heat flow, in terms of the system and surroundings.	heat flows from the surroundings to system	heat flows from the system to surroundings
If this reaction could go backwards, what would be the activation energy of the reverse reaction?	150 kJ	80 kJ

How does the information on Reference Table I relate to the information in a PE diagram?

Positive heat of reaction ($+\Delta H$) = endothermic

Negative heat of reaction ($-\Delta H$) = exothermic

How does the addition of a catalyst affect ….a potential energy diagram? …the reaction rate?

lowers the activation energy ("provides alternate pathway") ↑ increases rate (speeds up reaction)

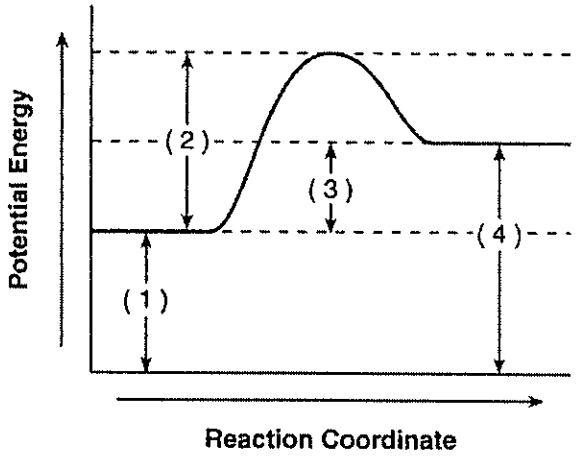
Regents Questions:

1.) For a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is equal to the

(1) heat of fusion
(2) heat of reaction
(3) activation energy of the forward reaction
(4) activation energy of the reverse reaction

Base your answers to questions #2 – 4 on the information below.

The potential energy diagram and balanced equation shown below represent a reaction between solid carbon and hydrogen gas to produce 1 mole of $C_2H_4(g)$ at 101.3 kPa and 298 K.



$2C(s) + 2H_2(g) + 52.4\ kJ \rightarrow C_2H_4(g)$

2.) State what interval 2 represents.

activation energy

3.) State what interval 3 represents.

heat of reaction

4.) Determine the net amount of energy absorbed when 2.00 moles of $C_2H_4(g)$ are produced.

104.8 kJ

5.) According to Table I, which equation represents a change resulting in the greatest quantity of energy released?

(1) $2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$ -84
(2) $2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$ +52.4
(3) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ -91.8
(4) $N_2(g) + O_2(g) \rightarrow 2NO(g)$ +182.6

6.) At 101.3 kPa and 298 K, a 1.0-mole sample of which compound absorbs the greatest amount of heat as the entire sample dissolves in water?

(1) LiBr -48.8
(2) NaOH -44.5
(3) NaCl +3.88
(4) NH4Cl +14.78

7.) Which balanced equation represents an endothermic reaction?

(1) $N_2(g) + O_2(g) \rightarrow 2NO(g)$ +182.6
(2) $C(s) + O_2(g) \rightarrow CO_2(g)$ -393.5
(3) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ -91.8
(4) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ -890.4

8.) At 101.3 kPa and 298K, which salt releases energy as it dissolves?

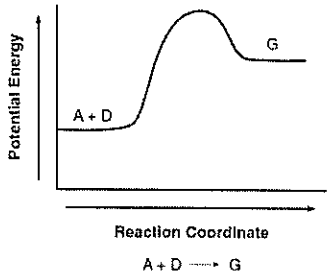
(1) NaCl +3.88
(2) NH_4NO_3 +25.69
(3) KNO_3 +34.89
(4) LiBr -48.83

9.) At 101.3 kPa and 298 K, which change occurs when pellets of solid NaOH are added to water and stirred?

(1) The water temperature decreases as heat energy is stored as chemical energy.
(2) The water temperature increases as heat energy is stored as chemical energy.
(3) The water temperature decreases as chemical energy is converted to heat energy.
(4) The water temperature increases as chemical energy is converted to heat energy.

ΔH = -44.51

10.) Given the potential energy diagram and equation representing the reaction between substances A and D:



According to Table I, substance G could be

(1) HI(g) +53
(2) $H_2O(g)$ -483.6
(3) $CO_2(g)$ -393.5
(4) $C_2H_6(g)$ -84

Name: KEY

Properties, Polarity, and IMF Station

1.) Which of these formulas contains the most polar bond?

