

**GRADE 12 CHEMISTRY**  
**MID-TERM — PRACTICE REVIEW TEST**

Name \_\_\_\_\_

Student Number \_\_\_\_\_

Attending  Non-Attending

Phone Number \_\_\_\_\_

Address \_\_\_\_\_

**VALUE: TOTAL 100 MARKS**

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**Note: Instructions**

Each student should bring a clean copy of tables listed below. These tables were included in the Chemistry course package.

- Periodic Table of Elements
- Periodic Table of Ions

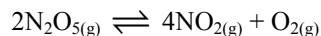
Velocity of light  $C = 3.00 \times 10^8$  m/s

Planck's Constant  $h = 6.63 \times 10^{-34}$  J/Hz

**PART A**

Circle the correct answer to the following questions. **THERE IS ONLY ONE CORRECT RESPONSE TO EACH QUESTION.** You may use a periodic table to assist in answering all questions on the exam. (47 x 1 = 47 marks)

1. Consider the following reaction:



At a certain temperature the rate of decomposition of  $\text{N}_2\text{O}_5$  is  $2.5 \times 10^{-6}$  mol/s. The rate of formation of  $\text{NO}_2$  is

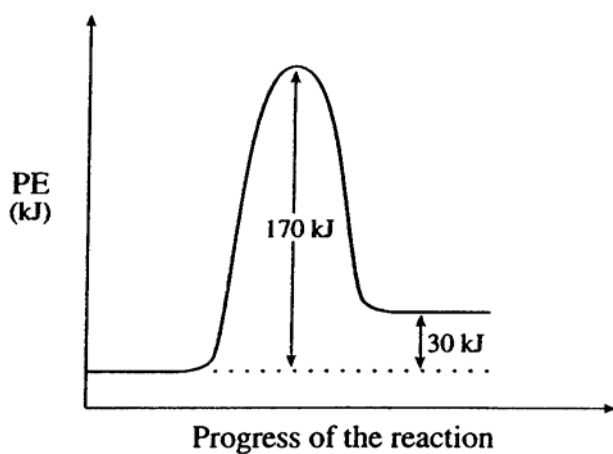
- a)  $1.0 \times 10^{-5}$  mol/s
- b)  $1.3 \times 10^{-6}$  mol/s
- c)  $2.5 \times 10^{-6}$  mol/s
- d)  $5.0 \times 10^{-6}$  mol/s

2. Which of the following factors affect the rates of both homogeneous and heterogeneous reactions?

I	nature of reactants
II	presence of a catalyst
III	temperature of system
IV	concentrations of reactants

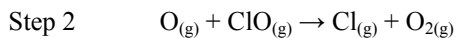
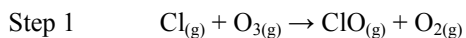
- a) I and IV only  
b) II and III only  
c) II, III and IV only  
d) I, II, III and IV

3. Consider the following potential energy diagram:



The activation energy for the reverse reaction is

- a) 30 kJ  
b) 140 kJ  
c) 170 kJ  
d) 200 kJ
4. Consider the following reaction mechanism:



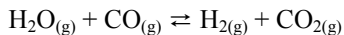
The reaction intermediate is

- a) Cl  
b)  $\text{O}_2$   
c)  $\text{O}_3$   
d) ClO

5. In a reaction mechanism, the rate determining step is the

- a) fastest and has the lowest activation energy
- b) fastest and has the highest activation energy
- c) slowest and has the lowest activation energy
- d) slowest and has the highest activation energy

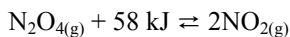
6. Consider the following equilibrium:



At high temperature, H<sub>2</sub>O and CO are placed in a closed container. As the system approaches equilibrium, the

- a) rate of the forward and reverse reactions both increase
- b) rate of the forward and reverse reactions both decrease
- c) rate of the forward reaction decreases and the rate of the reverse reaction increases
- d) rate of the forward reaction increases and the rate of the reverse reaction decreases

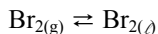
7. Consider the following equilibrium:



The equilibrium shifts right when

- a) NO<sub>2</sub> is added
- b) N<sub>2</sub>O<sub>4</sub> is removed
- c) the temperature is decreased
- d) the volume of the system is increased

8. Given the following equilibrium system:



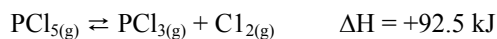
The equilibrium constant expression for the above system is

