

Chem 30 Diploma Exam Review Questions

Energy Unit

1. In a calorimetry experiment, 4.00 g of potassium iodide was added to 150 mL of water. If the temperature decreased by 8.70°C, calculate the molar enthalpy of solution for potassium iodide.

+/- _____ kJ/mol

2. A student supplied the following four metals with the same amount of energy. The initial temperature of each metal was 20.0 °C and the mass of each metal piece was 1.00 g.

- | |
|-------------|
| 1. Iron |
| 2. Tin |
| 3. Copper |
| 4. Aluminum |

Rank the metals from greatest to least in terms of final temperature reached.

_____ Greatest _____ Least

Use the following for the next question.

A student combined a 50.0 mL of 1.0 mol/L NaOH solution with 50.0 mL of 1.0 mol/L HCl solution during a neutralization calorimetry experiment. The change in temperature recorded was 15.0°C.

3. Using the information above determine the enthalpy of neutralization of HCl_(aq). Express your answer as **a.bc** x 10^d kJ/mol

+/- _____ kJ/mol

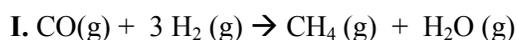
4. What mass of aluminium oxide will be formed from its elements when the enthalpy change is 3.00x10³ kJ?

_____ g

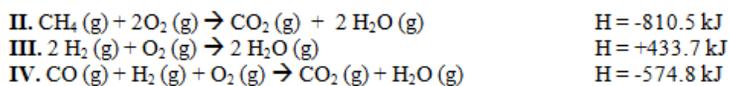
5. Determine the enthalpy of combustion when 10.0 g of methane is combusted. The molar enthalpy of combustion for methane is - 802.5 kJ/mol.

+/- _____ kJ

6. a. Calculate the enthalpy of reaction for:



Evidence:



- b. Using **reaction III**, what mass of hydrogen would be required to produce 1000 kJ of energy?

7. a. Determine the molar enthalpy of combustion for butane.

- b. Draw a potential energy diagram for the combustion of two moles of butane **and** write the reaction including the energy value as part of the reaction.

Use the following information to answer the **next two** questions.

Air bags are designed to deploy when a car moving in excess of 18 km/h undergoes a sudden decrease in speed. During the deceleration, an electrical circuit ignites a small amount of explosive powder to cause sodium azide, $\text{NaN}_{3(s)}$ to react inside the air bag. The sodium azide rapidly **decomposes**, producing nitrogen gas, which fills the bag. The equation for this reaction is $2\text{NaN}_{3(s)} \rightarrow 3\text{N}_{2(g)} + 2\text{Na}_{(s)} + 43.5 \text{ kJ}$

8. The decomposition of sodium azide is an *i* and has a *ii* ΔH value.

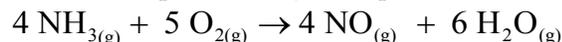
	<i>i</i>	<i>ii</i>
A.	endothermic	positive
B.	endothermic	negative
C.	exothermic	positive
D.	exothermic	negative

9. The molar heat of **formation** of sodium azide is

A. -43.5 kJ/mol B. -21.8 kJ/mol C. +21.8 kJ/mol D. +43.5 kJ/mol

Use the following information to answer the **next** question.

Large amounts of ammonia are used in the production of nitric acid, $\text{HNO}_{3(aq)}$. One step in the production of nitric acid is represented by the equation



10. For the reaction equation, the enthalpy change is *i* kJ because the energy absorbed when the bonds of the reactants are broken is *ii* than the energy *ii* when the bonds of the products are formed.

	<i>i</i>	<i>ii</i>	<i>iii</i>
A.	+902.0	less	absorbed
B.	-902.0	less	released
C.	+902.0	greater	absorbed
D.	-902.0	greater	released

11. Which compound is “energetically” the most stable?

A. Methane B. ethane C. propane D. butane

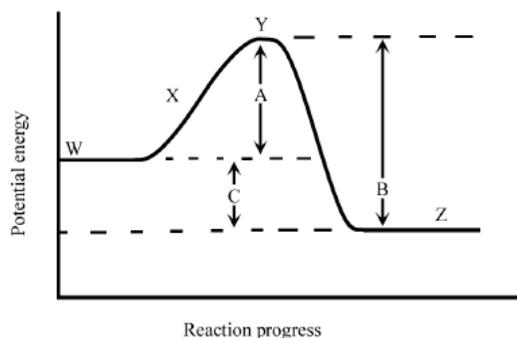
Use the following information to answer the **next** question.

Cancarb Ltd., a company located in Medicine Hat, produces high-quality carbon through the thermal decomposition of natural gas. The natural gas is heated in the absence of oxygen to 1300°C in a reaction chamber. The reaction is represented by the equation: $\text{CH}_{4(g)} \rightarrow \text{C}_{(s)} + 2 \text{H}_{2(g)}$

12. In this decomposition, the *i* have more *ii* energy than the *iii* .

	<i>i</i>	<i>ii</i>	<i>iii</i>
A.	Reactants	Potential	Products
B.	Products	Potential	Reactants
C.	Reactants	Kinetic	Products
D.	Products	Kinetic	Reactants

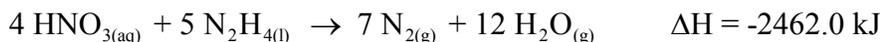
Use the following information to answer the **next** question



13. The activation energy (E_a) of the reverse reaction is labelled i and the activation energy value for the forward reaction is labelled ii and the enthalpy change for the reverse reaction is iii .

	i	ii	iii
A.	B	A	+ C
B.	B	A	- C
C.	A	B	+ C
D.	A	B	- C

Use the following information to answer the **next** question.



14. The molar enthalpy of reaction for nitrogen is i and is the energy ii per mole of nitrogen formed.

	i	ii
A.	-351.7 kJ/mol	Released
B.	+351.7 kJ/mol	Absorbed
C.	0 kJ/mol	Absorbed
D.	0 kJ/mol	Released

Use the following information to answer the **next** question

Cold packs are used to treat sprains and bruises. A chemical commonly used in cold packs is ammonium nitrate, $\text{NH}_4\text{NO}_{3(\text{s})}$, which can produce a cooling effect.

15. The change that occurs in this cold pack is an i change, which results in a(n) ii in the iii energy of the system.

	i	ii	iii
A.	endothermic	increase	potential
B.	exothermic	increase	potential
C.	endothermic	decrease	kinetic
D.	exothermic	decrease	kinetic

Use the following information to answer the **next** question.

