SOLUTIONS

* IMPORTANT REF. TABLES
  - ↳ Table F
  - ↳ Table G
  - ↳ Table T

* Solutions (compared to pure solvent) have:

  higher boiling points

  & lower freezing points

which solution will have the highest BP?

0.1 M NaCl
$\downarrow H_2O$
$Na^+ + Cl^-$

0.1 M $MgCl_2$
$\downarrow H_2O$
$Mg^{2+} + Cl^- + Cl^-$

* the more ions, the greater the effect

1. According to Table *F*, which ions combine with chloride ions to form an insoluble compound?

A) Fe^{2+} ion B) Ca^{2+} ions
C) Li^{+} ions D) Ag^{+} ions

2. Which compound is insoluble in water?

A) calcium bromide B) potassium bromide
C) silver bromide D) sodium bromide

3. Which barium salt is *insoluble* in water?

A) $BaCO_3$ B) $BaCl_2$
C) $Ba(ClO_4)_2$ D) $Ba(NO_3)_2$

4. Which compound is insoluble in water?

A) $BaSO_4$ B) $CaCrO_4$
C) $KClO_3$ D) Na_2S

5. Which ion, when combined with chloride ions, Cl^-, forms an insoluble substance in water?

A) Fe^{2+} B) Mg^{2+} C) Pb^{2+} D) Zn^{2+}

6. According to Reference Table *G*, how many grams of KNO_3 would be needed to saturate 200 grams of water at 70°C?

A) 43 g B) 86 g C) 134 g D) 268 g

134g → 100g H_2O x 2
x2 → 268 → 200g H_2O

7. An unsaturated aqueous solution of NH_3 is at 90°C in 100. grams of water. According to Reference Table *G*, how many grams of NH_3 could this unsaturated solution contain? < 10g

A) 5 g B) 10. g C) 15 g D) 20. g

8. According to your Reference Tables, which substance forms an unsaturated solution when 80 grams of the substance is dissolved in 100 grams of H_2O at 10°C?

A) KI B) KNO_3 supersaturated
C) $NaNO_3$ -saturated D) NaCl Supersaturated

9. At standard pressure, which substance becomes *less* soluble in water as temperature increases from 10.°C to 80.°C? Table G

A) HCl B) KCl
C) NaCl D) NH_4Cl

10. The solubility of KCl(s) in water depends on the

A) pressure on the solution
B) rate of stirring
C) size of the KCl sample
D) temperature of the water

11. What is the total mass of KNO_3 that must be dissolved in 50. grams of H_2O at 60.°C to make a saturated solution?

A) 32 g B) 53 g C) 64 g D) 106 g

x2 (105 → 100 / — → 50)

12. What is the mass of NH_4Cl that must dissolve in 200. grams of water at 50.°C to make a saturated solution?

A) 26 g B) 42 g
C) 84 g D) 104 g

x2 (52g - 100g) x2
104 - 200g

13. A 2400.-gram sample of an aqueous solution contains 0.012 gram of NH_3. What is the concentration of NH_3 in the solution, expressed as parts per million?

A) 5.0 ppm B) 15 ppm
C) 20. ppm D) 50. ppm

$ppm = \frac{0.012}{2400} \times 1000000$

14. Which sample, when dissolved in 1.0 liter of water, produces a solution with the highest boiling point?

A) 0.1 mole KI B) 0.2 mole KI
C) 0.1 mole $MgCl_2$ D) 0.2 mole $MgCl_2$

15. 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

A) a lower boiling point and a lower freezing point
B) a lower boiling point and a higher freezing point
C) a higher boiling point and a lower freezing point
D) a higher boiling point and a higher freezing point

16. Base your answer to the following question on the information below and on your knowledge of chemistry.

Seawater contains dissolved salts in the form of ions. Some of the ions found in seawater are Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, Cl^{-}, HCO_3^{-}, and SO_4^{2-}.

An investigation was conducted to determine the concentration of dissolved salts in seawater at one location. A 300.-gram sample of the seawater was placed in an open container. After a week, all the water had evaporated and 10. grams of solid salts remained in the container.

