

Chemistry 12



Complete Workbook

- ★ Aligned with Alberta curriculum
- ★ Contains Chemistry 30 practice questions and answers

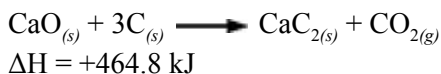
2020 EDITION

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Thermochemical Changes

1. Calcium carbide (CaC_2) can be made by heating calcium oxide (lime) with carbon (charcoal).



How much heat is absorbed in a reaction in which 2.33 mol $\text{C}_{(s)}$ is consumed under these conditions?

- A) 361 kJ
B) 36.0 kJ
C) 1.30×10^3 kJ
D) 155 kJ

2.

The standard heat of formation of $\text{HNO}_{3(l)}$ is -174.1 kJ/mol .

The equation that represents this reaction is _____.

- A) $\text{H}_{2(g)} + \text{N}_{2(g)} + \text{O}_{2(g)} \longrightarrow \text{HNO}_{3(l)} + 174.1 \text{ kJ}$
B) $\text{H}_{(g)} + \text{N}_{(g)} + \text{O}_3 \longrightarrow \text{HNO}_{3(l)} + 174.1 \text{ kJ}$
C) $\frac{1}{2} \text{H}_{2(g)} + \frac{1}{2} \text{N}_{2(g)} + \frac{3}{2} \text{O}_{2(g)} \longrightarrow \text{HNO}_{3(l)} + 174.1 \text{ kJ}$
D) $\text{H}_{(g)} + \text{N}_{(g)} + \text{O}_3 + 174.1 \text{ kJ} \longrightarrow \text{HNO}_{3(l)}$

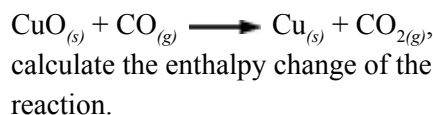
3. Uric acid ($\text{C}_5\text{H}_4\text{O}_3\text{N}_4$) gives off 1928.3 kJ of energy for each mole of acid burned. The mass of uric acid needed to heat 400 mL of water from 40.0°C to 60.0°C (to the nearest hundredth) is _____ g.
4. The molar heat of solution for $\text{NaOH}_{(s)}$ is -44.5 kJ/mol . If 40.0 g of $\text{NaOH}_{(s)}$ is dissolved in 200.0 mL of water in a

calorimeter, the temperature of the water would increase by

- A) 53.1°C
B) 2124°C
C) $5.31 \times 10^{-2}^\circ\text{C}$
D) 26.6°C

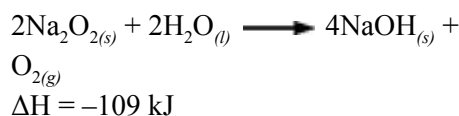
5. Copper metal can be refined by heating copper ore with carbon monoxide.

Given the reaction:

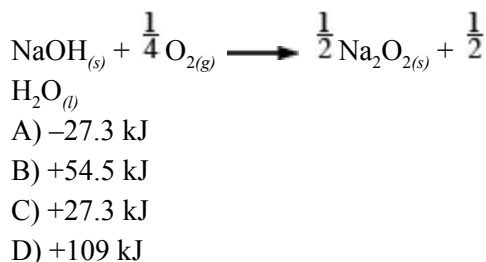


- A) -125.7 kJ
B) $+125.7 \text{ kJ}$
C) -114.4 kJ
D) $+114.4 \text{ kJ}$

6. Given the reaction:



calculate ΔH for the reaction:



7. The standard enthalpy of formation of copper(II) chloride is -220.1 kJ/mol . What is the enthalpy change, ΔH , for the reaction
- $$\text{CuCl}_{2(s)} \longrightarrow \text{Cu}_{(s)} + \text{Cl}_{2(g)}$$
- A) -220.1 kJ/mol
B) 110.05 kJ/mol
C) 220.1 kJ/mol
D) -110.05 kJ/mol

8. Which of the following statements best describes what occurs when a bowl of stew is warmed from 5°C to 55°C on a stove?

A) The potential energy of the stew increases.
 B) The kinetic energy of the stew increases.
 C) The atoms within the stew are rearranged.
 D) Water within the stew changes state.

9. A student read the following statements about a chemical reaction.

The reaction cools down its surroundings.

The reaction has a positive ΔH value.

The reaction is endothermic.

The enthalpy of the products is lower than that of the reactants.

Which statement is **not** consistent with the other three?

A) Statement I
 B) Statement II
 C) Statement III
 D) Statement IV

10. What mass of acetylene, $C_2H_{2(g)}$, must be burned to release 1.00 MJ of energy.

The heat of combustion of acetylene is -1310 kJ/mol .

A) 34.1 g

B) 20.0 kg
 C) 0.0293 kg
 D) 19.9 g

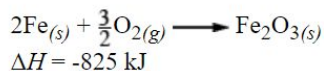
11.

250.0 g of sugar solution at 80.0°C is mixed with 700.0 g of water at 15.5°C. The final temperature of the mixture is 32.7°C. The specific heat capacity of water is $4.184 \text{ J/g } ^\circ\text{C}$

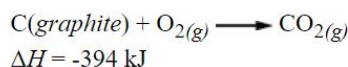
Use this information to determine the specific heat capacity of the sugar solution?

A) $4.11 \text{ J/g } ^\circ\text{C}$
 B) $2.72 \text{ J/g } ^\circ\text{C}$
 C) $4.56 \text{ J/g } ^\circ\text{C}$
 D) $4.26 \text{ J/g } ^\circ\text{C}$

Reaction 1:



Reaction 2:



12.

What is the enthalpy change for the reaction:



A) -1219 kJ | B) $+468 \text{ kJ}$ | C) $+357 \text{ kJ}$ |
 D) -431 kJ

13.

The dilution of pure nitric acid, $\text{HNO}_{3(l)}$, can be represented by the following equation:



Given:

$$\Delta H_f^\circ(\text{HNO}_{3(l)}) = -173 \text{ kJ/mol}$$

$$\Delta H_f^\circ(\text{HNO}_{3(aq)}) = -207 \text{ kJ/mol}$$

What quantity of heat is given off when $1.0 \times 10^2 \text{ g}$ of $\text{HNO}_{3(l)}$ is diluted to form a 1.0 mol/L aqueous solution?

A) 54 kJ

B) 3.8 kJ

C) 21 kJ

D) $3.3 \times 10^2 \text{ kJ}$

14.

$$\Delta H_f^\circ(\text{SO}_{3(g)}) = -396 \text{ kJ/mol}$$

$$\Delta H_f^\circ(\text{H}_2\text{O}_{(l)}) = -285.8 \text{ kJ/mol}$$



Given this information, determine the heat of formation, $\Delta H_f^\circ \text{H}_2\text{SO}_{4(aq)}$.

A) -456.8 kJ/mol

B) -906.8 kJ/mol

C) +456.8 kJ/mol

D) -335.2 kJ/mol

15. A polystyrene cup, filled with coffee and covered with a vented lid is a(n)

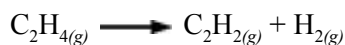
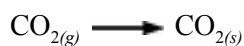
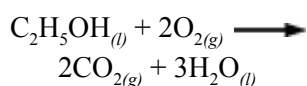
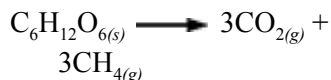
A) closed system.

B) open system.

C) isolated system.

D) thermodynamic system.

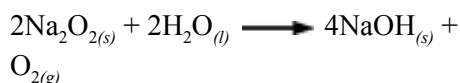
16.



Which of these represent endothermic reactions?

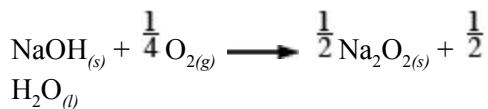
- A) I and II
- B) I and III
- C) II and IV
- D) IV only

17. Given the reaction:



$$\Delta H = -109 \text{ kJ}$$

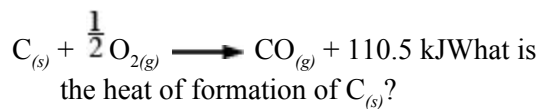
calculate ΔH for the reaction:



- A) -27.3 kJ
- B) $+54.5 \text{ kJ}$
- C) $+27.3 \text{ kJ}$
- D) $+109 \text{ kJ}$

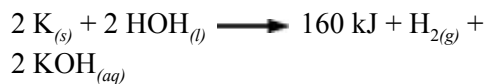
18. The heat of formation of octane, $\text{C}_8\text{H}_{18(l)}$ = $-2.5 \times 10^2 \text{ kJ/mol}$. The amount of energy released by the formation of 0.200 mol of octane under standard conditions (to the nearest tenth) is _____ kJ.

