BRITISH COLUMBIA

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

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?

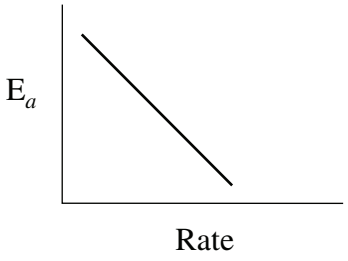
   A. the volume of the solution
   B. the pressure of the hydrogen gas
   C. the concentration of the solid sodium
   D. the mass of the beaker and its contents

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?

A.



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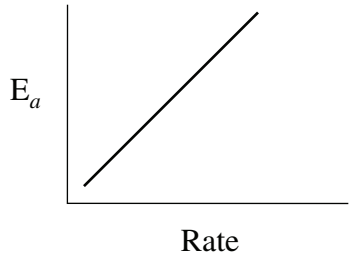

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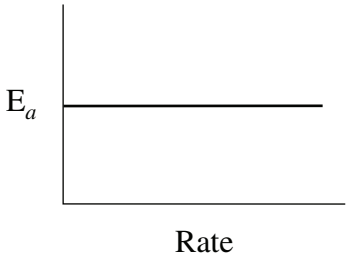

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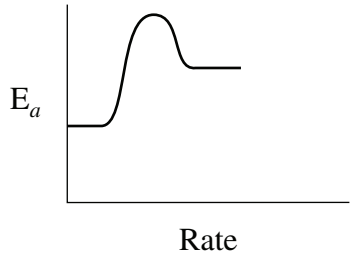


4. Consider the following:

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:	$H_2O_2 + I^- \rightarrow H_2O + IO^-$
Step 2:	$H_2O_2 + IO^- \rightarrow H_2O + O_2 + I^-$

Which of the following is correct?

	Activated complex	Catalyst
A.	$H_2O_2IO^-$	I^-
B.	$H_2O_2I^-$	IO^-
C.	IO^-	I^-
D.	IO^-	O_2

6. Consider the following equilibrium:

$$PCl_3(g) + Cl_2(g) \rightleftarrows PCl_5(g)$$

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:

$$2NO(g) + O_2(g) \leftrightarrows 2NO_2(g)$$

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

A. $[NO] > [O_2]$
B. $[NO] = 2[O_2]$
C. $[O_2] = 2[NO]$
D. $[NO]$ is constant

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

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

A. $2O_3(g) \overset{?}{\rightleftarrows} 3O_2(g)$ $\Delta H = -285$ kJ

B. $C(s) + 2H_2(g) \overset{?}{\rightleftarrows} CH_4(g)$ $\Delta H = -74$ kJ

C. $2SO_2(g) + O_2(g) \overset{?}{\rightleftarrows} 2SO_3(g)$ $\Delta H = -197$ kJ

D. $C_2H_2(g) + Ca(OH)_2(aq) \overset{?}{\rightleftarrows} CaC_2(s) + 2H_2O(\ell)$ $\Delta H = +183$ kJ

10. Consider the following system at equilibrium:

$$2HI(g) + Cl_2(g) \leftrightarrows 2HCl(g) + I_2(s)$$

Which of the following describes the equilibrium shift and the change in the concentration of $Cl_2(g)$ when some $I_2(s)$ is added?

	Equilibrium shift	$[\mathbf{Cl_2}]$
A.	no shift	no change
B.	left	increases
C.	left	decreases
D.	right	increases

11. 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.	right	increases
C.	left	remains constant
D.	left	decreases

12. Consider the following equilibrium:

$$2BN(s) + 3Cl_2(g) \leftrightarrows 2BCl_3(g) + N_2(g) \qquad K_{eq} = 1.6 \times 10^{-3}$$

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

$$BN(s) + \frac{3}{2}Cl_2 \leftrightarrows BCl_3 + \frac{1}{2}N_2$$

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:

$$Sb_2S_3(s) + 3H_2(g) \leftrightarrows 2Sb(s) + 3H_2S(g) \qquad K_{eq} = 0.43$$

At equilibrium, there were 0.60 mol Sb_2S_3, 1.10 mol H_2 and 0.80 mol Sb.
What was the equilibrium $[H_2S]$?

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

14. Consider the equilibrium:

$$2NO_2Cl(g) \leftrightarrows 2NO_2(g) + Cl_2(g) \qquad K_{eq} = 0.56$$

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 $[NO_2]$ increases.
B. The system proceeds left and $[NO_2]$ decreases.
C. The system proceeds right and $[NO_2]$ increases.
D. The system proceeds right and $[NO_2]$ decreases.