At standard pressure, compare the freezing point of seawater to the freezing point of distilled water.

Freezing pt of seawater is lower than freezing pt of distilled water.

KINETICS / EQUILIBRIUM

↳ "EQUAL exchange, CONSTANT concentration"

How to increase speed of reaction?

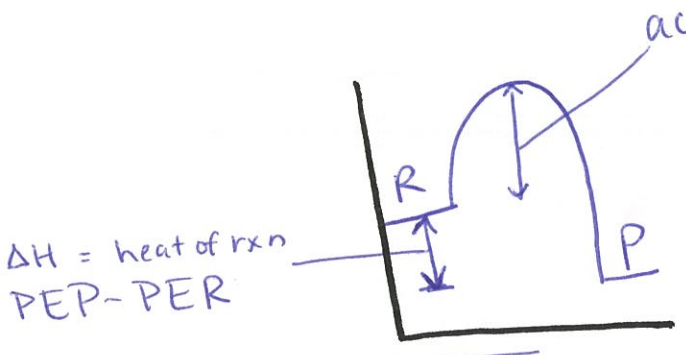
* more effective collisions!
  - ↑ temp
  - ↑ concentration
  - ↑ surface area (powder)
  - add a catalyst (lowers activation energy)

* the rate of forward reaction is EQUAL to the rate of the reverse reaction
* concentrations of products & reactants remain constant

PE Diagrams & Table I

↳ $CH_4(g) + 2\,O_2(g) \longrightarrow CO_2(g) + 2H_2O(l) +$ energy

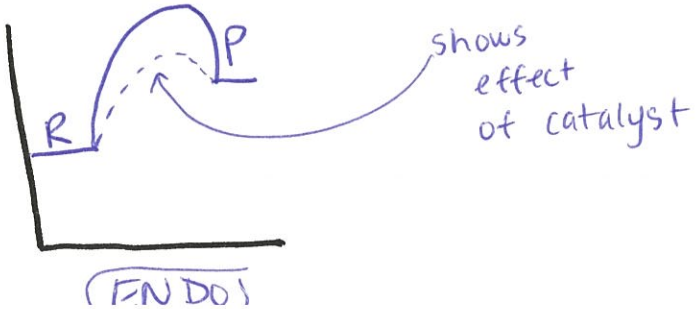
$-\Delta H$ exothermic



if you add a catalyst, this gets lowered

$+\Delta H$ endothermic

→ energy + $N_2(g) + O_2(g) \longrightarrow 2\,NO(g)$



1. The collision theory states that a reaction is most likely to occur when the reactant particles collide with the proper

A) formula masses
B) molecular masses
C) density and volume
D) energy and orientation

2. What is required for a chemical reaction to occur?

A) standard temperature and pressure
B) a catalyst added to the reaction system
C) effective collisions between reactant particles
D) an equal number of moles of reactants and products

3. Which statement explains why increasing the temperature increases the rate of a chemical reaction, while other conditions remain the same?

A) The reacting particles have less energy and collide less frequently.
B) The reacting particles have less energy and collide more frequently.
C) The reacting particles have more energy and collide less frequently.
D) The reacting particles have more energy and collide more frequently.

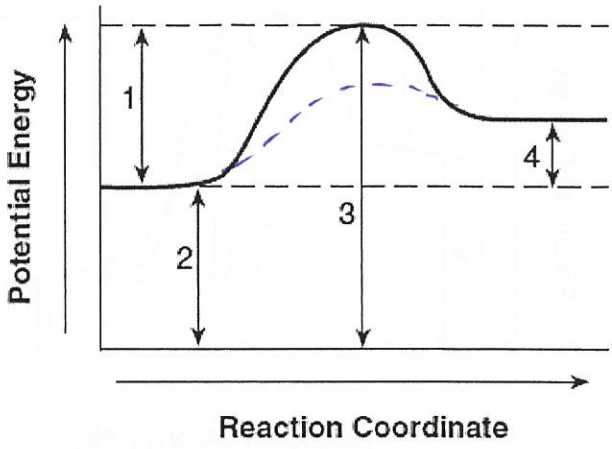
4. A 5.0-gram sample of Fe(s) is to be placed in 100 milliliters of HCl(aq). Which changes will result in the fastest rate of reaction?