19. Carbon will burn to form carbon monoxide as shown by the equation



- A) 0 kJ/mol
- B) $+110.5 \text{ kJ/mol}$
- C) -55.6 kJ/mol
- D) -110.5 kJ/mol

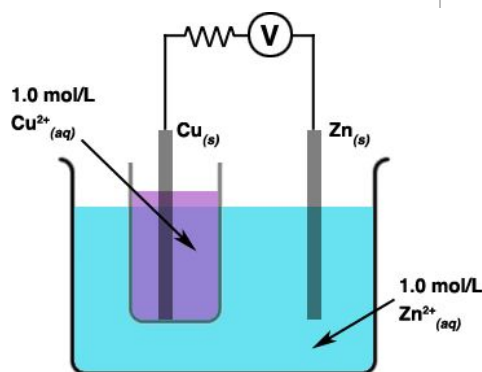
20. Given the following reaction, how much heat is released if 50.0 g of potassium metal reacts?



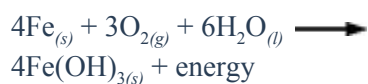
- A) 160 kJ
- B) 102 kJ
- C) 205 kJ
- D) 80.0 kJ

Electrochemical Changes

- One of the main reasons that copper pipes are used in household plumbing (rather than iron pipes) is that
 - copper is a better conductor of heat
 - iron will react with dissolved hard water minerals such as calcium ions
 - iron has a greater tendency to act as a reducing agent than copper
 - drain cleaners and soaps containing sodium hydroxide will react with iron



- Which of the following is true of the above electrochemical cell?
 - There color of the copper electrolyte will become more intense
 - Electrons will travel from the zinc electrode to the copper electrode.
 - Anions will migrate towards the copper electrode.
 - The reaction will not occur as there is no salt bridge.
- Corrosion of iron metal is a multi-billion dollar infrastructure cost every year. The reaction that occurs during corrosion is

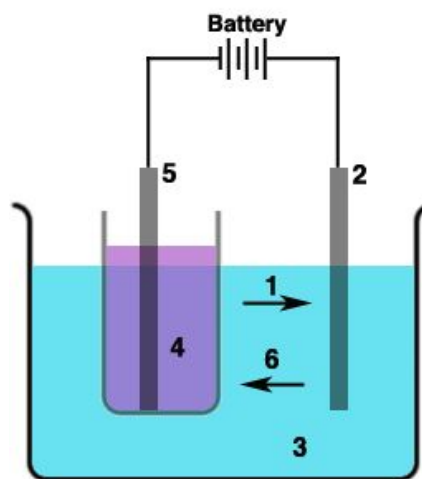
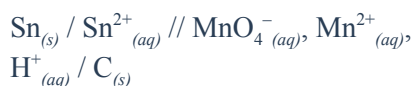


If 20.0 g of iron corroded, then the volume of oxygen gas consumed during

the reaction at SATP (to the nearest hundredth) is _____ L. (Note: 1 mol of oxygen at SATP occupies 24.8 L)

4.

The diagram below represents a cell:



The acidic permanganate solution is represented by

5.

A voltaic cell is constructed using a $\text{Cu}_{(s)} / \text{Cu}^{2+}_{(aq)}$ half-cell connected to a $\text{C}_{(s)} / \text{Cr}_2\text{O}_7^{2-}_{(aq)}, \text{H}^+_{(aq)}$ half-cell.

The correct net reaction of the cell is

- A) $3\text{Cu}^{2+}_{(aq)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \longrightarrow 3\text{Cu}_{(s)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$
- B) $3\text{Cu}_{(s)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \longrightarrow 3\text{Cu}^{2+}_{(aq)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$
- C) $\text{Cu}^{2+}_{(aq)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \longrightarrow \text{Cu}_{(s)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$
- D) $\text{Cu}_{(s)} + \text{Cr}_2\text{O}_7^{2-}_{(aq)} + 14\text{H}^+_{(aq)} \longrightarrow \text{Cu}^{2+}_{(aq)} + 2\text{Cr}^{3+}_{(aq)} + 7\text{H}_2\text{O}_{(l)}$

6.

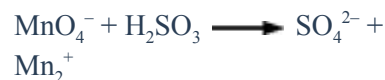
Galvanizing is a process used to prevent corrosion. The process of galvanization involves coating iron or steel with a thin layer of zinc metal.

Standard iron nails can be galvanized using an electrolytic cell. The nails should be attached to the

- A) electrode at which oxidation occurs
 B) electrode to which anions move
 C) electrode from which the electrons leave

D) electrode at which reduction occurs

7.

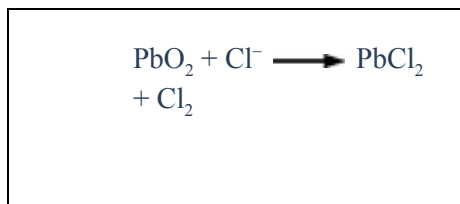


When the above reaction that occurs in acid solution is balanced, the coefficient in front of SO_4^{2-} is:

- A) 1
 B) 3
 C) 5
 D) 6

8. In an electrolytic cell, there is always a conversion of:
- A) chemical energy to electrical energy in a spontaneous change.
 B) chemical energy to electrical energy in a non-spontaneous change.
 C) electrical energy to chemical energy in a spontaneous change.
 D) electrical energy to chemical energy in a non-spontaneous change.

9.



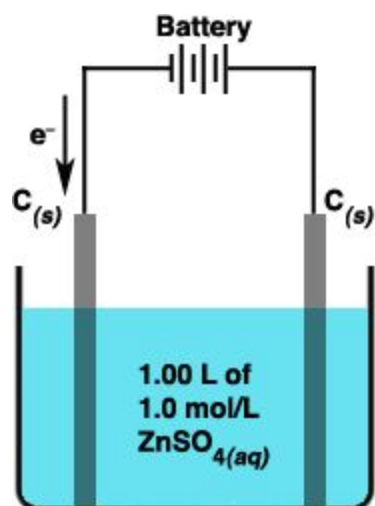
When the following reaction that occurs in acid solution is balanced, the coefficient in front of Cl_2 is

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

10. In a reaction, $\text{Fe}^{2+}_{(aq)}$:

- A) will undergo reduction when combined with $\text{Pb}_{(s)}$.
B) will act as an oxidizing agent when combined with $\text{Sn}_{(s)}$.
C) will always act as an oxidizing agent.
D) will act as an reducing agent when combined with $\text{Ag}^+_{(aq)}$.

11.



Which of the following statements describes what happens during the operation of this electrolytic cell?

- A) Chemical energy is converted to

electrical energy.

B) Electrical energy is converted to chemical energy.

C) Anions move towards the cathode.

D) Zinc will be plated at the anode.

12. In an electrolytic cell, there is always a conversion of:

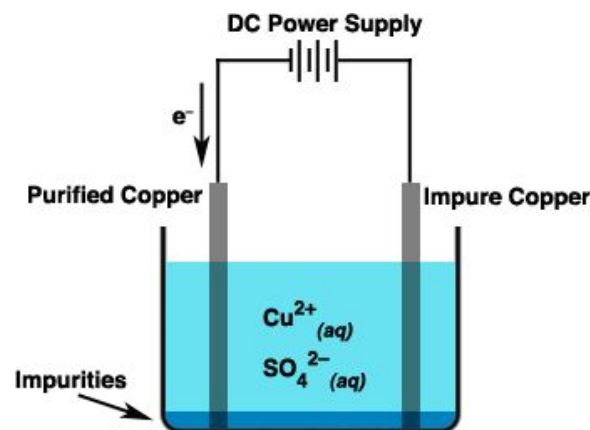
A) chemical energy to electrical energy in a spontaneous change.

B) chemical energy to electrical energy in a non-spontaneous change.

C) electrical energy to chemical energy in a spontaneous change.

D) electrical energy to chemical energy in a non-spontaneous change.

13. A common way to purify copper is to use an electrolytic cell like that shown below:



If the power supply produces a steady 5.25 A current, then the time required to deposit 10.0 g of purified copper is _____ min. (to the nearest tenth)

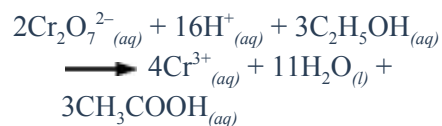
14. The oxidation numbers for sulfur in $\text{SO}_{2(g)}$, $\text{SO}_{3(g)}$, $\text{HSO}_3^-_{(aq)}$, and $\text{S}_2\text{O}_3^{2-}_{(aq)}$, are:

(Write your response as four numbers separated by commas.)