- a)  $K_{eq} = \frac{[\text{Br}_{2(l)}]}{[\text{Br}_{2(g)}]}$
- b)  $K_{eq} = [\text{Br}_{2(g)}]$
- c)  $K_{eq} = \frac{1}{[\text{Br}_{2(g)}]}$
- d)  $K_{eq} = [\text{Br}_{2(g)}][\text{Br}_{2(g)}]$

9. An equilibrium system shifts left when the temperature is increased. The forward reaction is

- a) exothermic and ΔH is positive
- b) exothermic and ΔH is negative
- c) endothermic and ΔH is positive
- d) endothermic and ΔH is negative

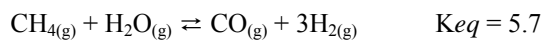
10. Consider the following equilibrium:



When the temperature decreases, the equilibrium

- a) shifts left and  $K_{eq}$  value increases
- b) shifts left and  $K_{eq}$  value decreases
- c) shifts right and  $K_{eq}$  value increases
- d) shifts right and  $K_{eq}$  value decreases

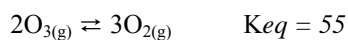
11. Consider the following equilibrium:



At equilibrium, the  $[\text{CH}_4] = 0.40 \text{ mol/L}$ ,  $[\text{CO}] = 0.30 \text{ mol/L}$  and  $[\text{H}_2] = 0.80 \text{ mol/L}$ . The  $[\text{H}_2\text{O}]$  is

- a) 0.067 mol/L
- b) 0.11 mol/L
- c) 2.2 mol/L
- d) 5.3 mol/L

12. Consider the following equilibrium:



If 0.060 mol of  $\text{O}_3$  and 0.70 mol of  $\text{O}_2$  are introduced into a 1.0 L vessel, the

- a)  $K_{\text{trial}} > K_{eq}$  and the  $[\text{O}_2]$  increases
- b)  $K_{\text{trial}} < K_{eq}$  and the  $[\text{O}_2]$  increases
- c)  $K_{\text{trial}} > K_{eq}$  and the  $[\text{O}_2]$  decreases
- d)  $K_{\text{trial}} < K_{eq}$  and the  $[\text{O}_2]$  decreases

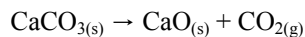
13. Which of the following units can be used to express the rate of a chemical reaction?

- a) mL/g
- b) mol/L
- c) g/mol
- d) mol/min

14. An increase in temperature increases the rate of a chemical reaction because

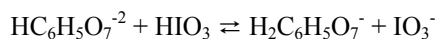
- a) the activation energy is lower
- b) exothermic reactions are always favoured
- c) a greater fraction of particles have sufficient kinetic energy
- d) the particles are more likely to have favourable collision geometry

15. Consider the following reaction:



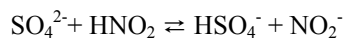
To increase the rate of decomposition of  $\text{CaCO}_3$ , one could

- a) add  $\text{CO}_2$
  - b) remove  $\text{CO}_2$
  - c) increase the temperature
  - d) decrease the temperature
16. A Brønsted-Lowry base is defined as a chemical species that
- a) accepts protons
  - b) neutralizes acids
  - c) donates electrons
  - d) produces hydroxide ions in solution
17. Which of the following solutions will have the greatest electrical conductivity?
- a) 1.0 M HCN
  - b) 1.0 M  $\text{H}_2\text{SO}_4$
  - c) 1.0 M  $\text{H}_3\text{PO}_4$
  - d) 1.0 M  $\text{CH}_3\text{COOH}$
18. Consider the following equilibrium:



The order of Brønsted-Lowry acids and bases is

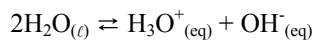
- a) acid, base, acid, base
  - b) acid, base, base, acid
  - c) base, acid, acid, base
  - d) base, acid, base, acid
19. Consider the following:



Equilibrium would favour

- a) the products since  $\text{HSO}_4^-$  is a weaker acid than  $\text{HNO}_2$
- b) the reactants since  $\text{HSO}_4^-$  is a weaker acid than  $\text{HNO}_2$
- c) the products since  $\text{HSO}_4^-$  is a stronger acid than  $\text{HNO}_2$
- d) the reactants since  $\text{HSO}_4^-$  is a stronger acid than  $\text{HNO}_2$

20. Consider the following equilibrium:



A few drops of 1.0 M HCl are added to the above system. When equilibrium is reestablished, the