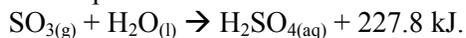
A student performed a calorimetry experiment and recorded the following data.

Mass of aluminum calorimeter	470.0 g
Mass of calorimeter water	100.0 g
Initial temperature of calorimeter water	23.0 °C
Mass of solid added to calorimeter	5.00 g
Final temperature of calorimeter water	24.6 °C

16. Determine the enthalpy of solution (dissolving) +/- _____ kJ.
(Record your answer to **three** digits)

Use the following information to answer the **next** question.

One component of acid rain can be formed in the atmosphere by the reaction:



17. The molar heat of formation of $\text{H}_2\text{SO}_4(\text{aq})$ in the atmosphere is, under standard conditions, is
a. -453.7 kJ/mol b. -586.7 kJ/mol c. -814.0 kJ/mol d. -909.3 kJ/mol
18. If the equation $2 \text{A} + \text{B} \rightarrow \text{C} + 2\text{D} + 57.0 \text{ kJ}$ was rewritten such that the energy term had a value of 171 kJ the balancing coefficients for the equation would be _____, _____, _____ and _____.

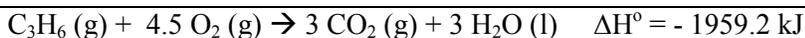
Use the following information to answer the **next** question.

Calorimetry Experiment Data

1. Mass change of ethanol
2. Mass of aluminium calorimeter
3. Mass of aluminium calorimeter and water
4. Initial temperature of aluminium calorimeter
5. Maximum temperature change of ethanol
6. Maximum temperature change of aluminium calorimeter and water

19. The Calorimetry experiment data required to determine the molar enthalpy of combustion of ethanol are _____, _____, _____ and _____.
20. The energy released when 0.500 mol of $\text{AgI}(\text{s})$ is formed from its elements is _____ kJ.

Use the following information to answer the **next** question.



21. The molar enthalpy of formation of cyclopropane, $3 \text{C}(\text{s}) + 3 \text{H}_2(\text{g}) \rightarrow \text{C}_3\text{H}_6(\text{g})$, is +/- _____ kJ.

Organic Unit

1. The formula that represents an alkene is _____ i _____ and the formula that represents an alkyne is _____ ii _____.

	i	ii
A.	C ₆ H ₁₂	C ₆ H ₁₀
B.	C ₆ H ₁₂	C ₆ H ₁₄
C.	C ₆ H ₁₀	C ₆ H ₁₂
D.	C ₆ H ₁₀	C ₆ H ₁₄

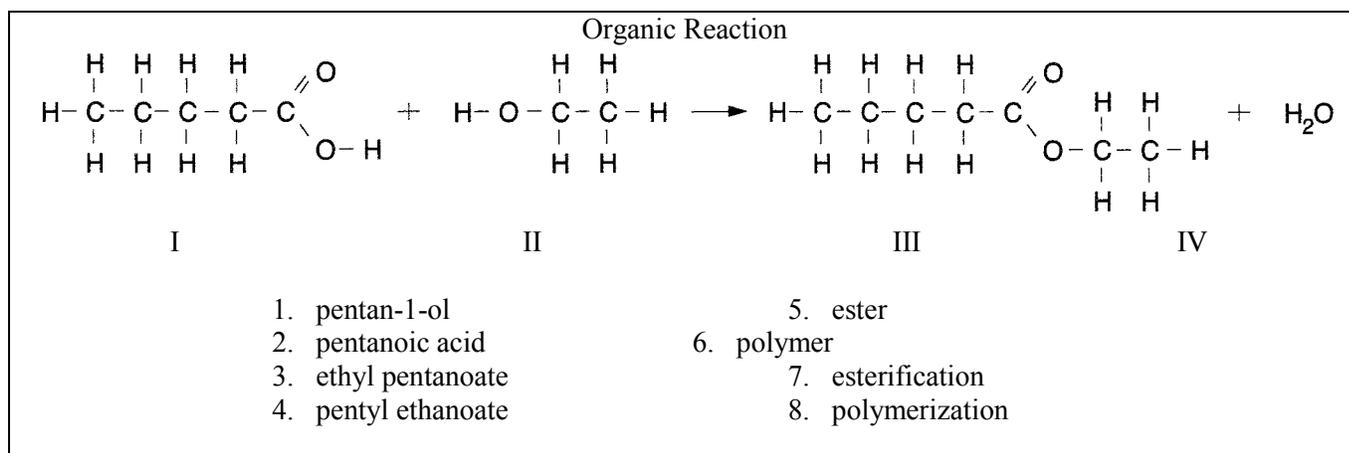
2. When butane undergoes a reaction with chlorine gas, the organic product is _____ i _____ in this _____ ii _____ reaction.

	i	ii
A.	dichlorobutane	Addition
B.	dichlorobutane	Substitution
C.	chlorobutane	Addition
D.	chlorobutane	Substitution

3. The name of the compound prepared from the _____ i _____ reaction of water and ethene is _____ ii _____.

	i	ii
A.	Addition	Ethanol
B.	Elimination	Ethanol
C.	Addition	Ethanoic acid
D.	elimination	Ethanoic acid

4. Use the following information to answer the next question



- The name of the substance labelled I is _____ (Record in the 1st box)
 The above reaction can be classified as a(n) _____ (Record in the 2nd box)
 The substance labelled III can be classified as a(n) _____ (Record in the 3rd box)
 The name of the substance labelled III is _____ (Record in the 4th box)

5. Use the following information to answer the **next** question

The molecule C₂H₅OH(l) can be used as a fuel additive or on its own as a fuel. It results in cleaner burning engines and less environmentally harmful emissions.

The coefficients for the balanced complete combustion reaction for the molecule above is

- C₂H₅OH(l) _____ (record answer in 1st box)
 O₂(g) _____ (record answer in 2nd box)
 CO₂(g) _____ (record answer in 3rd box)
 H₂O(g) _____ (record answer in 4th box)

6. $\text{CH}_3\text{CH}_2\text{COOCH}_3$ belongs to the functional group

- A. Carboxylic acids
- B. Esters
- C. Alcohols
- D. Aromatics

7. Use the following information to answer the **next** question

The IUPAC names for two organic molecules are hept-2-ene and but-2-ene.