15. Hydrochloric acid may be safely stored in a container made of:
- copper.
 - cadmium.
 - iron.
 - aluminum.
16. A piece of copper is placed in a beaker containing a silver nitrate solution. If the mass of the copper decreases by 7.21 g, what mass of silver metal would form?
- 0.227 g
 - 24.5 g
 - 12.2 g
 - 49.0 g
17. One way in which electrolytic cells differ from voltaic cells is that
- electrons transfer from the anode in one, but from the cathode in the other
 - one cell requires energy while the other releases energy
 - electrolytic cells produce energy but voltaic consume it
 - oxidation occurs at the anode at one, but at the cathode in the other
18. During photosynthesis, $\text{CO}_{2(g)} + \text{H}_2\text{O}_{(g)} + \text{energy} \longrightarrow \text{C}_6\text{H}_{12}\text{O}_{6(aq)} + \text{O}_{2(g)}$
- carbon in carbon dioxide is reduced.
 - hydrogen in water is reduced.
 - oxygen in carbon dioxide and/or water is reduced.
 - hydrogen in glucose is oxidized.

19.

In a breathalyzer, ethanol from the suspect's breath is oxidized by an acidic dichromate solution in the reaction ampule as in the following reaction:



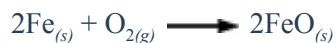
When alcohol from a suspect's breath sample is oxidized, the reducing agent is:

- $\text{Cr}^{3+}{}_{(aq)}$.
- $\text{Cr}_2\text{O}_7^{2-}{}_{(aq)}$.
- $\text{C}_2\text{H}_5\text{OH}_{(aq)}$.
- $\text{CH}_3\text{COOH}_{(aq)}$.

20. The oxidation numbers for chlorine in $\text{ClO}_{2(g)}$, $\text{Cl}_{2(g)}$, $\text{ClO}_3^-{}_{(aq)}$, and $\text{HClO}_{4(aq)}$ are:

(Write your response as four numbers separated by commas.)

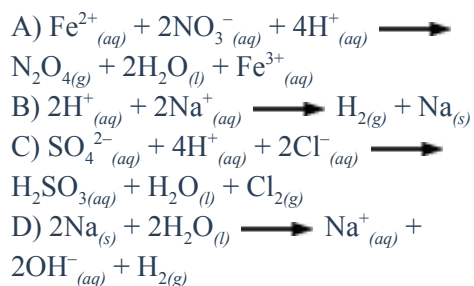
21.



In the reaction shown above, iron is:

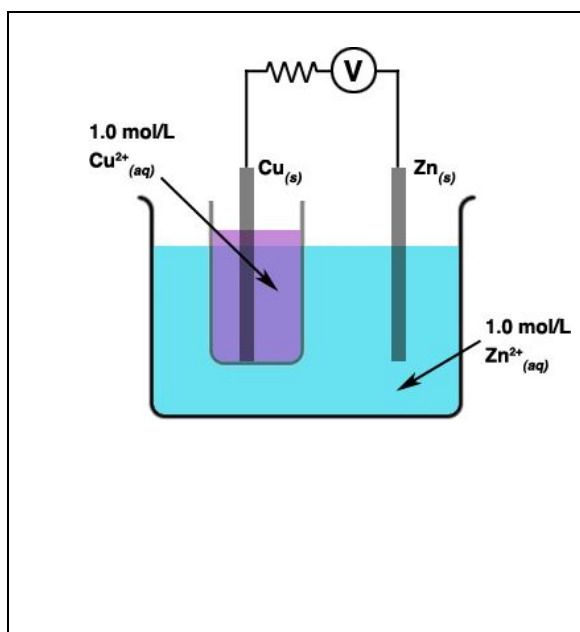
- oxidized and the reaction is exothermic.
- oxidized and the reaction is endothermic.
- reduced and the reaction is endothermic.
- reduced and the reaction is exothermic.

22. A laboratory's waste container is used to dispose of aqueous solutions of potassium nitrate, sodium sulfate, nitric acid, and iron (II) chloride. The most likely net redox reaction predicted to occur inside the container would be:



23. In a voltaic cell, there is always a conversion of:
- A) chemical energy to electrical energy in a spontaneous change.
 B) chemical energy to electrical energy in a non-spontaneous change.
 C) electrical energy to chemical energy in a spontaneous change.
 D) electrical energy to chemical energy in a non-spontaneous change.

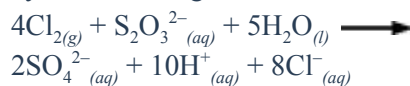
24.



As the reaction in the electrochemical cell progresses, the mass of

- A) the $\text{Zn}^{2+}_{(aq)}$ decreases
 B) the $\text{Cu}^{2+}_{(aq)}$ decreases
 C) the $\text{Zn}_{(s)}$ electrode decreases
 D) the $\text{Cu}_{(s)}$ electrode decreases

25. One of the ways used to dispose of unwanted and poisonous chlorine gas is by the following reaction:

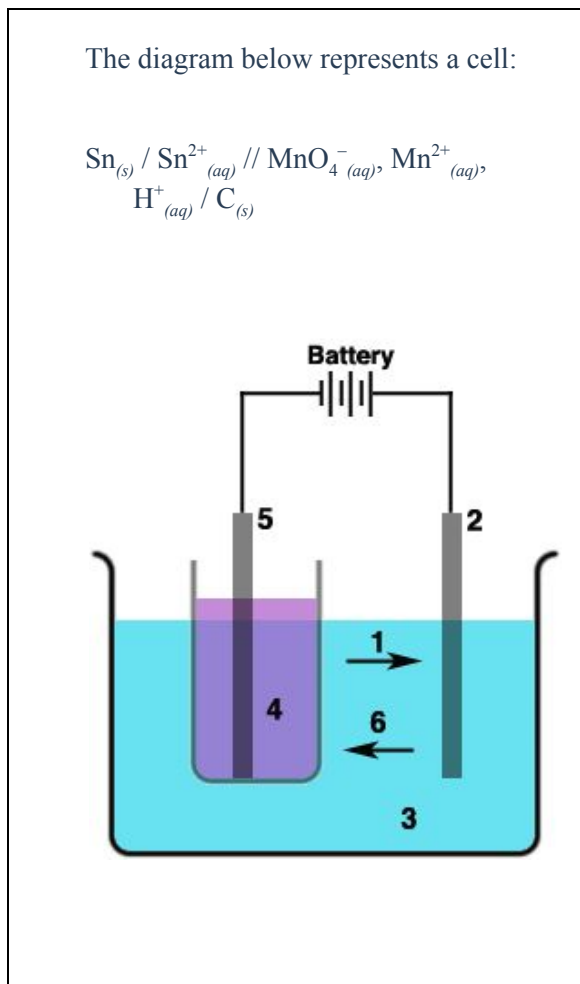


The reducing agent in this reaction is:

- A) $\text{Cl}^{-}_{(aq)}$.
 B) $\text{H}_2\text{O}_{(l)}$.
 C) $\text{S}_2\text{O}_3^{2-}_{(aq)}$.
 D) $\text{Cl}_{2(g)}$.

26. Which of the following generalizations is true of the Table of Selected Standard Electrode Potentials?
- A) Metal ions and non-metallic elements are generally oxidizing agents.
 B) Metal ions and non-metallic ions are generally oxidized.
 C) Metals and non-metal elements are generally oxidized.
 D) Metals and non-metal ions are generally reduced.

27.



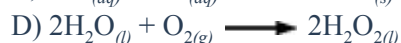
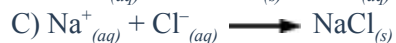
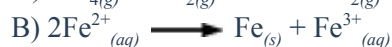
The acidic permanganate solution is represented by

28. Under standard conditions, hydrogen gas reacts with $\text{Ag}^{+}_{(aq)}$ ions to produce $\text{Ag}_{(s)}$. The net cell potential for this reaction (to the nearest hundredth) is \pm _____ V.

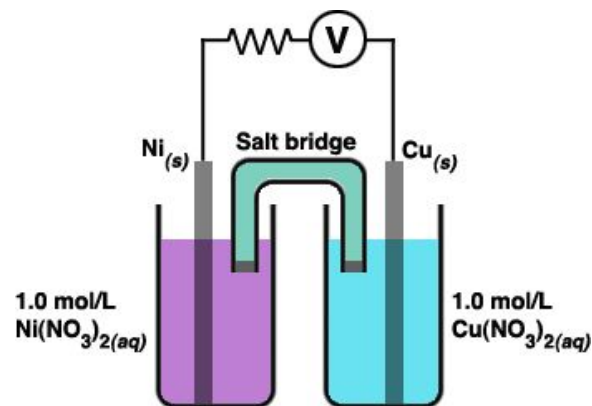
29. The oxidation numbers for sulfur in $\text{SO}_{2(g)}$, $\text{SO}_{3(g)}$, $\text{HSO}_3^{-}_{(aq)}$, and $\text{S}_2\text{O}_3^{2-}_{(aq)}$ are:

(Write your response as four numbers separated by commas.)