- a)  $[\text{H}_3\text{O}^+]$  has increased and the  $[\text{OH}^-]$  has decreased
  - b)  $[\text{H}_3\text{O}^+]$  has increased and the  $[\text{OH}^-]$  has increased
  - c)  $[\text{H}_3\text{O}^+]$  has decreased and the  $[\text{OH}^-]$  has increased
  - d)  $[\text{H}_3\text{O}^+]$  has decreased and the  $[\text{OH}^-]$  has decreased
21. In a solution with a  $[\text{OH}^-]$  of  $1.5 \times 10^{-4}$  M, the  $[\text{H}_3\text{O}^+]$  is
- a)  $6.7 \times 10^{-11}$  M
  - b)  $1.0 \times 10^{-7}$  M
  - c)  $1.5 \times 10^{-4}$  M
  - d)  $1.2 \times 10^{-2}$  M
22. The pH of pure water is 6.52 at 60°C. The  $[\text{OH}^-]$  is
- a)  $3.3 \times 10^{-8}$  M
  - b)  $1.0 \times 10^{-7}$  M
  - c)  $3.0 \times 10^{-7}$  M
  - d)  $8.1 \times 10^{-1}$  M
23. Consider the following equilibrium for an indicator:
- $$\begin{array}{ccc} \text{HInd} + \text{H}_2\text{O} & \rightleftharpoons & \text{Ind}^- + \text{H}_3\text{O}^+ \\ \text{yellow} & & \text{red} \end{array}$$
- When a few drops of phenol red are added to 1.0 M NaOH, the equilibrium
- a) shifts left and the colour of the solution turns red
  - b) shifts right and the colour of the solution turns red
  - c) shifts left and the colour of the solution turns yellow
  - d) shifts right and the colour of the solution turns yellow
24. A net ionic equation representing the reaction between 1.0 M  $\text{HNO}_2$  and 1.0 M NaOH is
- a)  $\text{Na}^+ + \text{NO}_2^- \rightarrow \text{NaNO}_2$
  - b)  $\text{H}^+ + \text{NaOH} \rightarrow \text{Na}^+ + \text{H}_2\text{O}$
  - c)  $\text{HNO}_2 + \text{OH}^- \rightarrow \text{NO}_2^- + \text{H}_2\text{O}$
  - d)  $\text{HNO}_2 + \text{NaOH} \rightarrow \text{NaNO}_2 + \text{H}_2\text{O}$
25. Which of the following oxides, when dissolved in water, will produce the most basic solution?
- a) BaO
  - b)  $\text{CO}_2$
  - c)  $\text{SO}_2$
  - d) ClO

26. Which of the following could act as a Brønsted-Lowry acid, but not as a Brønsted-Lowry base?
- $\text{HClO}_{4(\text{aq})}$
  - $\text{H}_2\text{O}_{(\text{l})}$
  - $\text{NH}_3_{(\text{aq})}$
  - $\text{HCO}_3^-_{(\text{aq})}$
27. The strength of an acid depends upon its
- $E^\circ$
  - pH
  - concentration
  - degree of ionization
28. Consider the following equilibrium:
- $$\text{HX}^- + \text{HZ}^- \rightleftharpoons \text{H}_2\text{X} + \text{Z}^{2-}$$
- The reactants are favoured. The strongest acid is
- $\text{Z}^{2-}$
  - $\text{HZ}^-$
  - $\text{HX}^-$
  - $\text{H}_2\text{X}$
29. The pH of a 0.025 M NaOH solution is
- 0.94
  - 1.60
  - 12.40
  - 13.06
30. The relationship between pOH and  $[\text{OH}^-]$  is
- $-\log \text{pOH} = [\text{OH}^-]$
  - $\text{pOH} = -\log [\text{OH}^-]$
  - $\text{antilog pOH} = [\text{OH}^-]$
  - $\text{pOH} = \text{antilog} (-[\text{OH}^-])$
31. A 25.0 mL sample of  $\text{H}_2\text{SO}_4$  requires 25.0 mL of 0.100 M KOH for complete neutralization. The initial concentration of the  $\text{H}_2\text{SO}_4$  is
- $5.00 \times 10^{-2} \text{ M}$
  - $1.00 \times 10^{-1} \text{ M}$
  - $2.00 \times 10^{-1} \text{ M}$
  - $4.00 \times 10^{-1} \text{ M}$
32. A solution is prepared by adding 10.0 mL of 0.10 HCl to 25.0 mL of 0.040 M NaOH. The pH of the resulting solution is
- 1.00
  - 3.00
  - 7.00
  - 12.60