Descriptions

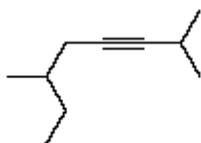
- | | |
|---------------|------------------------------------|
| 1 Saturated | 6 Alkanes |
| 2 Unsaturated | 7 Alkenes |
| 3 Cyclic | 8 Contains only single bonds |
| 4 Aliphatic | 9 Contains single and double bonds |
| 5 Aromatic | |

Numerical Response 3.

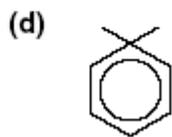
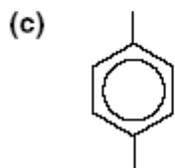
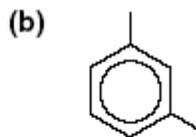
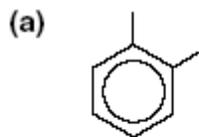
The descriptions numbered above that apply to both hept-2-ene and but-2-ene are _____, _____, _____, and _____.

8. Which of the following is the correct name for the compound shown below?

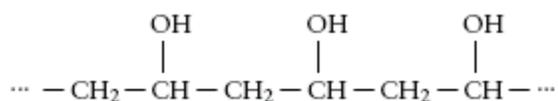
- A. 6-ethyl-2-methylhept-3-yne
- B. 2-ethyl-6-methylhept-4-yne
- C. 3,7-dimethyloct-5-yne
- D. 2,6-dimethyloct-3-yne



9. Which of the following molecules represents 1,3-dimethylbenzene?



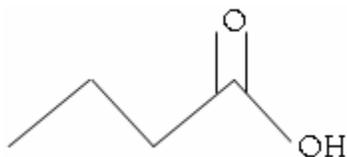
10. Polyvinyl alcohol has the following structure.



What is the monomer that is used to form this polymer?

- (a) $\text{HO} - \text{CH}_2 - \text{CH}_3$ (b) $\text{HO} - \text{CH}_2 - \overset{\text{O}}{\parallel}{\text{C}}\text{H}$
 (c) $\text{HO} - \text{CH} = \text{CH}_2$ (d) $\overset{\text{O}}{\parallel}{\text{C}} - \text{CH}_3$

Use the following information to answer the **next** question.



11. The functional group present in the given structure is i and the parent chain is carbons long.

	i	ii
A.	Carboxyl	5
B.	Carboxyl	4
C.	Hydroxyl	5
D.	Hydroxyl	4

Use the following information to answer the **next** question.

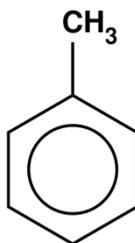
In an experiment, cyclohexanol is treated with phosphoric acid at a temperature of 110°C – 160°C. In this process, a compound 'x' and a water molecule are produced.

12. The product formed during this i reaction is ii .

	i	ii
A.	Cracking	Hexene
B.	Cracking	Cyclohexene
C.	Elimination	Hexene
D.	Elimination	Cyclohexene

Use the following information to answer the next question.

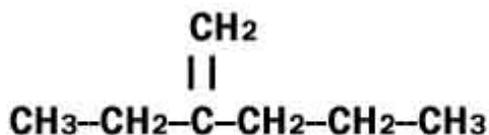
Toluene is an industrial solvent for glues that can be converted to a powerful explosive (TNT, trinitrotoluene).



16. Based on the structure of toluene, it can be classified as an ___ i ___ hydrocarbon and the IUPAC name for toluene is ___ ii ___

	i	ii
A.	Alkene	Methyl benzene
B.	Aromatic	Methyl benzene
C.	Alkene	Phenyl methane
D.	Aromatic	Phenyl methane

Use the following information to answer the next question



17. The name of this molecule is

- A. 2-ethylbutene
- B. 2-ethylpent-1-ene
- C. 3-propylbut-3-ene
- D. 2-methylpent-2-ene

18. Use the following information to answer the **next** question

The hydrocarbon industry is the driving force behind the Alberta economy. To process crude oil, fractional distillation is used. This process separates the crude oil into its different parts.

Given the following molecules, identify the order at which the molecules would be removed from the fractional distillation tower.

1. CH_4 2. $\text{C}_{15}\text{H}_{32}$ 3. $\text{C}_{25}\text{H}_{52}$ 4. C_8H_{18}

Height of Removal from Tower

- | | |
|------------------------|---|
| Lowest | _____ (Record in the 1 st box) |
| 2 nd lowest | _____ (Record in the 2 nd box) |
| 3 rd lowest | _____ (Record in the 3 rd box) |
| Highest | _____ (Record in the 4 th box) |

22. Use the following information to answer the next question

Organic Compounds

1. Alkanes
2. Alkenes
3. Alkynes

Use the terms numbered above to answer the descriptions about the substances when they contain the same number of carbon atoms.

(you may use a number more than once)

The compound with the highest boiling point _____ (box 1)

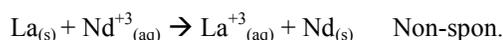
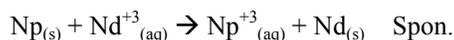
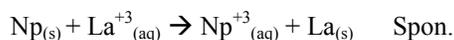
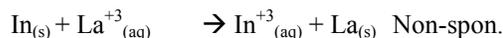
The most reactive compound _____ (box 2)

The compound with the lowest boiling point _____ (box 3)

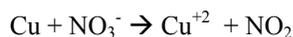
The least reactive compound _____ (box 4)

Electrochemistry

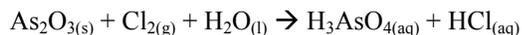
1. A number of reactions between four metals and their corresponding positive ions were attempted. Using the results below develop a reduction half reaction table.



2. Balance the following reaction by devising your own half reactions. (Assume acidic solution)



3. Balance the following reaction using oxidation numbers.



4. Calculate the concentration of the hydrogen peroxide based on the following data.

Experimental design: A 15.0 mL sample of acidified unknown hydrogen peroxide solution was titrated with a standardized solution of potassium dichromate that has a concentration of 0.0500 mol/L.

Evidence: The volume of potassium dichromate required to react 15.0 mL of hydrogen peroxide solution.

Trial	1	2	3	4
Final volume (mL)	13.9	26.3	38.8	13.1
Initial volume (mL)	0.4	13.9	26.3	0.8
Volume used (mL)	13.5	12.4	12.5	12.3

Use the information to answer the following question.