30. Which of the following equations is **not** predicted to represent a redox reaction?



31.



If a student replaced the $\text{Ni}_{(s)} / \text{Ni}^{2+}_{(aq)}$ half-cell with a $\text{Zn}_{(s)} / \text{Zn}^{2+}_{(aq)}$ half-cell instead, then

A) The E°_{net} of the cell would become larger.

B) The $\text{Cu}_{(s)}$ would change from cathode to anode.

C) The $\text{Cu}_{(s)}$ would change from anode to cathode.

D) The E°_{net} of the cell would become smaller.



When the following reaction that occurs in acid solution is balanced, the coefficient in front of Cl_2 is

A) 1

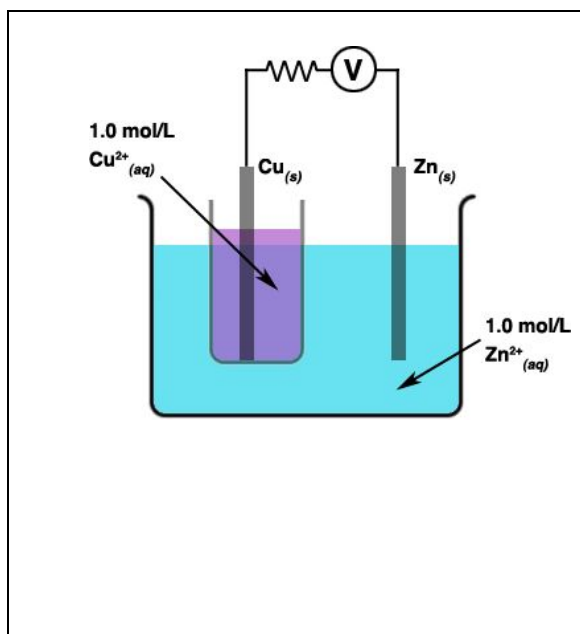
B) 2

C) 3

D) 4

33. One way in which electrolytic cells differ from voltaic cells is that
- A) oxidation occurs at the anode in one but at the cathode in the other
 - B) cations migrate to the cathode in one but to the anode in the other
 - C) electrolytic cells produce energy but voltaic consume it
 - D) the cell potential for one is positive but the other is negative

34.

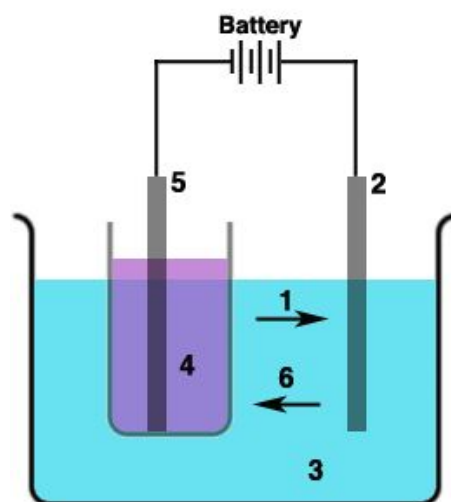
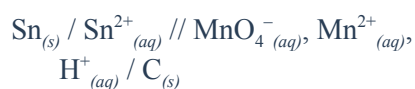


As the reaction in the electrochemical cell progresses, the mass of

- A) the $\text{Zn}^{2+}_{(aq)}$ decreases
- B) the $\text{Cu}^{2+}_{(aq)}$ decreases
- C) the $\text{Zn}_{(s)}$ electrode decreases
- D) the $\text{Cu}_{(s)}$ electrode decreases

35.

The diagram below represents a cell:



The carbon electrode is represented by which number?

36.

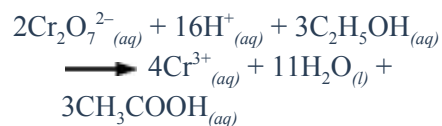
Properties

- 1 Reacts spontaneously with $\text{Zn}^{2+}_{(aq)}$
- 2 Reacts spontaneously with $\text{Ag}_{(s)}$
- 3 Is an oxidizing **and** a reducing agent
- 4 Is reduced by $\text{Au}_{(s)}$
- 5 Reacts spontaneously with $\text{K}^{+}_{(aq)}$
- 6 Reacts spontaneously with $\text{Al}^{3+}_{(aq)}$

Which property in the list is most appropriate for $\text{Hg}^{2+}_{(aq)}$?

37.

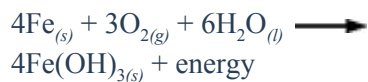
In a breathalyzer, ethanol from the suspect's breath is oxidized by an acidic dichromate solution in the reaction ampule as in the following reaction:



The ampule which contains the acidic dichromate testing solution would **best** be made of:

- A) chromium.
- B) zinc.
- C) plastic.
- D) copper.

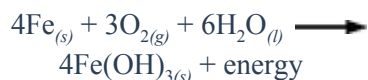
38. Corrosion of iron metal is a multi-billion dollar infrastructure cost every year. The reaction that occurs during corrosion is



If 20.0 g of iron corroded, then the volume of oxygen gas consumed during the reaction at SATP (to the nearest hundredth) is _____ L. (Note: 1 mol of oxygen at SATP occupies 24.8 L)

39. The oxidation numbers for manganese in $\text{MnO}_{2(s)}$, $\text{Mn}_2\text{O}_{3(s)}$, MnO_4^- (aq), and $\text{Mn}_2\text{O}_{5(s)}$, are:
(Write your response as four numbers separated by commas.)
40. If a block of refined magnesium were selected to serve as a sacrificial anode and if it were bolted onto the iron girder of a bridge, one would expect the
- A) iron to oxidize
 - B) magnesium to oxidize before the iron
 - C) magnesium to reduce before the iron
 - D) both the iron and the magnesium to react
- 41.

Corrosion of iron metal is a multi-billion dollar infrastructure cost every year. The reaction that occurs during corrosion is



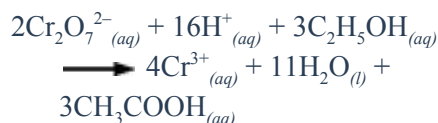
The oxidizing agent in this reaction is

- A) $\text{Fe}(\text{OH})_{3(s)}$
 - B) $\text{H}_2\text{O}_{(l)}$
 - C) $\text{O}_{2(g)}$
 - D) $\text{Fe}_{(s)}$
42. In an electrolytic cell, there is always a conversion of:
- A) chemical energy to electrical energy in a spontaneous change.
 - B) chemical energy to electrical energy in a non-spontaneous change.
 - C) electrical energy to chemical energy in a spontaneous change.

D) electrical energy to chemical energy in a non-spontaneous change.

43.

In a breathalyzer, ethanol from the suspect's breath is oxidized by an acidic dichromate solution in the reaction ampule as in the following reaction:



The ampule which contains the acidic dichromate testing solution would **best** be made of:

- A) chromium.
 - B) zinc.
 - C) plastic.
 - D) copper.
44. If the reduction of $\text{Se}_{(s)}$ had been chosen as the standard half-cell reaction, the E° value for
- $$2\text{H}^+{}_{(aq)} + 2\text{e}^- \longrightarrow \text{H}_{2(g)}$$
- (to the nearest hundredth) would be _____ V.

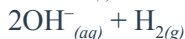
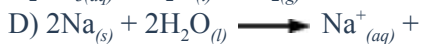
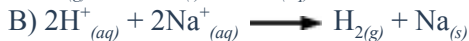
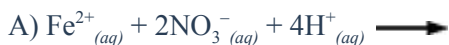
45.

- | | |
|---|------------------------|
| 1 | nitric acid |
| 2 | cobalt (II) chloride |
| 3 | gold (III) nitrate |
| 4 | aluminum (III) nitrate |

The above solutions in order of strongest oxidizing agent to weakest oxidizing agent would be:

(Enter your response as numbers separated by commas.)

46. A laboratory's waste container is used to dispose of aqueous solutions of potassium nitrate, sodium sulfate, nitric acid, and iron (II) chloride. The most likely net redox reaction predicted to occur inside the container would be:



47. Galvanizing is a process used to prevent corrosion. The process of galvanization involves coating iron or steel with a thin layer of zinc metal. In an electrolytic cell, 100.0 g of $\text{Zn}_{(s)}$ was plated in 2.50 h. The current that would have to be

supplied (to the nearest tenth) is

_____ A.

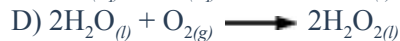
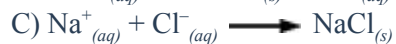
48. Four metals represented by the symbols H, I, J, and K and their corresponding ions combine with each other in the following set of reactions.