33. The number of sublevels for the atom having a principal quantum number of 3 is
- 2
  - 3
  - 8
  - 16
34. Which of the following atoms has the highest first ionization energy?
- Li
  - Mg
  - O
  - Cl
35. The frequency of a quantum of light (photon) with a wavelength of  $6.0 \times 10^{-7}$  m is:
- $2.0 \times 10^{-15}$  Hz
  - $5 \times 10^{15}$  Hz
  - $5.0 \times 10^{14}$  Hz
  - $1.8 \times 10^2$  Hz
36. The energy content of one quantum of light which has a wavelength of  $6.2 \times 10^2$  nm is:
- $3.2 \times 10^{-19}$  J
  - $1.9 \times 10^{11}$  J
  - $3.2 \times 10^{-15}$  J
  - $1.37 \times 10^{-32}$  J
37. The electron configuration for calcium (atomic number = 20) mass = 42 is:
- $1S^22S^22P^63S^23P^64S^23D^{10}4P^65S^25P^4$
  - $1S^22S^22P^63S^23P^64S^2$
  - $1S^22S^22P^63S^23P^64S^23D^2$
  - none of the above
38. The number of valence electrons for the atom with an electron configuration of  $1S^22S^22P^63S^23P^4$  is
- 2
  - 4
  - 6
  - 16
39. The figure 0.0128 has how many significant digits
- 5
  - 4
  - 3
  - 2

40. When the following calculation is performed the correct answer is:

$$\text{Calculation: } 21.4 \text{ g} \times \frac{1 \text{ kg}}{1000 \text{ g}}$$

- a) 21 400 kg  
b) 0.0 214 g  
c) 0.0 214 kg  
d) none of the above
41. For the following indicated operation (5.22 m x 82.7 m) the correct answer is
- a) 431.694 m<sup>2</sup>  
b) 431.69 m<sup>2</sup>  
c) 431.7 m<sup>2</sup>  
d) 432 m<sup>2</sup>
42. For the following indicated operation (4.375 g + 14.62 g + 327.9 g) the correct answer is
- a) 346.895 g  
b) 346.895 g  
c) 346.9 g  
d) 346.10 g
43. What type of bond exists between an atom of boron and sulfur. (Use the electronegativity values given in the periodic table).
- a) ionic  
b) covalent  
c) nonpolar covalent  
d) polar covalent
44. An atom with the following election configuration (1S<sup>2</sup>2S<sup>2</sup>2P<sup>6</sup>3S<sup>2</sup>3P<sup>6</sup>4S<sup>2</sup>3D<sup>5</sup>)
- a) has an atomic number of 25  
b) is the element manganese  
c) has a valence of 2  
d) all of the following A, B & C
45. The element carbon has the following ionization energies in kcal/mol
- |                      |                      |                      |                       |                       |
|----------------------|----------------------|----------------------|-----------------------|-----------------------|
| E <sub>1</sub> + 250 | E <sub>2</sub> + 555 | E <sub>3</sub> + 801 | E <sub>4</sub> + 1200 | E <sub>5</sub> + 6214 |
|----------------------|----------------------|----------------------|-----------------------|-----------------------|
- The number of valence electrons that carbon has is
- a) 4  
b) 3  
c) 2  
d) 5
46. The empirical formula for the following ionic (Al and S) is
- a) Al S  
b) Al<sub>2</sub> S<sub>3</sub>  
c) Al<sub>3</sub> S<sub>3</sub>  
d) Al S<sub>2</sub>

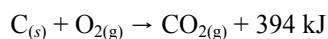
47. The maximum number of electrons that can occur the level with a principal quantum number of 4 is:

- a) 4
- b) 8
- c) 16
- d) 32

**PART B Written Response**

**Instructions:** You will be 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 the spaces below the questions. Answers must include units where appropriate and be given to the correct number of significant figures. **For questions involving calculation, full marks will NOT be given for providing only an answer.**

1. The combustion of coal, C, produces carbon dioxide gas according to the following equation:



(1) a) What is the value of  $\Delta H$  for this reaction?

(2) b) Using collision theory, explain why a lump of coal does not react with oxygen at room temperature and pressure.

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(2) c) Many coal mine disasters have resulted when a spark ignites coal dust in the air. Explain, using collision theory.