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

A. $CsCl$
B. CaC_2O_4
C. $Cr(NO_3)_3$
D. CH_3CH_2OH

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. $Al(NO_3)_3$

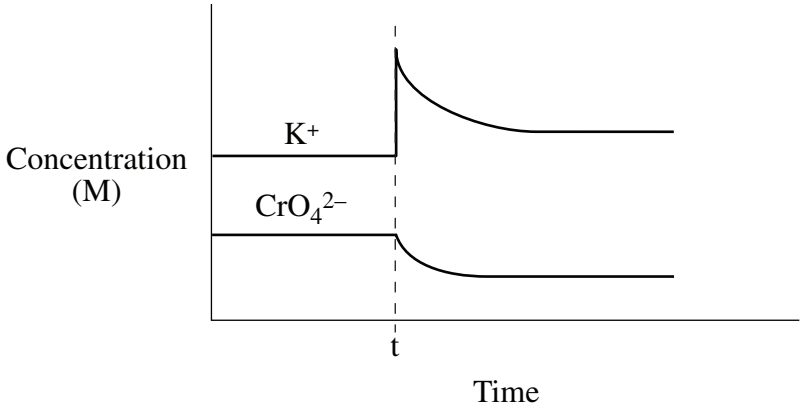
C. $Zn(NO_3)_2$

D. $Mg(NO_3)_2$

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

$$K_2CrO_4(s) + \text{energy} \leftrightarrows 2K^+(aq) + CrO_4{}^{2-}(aq)$$

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:

$$Sr_3(PO_4)_2(s) \rightleftarrows 3Sr^{2+}(aq) + 2PO_4^{3-}(aq)$$

The K_{sp} expression is

A. $K_{sp} = [Sr^{2+}]^3[PO_4^{3-}]^2$

B. $K_{sp} = [3Sr^{2+}][2PO_4^{3-}]$

C. $K_{sp} = [3Sr^{2+}]^3[2PO_4^{3-}]^2$

D. $K_{sp} = \dfrac{[3Sr^{2+}]^3[2PO_4^{3-}]^2}{[Sr_3(PO_4)_2]}$

21. A solution is found to contain a $[Pb^{2+}]$ of $0.10\,M$. 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. $[SO_4^{2-}] = 1.3 \times 10^{-4}\,M$

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
- $HClO_4$
- $H_3C_6H_5O_7$

Rank the acid solutions in order of decreasing conductivity.

A. $H_3C_6H_5O_7 > H_2CO_3 > HClO_4$
B. $HClO_4 > H_2CO_3 > H_3C_6H_5O_7$
C. $H_2CO_3 > H_3C_6H_5O_7 > HClO_4$
D. $HClO_4 > H_3C_6H_5O_7 > H_2CO_3$

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

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. A base is added to water and a new equilibrium is established. The new equilibrium can be described by

A. $pH < pOH$ and $K_w = 1 \times 10^{-14}$

B. $pH < pOH$ and $K_w < 1 \times 10^{-14}$

C. $pH > pOH$ and $K_w = 1 \times 10^{-14}$

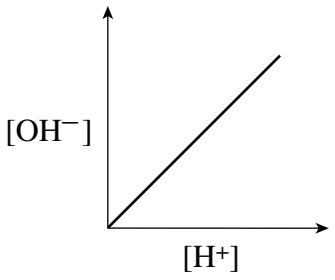
D. $pH > pOH$ and $K_w > 1 \times 10^{-14}$

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 $\left[OH^-\right]$ and $\left[H^+\right]$?

A.



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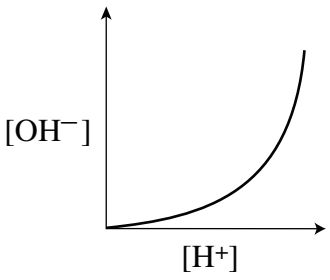

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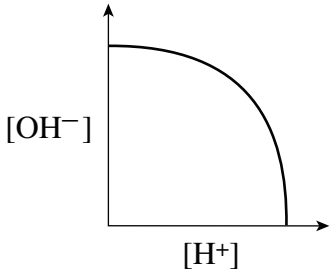

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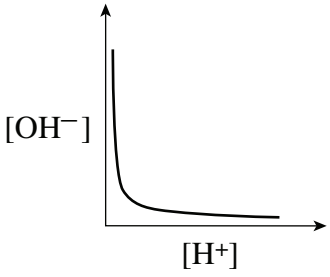


30. Which of the following $0.10\,M$ solutions of ions would have the highest pH?

A. CN^-

B. NH_4^+

C. SO_4^{2-}

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

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 $(NH_4)_2 SO_4$ with respect to hydrolysis?