When the oxidizing agents are arranged from strongest to weakest, the correct order is:



49. Which of the following equations is **not** predicted to represent a redox reaction?



50. Salts, such as calcium chloride, which is spread onto roadways during the winter increases the rate of rust formation on vehicles because the calcium chloride

A) increases the conductivity of the electrolyte on the metal surface

B) decreases the conductivity of the electrolyte on the metal surface

C) reacts with the metal producing rust

D) reacts with the rust breaking down the metal

Chemical Changes of Organic Compounds

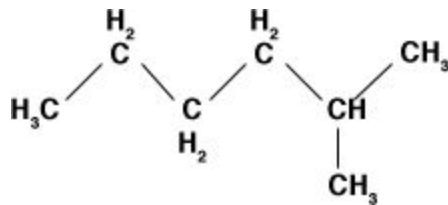
1. Which of the following is NOT an organic substance?

A) CCl_4
 B) C_2H_6
 C) CH_3ONa
 D) $\text{C}_2\text{O}_4\text{H}_2$

2. The compound C_4H_4 is named

A) cyclobutylene
 B) butyne
 C) cyclobutadiene
 D) cyclobutene

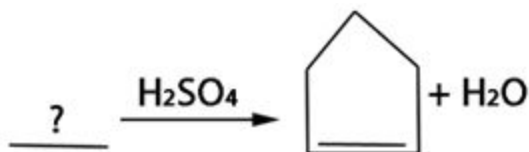
3.



The correct name for the substance represented in the diagram is

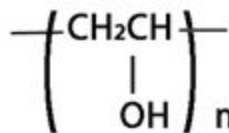
A) methylhexane
 B) 2-methylhexane
 C) 3-methylhexane
 D) 4-methylhexane

4.



What is the starting material in the above reaction?

A) pentane
 B) cyclopentanol
 C) cyclopentane
 D) cyclopentanal



5.

The monomer hydroxyethene is used to make the polymer shown in the diagram.

The process is classed as a(n)

_____ polymerization reaction.

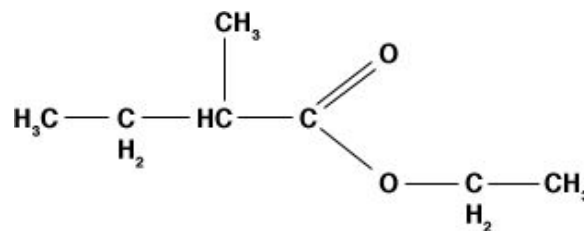
A) elimination
 B) condensation
 C) addition
 D) substitution

6. Which compound contains both ionic and covalent bonds?

A) NaCN
 B) H_2S
 C) CHCl_3
 D) MgF_2

7. Which of the following is a saturated hydrocarbon?

A) C_6H_{10}
 B) C_6H_6
 C) C_2H_4
 D) C_5H_{12}



8.

The correct name for the substance represented in the diagram is

A) butyl-2-methylethanoate
 B) ethylmethylbutanoate
 C) ethyl-2-methylbutanoate
 D) ethyl-1-methylbutanoate

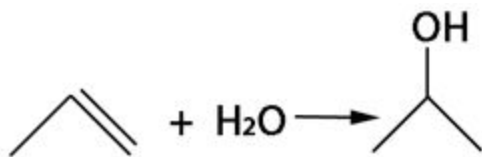
9.



What type of reaction will occur when the above compounds react?

- A) condensation
- B) substitution
- C) elimination
- D) hydrolysis

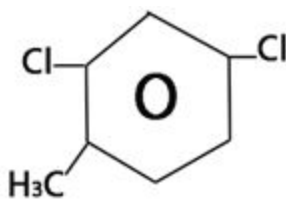
10.



The reaction shown above is an example of a _____ reaction.

- A) substitution
- B) elimination
- C) addition
- D) hydrolysis

11.



What is the name of the organic compound shown above?

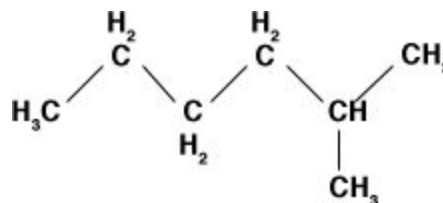
- A) 1-methyl-4,6-dichlorobenzene
- B) 2,4-dichloromethylbenzene
- C) 1,5-dichloro-2-methylbenzene
- D) 1,3-dichloro-4-methylbenzene

12. A student has been asked to prepare octyl ethanoate, an artificial orange flavour. The student could prepare this ester by reacting

- A) heptan-1-ol and ethanoic acid
- B) octan-1-ol and ethanoic acid
- C) ethanol and octanoic acid
- D) octan-1-ol and methanoic acid

13. In which one of the following compounds is there a triple bond?

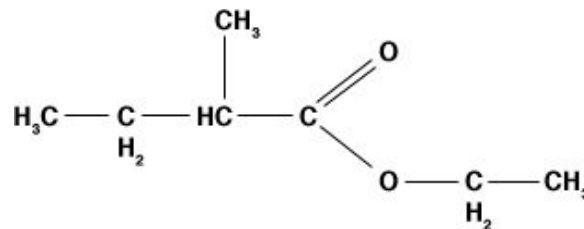
- A) C_2H_4
- B) $\text{CH}_3\text{CHCHCH}_2\text{CH}_3$
- C) $\text{CH}_2\text{CHCH}_2\text{CHCH}_2$
- D) $\text{CH}_3\text{CH}_2\text{CCCH}_2\text{CH}_3$



14.

The correct name for the substance represented in the diagram is

- A) methylhexane
- B) 2-methylhexane
- C) 3-methylhexane
- D) 4-methylhexane

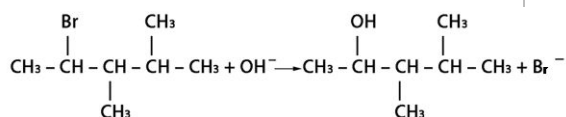


15.

The correct name for the substance represented in the diagram is

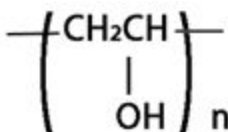
- A) butyl-2-methylethanoate
- B) ethylmethylbutanoate
- C) ethyl-2-methylbutanoate
- D) ethyl-1-methylbutanoate

16.



The example shown is a(n) _____ reaction.

- A) substitution
- B) condensation
- C) addition
- D) elimination



17.

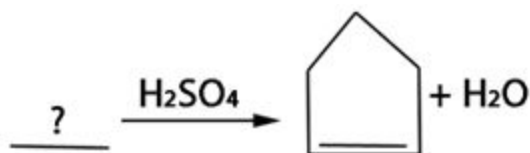
The monomer hydroxyethene is used to make the polymer shown in the diagram. The process is classed as a(n) _____ polymerization reaction.

- A) elimination
- B) condensation
- C) addition
- D) substitution

18. Methanal can be produced by the _____ of methanol.

- A) substitution
- B) reduction
- C) oxidation
- D) hydrolysis

19.



What is the starting material in the above reaction?

- A) pentane
- B) cyclopentanol
- C) cyclopentane

D) cyclopentanal

20. The reaction $\text{H}_3\text{CCH}_2\text{CHBrCH}_3 \longrightarrow \text{H}_3\text{CCH}_2\text{CH=CH}_2 + \text{HBr}$ is an example of a _____ reaction.

- A) addition
- B) elimination
- C) reduction
- D) substitution

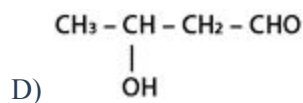
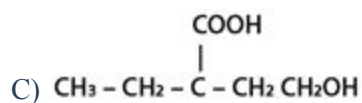
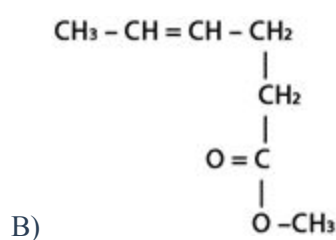
21. Whenever an ester is formed, what is always produced as well?