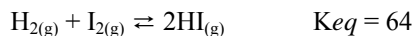
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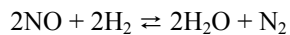
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(4) 2. Consider the following equilibrium:



Equal moles of  $\text{H}_2$  and  $\text{I}_2$  are placed in a 1.00 L container. At equilibrium, the  $[\text{HI}] = 0.160 \text{ mol/L}$ . Calculate the initial  $[\text{H}_2]$

3. Consider the following overall reaction:

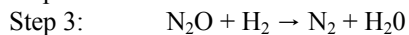
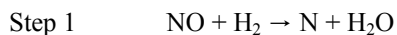


(1) a) Explain why the reaction is likely to involve more than one step.

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b) A proposed mechanism for the reaction is:



(2) i) Write the equation for Step 2.

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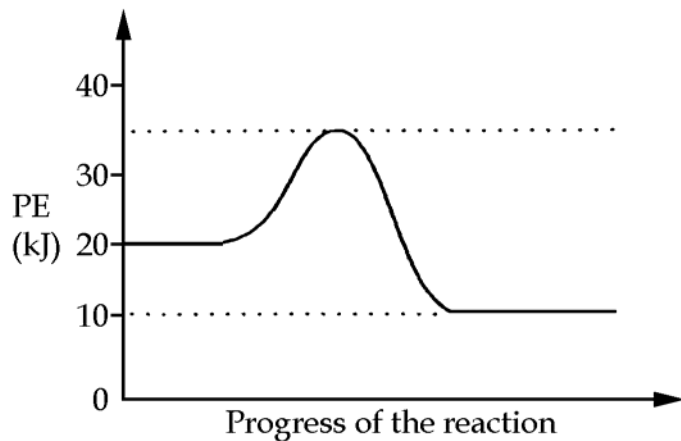
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(1) ii) Identify all reaction intermediates.

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4. Consider the following potential energy diagram for a reversible reaction:



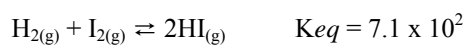
(1) a) Calculate the activation energy for the forward reaction.

(1) b) Calculate  $\Delta H$  for the forward reaction.

(1) c) Calculate the activation energy for the reverse reaction.

(1) d) On the diagram above, sketch a curve that could result when a catalyst is added.

(3) 5. Consider the following equilibrium:



At equilibrium, the  $[\text{H}_2] = 0.012 \text{ mol/L}$  and  $[\text{HI}] = 0.40 \text{ mol/L}$ . What is the equilibrium concentration of  $\text{I}_2$ ?

(2) 6. What is the  $[\text{H}_3\text{O}^+]$  in a solution formed by adding 60.0 mL of water to 40.0 mL of 0.040 M KOH?

(4) 7. Calculate the pH in 100.0 mL of 0.400 M  $\text{CH}_3\text{COOH}$  ( $K_a = 1.8 \times 10^{-5}$  is a weak acid)

- (2) 8. a) Define the term *weak Brønsted-Lowry base*.
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- (1) b) Give an example of a compound that acts as a weak base.
- (4) 9. Lactic acid,  $\text{C}_2\text{H}_5\text{O}_2\text{COOH}$ , is a weak acid produced by the body. At  $25^\circ\text{C}$ ,  $0.100\text{ M}$   $\text{C}_2\text{H}_5\text{O}_2\text{COOH}$  has a pH of 2.95. Calculate the value of  $K_a$  for lactic acid.
- (1) 10. The salt NaCN dissolves in water and forms a slightly basic solution. Write the dissociation equation for NaCN in water.
- (3) 11. What elements are composed of atoms having the following electron configurations.
- a)  $1\text{S}^22\text{S}^22\text{P}^63\text{S}^23\text{P}^64\text{S}^23\text{D}^3$
- b)  $1\text{S}^22\text{S}^22\text{P}^63\text{S}^23\text{P}^64\text{S}^23\text{D}^{10}4\text{P}^65\text{S}^24\text{D}^2$
- (2) 12. Write the electron configuration for
- a) thallium
- b) iron
- (3) 13. Draw electron dot formula for  $\text{SO}_4^{2-}$  (sulfate ion)

- (2) 14. What is the frequency of light with a wavelength of 610 nm?
- (2) 15. a) What is the wavelength of light with a frequency of  $9.62 \times 10^{12}$  Hz?
- (2) b) Calculate the energy of one photon of this light.
16. For each of the following molecules
- (2) a) Write the electron dot diagrams
- i) HBr
  - ii) C<sub>2</sub>H<sub>6</sub>
- (2) b) Draw arrows to represent bond dipoles
- i) HBr
  - ii) C<sub>2</sub>H<sub>6</sub>
- (1) c) Identify molecule (i) as ionic, nonpolar covalent or polar covalent.