



Chemistry 12

Resource Exam A

Exam Booklet

Contents: 19 pages
50 multiple-choice questions in the Exam Booklet

Examination: 2 hours
Additional Time Permitted: 60 minutes
© Province of British Columbia

PART A: MULTIPLE CHOICE
Value: 62.5% of the examination

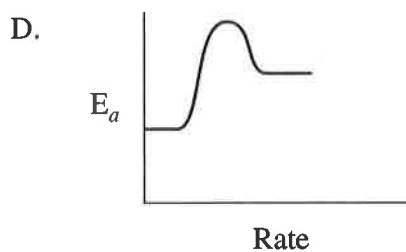
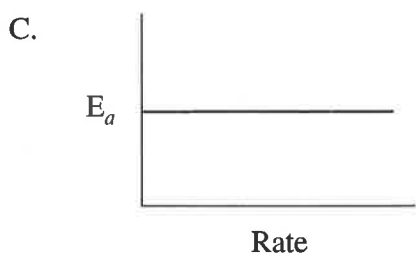
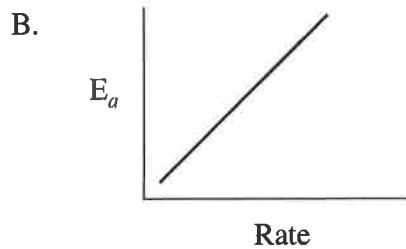
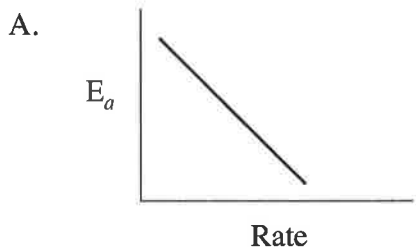
Suggested Time: 80 minutes

INSTRUCTIONS: For each question, select the **best** answer.

1. Solid sodium metal reacts rapidly with water in an open beaker to produce aqueous sodium hydroxide and hydrogen gas. A change in which of the following could be used to measure the rate of this reaction?
 - A. the volume of the solution
 - B. the pressure of the hydrogen gas
 - C. the concentration of the solid sodium
 - D. the mass of the beaker and its contents

2. Which of the following factors will increase the reaction rate of a heterogeneous reaction, but not of a homogeneous reaction?
 - A. adding a catalyst
 - B. increasing temperature
 - C. increasing concentration
 - D. increasing surface area

3. Which of the following could represent the relationship of activation energy to reaction rate?



4. Consider the following:

I	the electrolysis of water
II	the freezing of water
III	the melting of CuCl_2
IV	the combustion of CH_4

Which of the above would have a negative ΔH value?

- A. II only
- B. I and III only
- C. II and IV only
- D. I, III and IV

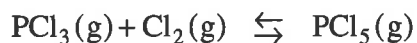
5. Consider the following reaction mechanism:

Step 1:	$\text{H}_2\text{O}_2 + \text{I}^- \rightarrow \text{H}_2\text{O} + \text{IO}^-$
Step 2:	$\text{H}_2\text{O}_2 + \text{IO}^- \rightarrow \text{H}_2\text{O} + \text{O}_2 + \text{I}^-$

Which of the following is correct?

	Activated complex	Catalyst
A.	$\text{H}_2\text{O}_2\text{IO}^-$	I^-
B.	$\text{H}_2\text{O}_2\text{I}^-$	IO^-
C.	IO^-	I^-
D.	IO^-	O_2

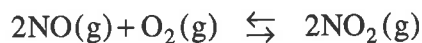
6. Consider the following equilibrium:



Initially, some PCl_3 and Cl_2 are placed in a flask. Which of the following describes what happens to the reverse reaction rate and to the pressure of the system as equilibrium is established?

	Reverse reaction rate	Pressure
A.	increases	increases
B.	increases	decreases
C.	decreases	decreases
D.	decreases	increases

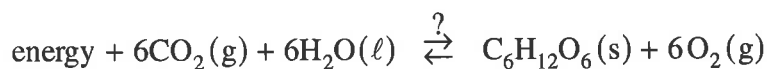
7. Consider the following system:



Which of the following would indicate whether equilibrium had been established?

- A. $[\text{NO}] > [\text{O}_2]$
- B. $[\text{NO}] = 2[\text{O}_2]$
- C. $[\text{O}_2] = 2[\text{NO}]$
- D. $[\text{NO}]$ is constant

8. Consider the following:



Which of the following describes how enthalpy and entropy change in the forward direction?