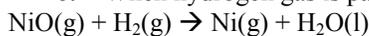
Sulfur reacts with oxygen in a redox reaction to a variety of compounds:

S_2O_3
 SO_2
 SO_3
 S_2O_7

5. Which of the following correctly lists the compounds from lowest to highest oxidation number of sulfur?

- a. $S_2O_3 < SO_2 < SO_3 < S_2O_7$ c. $S_2O_7 < SO_2 < S_2O_3 < SO_3$
b. $SO_2 < SO_3 < S_2O_3 < S_2O_7$ d. $SO_3 < S_2O_3 < S_2O_4 < SO_2$

6. When hydrogen gas is passed over nickel oxide, NiO(s), the latter is converted into nickel.



What happens to the nickel in this reaction?

- a. Displacement c. Disproportionation
b. Oxidation d. Reduction

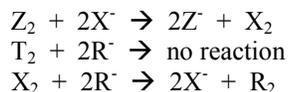
Consider a redox reaction: $Cu(s) + NO_3^-(aq) \rightarrow Cu^{2+}(aq) + NO(g)$ (acidic medium)

7. The balanced form of the above equation is

- a. $Cu(s) + NO_3^-(aq) + H^+(aq) \rightarrow Cu^{2+}(aq) + NO(g) + H_2O(g)$
b. $2Cu(s) + NO_3^-(aq) + 8H^+(aq) \rightarrow 2Cu^{2+}(aq) + NO(g) + 6H_2O(g)$
c. $3Cu(s) + 2NO_3^-(aq) + 8H^+(aq) \rightarrow 3Cu^{2+}(aq) + 2NO(g) + 4H_2O(g)$
d. $Cu(s) + NO_3^-(aq) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + 2NO(g) + H_2O(g)$

Use the following information to answer the next question

Four atoms, Z, T, X, and R, form diatomic molecular elements and negative ions. The following observations are made:



1. X_2
2. R_2
3. Z_2
4. T_2

8. When the elements are arranged in order of most reactive to least reactive, the list is

— — — — —

9. Which of the following industrial processes could **NOT** be classified as an oxidation-reduction reaction?

- a. $2NaCl(s) \rightarrow 2Na(s) + Cl_2(g)$
b. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$
c. $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$
d. $Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

10. The net ionic equation representing the reaction between chlorine gas and aqueous sodium iodide is

- a. $2Cl^-(aq) + I_2(s) \rightarrow Cl_2(g) + 2I^-(aq)$
b. $Na^+(aq) + Cl_2(g) \rightarrow Na(s) + 2Cl^-(aq)$
c. $Cl_2(g) + 2I^-(aq) \rightarrow 2Cl^-(aq) + I_2(s)$
d. $Na^+(aq) + I_2(s) + 2Cl^-(aq) \rightarrow Na(s) + 2I^-(aq) + Cl_2(g)$

Use the following information to answer the **next** question.

	$R^+_{(aq)}$	$G^+_{(aq)}$	$X^+_{(aq)}$
$R_{(s)}$	----	√	X
$G_{(s)}$	X	----	X
$X_{(s)}$	√	√	----

X = no reaction
 √ = spontaneous reaction
 ---- = not performed

11. The strongest reducing agent is
 a. $X^+_{(aq)}$ b. $X_{(s)}$ c. $G^+_{(aq)}$ d. $G_{(s)}$
12. Students tried the following combination of reactants in a laboratory. Which combination is expected to be non-spontaneous?
 a. $H_2(g) + Ag^+(aq)$ b. $Cr(s) + Sn^{2+}(aq)$ c. $Ba(s) + Fe^{2+}(aq)$ d. $Al(s) + Ca^{2+}(aq)$
13. Draw a voltaic cell using the half cell $Ni_{(s)}/Ni^{2+}_{(aq)}$. Choose anything else for the other half cell as long as the net voltage is greater than 1.00 V. All lab material is available.
- **Label the anode, cathode, electron flow and ion flow. Show half-reactions, net reaction and the E°_{net} cell.**

Use the following information to answer the next question.

Properties

1. Reacts spontaneously with $Cu^{2+}_{(aq)}$
2. Reacts spontaneously with $Cl^-_{(aq)}$
3. Is an oxidizing agent and reducing agent
4. Is reduced by hydrogen gas
5. Reacts spontaneously with $H_2O_{(l)}$
6. Reacts spontaneously with $Ag_{(s)}$
7. Is an inert electrode

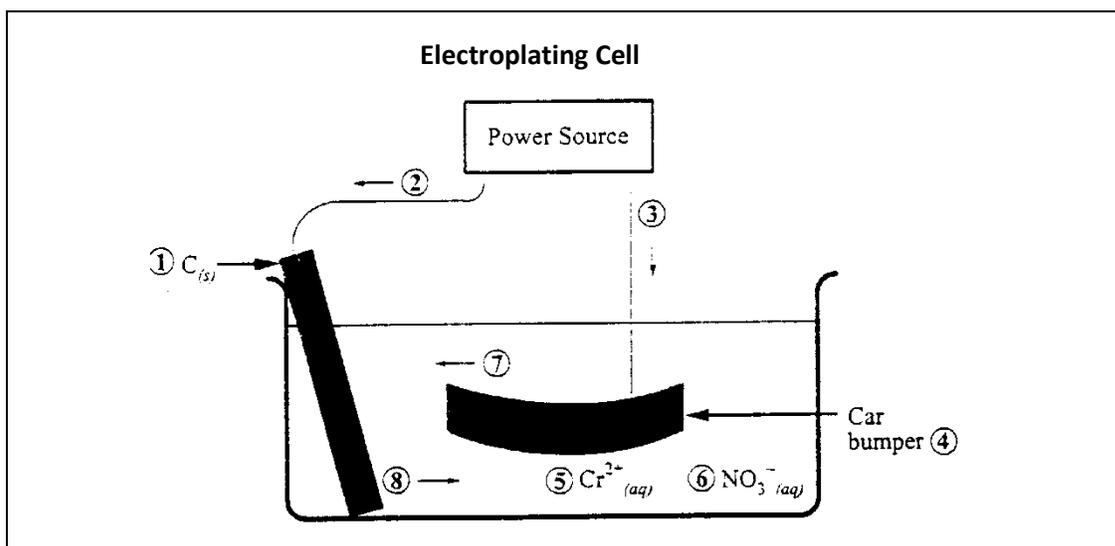
14. Match each of the following species with its **most** appropriate property.