3

(1) H–Br
(2) H–Cl
(3) H–F
(4) H–I

2.) The bonds between hydrogen and oxygen in a water molecule are classified as

1

(1) polar covalent
(2) nonpolar covalent
(3) ionic
(4) metallic

3.) Hexane (C_6H_{14}) and water do *not* form a solution. Which statement explains this phenomenon?

3

(1) Hexane is polar and water is nonpolar.
(2) Hexane is ionic and water is polar.
(3) Hexane is nonpolar and water is polar.
(4) Hexane is nonpolar and water is ionic.

4.) Which molecule is nonpolar?

4

(1) H_2O
(2) NH_3
(3) CO
(4) CO_2

5.) As a result of the gold foil experiment, it was concluded that an atom

2

(1) contains protons, neutrons, and electrons
(2) contains a small, dense nucleus
(3) has positrons and orbitals
(4) is a hard, indivisible sphere

6.) Which atom in the ground state has an outermost electron with the most energy?

1

(1) Cs
(2) K
(3) Li
(4) Na

7.) Which pair represents two forms of an element in the same phase at STP but with different structures and different properties?

2

(1) $I_2(s)$ and $I_2(g)$
(2) $O_2(g)$ and $O_3(g)$
(3) $H_2(g)$ and $Hg(g)$
(4) $H_2O(s)$ and $H_2O(\ell)$

8.) Which sample of CO_2 has a definite shape and a definite volume?

4

(1) $CO_2(aq)$
(2) $CO_2(g)$
(3) $CO_2(\ell)$
(4) $CO_2(s)$

9.) What occurs in order to break the bond in a Cl_2 molecule?

1

(1) Energy is absorbed.
(2) Energy is released.
(3) The molecule creates energy.
(4) The molecule destroys energy.

10.) Which statement describes a chemical change?

4

(1) Alcohol evaporates.
(2) Water vapor forms snowflakes.
(3) Table salt (NaCl) is crushed into powder.
(4) Glucose ($C_6H_{12}O_6$) and oxygen produce CO_2 and H_2O.

11.) At standard pressure, CH_4 boils at 112 K and H_2O boils at 373 K. What accounts for the higher boiling point of H_2O at standard pressure?

3

(1) covalent bonding
(2) ionic bonding
(3) hydrogen bonding
(4) metallic bonding

12.) A mixture of sand and table salt can be separated by filtration because the substances in the mixture differ in

4

(1) boiling point
(2) density at STP
(3) freezing point
(4) solubility in water

13.) Which sample of matter is classified as a substance?

2 (1) air (3) milk
(2) ammonia (4) seawater

14.) A solution consists of 0.50 mole of $CaCl_2$ dissolved in 100. grams of H_2O at 25°C. Compared to the boiling point and freezing point of 100. grams of H_2O at standard pressure, the solution at standard pressure has

(1) a lower boiling point and a lower freezing point
3 (2) a lower boiling point and a higher freezing point
(3) a higher boiling point and a lower freezing point
(4) a higher boiling point and a higher freezing point

15.) Which element is a liquid at 305 K and 1.0 atmosphere?

3 (1) magnesium (3) gallium
(2) fluorine (4) iodine

16.) At STP, which physical property of aluminum always remains the same from sample to sample?

2 (1) mass (3) length
(2) density (4) volume

17.) Which sample of matter sublimes at room temperature and standard pressure? S→g

3 (1) $Br_2(\ell)$ (3) $CO_2(s)$
(2) $Cl_2(g)$ (4) $SO_2(aq)$

18.) At 50.°C and standard pressure, intermolecular forces of attraction are strongest in a sample of

1 (1) ethanoic acid (3) propanone
(2) ethanol (4) water

19.) Which statement explains why neon is a Group 18 element?

3 (1) Neon is a gas at STP. (3) Neon atoms have a stable valence electron configuration.
(2) Neon has a low melting point. (4) Neon atoms have two electrons in the first shell.

20.) Which element has chemical properties that are most similar to the chemical properties of fluorine?

2 (1) boron (3) neon
(2) chlorine (4) oxygen

21.) A solid element that is malleable, a good conductor of electricity, and reacts with oxygen is classified as a

1 (1) metal (3) noble gas
(2) metalloid (4) nonmetal

22.) The phase of a sample of a molecular substance at STP is *not* determined by its

3 (1) arrangement of molecules (3) number of molecules
(2) intermolecular forces (4) molecular structure

23.) Which substance in the table below has the strongest intermolecular forces?

