BRITISH COLUMBIA

Chemistry 12
Resource Exam B
Exam Booklet

Contents: 21 pages
50 multiple-choice questions in the Exam Booklet

Examination: 2 hours
Additional Time Permitted: 60 minutes

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. Consider the following two reactions:

I	$2Na_3PO_4(aq) + 3CuCl_2(aq) \rightarrow Cu_3(PO_4)_2(s) + 6NaCl(aq)$
II	$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

   Which of the following would increase the rate of reaction II but not of reaction I?

   A. adding a suitable catalyst
   B. increasing the surface area of a reactant
   C. increasing the concentration of a reactant
   D. increasing the temperature of the reactants

3. As an activated complex forms products, which of the following describes the changes in KE and PE?

	KE	PE
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	decreases

Use the following reaction mechanism to answer questions 4 and 5.

Step 1	$2NO_2(g) \rightarrow N_2(g) + 2O_2(g)$	(slow)
Step 2	$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$	(fast)
Step 3	$N_2(g) + O_2(g) \rightarrow 2NO(g)$	(fast)

4. Increasing the concentration of which of the following would increase the rate of the overall reaction?

A. O_2
B. N_2
C. CO
D. NO_2

5. Identify an activated complex and reaction intermediate from the above mechanism.

	Activated complex	Reaction intermediate
A.	O_2	N_2
B.	N_2O_2	O_2
C.	N_2O_3	N_2
D.	CO	NO

6. Which of the following is correct for a reversible reaction?

A. $\Delta H(\text{reverse}) = E_a(\text{forward}) - E_a(\text{reverse})$
B. $E_a(\text{forward}) = E_a(\text{reverse}) - \Delta H(\text{forward})$
C. $\Delta H(\text{forward}) = E_a(\text{reverse}) - E_a(\text{forward})$
D. $E_a(\text{reverse}) = E_a(\text{forward}) - \Delta H(\text{forward})$

7. Consider the following equilibrium:

$$2Hg(\ell) + O_2(g) \leftrightarrows 2HgO(s)$$

A student places the following in four separate flasks:

Flask	Initial contents
1	HgO
2	HgO and O_2
3	Hg and O_2
4	Hg

In which flasks will the above equilibrium be established?

A. flasks 1 and 3
B. flasks 2 and 4
C. flasks 3 and 4
D. flasks 1, 2 and 3

8. Consider the following:

$$\text{energy} + 6CO_2(g) + 6H_2O(\ell) \overset{?}{\rightleftarrows} C_6H_{12}O_6(s) + 6O_2(g)$$

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

Use the following equilibrium to answer questions 9 and 10.

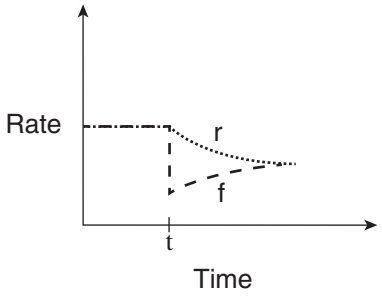
$$Ni(s) + 4CO(g) \rightleftarrows Ni(CO)_4(g) \qquad \Delta H = -603 \text{ kJ}$$

9. Which of the following describes what happens when the temperature is increased?

	Equilibrium shift	[CO]
A.	left	increases
B.	left	decreases
C.	right	increases
D.	right	decreases

10. Which graph represents the changes in the forward and reverse reaction rates when $Ni(CO)_4$ is removed from the above equilibrium at time t?

A.



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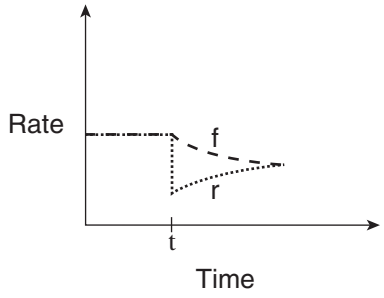

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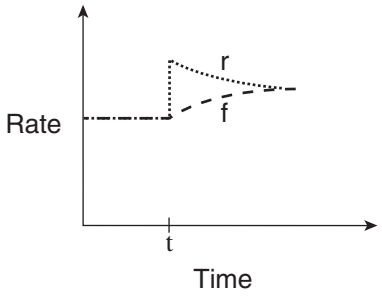

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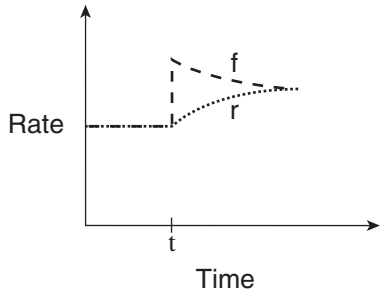


11. Consider the following equilibrium:

$$N_2H_6CO_2(s) \leftrightarrows CO_2(g) + 2NH_3(g)$$

Which of the following is the correct K_{eq} expression?