- A) hydrogen
- B) an acid
- C) a hydroxide
- D) water

22. The molecular formula, C_6H_{12} could represent

- A) a cycloalkene
- B) an alkyne
- C) a cycloalkane
- D) an alkane

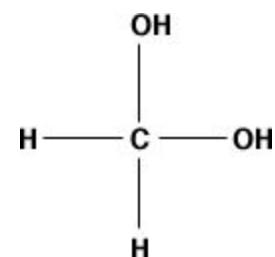
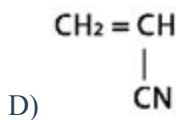
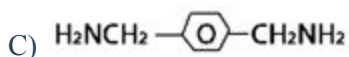
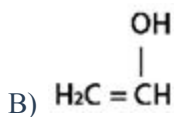
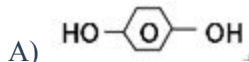
23. Which one of the following organic compounds is an ester?

A) $\text{CH}_3 - \text{CH}_2 - \text{O} - \text{CH}_3$ 

24. In which one of the following compounds is there a triple bond?

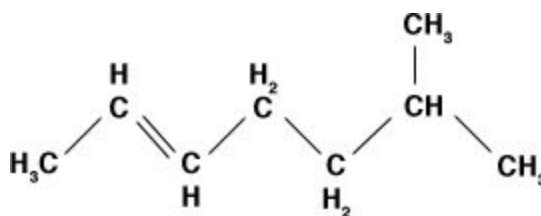
- A) C_2H_4
- B) $CH_3CHCHCH_2CH_3$
- C) $CH_2CHCH_2CHCH_2$
- D) $CH_3CH_2CCCH_2CH_3$

25. Which one of the following compounds could be used as starting material to produce a polyester?



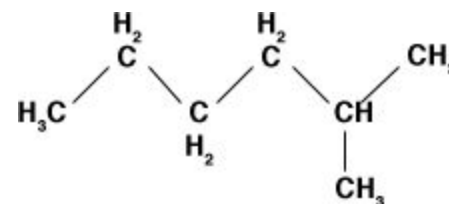
26. The correct name for the substance represented in the diagram is
- A) 1,1-dimethylalcohol
 - B) 1,1-hydroxymethane
 - C) dimethanol
 - D) methanediol

27.



The correct name for the substance represented in the diagram is

- A) 6-methylhept-2-ene
- B) 6-methylheptane
- C) 4-isopropylpent-2-ene
- D) 2-methylhept-5-ene



28.

The correct name for the substance represented in the diagram is

- A) methylhexane
- B) 2-methylhexane
- C) 3-methylhexane
- D) 4-methylhexane

29. The concept of multiple bonds is used to explain the molecular formula of

- A) C_2H_5OH
- B) SnH_4
- C) C_4H_8
- D) HF

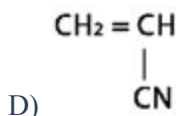
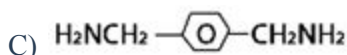
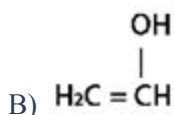
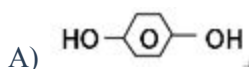
30. 2-methylpropan-2-ol (or 2-methyl-2-propanol) is an example of a

- A) secondary alcohol
- B) substituted alkane
- C) tertiary alcohol
- D) primary alcohol

31. The molecular formula, C_6H_{12} could represent

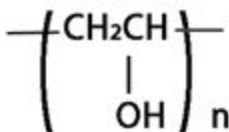
- A) a cycloalkene
- B) an alkyne
- C) a cycloalkane
- D) an alkane

32. Which one of the following compounds could be used as starting material to produce a polyester?



33. Methanal can be produced by the _____ of methanol.

- A) substitution
- B) reduction
- C) oxidation
- D) hydrolysis



34.

The monomer hydroxyethene is used to make the polymer shown in the diagram. The process is classed as a(n) _____ polymerization reaction.

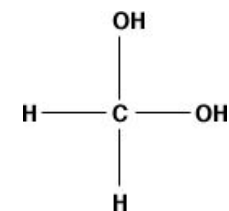
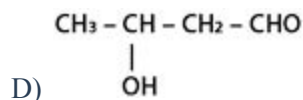
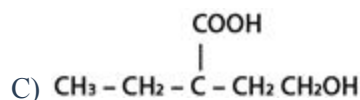
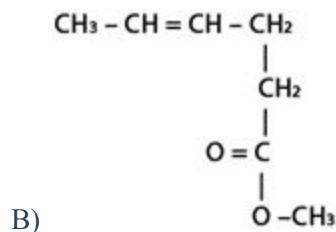
- A) elimination

- B) condensation
- C) addition
- D) substitution

35. 2-methylpropan-2-ol (or 2-methyl-2-propanol) is an example of a _____.

- A) secondary alcohol
- B) substituted alkane
- C) tertiary alcohol
- D) primary alcohol

36. Which one of the following organic compounds is an ester?



37.

The correct name for the substance represented in the diagram is

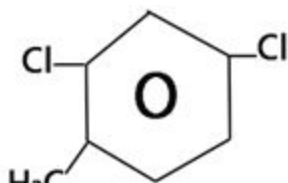
- A) 1,1-dimethylalcohol
- B) 1,1-hydroxymethane
- C) dimethanol
- D) methanediol

38. What monomer is used to build a protein molecule?

- A) a lipid
- B) an amino acid
- C) a nucleotide
- D) a simple sugar

39. When crude oil is spilled at sea, it forms a layer on top of the ocean. The reason for this is that hydrocarbons in the oil are

- A) non-polar and water is polar
- B) non-polar and water is non-polar
- C) polar and water is non-polar
- D) polar and water is polar



40.

What is the name of the organic compound shown above?

- A) 1-methyl-4,6-dichlorobenzene
- B) 2,4-dichloromethylbenzene
- C) 1,5-dichloro-2-methylbenzene
- D) 1,3-dichloro-4-methylbenzene

Chemical Equilibrium Focusing on Acid-Base Systems

- The calculated pH of a 0.250 mol/L solution of sodium sulfite is
A) -3.701
B) 10.299
C) -3.890
D) 10.111
- A solution containing 2.00 g of $\text{Sr}(\text{OH})_{2(s)}$ in 250 mL of water was prepared. The pH expected (to the nearest tenth) is _____.
-

Argon gas is pumped into the equilibrium system shown below. The pressure is to remain constant.



What change is expected?

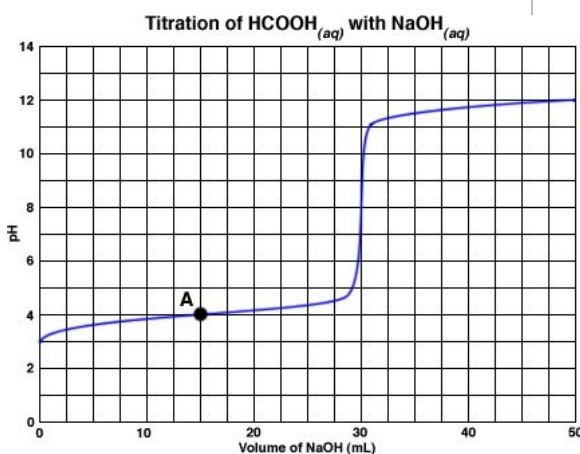
- no change will occur
 - the temperature will increase
 - the concentration of $\text{HI}_{(g)}$ will decrease
 - the concentration of $\text{H}_{2(g)}$ will increase
- Which is a correct statement regarding any aqueous solution?
A) As $[\text{H}_3\text{O}^+_{(aq)}]$ decreases, $[\text{OH}^-_{(aq)}]$ decreases
B) As $[\text{H}_3\text{O}^+_{(aq)}]$ increases, $[\text{OH}^-_{(aq)}]$ increases

- As pOH increases, $[\text{OH}^-_{(aq)}]$ decreases
- As pH increases, $[\text{H}_3\text{O}^+_{(aq)}]$ increases

- In a 1.00 mol/L $\text{CH}_3\text{COOH}_{(aq)}$ solution, which of the following species is present in the highest concentration?
A) $\text{H}_3\text{O}^+_{(aq)}$
B) $\text{CH}_3\text{COOH}_{(aq)}$
C) $\text{OH}^-_{(aq)}$
D) $\text{CH}_3\text{COO}^-_{(aq)}$
- The K_b value for the conjugate base of hydrogen oxalate ion is
A) 1.5×10^{-4}
B) 5.6×10^{-2}
C) 6.7×10^{-11}
D) 1.9×10^{-13}
- One important fact about any system at equilibrium is that the
A) reaction always favors the products.
B) concentration of products and reactants are always equal.
C) rate of forward reaction can never equal the rate of the reverse reaction.
D) mols of reactants and products remains unchanged.
- Sulphuric acid is best described as a
A) polyprotic weak acid
B) diprotic weak acid
C) diprotic strong acid
D) polyprotic strong acid
- The following reaction is called the Haber process.