Substance	Molar Mass (g/mol)	Boiling Point (kelvins)
HF	20.01	293
HCl	36.46	188
HBr	80.91	207
HI	127.91	237

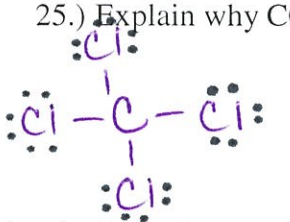
1 (1) HF (3) HBr
(2) HCl (4) HI

2.2 3.2

24.) Explain, in terms of electronegativity difference, why the bond in H–Cl is more polar than the bond in H–I.

2.2 2.7 There is a greater difference in electronegativity between H & Cl than H & I.

25.) Explain why CCl_4 is classified as a nonpolar molecule.



CCl_4 has all electrons distributed symmetrically within the molecule.

A scientist makes a solution that contains 44.0 grams of hydrogen chloride gas, HCl(g), in 200. grams of water, $H_2O(\ell)$, at 20.°C. This process is represented by the balanced equation below.

$$HCl(g) \xrightarrow{H_2O} H^+(aq) + Cl^-(aq)$$

26.) Explain, in terms of the distribution of particles, why the solution is a homogeneous mixture.

This solution is a homogeneous mixture because particles are distributed symmetrically.

Regents Chemistry: Electrochemistry/Redox Review **Name** ***KEY***

1 1.) Which statement is true for any electrochemical cell?
(1) Oxidation occurs at the anode, only.
(2) Reduction occurs at the anode, only.
(3) Oxidation occurs at both the anode and the cathode.
(4) Reduction occurs at both the anode and the cathode.

2 2.) Given the equation: $2\ Al + 3\ Cu^{2+} \rightarrow 2\ Al^{3+} + 3\ Cu$
The reduction half-reaction is
(1) $Al \rightarrow Al^{3+} + 3e^-$
(2) $Cu^{2+} + 2e^- \rightarrow Cu$
(3) $Al + 3e^- \rightarrow Al^{3+}$
(4) $Cu^{2+} \rightarrow Cu + 2e^-$

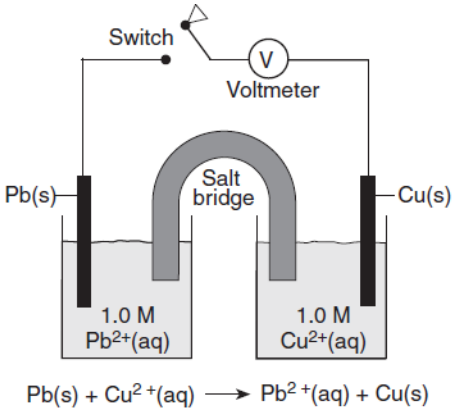
2 3.) Which type of reaction occurs when nonmetal atoms become negative nonmetal ions?
(1) oxidation (2) reduction (3) substitution (4) condensation

4 4.) In which compound does chlorine have the highest oxidation number?
(1) NaClO (2) $NaClO_2$ (3) $NaClO_3$ (4) $NaClO_4$

1 5.) A diagram of a chemical cell and an equation are shown to the right.

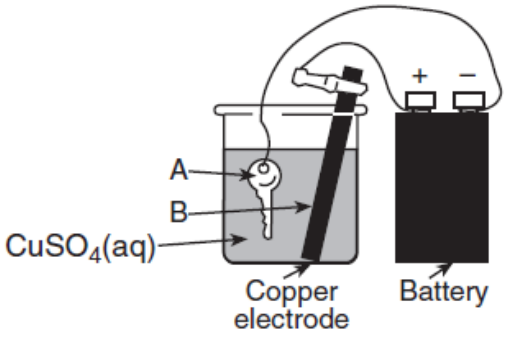
When the switch is closed, electrons will flow from

(1) the Pb(s) to the Cu(s)
(2) the Cu(s) to the Pb(s)
(3) the $Pb^{2+}(aq)$ to the Pb(s)
(4) the $Cu^{2+}(aq)$ to the Cu(s)



4 6.) What is the purpose of the salt bridge in a voltaic cell?
(1) It blocks the flow of electrons.
(2) It blocks the flow of positive and negative ions.
(3) It is a path for the flow of electrons.
(4) It is a path for the flow of positive and negative ions.