A. $K_{eq} = [CO_2][NH_3]$

B. $K_{eq} = [CO_2][NH_3]^2$

C. $K_{eq} = \dfrac{[CO_2][NH_3]^2}{[N_2H_6CO_2]}$

D. $K_{eq} = \dfrac{1}{[CO_2][NH_3]^2}$

12. Which of the following is correct?

A. A large K_{eq} means that products are favoured.
B. A large K_{eq} means that reactants are favoured.
C. A small K_{eq} means that the reaction rate is low.
D. A small K_{eq} means that the reaction rate is high.

13. Consider the equilibrium system:

$$N_2(g) + 3Cl_2(g) \rightleftarrows 2NCl_3(g) \qquad \Delta H = +460\,kJ$$

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

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

14. Consider the following equilibrium:

$$SO_3(g) + 6HF(g) \leftrightarrows SF_6(g) + 3H_2O(g) \qquad K_{eq} = 6.3 \times 10^{-3}$$

A 3.0 L flask contained 1.20 mol SO_3, 0.30 mol HF and 1.50 mol SF_6 at equilibrium. How many moles of H_2O were present?

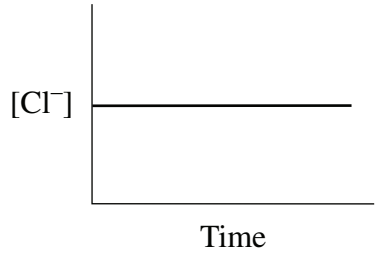
A. 1.5×10^{-8} mol
B. 1.7×10^{-3} mol
C. 5.0×10^{-9} mol
D. 5.1×10^{-3} mol

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

A. $Ca(OH)_2$
B. CH_3COOH
C. CH_3COCH_3
D. $Ca(CH_3COO)_2$

16. A saturated solution of $PbCl_2$ is prepared and then left to stand uncovered at 25°C. Which graph accurately illustrates the concentration of the chloride ion over time?

A.



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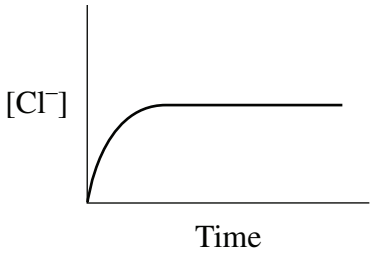

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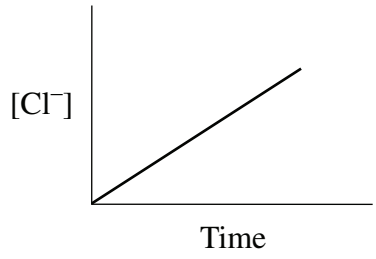