$H_2O_{(l)}$ _____
 $Zn_{(s)}$ _____
 $Sn^{4+}_{(aq)}$ _____
 $C_{(s)}$ _____

15. If the scale for electrode potentials is change so that the reduction of $Ni^{2+}_{(aq)} + 2 e^- \rightarrow Ni_{(s)}$ is 0.00 V, the electrode potential for the reduction of $Br_{2(l)}$ will be
 a. 0.26 V b. 0.81 V c. 1.07 V d. 1.33 V

16. If the lithium reduction half-reaction, $Li^+_{(aq)} + e^- \rightarrow Li_{(s)}$, has been assigned an E° value of 0.00 V, the predicted E°_{net} value for the reaction $Cu_{(s)} + Zn^{2+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Zn_{(s)}$ would be
 A. +3.38 V B. -2.28 V C. -0.42 V D. -1.10 V

17. A common voltaic cell may have the notation: $\text{Zn}_{(s)} / \text{ZnSO}_{4(aq)} // \text{Pb}(\text{NO}_3)_{2(aq)} / \text{Pb}_{(s)}$. The voltage generated by this cell is
- 0.40 V
 - 0.63 V
 - 0.76 V
 - 0.89 V
18. In an electrochemical cell, the cathode is the electrode at which electrons _____ the half-cell and _____ takes place.
- leave, oxidation
 - leave, reduction
 - enter, oxidation
 - enter, reduction
19. Silver plating or ornaments or utensils is done by electrolysis of a soluble silver compound. The object to be plated is placed at one of the electrodes. If 10.8 g of silver is to be deposited, how long will it take to plate the object using the electron flow of 0.500 A?
- 10.7 h
 - 5.37 h
 - 2.68 h
 - 1.34 h

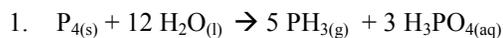


20. Use the numbers that identify the parts of the electroplating cell in the diagram above to complete the statements below.

The anode is identified by _____
 The electron movement is identified by _____
 The anion movement is identified by _____
 The cation is identified by _____

Use the following information to answer the **next two** questions.

Phosphine gas, $\text{PH}_3(\text{g})$, is used to produce a flame retardant for battling forest fires. Phosphine gas is produced in the following balanced reaction.

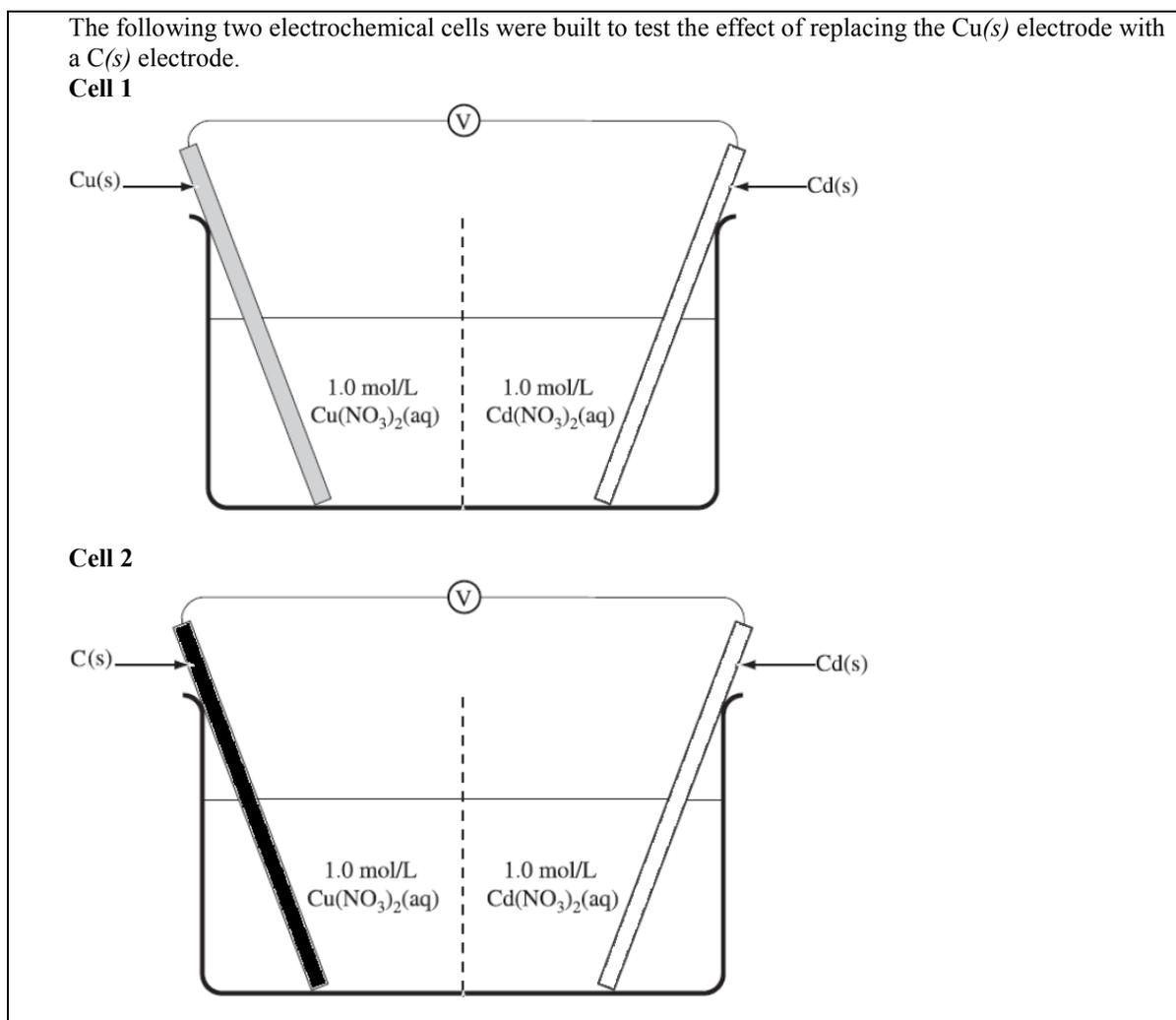


21. Which of the following statements is true?
- Phosphorus atoms only undergo oxidation.
 - Phosphorus atoms only undergo reduction.
 - Phosphorus atoms undergo disproportionation
 - The reaction is not a reduction/oxidation reaction.