2 7.) The diagram to the right shows a key being plated with copper in an electrolytic cell.
Given the reduction reaction for this cell:
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
This reduction occurs at
(1) *A,* which is the anode
(2) *A,* which is the cathode
(3) *B,* which is the anode
(4) *B,* which is the cathode



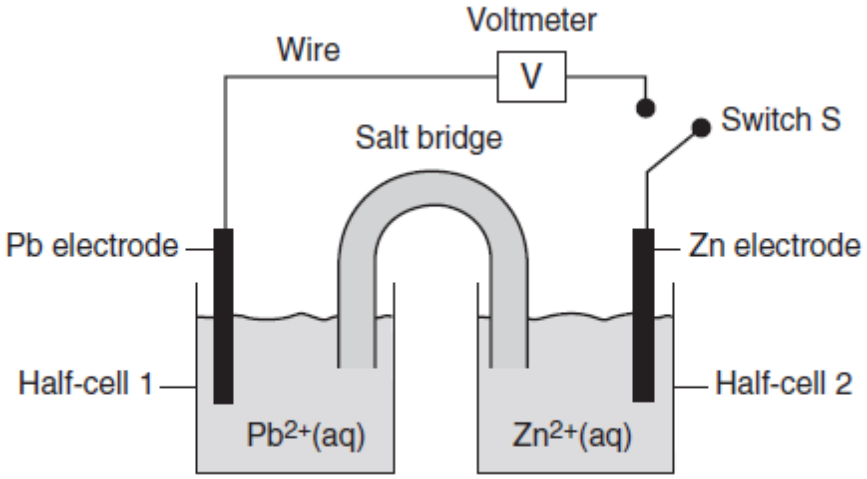
2 8.) A voltaic cell spontaneously converts
(1) electrical energy to chemical energy
(2) chemical energy to electrical energy
(3) electrical energy to nuclear energy
(4) nuclear energy to electrical energy

2 9.) Given the reaction for the corrosion of aluminum: $4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$
Which half-reaction correctly represents the oxidation that occurs?
(1) $Al + 3e^- \rightarrow Al^{3+}$
(2) $Al \rightarrow Al^{3+} + 3e^-$
(3) $O_2 + 4e^- \rightarrow 2\ O^{2-}$
(4) $O_2 \rightarrow 2\ O^{2-} + 4e^-$

___1___ 10.) Which change in oxidation number indicates oxidation?
(1) –1 to +2 (2) –1 to –2 (3) +2 to –3 (4) +3 to +2

11.) State one difference between voltaic cells and electrolytic cells. Include information about *both* types of cells in your answer. [1]
Allow 1 credit for a correct response. Students must discuss both voltaic and electrolytic cells. Acceptable responses include, but are not limited to, these examples:
- ***Voltaic cells produce energy; electrolytic cells consume energy.***
- ***voltaic changes chemical to electrical, electrolytic opposite***
- ***Voltaic cells involve spontaneous redox reactions; electrolytic cells involve nonspontaneous redox reactions.***
- ***voltaic spontaneous/electrolytic not***

Base your answers to questions 12 through 14 on the diagram below, which represents a voltaic cell at 298 K and 1 atm.



$Pb^{2+}(aq) + Zn \rightarrow Pb + Zn^{2+}(aq)$

12.) In which half-cell will oxidation occur when switch *S* is closed? [1] ***Half-cell 2***

13.) Write the balanced half-reaction equation that will occur in half-cell 1 when switch *S* is closed. [1]

$Pb^{2+} + 2\ e^- \rightarrow Pb$

14.) Describe the direction of electron flow between the electrodes when switch *S* is closed. [1]

From the Zn electrode, through the wire, to the Pb electrode (from the anode to the cathode)

Base your answers to questions 15 and 16 on the unbalanced redox reaction below.

$$Cu(s) + AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + Ag(s)$$

15.) Write the oxidation half-reaction. [1]

$Cu \rightarrow Cu^{2+} + 2\ e^-$

16.) Balance the redox equation below, using the smallest whole-number coefficients. [1]

_____ $Cu(s)$ + ___*2*___ $AgNO_3(aq) \rightarrow$ _____ $Cu(NO_3)_2(aq)$ + ___*2*___ $Ag(s)$

Name: KEY

Calculations- Equations Table T

1. Which kelvin temperature is equivalent to –24°C?

→ Which equation do you need to use? $K = {}^{\circ}C + 273$

3 (1) 226 K (2) 273 K (3) 249 K (4) 297 K

2. If 0.025 gram of $Pb(NO_3)_2$ is dissolved in 100. grams of H_2O, what is the concentration of the resulting solution, in parts per million?