$\text{N}_{2(g)}$	$3\text{H}_{2(g)}$	$2\text{NH}_{3(g)}$
0.01	0.22	0.11
45	mol/L	mol/L
mol/L		
L		L

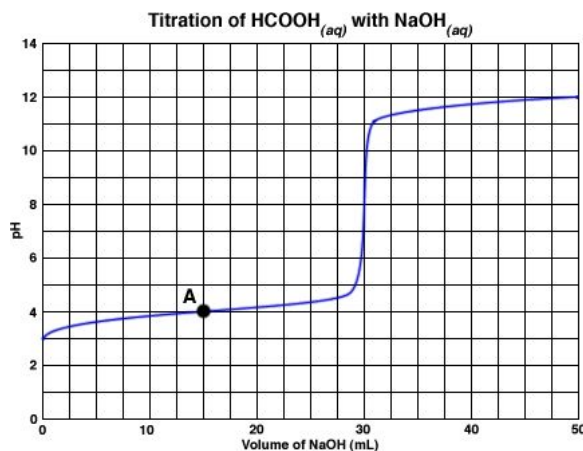
The equilibrium constant, K_c (to the nearest tenth), is _____.



10.

At point A during any titration, the solution is resistant to a change in pH if either a strong base or a strong acid is added to it. The reason for this is, at A, the solution contains equal amounts of

- A) $\text{HCOO}^-_{(aq)}$ and $\text{H}_3\text{O}^+_{(aq)}$
- B) $\text{HCOO}^-_{(aq)}$ and $\text{OH}^-_{(aq)}$
- C) $\text{HCOOH}_{(aq)}$ and $\text{OH}^-_{(aq)}$
- D) $\text{HCOOH}_{(aq)}$ and $\text{HCOO}^-_{(aq)}$ and



11.

At point A during any titration, the solution is resistant to a change in pH if either a strong base or a strong acid is added to it. The reason for this is, at A, the solution contains equal amounts of

- A) $\text{HCOO}^-_{(aq)}$ and $\text{H}_3\text{O}^+_{(aq)}$
- B) $\text{HCOO}^-_{(aq)}$ and $\text{OH}^-_{(aq)}$
- C) $\text{HCOOH}_{(aq)}$ and $\text{OH}^-_{(aq)}$
- D) $\text{HCOOH}_{(aq)}$ and $\text{HCOO}^-_{(aq)}$

12. In the acid-base reaction



- A) products are favoured
- B) $\text{HCN}_{(aq)}$ is acting as a proton acceptor
- C) $\text{HF}_{(aq)}$ is acting as a proton donor
- D) $\text{HF}_{(aq)}$ and $\text{CN}^-_{(aq)}$ are a conjugate acid-base pair

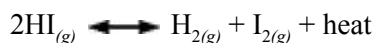
13. The $[\text{OH}^-_{(aq)}]$ of a solution with a pH = 7.00 is

- A) 1.0×10^{-14} mol/L
- B) 1.0×10^{-7} mol/L
- C) 1.0 mol/L
- D) 0 mol/L

14. In a standardization of a sodium hydroxide solution, a lab technician finds that 11.20 mL of $\text{NaOH}_{(aq)}$ are required to neutralize 1.25 g of *monoprotic* potassium hydrogen phthalate (KHP), $\text{KHC}_8\text{H}_4\text{O}_4(s)$. The concentration of the base must be
- A) 5.46×10^{-1} mol/L
 B) 6.12×10^{-3} mol/L
 C) 5.46 mol/L
 D) 6.12 mol/L
15. The K_b value for the conjugate base of ammonium ion is
- A) 5.6×10^{-10}
 B) 3.4×10^{-7}
 C) 6.8×10^{-8}
 D) 1.8×10^{-5}
16. The volume of 0.150 mol/L $\text{NaOH}_{(aq)}$ required to neutralize 500.0 mL of a strong monoprotic acid solution with a pH of 2.500 is
- A) 10.5 mL
 B) 1.58 mL
 C) 8.33 L
 D) 8.33 mL

17.

Argon gas is pumped into the equilibrium system shown below. The pressure is to remain constant.

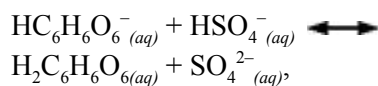


What change is expected?

- A) no change will occur
 B) the temperature will increase

- C) the concentration of $\text{HI}_{(g)}$ will decrease
 D) the concentration of $\text{H}_{2(g)}$ will increase

18. In the acid-base reaction



- A) reactants are favoured
 B) $\text{HC}_6\text{H}_6\text{O}_6^{-}(aq)$ is acting as an acid
 C) $\text{SO}_4^{2-}(aq)$ is a proton acceptor
 D) $\text{HSO}_4^{-}(aq)$ and $\text{HC}_6\text{H}_6\text{O}_6^{-}(aq)$ are a conjugate acid-base pair

19. One important fact about any system at equilibrium is that the

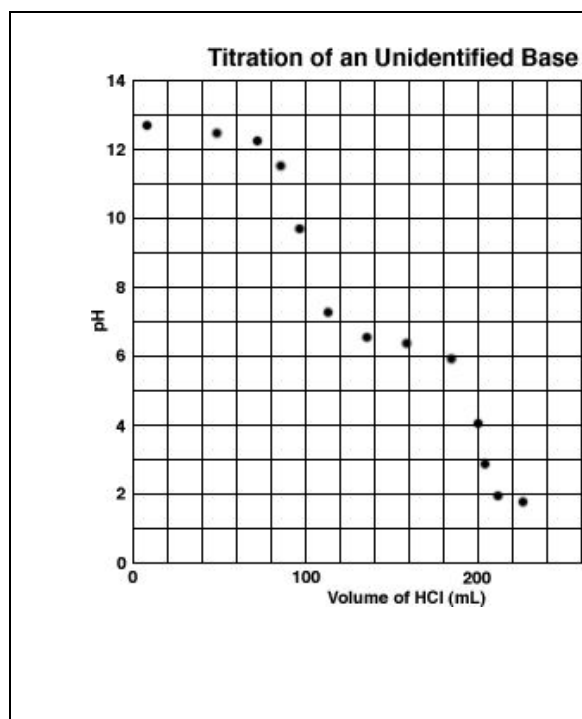
- A) reaction always favors the products.
 B) concentration of products and reactants are always equal.
 C) rate of forward reaction can never equal the rate of the reverse reaction.
 D) mols of reactants and products remains unchanged.

20. Use this list of acidic or basic solutions mixed to 1.00 mol/L to answer the following question.

- | | |
|-----------------------------------|------------------------|
| 1 $\text{H}_2\text{SO}_3(aq)$ | 5 $\text{KHCO}_3(aq)$ |
| 2 $\text{HF}_{(aq)}$ | 6 $\text{LiF}_{(aq)}$ |
| 3 $\text{CH}_3\text{COOH}_{(aq)}$ | 7 $\text{NaOH}_{(aq)}$ |
| 4 $\text{H}_3\text{PO}_4(aq)$ | 8 $\text{NH}_3(aq)$ |

When arranging the acidic solutions from **most acidic** to **least acidic**, the order is _____, _____, _____, _____ (Separate each number by commas).

21.



The graph shows the number of buffer regions to be

- A) one
- B) two
- C) three
- D) none

22. In which 0.10 mol/L solution would phenol red turn orange?

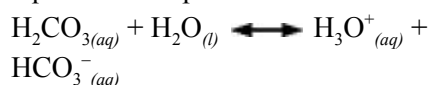
- A) $\text{HCl}_{(aq)}$
- B) $\text{K}_3\text{PO}_{4(aq)}$
- C) $\text{NaOH}_{(aq)}$
- D) $\text{CaCl}_{2(aq)}$

23. Phosphoric acid is best described as a

- A) triprotic weak acid
- B) triprotic strong acid
- C) monoprotic strong acid
- D) monoprotic weak acid

24. The primary buffer in the blood is the $\text{H}_2\text{CO}_{3(aq)} / \text{HCO}_3^-(aq)$ buffer system. The

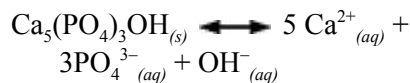
equilibrium expression for this buffer is:



If this buffer at equilibrium contains $1.0 \times 10^{-3} \text{ mol/L HCO}_3^-_{(aq)}$ and $1.5 \times 10^{-4} \text{ mol/L H}_2\text{CO}_{3(aq)}$, then the pH of the sample (to the nearest hundredth) is _____.

25.