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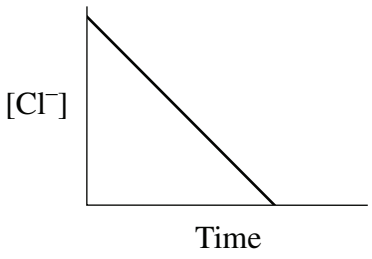
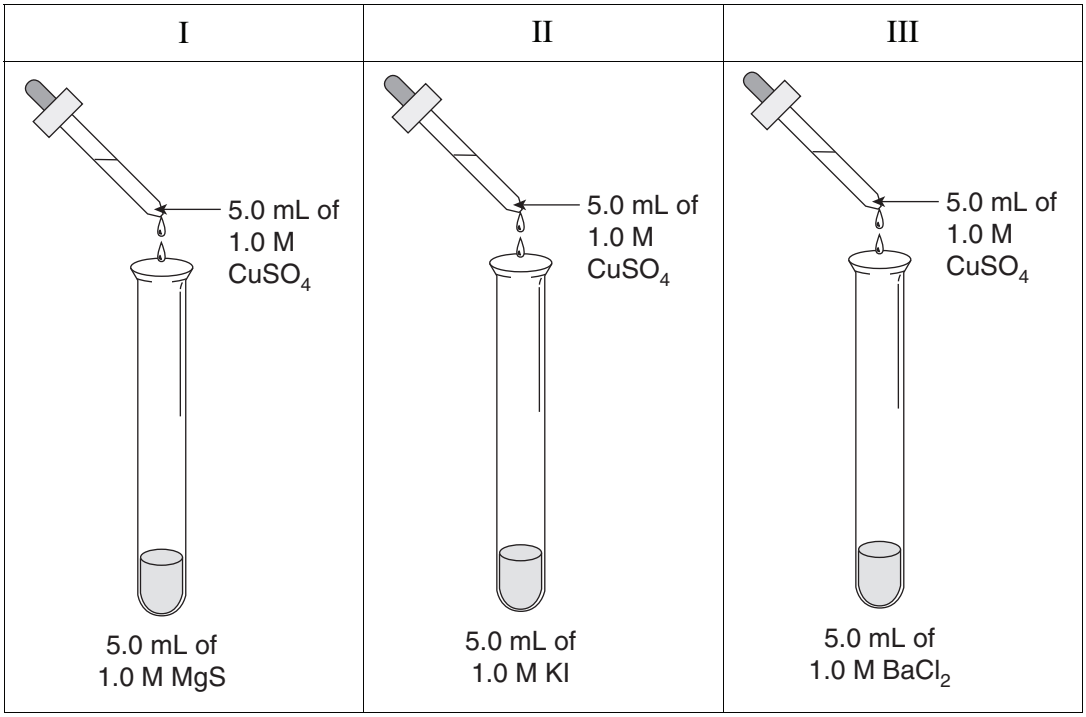


17. Three different 1.0 M solutions were prepared and 5.0 mL of each was placed in separate test tubes. In which of the test tubes will a precipitate form when 5.0 mL of 1.0 M $CuSO_4$ is added to each?



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

18. In which of the following solutions would $Zn(OH)_2$ be least soluble?

A. 0.1 M HCl
B. 0.1 M NaCl
C. 0.1 M $ZnCl_2$
D. 0.1 M $Sr(OH)_2$

19. The solubility of $AgIO_3$ is

A. $1.0 \times 10^{-15}\,M$
B. $1.6 \times 10^{-8}\,M$
C. $1.8 \times 10^{-4}\,M$
D. $3.2 \times 10^{-8}\,M$

20. A solution is found to contain a $[Pb^{2+}]$ of $0.10M$. What is the maximum $[SO_4^{2-}]$ that can exist in this solution before a precipitate forms?

A. $[SO_4^{2-}] = 1.8 \times 10^{-9}\,M$
B. $[SO_4^{2-}] = 1.8 \times 10^{-8}\,M$
C. $[SO_4^{2-}] = 1.8 \times 10^{-7}\,M$
D. $[SO_4^{2-}] = 1.3 \times 10^{-4}\,M$

21. In order to determine the concentration of chloride ion in a sample, the sample was placed in an Erlenmeyer flask and titrated. Which solution should be placed in the buret?