→ Which equation do you need to use? $ppm = \frac{\text{mass solute}}{\text{mass solution}} \times 1{,}000{,}000$

(1) 2.5×10^{-4} ppm (2) 2.5 ppm (3) 250 ppm (4) 4.0×10^{3} ppm

3

$$ppm = \frac{0.025\,g}{100\,g} \times 1{,}000{,}000$$

3. Based on data collected during a laboratory investigation, a student determined an experimental value of 322 joules per gram for the heat of fusion of H_2O. Calculate the student's percent error. Your response must include a correct numerical setup and the calculated result.

→ Which equation do you need to use? $\%\ error = \frac{mv - av}{av} \times 100$

$$\%\ error = \frac{322\ J/g - 334\ J/g}{334\ J/g} \times 100$$

← Table B!

-3.59 %

4. In a titration, a few drops of an indicator are added to a flask containing 35.0 milliliters of $HNO_3(aq)$ of unknown concentration. After 30.0 milliliters of 0.15 M NaOH(aq) solution is slowly added to the flask, the indicator changes color, showing the acid is neutralized.

a) The volume of the NaOH(aq) solution is expressed to what number of significant figures? 2

b) Show a numerical setup below for calculating the concentration of the $HNO_3(aq)$ solution.

→ Which equation do you need to use? $M_A V_A = M_B V_B$

$$M_A V_A = M_B V_B$$

$$X \cdot 35.0\,mL = 0.15\,M \times 30.0\,mL$$

$$X = \boxed{0.13\,M}$$

5. A student prepared two mixtures, each in a labeled beaker. Enough water at 20.°C was used to make 100 milliliters of each mixture.

Information about Two Mixtures at 20.°C

	Mixture 1	Mixture 2
Composition	NaCl in H_2O	Fe filings in H_2O
Student Observations	• colorless liquid • no visible solid on bottom of beaker	• colorless liquid • black solid on bottom of beaker
Other Data	• mass of NaCl(s) dissolved = 2.9 g	• mass of Fe(s) = 15.9 g • density of Fe(s) = 7.87 g/cm^3

Determine the volume of the Fe filings used to produce mixture 2.

→ Which equation do you need to use? $D = \frac{m}{V}$

$$\frac{7.87\ g/cm^3}{1} = \frac{15.9\ g}{x}$$

2.02 cm^3

6. One sample of a green vegetable contains 0.0035 gram of boron. Determine the total number of moles of boron in this sample.

→ Which equation do you need to use? $\#moles = \frac{given\ mass}{GFM}$

$$x = \frac{0.0035\ g}{10.81\ g/mol}$$

0.00032 moles

7. A 2.50-liter aqueous solution contains 1.25 moles of dissolved sodium chloride. The dissolving of NaCl(s) in water is represented by the equation below.

$$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$$

a) Determine the molarity of this solution.

→ Which equation do you need to use? $Molarity = \frac{moles\ solute}{L\ solution}$

$$M = \frac{1.25\ mol}{2.50\ L}$$

0.500 M

8. Gypsum is a mineral that is used in the construction industry to make drywall (sheetrock). The chemical formula for this hydrated compound is $CaSO_4 \cdot 2\ H_2O$. A hydrated compound contains water molecules within its crystalline structure. Gypsum contains 2 moles of water for each 1 mole of calcium sulfate.

a) What is the gram formula mass of $CaSO_4 \cdot 2\ H_2O$?

Ca : 40.08 x 1 = 40.08
S : 32.065 x 1 = 32.065
O : 16 x 4 = + 64
136.145

H : 1.00794 x 4 = 4.03
O : 16 x 2 = + 32
36.03

136.145
+ 36.03
172.18 g/mol

b) In the space provided, show a correct numerical setup and calculate the percent composition by mass of water in this compound.