A) increasing the surface area of Fe(s) and increasing the concentration of HCl(aq)
B) increasing the surface area of Fe(s) and decreasing the concentration of HCl(aq)
C) decreasing the surface area of Fe(s) and increasing the concentration of HCl(aq)
D) decreasing the surface area of Fe(s) and decreasing the concentration of HCl(aq)

5. In a chemical reaction, a catalyst provides an alternate reaction pathway that

A) decreases the concentration of the products
B) increases the concentration of the reactants
C) has a lower activation energy
D) has a higher activation energy

6. Given the potential energy diagram for a reaction:



Which intervals are affected by the addition of a catalyst?

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

7. Which compound is formed from its elements by an exothermic reaction at 298 K and 101.3 kPa?

A) $C_2H_4(g)$
B) $HI(g)$
C) $H_2O(g)$
D) $NO_2(g)$

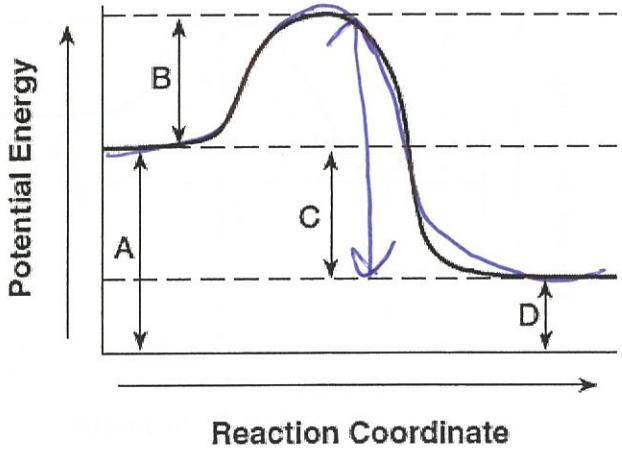
8. In terms of potential energy, *PE*, which expression defines the heat of reaction for a chemical change?

A) $PE_{products} - PE_{reactants}$
B) $PE_{reactants} - PE_{products}$
C) $\frac{PE_{products}}{PE_{reactants}}$
D) $\frac{PE_{reactants}}{PE_{products}}$

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

A) $2C(s) + 3H_2(g) \rightarrow C_2H_6(g)$
B) $2C(s) + 2H_2(g) \rightarrow C_2H_4(g)$
C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
D) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

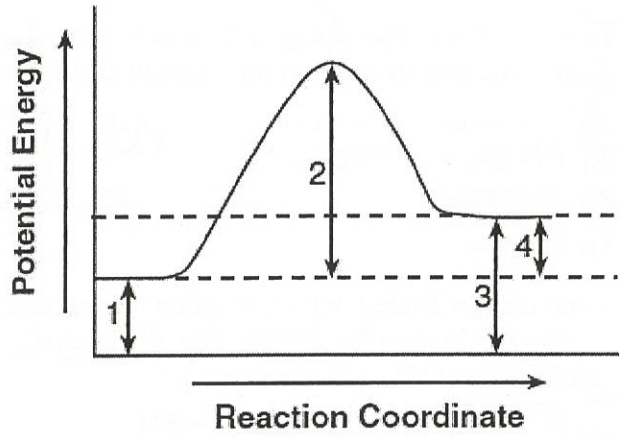
10. Given the potential energy diagram representing a reversible reaction:



The activation energy for the reverse reaction is represented by

A) $A + B$ B) $B + C$
C) $B + D$ D) $C + D$

11. Given the potential energy diagram for a chemical reaction:



Which numbered interval represents the heat of reaction?