A. 0.10 M HCl
B. 0.10 M NaCl
C. 0.10 M NaOH
D. 0.10 M $AgNO_3$

22. Which of the following is produced when perchloric acid reacts with calcium hydroxide?

I	$CaCl_2$
II	H_2O
III	$Ca(ClO_4)_2$
IV	H_3O^+

A. I and II
B. II and III
C. III and IV
D. I and IV

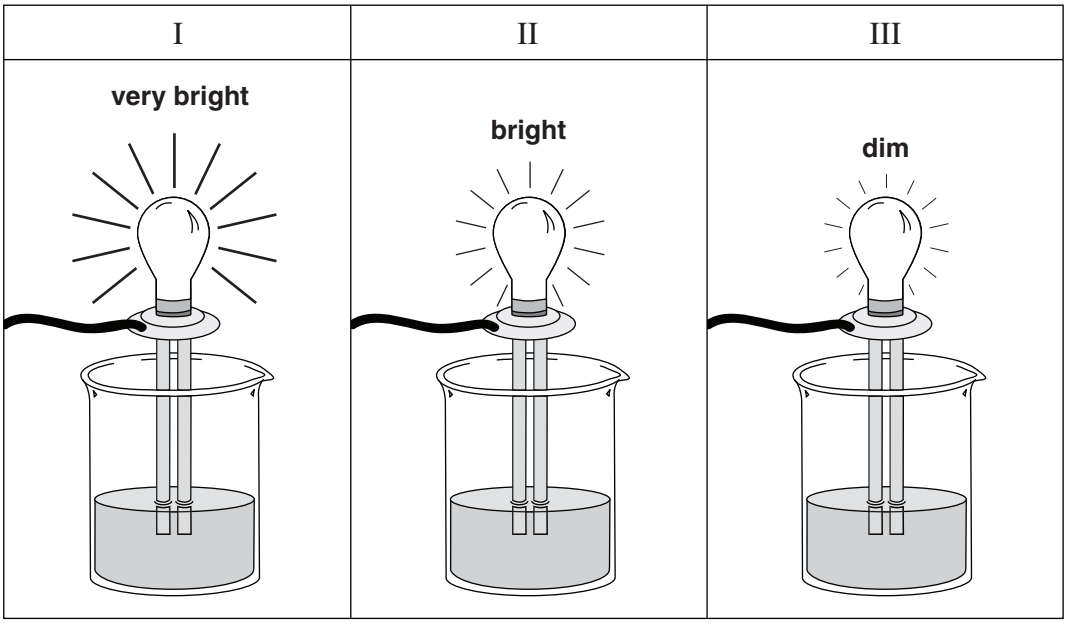
23. Consider the following equation:

$$C_6H_5O^- + H_2C_6H_5O_7^- \leftrightarrows HC_6H_5O_7^{2-} + C_6H_5OH$$

The C_6H_5OH is

A. a Brønsted–Lowry acid since it donates a proton.
B. a Brønsted–Lowry base since it accepts a proton.
C. an Arrhenius acid since it produces OH^- in solution.
D. an Arrhenius base since it produces OH^- in solution.

24. The electrical conductivity of 1.0 M solutions of H_3PO_4, H_2SO_4 and HIO_3 were compared.



The identity of the acid in each beaker is

	Beaker I	Beaker II	Beaker III
A.	H_2SO_4	HIO_3	H_3PO_4
B.	H_3PO_4	H_2SO_4	HIO_3
C.	HIO_3	H_2SO_4	H_3PO_4
D.	H_3PO_4	HIO_3	H_2SO_4

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. $Al(H_2O)_6^{3+}$

26. Which species in solution will produce the greatest hydroxide ion concentration?

A. F^-

B. H_2S

C. PO_4^{3-}

D. HPO_4^{2-}

27. Consider the following equilibrium:

$$2H_2O(\ell) \rightleftarrows H_3O^+(aq) + OH^-(aq)$$

What changes occur to $[H_3O^+]$ and pH when NaOH is added?

A. $[H_3O^+]$ increases and pH increases.

B. $[H_3O^+]$ increases and pH decreases.

C. $[H_3O^+]$ decreases and pH increases.

D. $[H_3O^+]$ decreases and pH decreases.

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 is a formula for calculating pH at any temperature?

A. $\mathrm{pH} = \log\left[\mathrm{H_3O^+}\right]$

B. $\mathrm{pH} = 14.0 - \mathrm{pOH}$

C. $\mathrm{pH} = 14.0 + \mathrm{pOH}$

D. $\mathrm{pH} = \mathrm{pK}_w - \mathrm{pOH}$

30. Which of the following $0.10\,\mathrm{M}$ solutions of ions would have the highest pH?

A. $\mathrm{CN^-}$

B. $\mathrm{NH_4^+}$

C. $\mathrm{SO_4^{2-}}$

D. $\mathrm{Cr(H_2O)_6^{3+}}$

31. Which of the following represents the dissociation equation of a salt in water?

A. $\mathrm{KCl(s) \rightarrow K^+(aq) + Cl^-(aq)}$

B. $\mathrm{Ca^{2+}(aq) + SO_4{}^{2-}(aq) \rightarrow CaSO_4(s)}$

C. $\mathrm{HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(\ell)}$

D. $\mathrm{2Na(s) + 2H_2O(\ell) \rightarrow 2NaOH(aq) + H_2(g)}$

32. Which of the following describes the predominant reaction in a solution of $\mathrm{(NH_4)_2\,SO_4}$ with respect to hydrolysis?