	Enthalpy	Entropy
A.	increases	decreases
B.	increases	increases
C.	decreases	increases
D.	decreases	decreases

9. Considering changes in enthalpy and entropy, which of the following will react completely?

- A. $2\text{O}_3(\text{g}) \rightleftharpoons 3\text{O}_2(\text{g}) \quad \Delta\text{H} = -285 \text{ kJ}$
- B. $\text{C}(\text{s}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) \quad \Delta\text{H} = -74 \text{ kJ}$
- C. $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) \quad \Delta\text{H} = -197 \text{ kJ}$
- D. $\text{C}_2\text{H}_2(\text{g}) + \text{Ca}(\text{OH})_2(\text{aq}) \rightleftharpoons \text{CaC}_2(\text{s}) + 2\text{H}_2\text{O}(\ell) \quad \Delta\text{H} = +183 \text{ kJ}$

10. Consider the following system at equilibrium:



Which of the following describes the equilibrium shift and the change in the concentration of $\text{Cl}_2(\text{g})$ when some $\text{I}_2(\text{s})$ is added?

	Equilibrium shift	$[\text{Cl}_2]$
A.	no shift	no change
B.	left	increases
C.	left	decreases
D.	right	increases

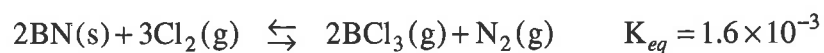
11. Consider the equilibrium system:



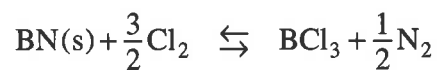
Which of the following describes what happens when some NCl_3 is added?

	Equilibrium Shift	Value of K_{eq}
A.	right	remains constant
B.	right	increases
C.	left	remains constant
D.	left	decreases

12. Consider the following equilibrium:

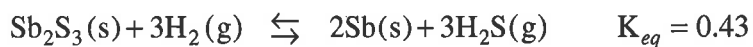


Which of the following would be the value of K_{eq} for the reaction:



- A. 1.6×10^{-3}
- B. 3.2×10^{-3}
- C. 4.0×10^{-2}
- D. 8.0×10^{-4}

13. The following equilibrium system was observed in a 1.0 L flask:

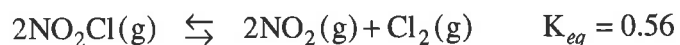


At equilibrium, there were 0.60 mol Sb_2S_3 , 1.10 mol H_2 and 0.80 mol Sb .

What was the equilibrium $[\text{H}_2\text{S}]$?

- A. 0.57 M
- B. 0.81 M
- C. 0.83 M
- D. 1.5 M

14. Consider the equilibrium:



If 0.80 mol NO_2Cl , 0.32 mol NO_2 and 0.66 mol Cl_2 are placed in a 1.0 L container, which of the following describes what happens?

- A. The system proceeds left and $[\text{NO}_2]$ increases.
- B. The system proceeds left and $[\text{NO}_2]$ decreases.
- C. The system proceeds right and $[\text{NO}_2]$ increases.
- D. The system proceeds right and $[\text{NO}_2]$ decreases.

15. Which of the following will form a molecular solution when it is dissolved in water?

- A. CsCl
- B. CaC_2O_4
- C. $\text{Cr}(\text{NO}_3)_3$
- D. $\text{CH}_3\text{CH}_2\text{OH}$

16. A 1.0 L sample of saturated solution was prepared at 25°C . The saturated solution was then allowed to evaporate at 25°C until 0.25 L of solution remained. The concentration of the saturated solution after evaporation was

- A. the same as before evaporation.
- B. 3 times lower than before evaporation.
- C. 4 times lower than before evaporation.
- D. 4 times higher than before evaporation.

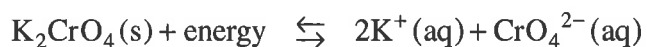
17. Which of the following salts has a solubility less than 0.1 M?

- A. FeCl_2
- B. CaCl_2
- C. FeSO_4
- D. CaSO_4

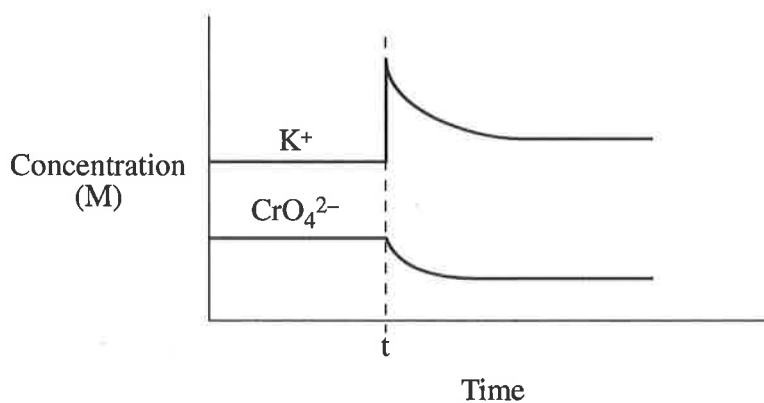
18. A solution contains the anions S^{2-} and OH^- . Which of the following compounds could be added to precipitate only one of these anions?