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

12. When a reversible reaction is at equilibrium, the concentration of products and the concentration of reactants must be

A) decreasing B) increasing
C) constant D) equal

13. What occurs when a reaction reaches equilibrium?

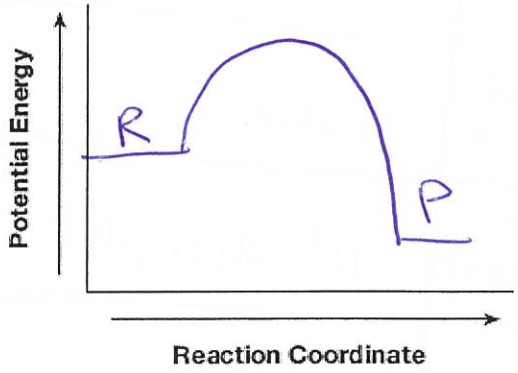
A) The concentration of the reactants increases.
B) The concentration of the products increases.
C) The rate of the forward reaction is equal to the rate of the reverse reaction.
D) The rate of the forward reaction is slower than the rate of the reverse reaction.

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

Carbon monoxide, CO(g), is a toxic gas found in automobile exhaust. The concentration of CO(g) can be decreased by using a catalyst in the reaction between CO(g) and O_2(g). This reaction is represented by the balanced equation below.

$2CO(g) + O_2 \xrightarrow{catalyst} 2CO_2(g) + \text{energy}$ exo

14. On the labeled axes below, draw the potential energy curve for the reaction represented by this equation.



15. Explain, in terms of collision theory, why an increase in temperature increases the rate of the reaction.

More effective collisions take place.

ACIDS / BASES

Here's what you gotta know:

acids	what ion is "yielded" when it is dissolved in H_2O?	bases
H^+ / H_3O^+ hydronium		OH^- hydroxide
Table K	where can I find a list in my R.T.?	Table L
H^+ donor	Is there another (alternate) definition?	H^+ acceptor
< 7	what could be a possible pH?	> 7
yes! it's an electrolyte	Does it conduct electricity when dissolved in H_2O? (electrolyte)	yes!

pH scale: acids $H^+ > OH^-$ | neutral ($OH^- = H^+$) | bases $OH^- > H^+$

0 1 2 3 4 5 6 (7) 8 9 10 11 12 13 14

* as pH increases, $[H^+]$ decreases
* a change by 1 pH equals a 10x change in $[H^+]$

Neutralization:

ACID + BASE → SALT + WATER

ex: HCl + NaOH → NaCl + H_2O

of Table: M T-titration

1. The electrical conductivity of an aqueous solution depends on the concentration of which particles in the solution?

A) molecules B) electrons
C) atoms D) ions

2. Which compound is an electrolyte?

A) H_2O B) C_2H_6
C) H_3PO_4 acid D) CH_3OH

3. Which compound is an electrolyte?

A) CCl_4 B) CH_3OH
C) $C_6H_{12}O_6$ D) $Ca(OH)_2$ base

4. Which compounds are classified as electrolytes? Table, K or L

A) KNO_3 and H_2SO_4 salt + acid
B) KNO_3 and CH_3OH
C) CH_3OCH_3 and H_2SO_4
D) CH_3OCH_3 and CH_3OH

Table F

5. Which pair of compounds represents one Arrhenius acid and one Arrhenius base?

A) CH_3OH and NaOH B) CH_3OH and HCl
C) HNO_3 and NaOH D) HNO_3 and HCl
acid base

6. Given the equation representing a reaction at equilibrium:

loses H^+

$$H_2S(aq) + CH_3NH_2(aq) \longleftrightarrow HS^-(aq) + CH_3NH_3^+(aq)$$

gains H^+

According to one acid-base theory, the forward reaction is classified as an acid-base reaction because

A) H_2S is a H^+ donor and CH_3NH_2 is a H^+ acceptor
B) CH_3NH_2 is a H^+ donor and H_2S is a H^+ acceptor
C) HS^- and $CH_3NH_3^+$ are both H^+ donors
D) $CH_3NH_3^+$ and HS^- are both H^+ acceptors