A. $\mathrm{(NH_4)_2\,SO_4(aq) \rightleftarrows 2NH_4^+(aq) + SO_4^{2-}(aq)}$

B. $\mathrm{NH_4^+(aq) + H_2O(\ell) \rightleftarrows H_3O^+(aq) + NH_3(aq)}$

C. $\mathrm{SO_4^{2-}(aq) + H_2O(\ell) \rightleftarrows HSO_4^-(aq) + OH^-(aq)}$

D. No hydrolysis reaction occurs.

33. Which of the following salt solutions is acidic?

A. $KClO_4$
B. NH_4Br
C. $NaHCO_3$
D. $Na_2C_2O_4$

34. The indicator phenol red will be red in which of the following solutions?

A. 1.0 M HF
B. 1.0 M HBr
C. 1.0 M NH_4Cl
D. 1.0 M Na_2CO_3

35. Which of the following chemical indicators has a $K_a = 2.5 \times 10^{-5}$?

A. methyl orange
B. phenolphthalein
C. thymolphthalein
D. bromcresol green

36. A 25.0 mL sample of $H_2SO_4(aq)$ is titrated with 15.5 mL of 0.50 M $NaOH(aq)$. What is the concentration of the $H_2SO_4(aq)$?

A. 0.078 M
B. 0.16 M
C. 0.31 M
D. 0.62 M

37. What is the complete ionic equation for the neutralization of $0.1\ \text{M}\ \text{Sr(OH)}_2\,(\text{aq})$ with $0.1\ \text{M}\ \text{H}_2\text{SO}_4\,(\text{aq})$?

A. $\text{H}^+\,(\text{aq}) + \text{OH}^-\,(\text{aq}) \rightarrow \text{H}_2\text{O}(\ell)$

B. $\text{Sr}^{2+}\,(\text{aq}) + \text{SO}_4{}^{2-}\,(\text{aq}) \rightarrow \text{SrSO}_4\,(\text{s})$

C. $\text{Sr}^{2+}\,(\text{aq}) + 2\,\text{OH}^-\,(\text{aq}) + 2\text{H}^+\,(\text{aq}) + \text{SO}_4{}^{2-}\,(\text{aq}) \rightarrow \text{SrSO}_4\,(\text{s}) + 2\text{H}_2\text{O}(\ell)$

D. $\text{Sr}^{2+}\,(\text{aq}) + 2\,\text{OH}^-\,(\text{aq}) + 2\text{H}^+\,(\text{aq}) + \text{SO}_4{}^{2-}\,(\text{aq}) \rightarrow \text{Sr}^{2+}\,(\text{aq}) + \text{SO}_4{}^{2-}\,(\text{aq}) + 2\text{H}_2\text{O}(\ell)$

38. Normal rainwater contains dissolved

A. $\text{CO}_2\,(\text{g})$ and is slightly acidic.

B. $\text{CO}_2\,(\text{g})$ and is slightly basic.

C. $\text{NO}_2\,(\text{g})$ and is slightly acidic.

D. $\text{NO}_2\,(\text{g})$ and is slightly basic.

39. 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

40. Consider the following redox reaction:

$$\text{BH}_4{}^- + \text{ClO}_3{}^- \rightarrow \text{H}_2\text{BO}_3{}^- + \text{Cl}^-$$

Which substance is losing electrons?

A. the B in $\text{BH}_4{}^-$

B. the H in $\text{BH}_4{}^-$

C. the O in $\text{ClO}_3{}^-$

D. the Cl in $\text{ClO}_3{}^-$

41. Consider the following reduction half-reactions:

I	$La^{3+} + 3e^- \rightarrow La$
II	$Ag^{2+} + e^- \rightarrow Ag^+$
III	$VO_2^+ + 2H^+ + e^- \rightarrow VO^{2+} + H_2O$

It is observed that Ag^+ and VO_2^+ do not react together, but La and VO_2^+ do react spontaneously. Which of the following describes the relative reduction potentials for the half-reactions shown above?