- A. $Sr(NO_3)_2$
- B. $Al(NO_3)_3$
- C. $Zn(NO_3)_2$
- D. $Mg(NO_3)_2$

19. Consider the equation for a saturated solution of potassium chromate:



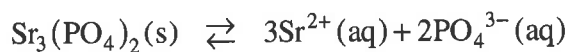
A concentration vs. time graph for a saturated solution of K_2CrO_4 is shown below.



What happened at time t ?

- A. KNO_3 was added to the system.
- B. K_2CrO_4 was removed from the system.
- C. The temperature of the system was increased.
- D. The temperature of the system was decreased.

20. Consider the following solubility equilibrium:



The K_{sp} expression is

- A. $K_{sp} = [\text{Sr}^{2+}]^3 [\text{PO}_4^{3-}]^2$
- B. $K_{sp} = [3\text{Sr}^{2+}][2\text{PO}_4^{3-}]$
- C. $K_{sp} = [3\text{Sr}^{2+}]^3 [2\text{PO}_4^{3-}]^2$
- D. $K_{sp} = \frac{[3\text{Sr}^{2+}]^3 [2\text{PO}_4^{3-}]^2}{[\text{Sr}_3(\text{PO}_4)_2]}$

21. A solution is found to contain a $[\text{Pb}^{2+}]$ of 0.10M. What is the maximum $[\text{SO}_4^{2-}]$ that can exist in this solution before a precipitate forms?

- A. $[\text{SO}_4^{2-}] = 1.8 \times 10^{-9} \text{ M}$
- B. $[\text{SO}_4^{2-}] = 1.8 \times 10^{-8} \text{ M}$
- C. $[\text{SO}_4^{2-}] = 1.8 \times 10^{-7} \text{ M}$
- D. $[\text{SO}_4^{2-}] = 1.3 \times 10^{-4} \text{ M}$

22. Which of the following general properties could be used to describe a basic solution?

I	conducts electricity
II	reacts with Na_2CO_3 to produce CO_2
III	feels slippery

- A. III only
- B. I and III only
- C. II and III only
- D. I, II and III

23. Which of the following is a conjugate acid base pair?

	Acid	Conjugate base
A.	NH_4^+	NH_3
B.	H_3O^+	OH^-
C.	H_3PO_4	HPO_4^{2-}
D.	HPO_4^{2-}	H_2PO_4^-

24. Consider the following 1.0 M acid solutions:

- H_2CO_3
- HClO_4
- $\text{H}_3\text{C}_6\text{H}_5\text{O}_7$

Rank the acid solutions in order of decreasing conductivity.

- A. $\text{H}_3\text{C}_6\text{H}_5\text{O}_7 > \text{H}_2\text{CO}_3 > \text{HClO}_4$
B. $\text{HClO}_4 > \text{H}_2\text{CO}_3 > \text{H}_3\text{C}_6\text{H}_5\text{O}_7$
C. $\text{H}_2\text{CO}_3 > \text{H}_3\text{C}_6\text{H}_5\text{O}_7 > \text{HClO}_4$
D. $\text{HClO}_4 > \text{H}_3\text{C}_6\text{H}_5\text{O}_7 > \text{H}_2\text{CO}_3$

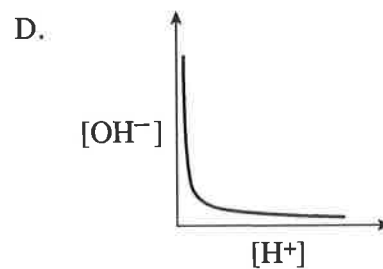
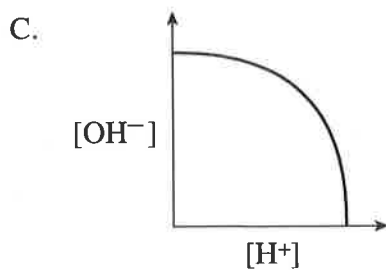
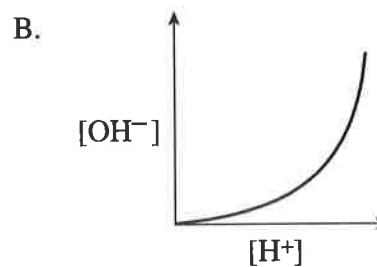
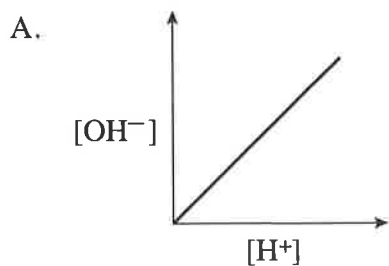
25. Water reacts most completely as a base with which of the following?