→ Which equation do you need to use? $\%\ comp = \frac{mass\ part}{mass\ whole} \times 100$

$\%\ comp = \frac{36.039}{172.18g} \times 100$

20.93 %

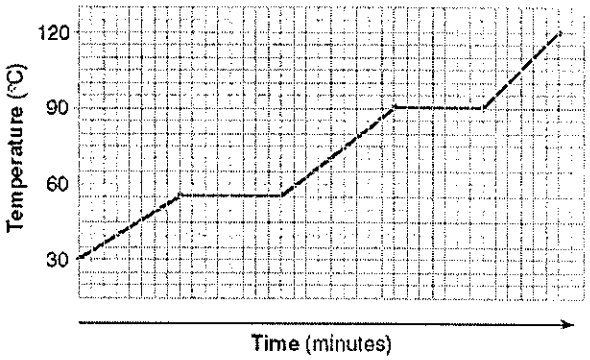
Regents Chemistry: Temperature, Heat, & Heating/Cooling Curves **Name:** KEY

1.) The temperature of a sample of matter is a measure of the
(1) average potential energy of the particles of the sample
(2) average kinetic energy of the particles of the sample
(3) total nuclear energy of the sample
(4) total thermal energy of the sample

2.) Which sample of ethanol has particles with the highest average kinetic energy?
(1) 10.0 mL of ethanol at 25°C
(2) 10.0 mL of ethanol at 55°C
(3) 100.0 mL of ethanol at 35°C
(4) 100.0 mL of ethanol at 45°C

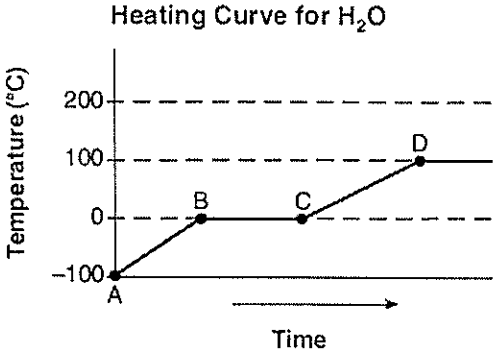
3.) The graph below represents the heating curve of a substance that starts as a solid below its freezing point.

What is the melting point of this substance?
(1) 30°C
(2) 55°C
(3) 90°C
(4) 120°C

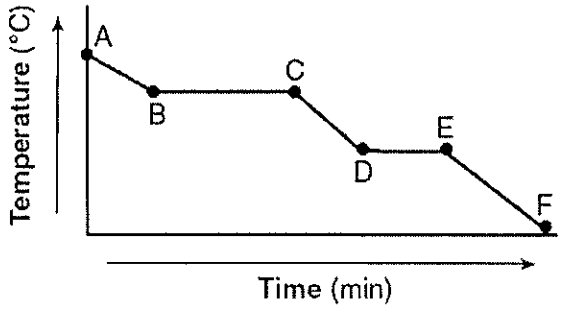


4.) The graph represents the relationship between temperature and time as heat is added to a sample of H_2O.

Which statement correctly describes the energy of the particles of the sample during interval *BC*?
(1) Potential energy decreases and average kinetic energy increases.
(2) Potential energy increases and average kinetic energy increases.
(3) Potential energy increases and average kinetic energy remains the same.
(4) Potential energy remains the same and average kinetic energy increases.



5.) Given the cooling curve of a substance:



During which intervals is potential energy decreasing and average kinetic energy remaining constant?
(1) *AB* and *BC*
(2) *AB* and *CD*
(3) *DE* and *BC*
(4) *DE* and *EF*

6.) What is the amount of heat energy released when 50.0 grams of water is cooled from 20.0°C to 10.0°C?
(1) 5.00×10^2 J
(2) 2.09×10^3 J
(3) 1.67×10^5 J
(4) 1.13×10^6 J

→ -q!

$q = mC\Delta T = (50)(4.18)(10-20)$
$= -2090$ J

7.) A 36-gram sample of water has an initial temperature of 22°C. After the sample absorbs 1200 joules of heat energy, the final temperature of the sample is

(1) 8.0°C (2) 14°C (3) 30.°C (4) 55°C

gets warmer!

$q = mC\Delta T$

$1200 = (36)(4.18)(x-22)$

$7.97 = x - 22$

$x = 29.97°C$

8.) What is the total amount of heat required to vaporize 1.00 gram of $H_2O(\ell)$ at 100.°C and 1 atmosphere?

(1) 4.18 J (2) 334 J (3) 373 J (4) 2260 J

$q = mH_v$

$= (1g)(2260 J/g)$

9.) What is the minimum amount of heat required to completely melt 20.0 grams of ice at its melting point?

(1) 20.0 J (2) 83.6 J (3) 6680 J (4) 45 200 J

$q = mH_f = (20)(334)$

10.) At standard pressure, the total amount of heat required to completely vaporize a 100.-gram sample of water at its boiling point is

(1) 2.26×10 J (2) 2.26×10^2 J (3) 2.26×10^3 J (4) 2.26×10^5 J

$q = mH_v = (100)(2260) = 226{,}000$ J

Base your answers to questions 11 through 13 on the information below.