A. I > II > III
B. I > III > II
C. II > III > I
D. III > I > II

42. Which substance is a product of the reaction between acidified MnO_4^- and H_2O_2?

A. H_2
B. OH^-
C. Mn^{2+}
D. MnO_2

43. A titration of a $FeSO_4(aq)$ sample with acidified $K_2Cr_2O_7(aq)$ produced the following results:

Volume of $FeSO_4$ sample	10.0 mL
Concentration of $K_2Cr_2O_7$	0.278 M
Volume of acidified $K_2Cr_2O_7$	12.7 mL

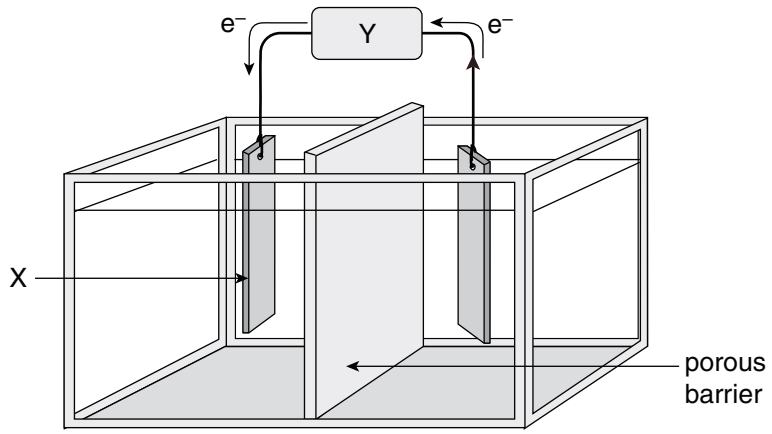
The equation for the overall reaction is:

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

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

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

44. Consider the following electrochemical cell:



Which of the following could be electrode X and object Y?

	Electrode X	Object Y
A.	cathode	motor
B.	cathode	salt bridge
C.	anode	motor
D.	anode	salt bridge

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

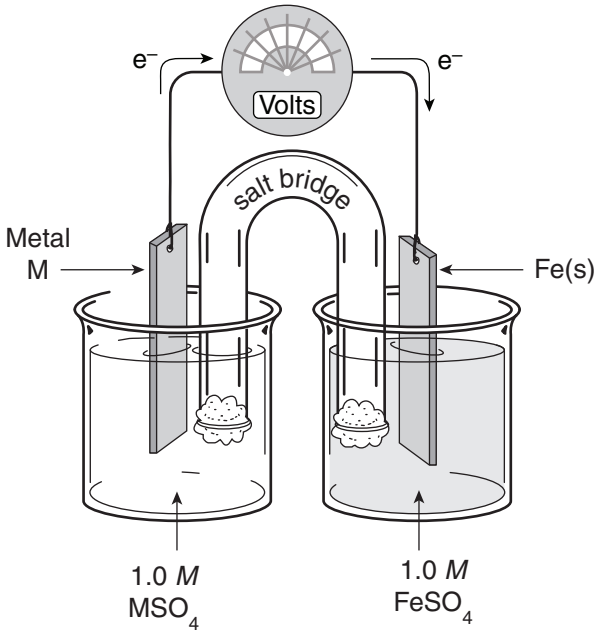
$$Ni^{2+} + Cd \rightarrow Ni + Cd^{2+} \qquad E^{\circ} = +0.14\ V$$

$$3Cd^{2+} + 2La \rightarrow 3Cd + 2La^{3+} \qquad E^{\circ} = +1.97\ V$$

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

A. −2.37 V
B. −2.11 V
C. −0.12 V
D. +1.85 V

46. Consider the following electrochemical cell:



The identity of the metal at M and the reading on the voltmeter are:

	Metal M	Voltage
A.	zinc	+0.31 V
B.	tin	+0.31 V
C.	zinc	+1.21 V
D.	tin	+0.59 V

47. 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.

48. Which of the following are produced at the anode and cathode in the electrolysis of aqueous potassium sulfate using carbon electrodes?

	Anode	Cathode
A.	potassium	oxygen
B.	hydrogen	oxygen
C.	oxygen	hydrogen
D.	sulfur	potassium

49. An aqueous solution of $CuSO_4$ is electrolyzed using copper electrodes. Which of the following is correct?

	Mass of Anode	$[Cu^{2+}]$
A.	increases	increases
B.	increases	stays the same
C.	decreases	stays the same
D.	decreases	increases

50. Very pure $Al(s)$ is produced from $Al^{3+}(\ell)$ in an electrolytic cell. In this case, the $Al(s)$ is produced at the

A. anode as a result of oxidation.
B. anode as a result of reduction.
C. cathode as a result of oxidation.
D. cathode as a result of reduction.

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