22. The half reaction representing the process responsible for the corrosion of unprotected iron metal is i . Attaching a sacrificial anode made of ii would help to protect the iron from corrosion.

	<i>i</i>	<i>ii</i>
A.	$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	Cr(s)
B.	$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$	Cr(s)
C.	$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	Sn(s)
D.	$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-(\text{aq})$	Sn(s)

Use the following information to answer the *next* question.

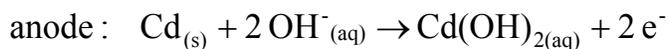


23. Select the row that correctly describes the theoretical effects of replacing the Cu(s) electrode with the C(s) electrode.

ROW	Direction of e^- flow	E°_{Cell} value	Anode of the Cell
A.	No Change	Increases	C(s)
B.	No Change	No Change	Cd(s)
C.	Reversed	Increases	C(s)
D.	Reversed	No Change	Cd(s)

Use the following information to answer the **next two** questions.

A nickel-cadmium, or NiCad, battery has a long active-life and a long shelf-life, but is more expensive to produce than an alkaline battery. The discharging battery has an electrical potential of 1.20 V. The pertinent half-reactions are:

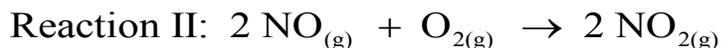
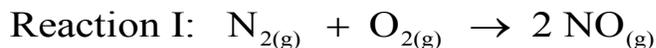


24. The reduction potential for anode half-cell is;

- A. -1.69 V B. -0.71V C. +0.71 V D. +1.69 V

Use the following information to answer the **next** question.

In a car engine, $\text{NO}_{(g)}$ can form. Once released into the air, $\text{NO}_{(g)}$ can react with oxygen and water to produce acid rain.



25. The oxidation numbers for nitrogen in the order given are;

- $\text{N}_{2(g)}$ _____
 $\text{NO}_{2(g)}$ _____
 $\text{HNO}_{3(aq)}$ _____
 $\text{HNO}_{2(aq)}$ _____

Use the following information to answer the **next** question.

Galvanizing, a process used to prevent corrosion, involves coating iron metal with a thin layer of zinc metal.

26. Iron nails can be galvanized using an electrolytic process. The nails to be galvanized would be attached to the _____ i _____ where _____ ii _____ occurs.

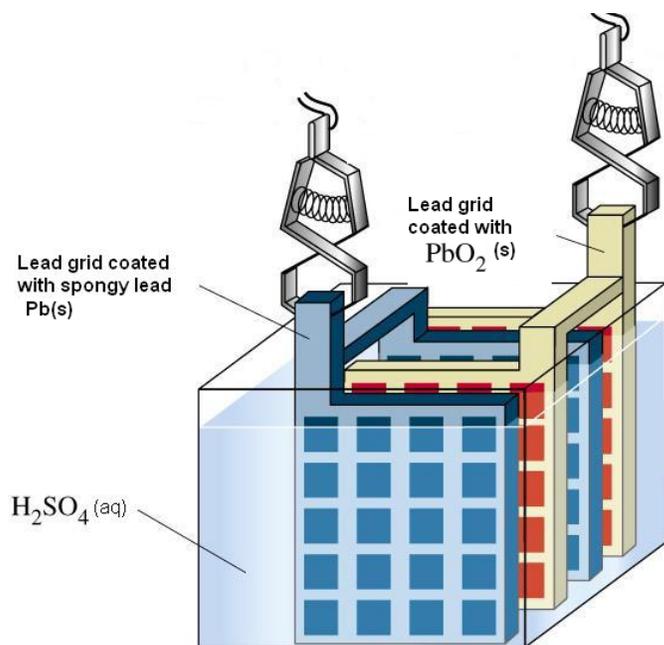
	<i>i</i>	<i>ii</i>
A.	Cathode	Reduction
B.	Anode	Oxidation
C.	Anode	Reduction
D.	Cathode	Oxidation

27. A galvanized nail was placed in a copper (II) sulfate solution. After a day, the blue colour of the solution disappeared and copper metal was produced. The procedure was repeated with objects made of other metals. Similar results would **not** be predicted for;

- A. an uncoated iron nail B. a gold plated bracelet C. a chromium plated spoon D. a nickel plated coin

Use the following information to answer the **next** question

Redox reactions play very important roles in providing society with highly portable energy devices such as lead storage batteries. Lead storage batteries are commonly used in cars primarily because of the voltage that they produce. A cutaway diagram of a lead storage battery is illustrated below, along with a listing of some of the batteries features.



28. The half reaction that occurs at the anode of this cell is;

- A. $\text{PbO}_2(\text{s}) + \text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$
- B. $\text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2\text{SO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- C. $\text{Pb}(\text{s}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$
- D. $\text{Pb}(\text{s}) \rightarrow \text{Pb}^{2+}(\text{aq}) + 2\text{e}^-$

29. When the skeletal equation $\text{Br}_2 \rightarrow \text{BrO}_3^-$ is balanced in acidic conditions, $\text{H}_2\text{O}(\text{l})$, $\text{H}^+(\text{aq})$ and e^- will appear. Which of the following are the correct balancing coefficients?

	H_2O	H^+	e^-
A.	3	3	2
B.	6	6	4
C.	6	6	5
D.	6	12	10

30. What products result from the electrolysis of **molten** KBr ?

ROW	Product at the cathode	Product at the anode
A.	K	O ₂
B.	K	Br ₂
C.	O ₂	H ₂
D.	Br ₂	K

Use the following information to answer the **next** question

Under certain circumstances the acidified potassium chlorate undergoes disproportionation to form potassium chloride and potassium perchlorate, as shown in the following **unbalanced equation**.



33. When the equation is balanced using whole number coefficients, the

Coefficient for KClO₃ is _____

Coefficient for KCl is _____

Coefficient for KClO₄ is _____

Number of electrons transferred is _____

Acid-Base Equilibrium Unit

1. Analysis of the equilibrium $2\text{NOCl}(g) \leftrightarrow 2\text{NO}(g) + \text{Cl}_2(g)$ gave the following information:

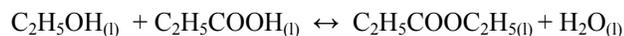
$$\begin{aligned}[\text{NOCl}] &= 0.500 \text{ mol/L} \\ [\text{NO}] &= 2.00 \times 10^{-2} \text{ mol/L} \\ [\text{Cl}_2] &= 1.00 \times 10^{-2} \text{ mol/L}\end{aligned}$$

What is the value for K_C for this system?