Heat is added to a 200.-gram sample of $H_2O(s)$ to melt the sample at 0°C. Then the resulting $H_2O(\ell)$ is heated to a final temperature of 65°C.

11.) Determine the total amount of heat required to completely melt the sample.

$q = mH_f$

$= (200)(334)$

66,800 J

12.) Show a numerical setup for calculating the total amount of heat required to raise the temperature of the $H_2O(\ell)$ from 0°C to its final temperature.

$q = mC\Delta T$

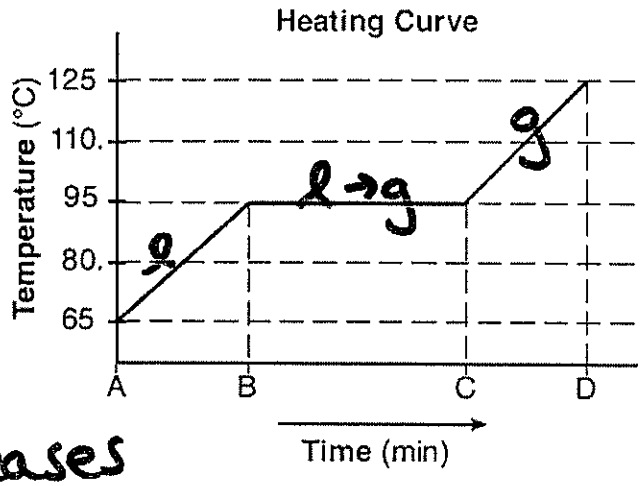
$= (200)(4.18)(65-0)$

13.) Compare the amount of heat required to vaporize a 200.-gram sample of $H_2O(\ell)$ at its boiling point to the amount of heat required to melt a 200.-gram sample of $H_2O(s)$ at its melting point.

The heat required to vaporize (2260 J/g) is greater than the heat required to melt (334 J/g).

Base your answers to questions 14 and 15 on the information below and on your knowledge of chemistry.

A sample of a substance is a liquid at 65°C. The sample is heated uniformly to 125°C.
The heating curve for the sample at standard pressure is shown to the right.



14.) Determine the boiling point of the sample at standard pressure.

95 °C

15.) State what happens to the potential energy of the particles of the sample during time interval BC.

potential energy increases

Base your answers to questions 16 through 18 on the information below.

A student investigated heat transfer using a bottle of water. The student placed the bottle in a room at 20.5°C. The student measured the temperature of the water in the bottle at 7 a.m. and again at 3 p.m. The data from the investigation are shown in the table to the right.

Water Bottle Investigation Data

7 a.m.		3 p.m.	
Mass of Water (g)	Temperature (°C)	Mass of Water (g)	Temperature (°C)
800.	12.5	800.	20.5

16.) Compare the average kinetic energy of the water molecules in the bottle at 7 a.m. to the average kinetic energy of the water molecules in the bottle at 3 p.m.

12.5°C 20.5°C
The ave. KE at 3pm is greater than at 7 am

17.) State the direction of heat transfer between the surroundings and the water in the bottle from 7 a.m. to 3 p.m.

Heat flows from the surroundings to the water in the bottle.

18.) Show a numerical setup for calculating the change in the thermal energy of the water in the bottle from 7 a.m. to 3 p.m.

heat!
$q = mC\Delta T$
$= (800)(4.18)(20.5 - 12.5)$

Base your answers to questions 19 and 20 on the information below.

The boiling point of a liquid is the temperature at which the vapor pressure of the liquid is equal to the pressure on the surface of the liquid. The heat of vaporization of ethanol is 838 joules per gram. A sample of ethanol has a mass of 65.0 grams and is boiling at 1.00 atmosphere.

19.) Based on Table *H*, what is the temperature of this sample of ethanol?

1 atm = 101.3 kPa

~78-79 °C (accept 78-80)

20.) Calculate the minimum amount of heat required to completely vaporize this sample of ethanol. Your response must include *both* a correct numerical setup and the calculated result.