7. The reaction of an Arrhenius acid with an Arrhenius base produces water and

A) a salt B) an ester
C) an aldehyde D) a halocarbon

8. Which type of substance yields hydrogen ions, H^+, in an aqueous solution?

A) an Arrhenius acid
B) an Arrhenius base
C) a saturated hydrocarbon
D) an unsaturated hydrocarbon

9. Which change in the H^+ ion concentration of an aqueous solution represents a *decrease* of one unit on the pH scale?

A) a tenfold increase
B) a tenfold decrease
C) a hundredfold increase
D) a hundredfold decrease

$M_A V_A = M_B V_B$
$(0.6)x = (0.3)(100)$
$x = 50$

10. When the hydronium ion concentration of an aqueous solution is increased by a factor of 10, the pH value of the solution

A) decreases by 1 B) increases by 1
C) decreases by 10 D) increases by 10

11. Phenolphthalein is pink in an aqueous solution having a pH of

Table M
>9

A) 5 B) 2 C) 7 D) 12

12. What is the color of the indicator thymol blue in a solution that has a pH of 11?

A) red B) blue
C) pink D) yellow

13. One acid-base theory defines an acid as an

A) H^- acceptor B) H^- donor
C) H^+ acceptor D) H^+ donor

14. Which volume of 0.600 M H_2SO_4(aq) exactly neutralizes 100 milliliters of 0.300 M $Ba(OH)_2$(aq)?

A) 25.0 mL B) 50.0 mL
C) 100. mL D) 200. mL

15. Which solution reacts with LiOH(aq) to produce a salt and water?

base look for acid

A) KCl(aq) B) CaO(aq)
C) NaOH(aq) D) H_2SO_4(aq)

16. In a titration, 20.0 milliliters of a 0.150 M NaOH(aq) solution exactly neutralizes 24.0 milliliters of an HCl(aq) solution. What is the concentration of the HCl(aq) solution?

A) 0.125 M B) 0.180 M
C) 0.250 M D) 0.360 M

$M_A V_A = M_B V_B$

$(x)(24) = (0.15)(20)$

$x(24) = 3$

$x = 0.125$

ELECTROCHEMISTRY / REDOX

2 types of electrochemical cells

in both:
AN OX & A BIG RED CAT
↳ anode is site of oxidation
cathode is site of reduction, mass ↑
e⁻ flow from anode to cathode

reduction
* gaining electrons
* charge decreases

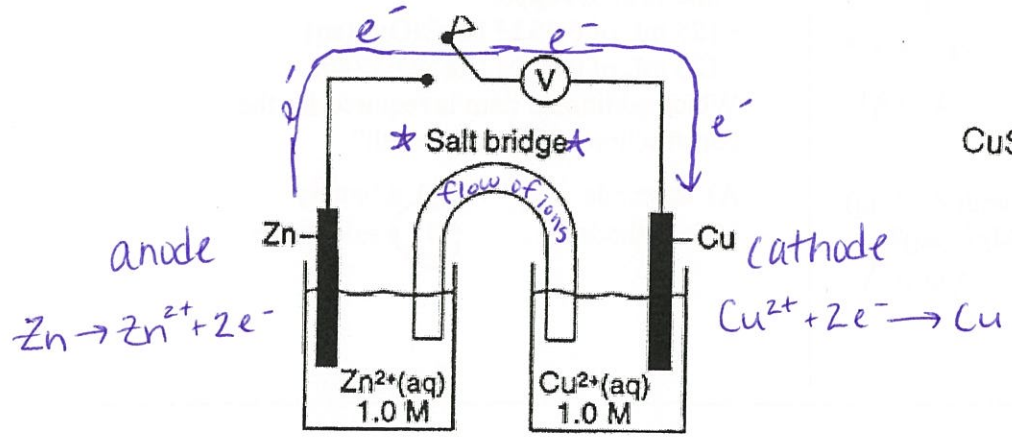
oxidation
* losing electrons
* charge increases