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

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

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

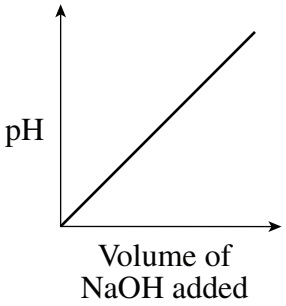
D. No hydrolysis reaction occurs.

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?

A.



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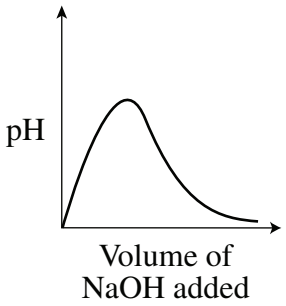

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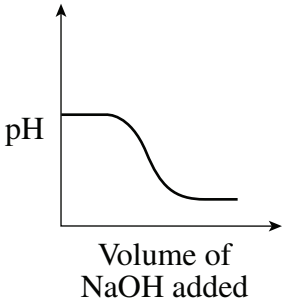

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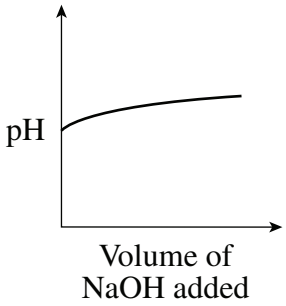


38. A gas which is produced by internal combustion engines and contributes to the formation of acid rain is

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 $C_6H_{12}O_6$ is converted to C_2H_5OH?

A. increase by 2
B. increase by 4
C. decrease by 2
D. decrease by 4

41. Consider the following redox equilibrium:

$$X_2 + Y^{2+} \leftrightarrows 2X^- + Y^{4+} \qquad K_{eq} = 6.2 \times 10^{-8}$$

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 $FeSO_4(aq)$ 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

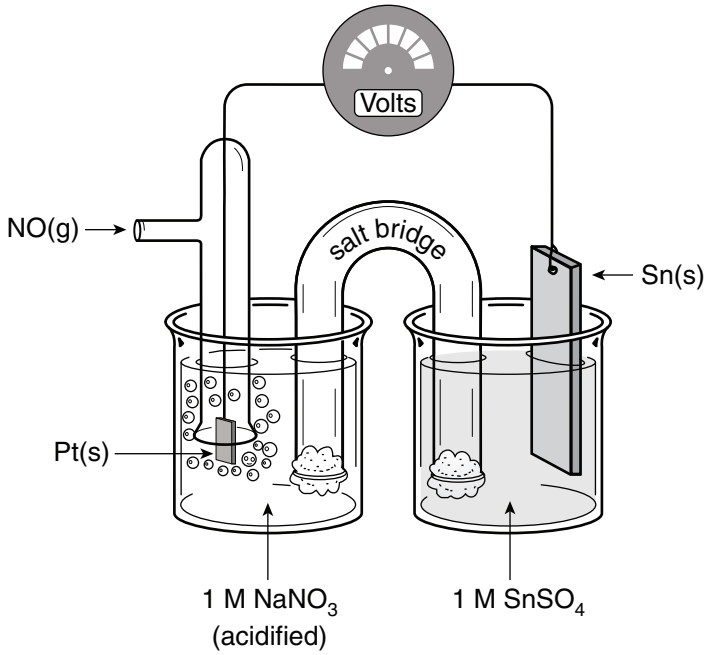
The equation for the overall reaction is:

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

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

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



44. The reaction occuring at the cathode is

A. $Na^+ + e^- \rightarrow Na$

B. $Sn^{2+} + 2e^- \rightarrow Sn$

C. $NO_3^- + 4H^+ + 3e^- \rightarrow NO(g) + 2H_2O$

D. $2NO_3^- + 4H^+ + 2e^- \rightarrow N_2O_4(g) + 2H_2O$

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:

$$3Ce^{4+} + Au \rightarrow 3Ce^{3+} + Au^{3+} \qquad E° = +0.11\ V$$

$$Co^{3+} + Ce^{3+} \rightarrow Co^{2+} + Ce^{4+} \qquad E° = +0.21\ V$$

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

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. $Mg \rightarrow Mg^{2+} + 2e^-$
B. $Mg^{2+} + 2e^- \rightarrow Mg$
C. $4\,OH^- \rightarrow O_2 + 2H_2O + 4e^-$
D. $O_2 + 2H_2O + 4e^- \rightarrow 4\,OH^-$

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. $Zn \rightarrow Zn^{2+} + 2e^-$

B. $Zn^{2+} + 2e^- \rightarrow Zn$

C. $Cl_2 + 2e^- \rightarrow 2Cl^-$

D. $2Cl^- \rightarrow Cl_2 + 2e^-$

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.