- A. HSO_3^-
B. H_3BO_3
C. H_2PO_4^-
D. $\text{Al}(\text{H}_2\text{O})_6^{3+}$

26. Which species in solution will produce the greatest hydroxide ion concentration?
- F^-
 - H_2S
 - PO_4^{3-}
 - HPO_4^{2-}
27. A base is added to water and a new equilibrium is established. The new equilibrium can be described by
- $pH < pOH$ and $K_w = 1 \times 10^{-14}$
 - $pH < pOH$ and $K_w < 1 \times 10^{-14}$
 - $pH > pOH$ and $K_w = 1 \times 10^{-14}$
 - $pH > pOH$ and $K_w > 1 \times 10^{-14}$
28. The ionization of water is endothermic. Which of the following could be correct if the temperature of water is decreased?

	K_w	pH	Classification
A.	decreases	7.1	basic
B.	increases	6.8	acidic
C.	decreases	7.1	neutral
D.	stays the same	7.0	neutral

29. Which of the following graphs describes the relationship between $[\text{OH}^-]$ and $[\text{H}^+]$?



30. Which of the following 0.10 M solutions of ions would have the highest pH?

- A. CN^-
- B. NH_4^+
- C. SO_4^{2-}
- D. $\text{Cr}(\text{H}_2\text{O})_6^{3+}$

31. Which of the following describes the relationship between base strength and K_b value?

	Base Strength	K_b
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	remains constant

32. The value of K_b for HPO_4^{2-} is

- A. 1.6×10^{-7}
- B. 4.5×10^{-2}
- C. 6.2×10^{-8}
- D. 2.2×10^{-13}

33. Which of the following 1.0 M solutions would have a pH greater than 7.00?

- A. HF
- B. KNO_3
- C. NH_4Cl
- D. KCH_3COO

34. What is the pH at the transition point for an indicator with a K_a of 2.5×10^{-4} ?

- A. 1.00
- B. 3.60
- C. 7.00
- D. 10.40

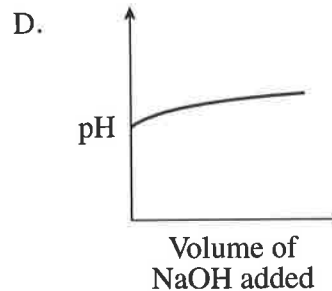
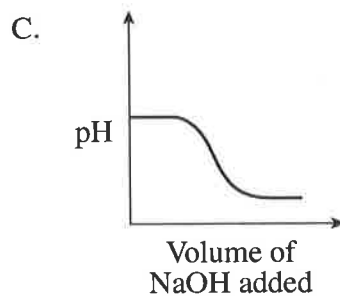
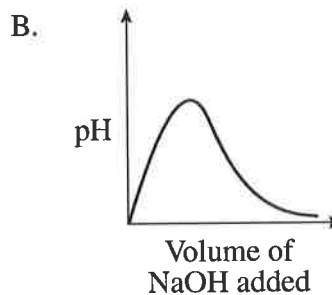
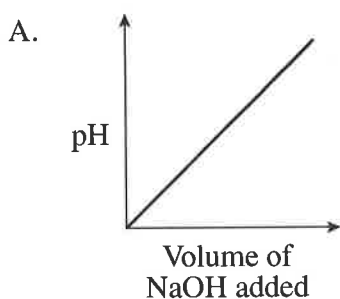
35. Which of the following describes the predominant reaction in a solution of $(\text{NH}_4)_2\text{SO}_4$ with respect to hydrolysis?

- A. $(\text{NH}_4)_2\text{SO}_4(\text{aq}) \rightleftharpoons 2\text{NH}_4^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- B. $\text{NH}_4^+(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{NH}_3(\text{aq})$
- C. $\text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\ell) \rightleftharpoons \text{HSO}_4^-(\text{aq}) + \text{OH}^-(\text{aq})$
- D. No hydrolysis reaction occurs.

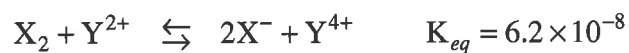
36. What is the pH of the solution formed when 0.085 moles NaOH is added to 1.00 L of 0.075 M HCl ?

- A. 2.00
- B. 7.00
- C. 12.00
- D. 12.78

37. Which of the following graphs describes the relationship between the pH of a buffer and the volume of NaOH added to the buffer?