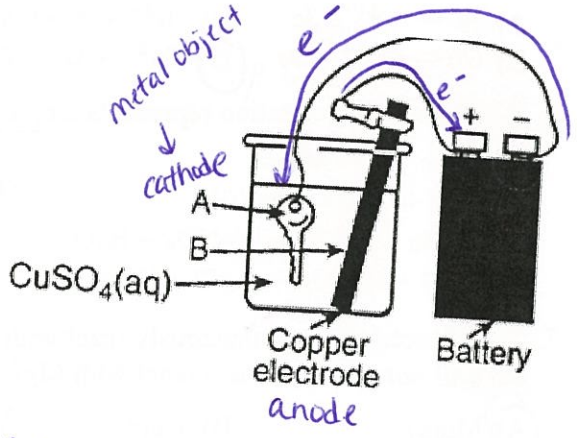
VOLTAIC

* is a battery
* Chemical → electrical energy
* Spontaneous (anode is higher on Table J)

ELECTROLYTIC

* requires a battery
* electrical to chemical energy
* non Spontaneous





Ref Table T

+1 +7 -2 -2 -2
$KMnO_4$

1. What is the oxidation number of manganese in $KMnO_4$?

A) +7 B) +2 C) +3 D) +4

2. During an oxidation-reduction reaction, the number of electrons gained is

A) equal to the number of electrons lost
B) equal to the number of protons gained
C) less than the number of electrons lost
D) less than the number of protons gained

3. Given the balanced equation representing a reaction:

$$2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$$

Which particles are transferred in this reaction?

A) electrons B) neutrons
C) positrons D) protons

4. Given the equation representing a reaction:
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$
charge ↓, gaining e⁻
Which term best describes this reaction?

A) ionization B) neutralization
C) oxidation D) reduction

5. Given the balanced ionic equation representing a reaction:
reduced
$$2Al(s) + 3Cu^{2+}(aq) \rightarrow 2Al^{3+}(aq) + 3Cu(s)$$
oxidized
Which half-reaction represents the reduction that occurs?

A) $Al \rightarrow Al^{3+} + 3e$ B) $Al^{3+} + 3e \rightarrow Al$
C) $Cu \rightarrow Cu^{2+} + 2e$ D) $Cu^{2+} + 2e \rightarrow Cu$

6. Which balanced equation represents a redox reaction?
↓ changes in charge

A) $Mg + Cl_2 \rightarrow MgCl_2$ (0, 0, +2, −1)
B) $CaO + H_2O \rightarrow Ca(OH)_2$
C) $HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$
D) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

7. Which metal will spontaneously react with $Zn^{2+}(aq)$, but will *not* spontaneously react with $Mg^{2+}(aq)$?
Table J

A) Mn(s) B) Cu(s)
C) Ni(s) D) Ba(s)

8. A voltaic cell converts chemical energy to

A) electrical energy with an external power source
B) nuclear energy with an external power source
C) electrical energy without an external power source
D) nuclear energy without an external power source

9. In an operating voltaic cell, reduction occurs

A) at the anode B) at the cathode
C) in the salt bridge D) in the wire

10. During the operation of a voltaic cell, the cell produces

A) electrical energy spontaneously
B) chemical energy spontaneously
C) electrical energy nonspontaneously
D) chemical energy nonspontaneously

11. Which statement describes where the oxidation and reduction half-reactions occur in an operating electrochemical cell?

A) Oxidation and reduction both occur at the anode.
B) Oxidation and reduction both occur at the cathode.
C) Oxidation occurs at the anode, and reduction occurs at the cathode.
D) Oxidation occurs at the cathode, and reduction occurs at the anode.

12. A student collects the materials and equipment below to construct a voltaic cell:

- two 250-mL beakers
- wire and a switch
- one strip of magnesium
- one strip of copper
- 125 mL of 0.20 M $Mg(NO_3)_2(aq)$
- 125 mL of 0.20 M $Cu(NO_3)_2(aq)$

Which additional item is required for the construction of the voltaic cell?