Tooth decay results from the dissolving of tooth enamel, or hydroxyapatite, $\text{Ca}_5(\text{PO}_4)_3\text{OH}_{(s)}$. Bacteria in the presence of sugars in the mouth change the pH of the mouth which causes the following equilibrium:



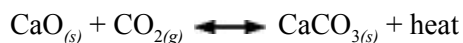
When sugar ferments on teeth and gums, the mouth becomes more acidic. Tooth enamel

- A) is formed as the concentration of the hydroxide ion decreases and the equilibrium shifts to the left
- B) is formed as the concentration of the hydroxide ion increases and the equilibrium shifts to the left
- C) breaks down as the concentration of the hydroxide ion decreases and the equilibrium shifts to the right
- D) breaks down as the concentration of the hydroxide ion increases and the equilibrium shifts to the right

26. Orange juice contains sufficient hydronium ions to kill a human if their blood and tissues were not buffered. One of the buffers in the interstitial fluid is the H_2PO_4^- / HPO_4^{2-} system. When a small amount of acid from the orange juice enters the fluid between your cells, the pH is maintained by this buffer because the H_3O^+ reacts with
- HPO_4^{2-} to produce H_2PO_4^-
 - H_2PO_4^- to produce H_3PO_4
 - H_2PO_4^- to produce HPO_4^{2-}
 - HPO_4^{2-} to produce PO_4^{3-}

27.

The following equilibrium is set up in a closed container:



If the mass of $\text{CaCO}_{3(s)}$ is doubled at constant temperature and pressure, what change will occur in the equilibrium?

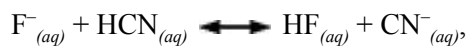
- no change will occur
- the temperature will decrease
- the mass of $\text{CaO}_{(s)}$ will increase
- the volume of the container will increase

28. A conjugate acid-base pair is
- $\text{HOOC}\text{COOH}_{(aq)}$ and CO_3^{2-}
 - $\text{H}_2\text{CO}_{3(aq)}$ and CO_3^{2-}
 - $\text{H}_2\text{SO}_{3(aq)}$ and H_2PO_4^-
 - OH^- and $\text{H}_2\text{O}_{(l)}$
29. A 0.350 mol/L unknown solution is tested and found to have a $[\text{H}_3\text{O}^+]$

equal to 0.0250 mol/L. The pH of this solution is

- 1.60
- 12.40
- 0.456
- 13.544

30. In the acid-base reaction



- products are favoured
- $\text{HCN}_{(aq)}$ is acting as a proton acceptor
- $\text{HF}_{(aq)}$ is acting as a proton donor
- $\text{HF}_{(aq)}$ and CN^- are a conjugate acid-base pair

31. The primary buffer in the blood is the $\text{H}_2\text{CO}_{3(aq)}$ / HCO_3^- buffer system. The equilibrium expression for this buffer is:
- $$\text{H}_2\text{CO}_{3(aq)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_3\text{O}^+ + \text{HCO}_3^-$$
- If this buffer at equilibrium contains 1.0×10^{-3} mol/L HCO_3^- and 1.5×10^{-4} mol/L $\text{H}_2\text{CO}_{3(aq)}$, then the pH of the sample (to the nearest hundredth) is _____.

32. A 0.45 M solution of $\text{NH}_4\text{Cl}_{(aq)}$ would have a pH of
- 0.45
 - 4.80
 - 9.20
 - 2.54
33. In a standardization of a sodium hydroxide solution, a lab technician finds that 11.20 mL of $\text{NaOH}_{(aq)}$ are required to neutralize 1.25 g of *monoprotic* potassium hydrogen phthalate (KHP), $\text{KHC}_8\text{H}_4\text{O}_4$. The concentration of the base must be
- 5.46×10^{-1} mol/L
 - 6.12×10^{-3} mol/L
 - 5.46 mol/L
 - 6.12 mol/L

34. Which is a correct statement regarding any aqueous solution?

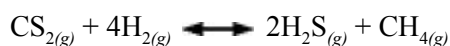
- A) As $[\text{H}_3\text{O}^+_{(aq)}]$ decreases, $[\text{OH}^-_{(aq)}]$ decreases
- B) As $[\text{H}_3\text{O}^+_{(aq)}]$ increases, $[\text{OH}^-_{(aq)}]$ increases
- C) As pOH increases, $[\text{OH}^-_{(aq)}]$ decreases
- D) As pH increases, $[\text{H}_3\text{O}^+_{(aq)}]$ increases

35. One important fact about any system at equilibrium is that the

- A) reaction always favors the products.
- B) concentration of products and reactants are always equal.
- C) rate of forward reaction can never equal the rate of the reverse reaction.
- D) mols of reactants and products remains unchanged.

36.

For the equilibrium system



What will happen to the concentration of $\text{CS}_{2(g)}$ if more $\text{H}_{2(g)}$ is added at constant volume?

- A) no change will occur
- B) the concentration will decrease
- C) the concentration will increase
- D) not enough information is given to answer

37. Which of the following chemical combinations could act as a buffer solution?

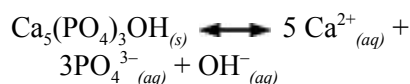
- A) $\text{S}^{2-}_{(aq)}$ and $\text{H}_2\text{S}_{(aq)}$
- B) $\text{HOH}_{(l)}$ and $\text{HCl}_{(aq)}$
- C) $\text{NH}_4^+_{(aq)}$ and $\text{HNO}_{3(aq)}$
- D) $\text{C}_6\text{H}_8\text{O}_{6(aq)}$ and $\text{NaC}_6\text{H}_7\text{O}_{6(aq)}$

38. A conjugate acid-base pair is

- A) $\text{HOCCOOH}_{(aq)}$ and $\text{CO}_3^{2-}_{(aq)}$
- B) $\text{H}_2\text{CO}_{3(aq)}$ and $\text{CO}_3^{2-}_{(aq)}$
- C) $\text{H}_2\text{SO}_{3(aq)}$ and $\text{H}_2\text{PO}_4^-_{(aq)}$
- D) $\text{OH}^-_{(aq)}$ and $\text{H}_2\text{O}_{(l)}$

39.

Tooth decay results from the dissolving of tooth enamel, or hydroxyapatite, $\text{Ca}_5(\text{PO}_4)_3\text{OH}_{(s)}$. Bacteria in the presence of sugars in the mouth change the pH of the mouth which causes the following equilibrium:



When sugar ferments on teeth and gums, the mouth becomes more acidic. Tooth enamel

- A) is formed as the concentration of the hydroxide ion decreases and the equilibrium shifts to the left
- B) is formed as the concentration of the hydroxide ion increases and the equilibrium shifts to the left
- C) breaks down as the concentration of the hydroxide ion decreases and the equilibrium shifts to the right
- D) breaks down as the concentration of the hydroxide ion increases and the equilibrium shifts to the right

40. Phosphoric acid is best described as a
- A) triprotic weak acid
 - B) triprotic strong acid
 - C) monoprotic strong acid
 - D) monoprotic weak acid

Answer Key

Thermochemical Changes

1. A
2. C
3. 2.92
4. A
5. A
6. C
7. C
8. B
9. D
10. D
11. D
12. B
13. A
14. B
15. B
16. D
17. C
18. 50.0
19. A
20. B

Electrochemical Changes

1. C
2. B
3. 6.66
4. 4
5. B
6. D
7. C
8. D
9. A
10. D
11. B
12. D
13. 96.4
14. 4, 6, 4, 2
15. A
16. B
17. B

18. A
19. C
20. 4, 0, 5, 7
21. A
22. A
23. A
24. C
25. C
26. A
27. 4
28. 0.80
29. 4, 6, 4, 2
30. C
31. A
32. A
33. D
34. C
35. 5
36. 2
37. C
38. 6.66
39. 4, 3, 7, 5
40. B
41. C
42. D
43. C
44. 0.4
45. 3, 1, 2, 4
46. A
47. 32.8
48. A
49. C
50. A

Chemical Changes of Organic Compounds

1. C
2. C
3. B
4. B
5. C

6. A
7. D
8. C
9. A
10. C
11. D
12. B
13. D
14. B
15. C
16. A
17. C
18. C
19. B
20. B
21. D
22. C
23. B
24. D
25. A
26. D
27. A
28. B
29. C
30. C
31. C
32. A
33. C
34. C
35. C
36. B
37. D
38. B
39. A
40. D

**Chemical Equilibrium Focusing
on Acid-Base Systems**

1. B
2. 13.1
3. C

4. C
5. B
6. D
7. D
8. C
9. 78.4
10. D
11. D
12. C
13. B
14. A
15. D
16. A
17. C
18. C
19. D
20. 1, 4, 2, 3
21. B
22. D
23. A
24. 7.17
25. C
26. A
27. A
28. D
29. A
30. C
31. 7.17
32. B
33. A
34. C
35. D
36. B
37. D
38. D
39. C
40. A