38. A gas which is produced by internal combustion engines and contributes to the formation of acid rain is
- A. H_2
 - B. O_3
 - C. CH_4
 - D. NO_2
39. A substance that is oxidized
- A. loses electrons and is a reducing agent.
 - B. gains electrons and is a reducing agent.
 - C. loses electrons and is an oxidizing agent.
 - D. gains electrons and is an oxidizing agent.
40. What is the oxidation number change for C when $\text{C}_6\text{H}_{12}\text{O}_6$ is converted to $\text{C}_2\text{H}_5\text{OH}$?
- A. increase by 2
 - B. increase by 4
 - C. decrease by 2
 - D. decrease by 4
41. Consider the following redox equilibrium:



Which is the strongest oxidizing agent?

- A. X_2
- B. X^-
- C. Y^{4+}
- D. Y^{2+}

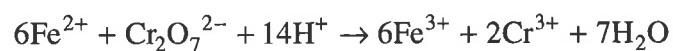
42. Which of the following substances will react spontaneously?

- A. Cu^{2+} and Cl^-
- B. Au(s) and Cl^-
- C. Au^{3+} and H_2O_2
- D. Cu^{2+} and H_2O_2

43. A titration of a $\text{FeSO}_4(\text{aq})$ sample with acidified $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ produced the following results:

Volume of FeSO_4 sample	10.0 mL
Concentration of $\text{K}_2\text{Cr}_2\text{O}_7$	0.278 M
Volume of acidified $\text{K}_2\text{Cr}_2\text{O}_7$	12.7 mL

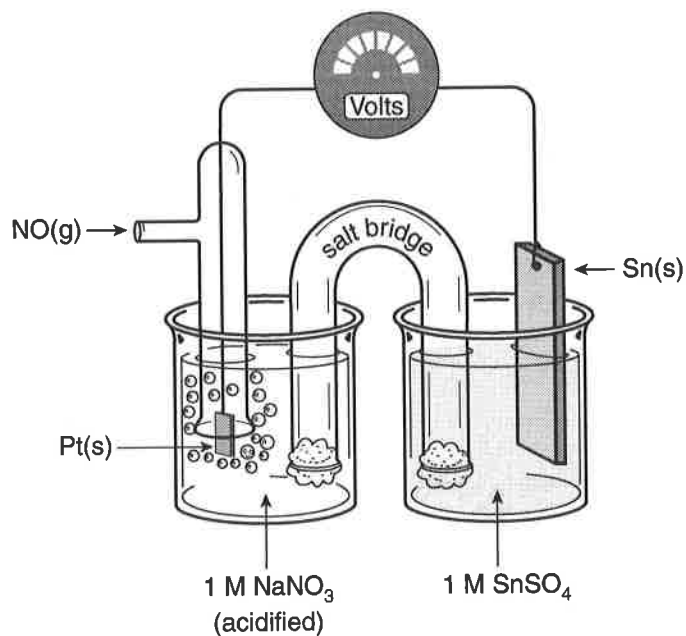
The equation for the overall reaction is:



What is the $[\text{Fe}^{2+}]$ in the sample?

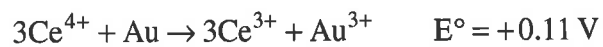
- A. 0.0212 M
- B. 0.0588 M
- C. 0.353 M
- D. 2.12 M

Use the following electrochemical cell diagram to answer questions 44 and 45.



44. The reaction occurring at the cathode is
- A. $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$
 - B. $\text{Sn}^{2+} + 2\text{e}^- \rightarrow \text{Sn}$
 - C. $\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightarrow \text{NO}(\text{g}) + 2\text{H}_2\text{O}$
 - D. $2\text{NO}_3^- + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{N}_2\text{O}_4(\text{g}) + 2\text{H}_2\text{O}$
45. The cell potential at equilibrium is
- A. 0.00 V
 - B. +0.94 V
 - C. +0.96 V
 - D. +1.10 V

46. Consider the following redox reactions and their corresponding cell potentials:



What is the reduction potential for $\text{Co}^{3+} + \text{e}^- \rightarrow \text{Co}^{2+}$?

- A. +1.82 V
- B. +1.18 V
- C. +0.32 V
- D. -0.10 V

47. During the corrosion of magnesium, the anode reaction is

- A. $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
- B. $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$
- C. $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$
- D. $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$

48. Why does the zinc coating on the inside of an iron soup can keep the iron from reacting with the soup?

- A. Zinc is a weaker reducing agent than iron.
- B. Zinc is a weaker oxidizing agent than iron.
- C. Zinc is a stronger reducing agent than iron.
- D. Zinc is a stronger oxidizing agent than iron.