_____ Record your answer in the format of $a.bc \times 10^{-d}$

Use the following information to answer the next question.

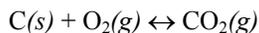
The unique flavour of fruits and berries is due to the presence of esters, chemical compounds that are easily synthesized in the lab. For example, ethyl propanoate is responsible for the flavour characteristic to pineapple. It is produced by the reaction:



When 7.71 mol of $\text{C}_2\text{H}_5\text{OH}_{(l)}$ and 7.37 mol of $\text{C}_2\text{H}_5\text{COOH}_{(l)}$ are reacted in a beaker, 4.80 mol of $\text{C}_2\text{H}_5\text{COOC}_2\text{H}_5_{(l)}$ are present when equilibrium is established and the total volume of liquid is exactly 1.00 L

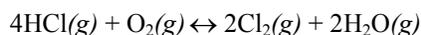
2. Calculate the K_{eq} for this system. Are the reactants or products favoured at equilibrium? Justify your choice.

3. What is the equilibrium law expression for the reaction:



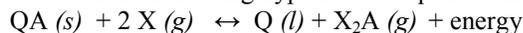
- A. $K_C = \frac{[\text{C}(s)][\text{O}_2(g)]}{[\text{CO}_2(g)]}$
- B. $K_C = \frac{[\text{CO}_2(g)]}{[\text{C}(g)][\text{O}_2(g)]}$
- C. $K_C = \frac{[\text{CO}_2(g)]}{[\text{O}_2(g)]}$
- D. $K_C = \frac{[\text{O}_2(g)]}{[\text{CO}_2(g)]}$

4. In order to shift the following reaction to the right a chemist would remove ____ i ____ and add ____ ii ____.



	i	ii
a.	Chlorine	Oxygen
b.	Oxygen	Chlorine
c.	Oxygen	Hydrogen chloride
d.	Water	Chlorine

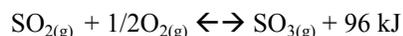
5. Consider the following hypothetical equilibrium system:



This reaction can be shifted to increase the temperature by adding ____ i ____ and changing the volume to ____ ii ____ pressure.

	i	ii
a.	X	Decrease
b.	X ₂ A	Decrease
c.	X	Increase
d.	X ₂ A	Increase

6. The condition that will favour a high concentration of SO_{3(g)} for the reaction is ____ i ____ and ____ ii ____.



	i	ii
a.	High temperature	Low pressure
b.	High temperature	High pressure
c.	Low Temperature	Low pressure
d.	Low Temperature	High pressure

7. The reaction: X_(g) + Y_(g) ↔ Z_(g) reached equilibrium in a closed container. A decrease in temperature causes the equilibrium to shift towards the products. The reaction can be classified as ____ i ____ in and the energy value would be placed on the ____ ii ____ side of the equation.

	i	ii
a.	Exothermic	Reactant
b.	Exothermic	Product
c.	Endothermic	Product
d.	Endothermic	reactant

8. Given the equilibrium, PCl_{5(g)} ↔ PCl_{3(g)} + Cl_{2(g)} K_{eq}=0.59. What is the equilibrium concentration of PCl₃, given that the equilibrium concentration of PCl₅ is 0.200 mol/L?

- 0.58 mol/L
- 0.059 mol/l
- 0.34 mol/L
- 0.12 mol/L

13. Fill in the following chart:

Solution	[solution]	[H ₃ O ⁺]	[OH ⁻]	pH	pOH
HCl	2.50X 10 ⁻⁴ mol/L				

14. What is the pH a 0.25 mol/L solution of methanoic acid? (include a reaction with water and the use of the ICE chart)

15. Nitrous acid is added to a solution of potassium phosphate. Write the net ionic reaction, indicating which reaction is favored.

16. Ammonia is a weak base.

- Write out the equilibrium reaction and the K_b expression for a solution of ammonia
- Determine the K_b for a solution of ammonia

17. In a solution of HCOOH_(aq), the species present in the highest concentration is:

- HCOOH
- HCOO⁻
- H₃O⁺
- OH⁻

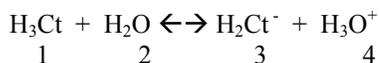
18. An acid base reaction that favors the formation of products is

- HF + HCO₃⁻
- H₂CO₃ + NO₂⁻
- H₂S + SO₄⁻²
- H₂SO₃ + HOOCOO⁻

19. What is the name of the unknown acid, if the concentration of the acid is 0.10 mol/L and the pH 2.39?

- Methanoic acid
- Phosphoric acid
- Nitric acid
- Butanoic acid

20. When citric acid combines with water in the mouth, one reaction that occurs is:



The conjugate acid base pairs are:

- 1,2 and 3,4
- 1,3 and 2,4
- 1,4 and 2,3
- none of the above

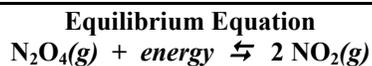
21. A reaction in which equilibrium favours the products is

- A. $\text{HSO}_4^- (\text{aq}) + \text{F}^- (\text{aq}) \leftrightarrow \text{HF} (\text{aq}) + \text{SO}_4^{2-} (\text{aq})$
B. $\text{HF} (\text{aq}) + \text{H}_2\text{O} (\text{l}) \leftrightarrow \text{H}_3\text{O}^+ (\text{aq}) + \text{F}^- (\text{aq})$
C. $\text{HF} (\text{aq}) + \text{SO}_4^{2-} (\text{aq}) \leftrightarrow \text{HSO}_4^- (\text{aq}) + \text{F}^- (\text{aq})$
D. $\text{HCN} (\text{aq}) + \text{F}^- (\text{aq}) \leftrightarrow \text{HF} (\text{aq}) + \text{CN}^- (\text{aq})$

22. Which of the following substances is most likely amphoteric?

- a. $\text{CH}_4 (\text{aq})$ b. $\text{CH}_3\text{OH} (\text{aq})$ c. $\text{CH}_3\text{COO}^- (\text{aq})$ d. $\text{HOOC}^- (\text{aq})$

Use the following information for the **next** question.