A) an anode B) a battery
C) a cathode D) a salt bridge

13. An electrolytic cell differs from a voltaic cell because an electrolytic cell

A) generates its own energy from a spontaneous physical reaction
B) generates its own energy from a nonspontaneous physical reaction
C) requires an outside energy source for a spontaneous chemical reaction to occur
D) requires an outside energy source for a nonspontaneous chemical reaction to occur

14. Where do reduction and oxidation occur in an electrolytic cell?

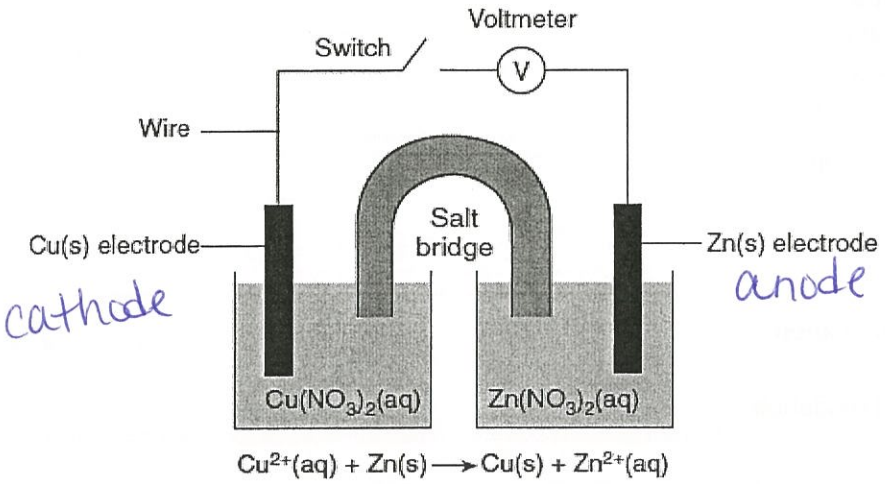
A) Both occur at the anode.
B) Both occur at the cathode.
C) Reduction occurs at the anode, and oxidation occurs at the cathode.
D) Reduction occurs at the cathode, and oxidation occurs at the anode.

15. Which energy conversion must occur in an operating electrolytic cell?

A) electrical energy to chemical energy
B) electrical energy to nuclear energy
C) chemical energy to electrical energy
D) chemical energy to nuclear energy

Base your answers to questions **16** through **19** on the information below and on your knowledge of chemistry.

A student constructs an electrochemical cell during a laboratory investigation. When the switch is closed, electrons flow through the external circuit. The diagram and ionic equation below represent this cell and the reaction that occurs.



$Cu^{2+}(aq) + Zn(s) \longrightarrow Cu(s) + Zn^{2+}(aq)$

AN OX
BIG RED CAT

cathode

anode

16. State what happens to the mass of the Cu electrode and the mass of the Zn electrode in the operating cell.

Zn electrode (anode) mass decreases. Cu electrode (cathode) mass increases.

17. Write a balanced equation for the half-reaction that occurs in the Cu half-cell when the cell operates.

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

18. State in terms of the Cu(s) electrode and the Zn(s) electrode, the direction of electron flow in the external circuit when the cell operates.

From Zn(s) to Cu(s). (anode → cathode)

19. State the form of energy that is converted to electrical energy in the operating cell.

Chemical energy.

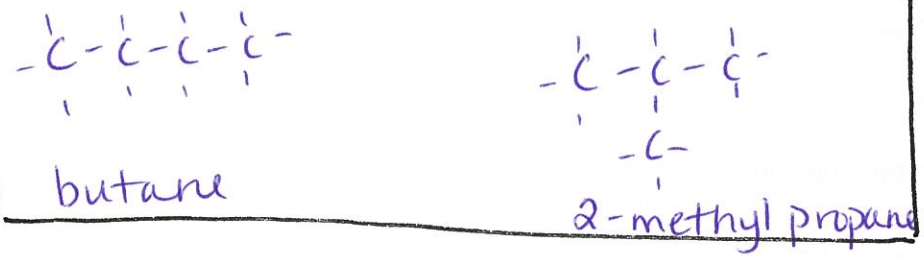
organiC chemistry

* "Homologous" Series" → Table Q

ex: is C_4H_8 (alkene) SATURATED or UNSATURATED? (has at least 1 double or triple C-C bond)

* Isomers → same molecular formulas, different structural formulas

ex: DRAW ISOMERS OF BUTANE



butane

2-methyl propane

* Organic Reactions
  - ↳ saponification - makes soap
  - ↳ combustion - burning in presence of O_2

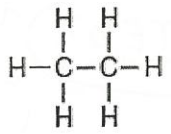
Ref Tables P, Q, R

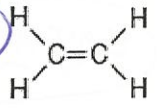
1. Which formula represents an alkane?