49. The molten salt, ZnCl_2 , undergoes electrolysis. The cathode reaction is

- A. $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$
- B. $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$
- C. $\text{Cl}_2 + 2\text{e}^- \rightarrow 2\text{Cl}^-$
- D. $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$

50. A metal spoon is to be electroplated with silver using a DC power supply. Which of the following is correct?

	Spoon	Power supply connection
A.	anode	positive terminal
B.	cathode	positive terminal
C.	anode	negative terminal
D.	cathode	negative terminal

**This is the end of the multiple-choice section.
Answer the remaining questions in the Response Booklet.**

Chemistry 12
Resource Exam A
Answer Key

Cognitive Processes	Weightings	Question Types
K = Knowledge	11%	50 = Multiple Choice (MC)
U = Understanding	78%	8 = Written Response (WR)
H = Higher Mental Processes	11%	

Topics	Prescribed Learning Outcomes (PLOs)	Weightings
1. Reaction Kinetics	A1-8	12%
2. Dynamic Equilibrium	B1-6	16%
3. Solubility Equilibria	C1-8	16%
4. Acids, Bases, and Salts	D1-6, E, F1-8	33%
5. Oxidation – Reduction	G1-4, H1-5	23%

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
1.	D	U	1	1	A2	MC
2.	D	U	1	1	A2	MC
3.	A	U	1	1	A4	MC
4.	C	H	1	1	A4	MC
5.	A	U	1	1	A6	MC
6.	B	U	1	2	B1	MC
7.	D	K	1	2	B1	MC
8.	A	U	1	2	B2	MC
9.	A	U	1	2	B2	MC
10.	A	U	1	2	B3	MC
11.	C	U	1	2	B5	MC
12.	C	H	1	2	B5	MC
13.	C	U	1	2	B6	MC
14.	C	U	1	2	B6	MC
15.	D	U	1	3	C1	MC
16.	A	H	1	3	C2	MC
17.	D	U	1	3	C4	MC
18.	D	U	1	3	C5	MC
19.	A	H	1	3	C5	MC
20.	A	K	1	3	C6	MC
21.	C	U	1	3	C7	MC
22.	B	K	1	4	D1	MC
23.	A	U	1	4	D3	MC
24.	D	U	1	4	D4	MC
25.	D	U	1	4	D5	MC
26.	C	U	1	4	D5	MC

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
27.	C	U	1	4	E1	MC
28.	C	H	1	4	E1	MC
29.	D	U	1	4	E2	MC
30.	A	U	1	4	E3	MC
31.	A	K	1	4	E3	MC
32.	A	U	1	4	E4	MC
33.	D	U	1	4	F5	MC
34.	B	U	1	4	F3	MC
35.	B	U	1	4	F4	MC
36.	C	U	1	4	F1	MC
37.	D	H	1	4	F6	MC
38.	D	K	1	4	F8	MC
39.	A	K	1	5	G1	MC
40.	C	U	1	5	G1	MC
41.	C	H	1	5	G2	MC
42.	C	U	1	5	G2	MC
43.	D	U	1	5	G4	MC
44.	C	U	1	5	H1	MC
45.	A	K	1	5	H1	MC
46.	A	H	1	5	H1	MC
47.	A	U	1	5	H3	MC
48.	C	U	1	5	H3	MC
49.	B	U	1	5	H4	MC
50.	D	U	1	5	H5	MC

Question Number	Keyed Response	Cognitive Process	Mark	Topic	PLO	Question Type
1.	—	U	4	1	A2	WR
2.	—	U	4	2	B6	WR
3.	—	U	4	3	C3,C4	WR
4.	—	U	3	4	D6	WR
5.	—	U	5	4	E4	WR
6.	—	U	3	4	F1	WR
7.	—	U	4	5	G3	WR
8.	—	U	3	5	H4	WR



Chemistry 12

Resource Exam A

Response Booklet

Instructions

Answer the following questions in the space provided in this **Response Booklet**. You are expected to communicate your knowledge and understanding of chemical principles in a clear and logical manner. Your steps and assumptions leading to a solution must be written in this **Response Booklet**. Answers must include units where appropriate and be given to the correct number of significant figures. **For questions involving calculations, full marks will NOT be given for providing only an answer.**

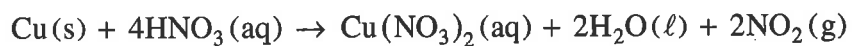
PART B: WRITTEN RESPONSE

Value: 37.5% of the examination

Suggested Time: 40 minutes

1. (4 marks)

In a fume hood, a student reacted copper and nitric acid in a flask according to the following equation:



The following data was collected:

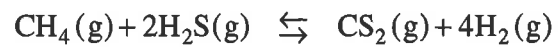
Time (min)	Mass of flask and contents (g)
0.0	250.50
2.5	249.25
5.0	248.24
7.5	247.44

Calculate the overall rate of reaction in grams NO_2 per minute.