Stresses Applied to a System at Equilibrium

1.	increase volume	5.	increase in $\text{NO}_2 (\text{g})$ concentration
2.	decrease volume	6.	decrease in $\text{NO}_2 (\text{g})$ concentration
3.	increase temperature	7.	increase in $\text{N}_2\text{O}_4 (\text{g})$ concentration
4.	decrease temperature	8.	decrease in $\text{N}_2\text{O}_4 (\text{g})$ concentration

23. The stresses numbered above that will cause the equilibrium system to shift to the reactants are: _____, _____, _____, and _____.
(Record your answer in **ascending order** on the answer sheet.)

24. The conjugate base of $\text{N}_2\text{H}_5^+ (\text{aq})$ is

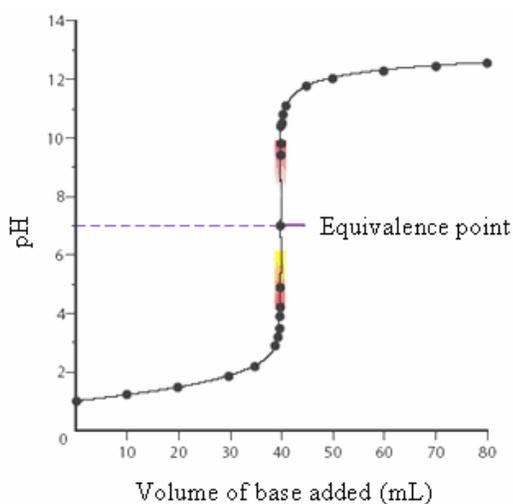
- a. $\text{HOH} (\text{l})$ b. $\text{OH}^- (\text{aq})$ c. $\text{N}_2\text{H}_4 (\text{aq})$ d. $\text{N}_2\text{H}_6^{2+} (\text{aq})$

25. Determine the pH for a 0.100 mol/L solution of benzoic acid. _____

(Record your answer to **three digits** on the answer sheet.)

Use the following information to answer the **next** question.

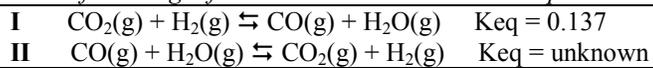
While performing a titration in the laboratory, a student plotted the following graph:



26. The graph plotted belongs to a titration between

- A. $\text{HCl} (\text{aq})$ with $\text{NaOH} (\text{aq})$ C. $\text{HOOC} (\text{aq})$ with $\text{NaOH} (\text{aq})$
B. $\text{CH}_3\text{COOH} (\text{aq})$ with $\text{NaOH} (\text{aq})$ D. $\text{H}_2\text{S} (\text{aq})$ with $\text{NaOH} (\text{aq})$

Use the following information to answer the next 3 question



32. If hydrogen gas is added to reaction I at equilibrium, then the concentration of the carbon dioxide will i and the value of the K_C will ii .

ROW	<i>i</i>	<i>ii</i>
A	decrease	stay the same
B	increase	stay the same
C	increase	decrease
D	decrease	increase

33. In reaction II, the K_{eq} is _____.

Use the following additional information to answer the next question

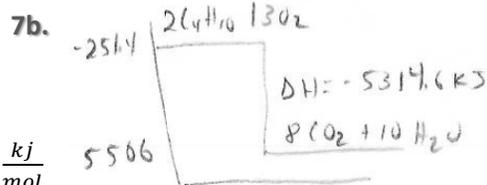
Reaction I at Equilibrium			
$[\text{CO}_2(\text{g})]$ mol/L	$[\text{H}_2(\text{g})]$ mol/L	$[\text{CO}(\text{g})]$ mol/L	$[\text{H}_2\text{O}(\text{g})]$ mol/L
?	1.50	2.50	.250

34. The concentration of $\text{CO}_2(\text{g})$ in reaction I at equilibrium is _____ mol/L

Answers

Energy Unit

1. 227 2. 2314 3. 6293 4. 183 5. 500 6a. +664.4 kJ
 6b. 9.32 g 7a. $-2657.3 \frac{\text{kJ}}{\text{mol}}$
8. D 9. C 10. B 11. D 12. B 13. A 14. A 15. A 16. 1.34 17. D
18. 6336 19. 1236 20. 30.9 21. 78.7

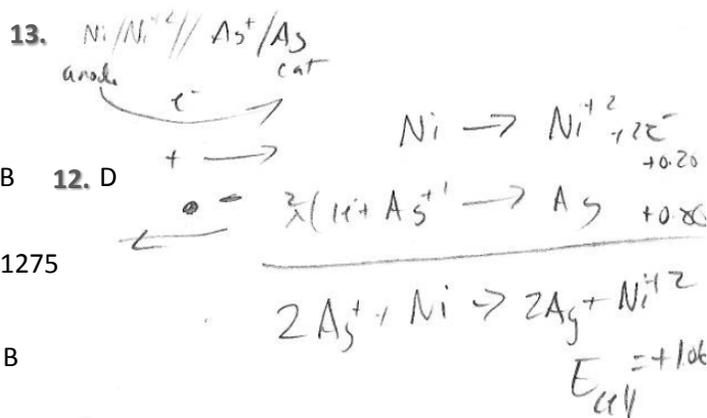


Organic Unit

1. A 2. D 3. A 4. 2753 5. 1323 6. B 7. 2479 8. D 9. B 10. C
11. B 12. D 13. 2346 14. C 15. 1345 16. B 17. B 18. 3241 19. 1214 20. 4123
21. 4613 22. 3321

Electrochemistry

5. A 6. D 7. C 8. 3124 9. C 10. C 11. B 12. D
14. 3147 15. D 16. D 17. B 18. D 19. B 20. 1275
21. C 22. B 23. B 24. A 25. 0453 26. A 27. B
28. C 29. D 30. B 33. 4136 (there is no #31, 32)



Acid-Base Equilibrium Unit

1. 1605 2. 3.08 3. C 4. A 5. C 6. D 7. B 8. C 9. 4617 10. C
11. A 12. D 13.
- | $[\text{H}_3\text{O}^+]$ | $[\text{OH}^-]$ | pH | pOH |
|--------------------------|------------------------|-------|--------|
| 2.5×10^{-11} | 4.00×10^{-11} | 3.602 | 10.398 |
15. HNO_2 ; K_3PO_4 $\text{HNO}_2 + \text{PO}_4^{3-} \rightleftharpoons \text{HPO}_4^{2-} + \text{NO}_2^-$ (75%)
17. A 18. A 19. A 20. B 21. A 22. D 23. 2458
24. C 25. 2.60 26. A 27. B 28. 1636 29. C 30. 9111
31. D 32. A 33. 7.30 34. 3.04