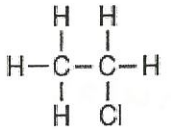
   A) C_2H_2 B) C_2H_4 C) C_3H_4 D) C_3H_8

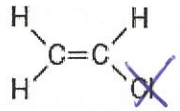
C_nH_{2n+2}

2. Which formula represents an unsaturated hydrocarbon?

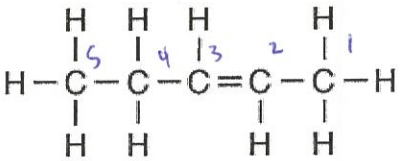
A)


B)


C)


D)


3. Given the formula representing a compound:



What is a chemical name of this compound?

A) 2-pentene B) 2-pentyne
C) 3-pentene D) 3-pentyne

4. A molecule of an unsaturated hydrocarbon must have

   A) at least one single carbon-carbon bond
   B) at least one multiple carbon-carbon bond
   C) two or more single carbon-carbon bonds
   D) two or more multiple carbon-carbon bonds

5. Which general formula represents the homologous series of hydrocarbons that includes the compound l-heptyne?

alkyne

A) C_nH_{2n-6} B) C_nH_{2n-2}
C) C_nH_{2n} D) C_nH_{2n+2}

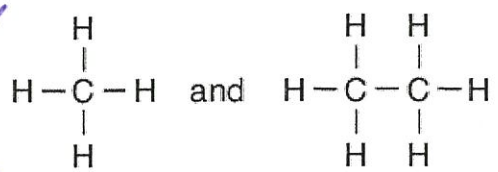
6. Which element is present in all organic compounds?

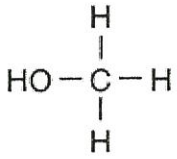
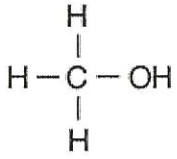
A) nitrogen B) oxygen
C) carbon D) sulfur

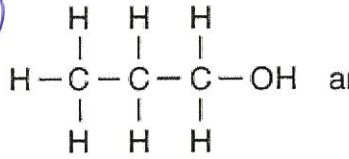
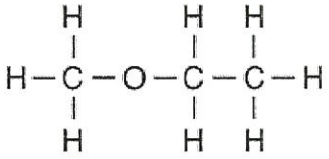
7. Which atoms can bond with each other to form chains, rings, or networks?

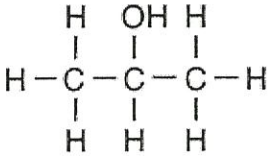
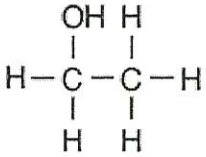
A) carbon atoms B) hydrogen atoms
C) oxygen atoms D) nitrogen atoms

8. Which formulas represent compounds that are isomers of each other?

A)  and

B)  and 

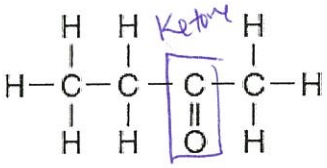
C)  and 

D)  and 

9. Which compound yields H^+ ions as the only positive ions in an aqueous solution?

A) KOH
B) NaOH
C) CH_3OH
D) CH_3COOH

10. Given the formula for a compound:



A chemical name for this compound is

A) butanal
B) butanol
C) butanone
D) butanoic acid

11. Which reaction results in the production of soap?

A) esterification
B) fermentation
C) polymerization
D) saponification

12. Which term represents a chemical reaction?

A) deposition
B) combustion
C) sublimation
D) vaporization