$q = mH_v$
$= (65)(838) =$

54,470 J

Name: KEY

Vocabulary Review Station

1.) Which term represents the attraction one atom has for the electrons in a bond with another atom?
(1) electronegativity
(2) electrical conductivity
(3) first ionization energy
(4) mechanical energy

2.) The coefficients in a balanced chemical equation represent
(1) the mass ratios of the substances in the reaction
(2) the mole ratios of the substances in the reaction
(3) the total number of electrons in the reaction
(4) the total number of elements in the reaction

3.) Which type of formula represents the simplest whole-number ratio of atoms of the elements in a compound?
(1) molecular formula
(2) condensed formula
(3) empirical formula
(4) structural formula

4.) In the wave-mechanical model of the atom, an orbital is defined as
(1) a region of the most probable proton location
(2) a region of the most probable electron location
(3) a circular path traveled by a proton around the nucleus
(4) a circular path traveled by an electron around the nucleus

5.) The atomic mass of magnesium is the weighted average of the atomic masses of
(1) all of the artificially produced isotopes of Mg
(2) all of the naturally occurring isotopes of Mg
(3) the two most abundant artificially produced isotopes of Mg
(4) the two most abundant naturally occurring isotopes of Mg

6.) Which element has atoms with the strongest attraction for electrons in a chemical bond?
(1) chlorine
(2) nitrogen
(3) fluorine
(4) oxygen

greatest electronegativity!

7.) Which statement describes a reversible reaction at equilibrium?
(1) The activation energy of the forward reaction must equal the activation energy of the reverse reaction.
(2) The rate of the forward reaction must equal the rate of the reverse reaction.
(3) The concentration of the reactants must equal the concentration of the products.
(4) The potential energy of the reactants must equal the potential energy of the products.

8.) Which substance can *not* be broken down by a chemical change?
(1) ammonia
(2) ethanol
(3) propanal
(4) zirconium

9.) Which term is defined as the difference between the potential energy of the products and the potential energy of the reactants in a chemical reaction?
(1) activation energy
(2) thermal energy
(3) heat of fusion
(4) heat of reaction

10.) Which statement describes one acid-base theory?
(1) An acid is an H^+ acceptor, and a base is an H^+ donor.
(2) An acid is an H^+ donor, and a base is an H^+ acceptor.
(3) An acid is an H^- acceptor, and a base is an H^- donor.
(4) An acid is an H^- donor, and a base is an H^- acceptor.

11.) Which notations represent different isotopes of the element sodium?
(1) ^{32}S and ^{34}S
(2) S^{2-} and S^{6+}
(3) Na^{+} and Na^{0}
(4) ^{22}Na and ^{23}Na

12.) What can be explained by the Arrhenius theory?
(1) the behavior of many acids and bases
(2) the effect of stress on a phase equilibrium
(3) the operation of an electrochemical cell
(4) the spontaneous decay of some nuclei

13.) Any substance composed of two or more elements that are chemically combined in a fixed proportion is
(1) an isomer
(2) an isotope
(3) a solution
(4) a compound

14.) All atoms of uranium have the same
(1) mass number
(2) atomic number
(3) number of neutrons plus protons
(4) number of neutrons plus electrons

15.) Hydrocarbons are composed of the elements
(1) carbon and hydrogen, only
(2) carbon and oxygen, only
(3) carbon, hydrogen, and oxygen
(4) carbon, nitrogen, and oxygen

16.) Which compounds are classified as electrolytes?
(1) KNO_3 and H_2SO_4
(2) KNO_3 and CH_3OH
(3) CH_3OCH_3 and H_2SO_4
(4) CH_3OCH_3 and CH_3OH

17.) The isomers butane and methylpropane have
(1) the same molecular formula and the same properties
(2) the same molecular formula and different properties
(3) different molecular formulas and the same properties
(4) different molecular formulas and different properties

18.) The laboratory process in which the volume of a solution of known concentration is used to determine the concentration of another solution is called
(1) distillation
(2) fermentation
(3) titration
(4) transmutation

19.) All elements on the modern Periodic Table are arranged in order of increasing
(1) atomic mass
(2) molar mass
(3) number of neutrons per atom
(4) number of protons per atom

20.) The temperature of a sample of matter is a measure of the
(1) average potential energy of the particles of the sample
(2) average kinetic energy of the particles of the sample
(3) total nuclear energy of the sample
(4) total thermal energy of the sample

21.) Samples of four Group 15 elements, antimony, arsenic, bismuth, and phosphorus, are in the gaseous phase. An atom in the ground state of which element requires the *least* amount of energy to remove its most loosely held electron?
(1) As
(2) Bi
(3) P
(4) Sb

↑ lowest first ionization energy!