How much time will it take to react 0.50 g of Cu at this rate?

2. (4 marks)

Consider the following equilibrium:



Initially, 0.120 mol CH_4 and 0.280 mol H_2S were placed in a 2.00 L flask. At equilibrium, $[\text{CS}_2] = 0.030 \frac{\text{mol}}{\text{L}}$. Calculate K_{eq} .

3. (4 marks)

Write the net ionic equation for the reaction that occurs when 40.0 mL of 1.50 M AgNO_3 is mixed with excess Na_2SO_4 solution, and calculate the mass of the precipitate that forms.

4. (3 marks)

- Identify an amphoteric substance and write two balanced equations that demonstrate its amphoteric nature.

5. (5 marks)

A 2.00 M diprotic acid (H_2X) has a pH of 0.60. Calculate its K_a value. Start by writing a general equation for the predominant equilibrium.

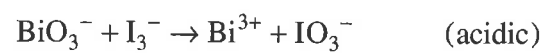
6. (3 marks)

A titration was performed by adding 0.125 M NaOH to a 25.00 mL sample of H_2SO_4 . Calculate the $[\text{H}_2\text{SO}_4]$ from the following data.

	Trial #1	Trial #2	Trial #3
Initial volume of NaOH (mL)	4.00	17.05	8.00
Final volume of NaOH (mL)	17.05	28.00	19.05

7. (4 marks)

Balance the following in acidic solution.



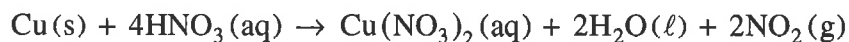
8. (3 marks)

Draw an operating electrolytic cell used in the electrolysis of molten sodium chloride, $\text{NaCl}(\ell)$.
Label the anode and cathode.

Chemistry 12
Resource Exam A
Scoring Guide

1. (4 marks)

In a fume hood, a student reacted copper and nitric acid in a flask according to the following equation:



The following data was collected:

Time (min)	Mass of flask and contents (g)
0.0	250.50
2.5	249.25
5.0	248.24
7.5	247.44

Calculate the overall rate of reaction in grams NO_2 per minute.

(1 mark)

How much time will it take to react 0.50 g of Cu at this rate?

(3 marks)

Solution:

For Example:

Calculate the overall rate of reaction in grams NO_2 per minute.

$$\text{rate} = \frac{(250.50 \text{ g} - 247.44 \text{ g})}{7.5 \text{ min}} = 0.41 \text{ g/min}$$

← 1 mark

How much time will it take to react 0.50 g of Cu at this rate?

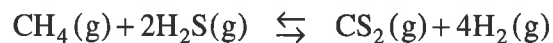
$$\text{time (min)} = 0.50 \text{ g Cu} \times \frac{1 \text{ mol Cu}}{63.5 \text{ g Cu}} \times \frac{2 \text{ mol NO}_2}{1 \text{ mol Cu}} \times \frac{46.0 \text{ g NO}_2}{1 \text{ mol NO}_2} \times \frac{1 \text{ min}}{0.41 \text{ g NO}_2}$$

$$= 1.8 \text{ min}$$

← 3 marks

2. (4 marks)

Consider the following equilibrium:



Initially, 0.120 mol CH_4 and 0.280 mol H_2S were placed in a 2.00 L flask. At equilibrium, $[\text{CS}_2] = 0.030 \frac{\text{mol}}{\text{L}}$. Calculate K_{eq} .

Solution:

For Example:

	$\text{CH}_4(\text{g})$	$+ 2\text{H}_2\text{S}(\text{g})$	\rightleftharpoons	$\text{CS}_2(\text{g})$	$+ 4\text{H}_2(\text{g})$	← 1 mark
I	0.0600	0.140		0	0	
C	-0.030	-0.060		+0.030	+0.120	
E	0.030	0.080		0.030	0.120	← 1 mark

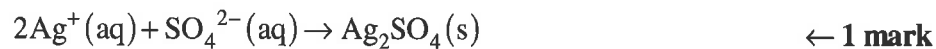
$$\begin{aligned}
 K_{eq} &= \frac{[\text{CS}_2][\text{H}_2]^4}{[\text{CH}_4][\text{H}_2\text{S}]^2} \\
 &= \frac{(0.030)(0.120)^4}{(0.030)(0.080)^2} && \left. \begin{array}{l} \left. \right\} \leftarrow 1 \text{ mark} \\ \left. \right\} \leftarrow 1 \text{ mark} \end{array} \right. \\
 &= 0.032
 \end{aligned}$$

3. (4 marks)

Write the net ionic equation for the reaction that occurs when 40.0 mL of 1.50 M AgNO₃ is mixed with excess Na₂SO₄ solution, and calculate the mass of the precipitate that forms.

Solution:

For Example:



$$\text{moles of Ag}^+ : 1.50 \frac{\text{mol}}{\text{L}} \times 0.0400 \text{ L} \times \frac{1 \text{ mol Ag}^+}{1 \text{ mol AgNO}_3} = 0.0600 \text{ mol} \quad \leftarrow 1 \text{ mark}$$

$$\text{Moles of Ag}_2\text{SO}_4 : 0.0600 \text{ mol} \times \frac{1 \text{ mol Ag}_2\text{SO}_4}{2 \text{ mol Ag}^+} = 0.0300 \text{ mol Ag}_2\text{SO}_4 \quad \leftarrow 1 \text{ mark}$$

$$\text{Mass of Ag}_2\text{SO}_4 : 0.0300 \text{ mol} \times 311.9 \frac{\text{g}}{\text{mol}} = 9.36 \text{ g} \quad \leftarrow 1 \text{ mark}$$

4. (3 marks)

Identify an amphiprotic substance and write two balanced equations that demonstrate its amphiprotic nature.

Solution:

For Example:

Amphiprotic substance: H_2O ← 1 mark

H_2O behaving like an acid: $\text{H}_2\text{O} + \text{F}^- \rightleftharpoons \text{OH}^- + \text{HF}$ ← 1 mark

H_2O behaving like a base: $\text{H}_2\text{O} + \text{HF} \rightleftharpoons \text{H}_3\text{O}^+ + \text{F}^-$ ← 1 mark

5. (5 marks)

A 2.00 M diprotic acid (H_2X) has a pH of 0.60. Calculate its K_a value. Start by writing a general equation for the predominant equilibrium.

Solution:

For Example:

	H_2X	+	$\text{H}_2\text{O}(\ell)$	\rightleftharpoons	H_3O^+	+	HX^-	← 1 mark
[I]	2.00 M				0		0	
[C]	-0.25				+0.25		+0.25	
[E]	1.75				0.25		0.25	← 1 mark

$\text{pH} = 0.60; [\text{H}_3\text{O}^+] = 0.25 \text{ M}$ ← 1 mark

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{HX}^-]}{[\text{H}_2\text{X}]}$$
$$= \frac{(0.25)(0.25)}{1.75} \quad \leftarrow 1 \text{ mark}$$
$$= 0.036 \quad \leftarrow 1 \text{ mark}$$

6. (3 marks)

A titration was performed by adding 0.125 M NaOH to a 25.00 mL sample of H_2SO_4 . Calculate the $[\text{H}_2\text{SO}_4]$ from the following data.

	Trial #1	Trial #2	Trial #3
Initial volume of NaOH (mL)	4.00	17.05	8.00
Final volume of NaOH (mL)	17.05	28.00	19.05

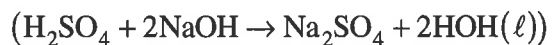
Solution:

For Example:

	Trial #1	Trial #2	Trial #3
NaOH added (mL)	13.05	10.95	11.05

↑ discard

average NaOH added = 11.00 mL = 0.01100 L

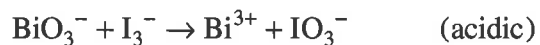


$$[\text{H}_2\text{SO}_4] = \frac{0.125 \text{ mol NaOH}}{\text{L}} \times 0.01100 \text{ L} \times \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \times \frac{1}{0.02500 \text{ L}}$$

$$= 0.0275 \text{ M} \quad \uparrow \text{ 1 mark} \quad \uparrow \text{ 1 mark} \quad \uparrow \text{ 1 mark}$$

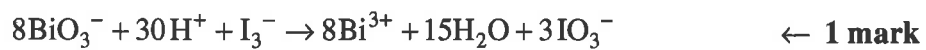
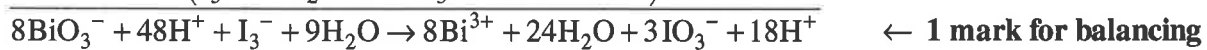
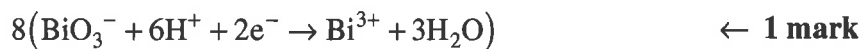
7. (4 marks)

Balance the following in acidic solution.



Solution:

For Example:



8. (3 marks)

Draw an operating electrolytic cell used in the electrolysis of molten sodium chloride, $\text{NaCl}(\ell)$.
Label the anode and cathode.

Solution:

For Example:

