

Name: \_\_\_\_\_

Teacher: \_\_\_\_\_

***DO NOT OPEN THE EXAMINATION PAPER UNTIL  
YOU ARE TOLD BY THE SUPERVISOR TO BEGIN***

# CHEMISTRY 2202

## ***FINAL EXAMINATION***

Value: 100%

### **General Instructions**

This examination consists of two parts. Both parts are contained in this booklet and further general instructions are provided on appropriate pages.

#### **Part I - Multiple Choice (40%)**

Select the letter of the correct response from those provided. EITHER shade the letter on your computer scorable card OR place the letter in the blank provided on your Multiple Choice Answer Sheet, whichever format is being used by your school for this exam.

**Do ALL questions in this section.**

#### **Part II - Constructed Response (60%)**

Answer ALL questions fully and concisely in the space provided. Show all work, and use correct units and significant digits in all final answers.

A Periodic Table and a Chemistry Data Sheet are provided.

### **Student Checklist**

***The items below are your responsibility. Please ensure that they are completed.***

Write your name and teacher's name on the top of this page.

Write your name, teacher's name, course name and number on the Part I answer sheet.

Check the exam to see that there are no missing pages.

**ALL MATERIALS MUST BE PASSED IN WITH THIS EXAM.** Use your time wisely. Good luck!

**Part 1**

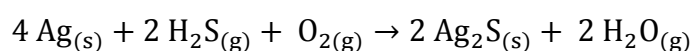
**Total Value – 40%**

1. What is the isotope name of  ${}^{68}_{29}\text{Cu}$  ?
  - (A) copper-29
  - (B) copper-39
  - (C) copper-68
  - (D) copper-97
  
2. Buckminsterfullerines are large molecules that resemble a see-through soccer ball. These molecules are composed entirely of carbon atoms. What is the chemical formula for a buckminsterfullerene that has a molar mass of 841 g/mol?
  - (A)  $\text{C}_{60}$
  - (B)  $\text{C}_{70}$
  - (C)  $\text{C}_{829}$
  - (D)  $\text{C}_{853}$
  
3. What is the molar mass of calcium hydroxide,  $\text{Ca}(\text{OH})_2$ ?
  - (A) 38.00 g/mol
  - (B) 58.10 g/mol
  - (C) 74.10 g/mol
  - (D) 116.20 g/mol
  
4. How many calcium atoms are there in a 3.00 mol sample?
  - (A)  $4.98 \times 10^{-24}$
  - (B)  $2.01 \times 10^{23}$
  - (C)  $6.02 \times 10^{23}$
  - (D)  $1.81 \times 10^{24}$
  
5. What is the mass of 0.300 mol of  $\text{CaSO}_4$  (molar mass = 136.15 g/mol)?
  - (A)  $2.20 \times 10^{-3}$  g
  - (B) 40.8 g
  - (C) 48.9 g
  - (D)  $4.54 \times 10^2$  g

6. How many molecules of  $C_6H_{12}O_6$  (molar mass = 180.18 g/mol) are present in a 5.50 g sample?

- (A)  $5.07 \times 10^{-26}$
- (B)  $3.05 \times 10^{-2}$
- (C)  $1.84 \times 10^{22}$
- (D)  $1.97 \times 10^{25}$

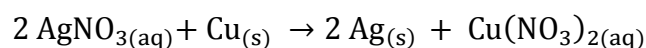
7. Given the balanced chemical equation,



what volume of  $H_2O_{(g)}$  should be produced at STP by the reaction of 0.208 mol of  $Ag_{(s)}$  with sufficient quantities of  $H_2S_{(g)}$  and  $O_{2(g)}$ ?

- (A) 0.104 L
- (B) 2.33 L
- (C) 4.66 L
- (D) 9.30 L

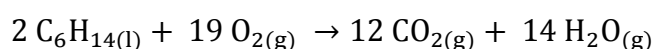
8. In a lab activity, students react solid copper in a silver nitrate solution:



If 5 mol of  $AgNO_{3(aq)}$  is mixed with 3 mol of  $Cu_{(s)}$ , which is the limiting reagent?

- (A)  $Ag_{(s)}$
- (B)  $AgNO_{3(aq)}$
- (C)  $Cu_{(s)}$
- (D)  $Cu(NO_3)_2(aq)$

9. How many moles of  $CO_{2(g)}$  are produced by the complete combustion of 3.5 mol of  $C_6H_{14(l)}$ ?

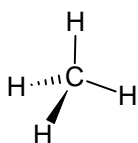


- (A) 3.5 mol
- (B) 12 mol
- (C) 21 mol
- (D) 42 mol

10. Which term best describes a solution that cannot dissolve any more solute at a constant temperature?
- (A) dilute
  - (B) polyunsaturated
  - (C) saturated
  - (D) unsaturated
11. What is the concentration of 0.250L solution that contains 2.50 g of  $\text{Ca}_3(\text{PO}_4)_2$  (molar mass = 310.18 g/mol)?
- (A)  $2.02 \times 10^{-3}$  mol/L
  - (B)  $3.22 \times 10^{-2}$  mol/L
  - (C) 31.0 mol/L
  - (D) 194 mol/L
12. Large deposits of gypsum, an ionic hydrate, are located in western Newfoundland. By mass, what percentage of gypsum,  $\text{CaSO}_4 \cdot 2 \text{H}_2\text{O}$ , is water?
- (A) 6.210%
  - (B) 20.93%
  - (C) 66.67%
  - (D) 79.07%
13. What mass of NaOH (molar mass = 40.00 g/mol) is present in 0.250 L of a 0.100 mol/L solution?
- (A)  $2.50 \times 10^{-2}$  g
  - (B) 1.00 g
  - (C) 16.0 g
  - (D)  $1.00 \times 10^2$  g
14. At **25.0 °C** and **100.0 kPa**, the molar volume of a gas is **24.8 L/mol**. What volume would  $4.85 \times 10^{23}$  atoms of helium occupy under these conditions?
- (A) 0.0325 L
  - (B) 0.805 L
  - (C) 18.0 L
  - (D) 20.0 L

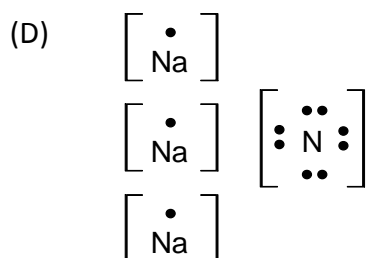
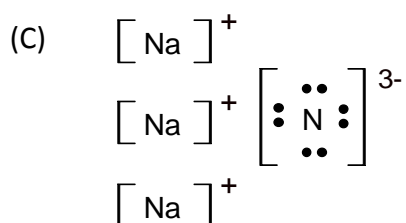
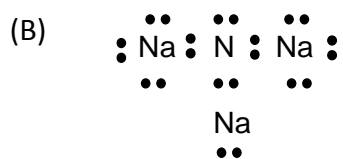
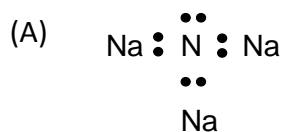
15. Which is the correct equation for the dissociation of potassium phosphate,  $K_3PO_{4(s)}$ ?
- (A)  $K_3PO_{4(s)} \rightarrow 3K_{(aq)}^+ + PO_{4(aq)}^{3-}$
- (B)  $K_3PO_{4(s)} \rightarrow K_{3(aq)}^+ + PO_{4(aq)}^{3-}$
- (C)  $K_3PO_{4(s)} \rightarrow 3K_{(aq)}^+ + P_{(aq)}^{3-} + 4O_{(aq)}^{2-}$
- (D)  $K_3PO_{4(s)} \rightarrow K_{(aq)}^{3+} + PO_{4(aq)}^{3-}$
16. Which has low solubility in water?
- (A)  $Ba(OH)_2$
- (B)  $CaSO_4$
- (C)  $Cu(NO_3)_2$
- (D)  $MgCl_2$
17. What is the concentration of nitrate ions in a 0.60 mol/L solution of lead(IV) nitrate,  $Pb(NO_3)_{4(aq)}$ ?
- (A) 0.15 mol/L
- (B) 0.60 mol/L
- (C) 1.8 mol/L
- (D) 2.4 mol/L
18. After combining solutions of sodium carbonate and calcium nitrate, a student filtered the reaction mixture to collect a precipitate of calcium carbonate. Which occurs if the precipitate is weighed before it is completely dry?
- (A) % yield is higher than it should be
- (B) % yield is lower than it should be
- (C) theoretical yield is higher than it should be
- (D) theoretical yield is lower than it should be
19. What is the number of bonding electrons in an atom of phosphorus?
- (A) 1
- (B) 2
- (C) 3
- (D) 4

20. Which bond is polar?
- (A) C – Br
  - (B) C – C
  - (C) C – I
  - (D) C – S
21. Which substance has the highest melting point?
- (A) Fe
  - (B) H<sub>2</sub>O
  - (C) NaCl
  - (D) SiO<sub>2</sub>
22. Which substance should have high solubility in water?
- (A) CCl<sub>4</sub>
  - (B) CH<sub>4</sub>
  - (C) CH<sub>3</sub>Cl
  - (D) CO<sub>2</sub>
23. Which molecular shape is illustrated by this diagram?



- (A) bent
  - (B) pyramidal
  - (C) tetrahedral
  - (D) trigonal planar
24. What is the shape around the central atom in CSF<sub>2</sub>?
- (A) bent
  - (B) pyramidal
  - (C) tetrahedral
  - (D) trigonal planar

25. Which Lewis Diagram best represents sodium nitride?



26. Which bond is most polar?

- (A) S-Br
- (B) S-H
- (C) S-I
- (D) S-N

27. Which substance experiences hydrogen bonding forces of attraction?

- (A)  $\text{CH}_3\text{Br}_{(g)}$
- (B)  $\text{CH}_3\text{Cl}_{(l)}$
- (C)  $\text{CH}_3\text{I}_{(g)}$
- (D)  $\text{CH}_3\text{OH}_{(l)}$

28. Which best describes metallic bonding?

- (A) the attraction of oppositely charged ions
- (B) the attraction of positive ions for mobile valence electrons
- (C) the attraction of positive nuclei for shared pairs of electrons
- (D) the attraction of opposite dipoles of neighbouring molecules

29. A student has two unknown substances, X and Y. Substance X **does not** conduct electricity as a solid or a liquid. Substance Y **does** conduct electricity as a solid and a liquid. What would be the most likely identities of substances X and Y?

	<b>X</b>	<b>Y</b>
(A)	$\text{Fe}_{(s)}$	$\text{SiC}_{(s)}$
(B)	$\text{NaI}_{(s)}$	$\text{C}_6\text{H}_{12}\text{O}_{6(s)}$
(C)	$\text{Ca}(\text{OH})_{2(s)}$	$\text{I}_{2(s)}$
(D)	$\text{C}_{30}\text{H}_{62(s)}$	$\text{Pb}_{(s)}$

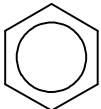
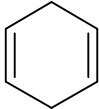
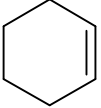
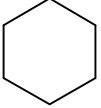
30. Which substance has the strongest London dispersion forces?
- (A)  $\text{CO}_2$   
(B) HF  
(C)  $\text{H}_2\text{O}$   
(D)  $\text{NH}_3$
31. An unknown substance was found to be hard. It had a high melting point and conducted electricity when dissolved in water. What is the identity of the unknown solid?
- (A)  $\text{C}_6\text{H}_{12}\text{O}_6$   
(B)  $\text{FeCl}_3$   
(C) SiC  
(D) V
32. Which compound is organic?
- (A)  $\text{CH}_3\text{OH}$   
(B)  $\text{CaCO}_3$   
(C)  $\text{NaClO}_3$   
(D)  $\text{NCl}_3$
33. Which is an alkane?
- (A) benzene  
(B) ethyne  
(C) hexene  
(D) propane



34. Which is a hydrocarbon?

- (A)  $\text{CH}_3\text{COOH}$
- (B)  $\text{CH}_3\text{OH}$
- (C)  $\text{CH}_4$
- (D)  $\text{CH}_3\text{Cl}$

35. Which is benzene?

- (A) 
- (B) 
- (C) 
- (D) 

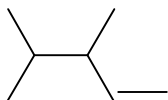
36. Which represents a carboxylic acid?

- (A)  $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$
- (B)  $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$
- (C)  $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{CH}_3$
- (D)  $\text{H}_3\text{C}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$

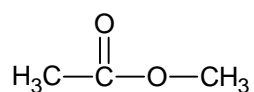
37. Which is a structural isomer of cyclopentane?

- (A) cyclopentene
- (B) methylbutane
- (C) methylcyclobutane
- (D) methylpropane

38. Which is the correct name for the structure below?



- (A) 3,4-dimethyl-1-pentene  
(B) 2,3-dimethyl-4-pentene  
(C) 3,4-dimethyl-2-pentene  
(D) 2,3-dimethyl-5-pentene
39. A student picks up a bottle containing four hydrocarbons. If the cover is left off the bottle, which hydrocarbon will vapourize first?
- (A) methylbutane  
(B) 2-heptene  
(C) hexane  
(D) 3,3,4,4-tetramethyldecane
40. Which substance reacts with methanol to produce the compound below?



- (A) ethanoic acid  
(B) ethanol  
(C) propanol  
(D) propanoic acid

**End of Part 1**

## Part II- Constructed Response

Total Value: 60%

Answer ALL questions in the space provided. All necessary workings must be shown to receive full marks.

*Value*

- 4      41. a. Percent composition analysis reveals that a compound is 71.06% cobalt and 28.94% oxygen. Determine the empirical formula.
- 3      b. A compound has a molar mass of 84.18 g/mol. Percent composition analysis revealed that the compound has an empirical formula of  $\text{CH}_2$ . Determine the molecular formula of the compound.
- 3      c. Calculate the volume of 10.0 g of nitrogen dioxide,  $\text{NO}_{2(\text{g})}$  at STP.

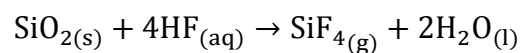
41. (continued)

Value

2 d. (i) Determine the volume of a 2.00 mol/L  $\text{KNO}_{3(\text{aq})}$  solution required to make 250.0 mL of a 0.200 mol/L  $\text{KNO}_{3(\text{aq})}$  solution.

2 (ii) Outline the steps you would use to prepare this new solution.

4 e. (i) A student reacts 50.0 g of  $\text{SiO}_{2(\text{s})}$  with excess  $\text{HF}_{(\text{aq})}$ . Calculate the theoretical yield of  $\text{H}_2\text{O}_{(\text{l})}$  in grams.



2 (ii) If the actual yield of  $\text{H}_2\text{O}_{(\text{l})}$  produced in part (i) was 24.6 g, determine the percent yield.

41. (Continued)

Value

- 4 f. A student discovered a bottle which contains a clear colorless solution. The label on the bottle, which was partially removed, read “\_\_\_\_\_ nitrate”. The student tested two samples of the solution to determine the compound.

In test tube A the student added a few drops of  $\text{NaCl}_{(\text{aq})}$  and a precipitate formed.

In test tube B the student added a few drops of  $\text{Na}_2\text{SO}_{4(\text{aq})}$  and a precipitate formed.

What are two possible names for the solution in the bottle? Explain.

- 3 g. Naturally occurring magnesium exists as a mixture of three isotopes. Mg-24 has an atomic mass of 23.985 amu and a relative abundance of 78.70%. Mg-25 has an atomic mass of 24.985 amu and a relative abundance of 10.13%. The average atomic mass of magnesium is 24.31 amu. Calculate the atomic mass of the remaining isotope.

Value

42. a. For the molecule  $\text{CH}_3\text{F}$ :
- 2 (i) Draw the Lewis dot diagram.
- 2 (ii) **Draw** the VSEPR shape diagram and provide the name of the shape around the central atom.
- 2 (iii) Is  $\text{CH}_3\text{F}$  a polar molecule? Explain.
- b. For each pair of substances, predict which will have the higher boiling point. Justify each prediction.
- 2 (i)  $\text{CF}_4$  or  $\text{CBr}_4$
- 2 (ii)  $\text{SiO}_2$  or Pb
- 2 (iii)  $\text{CH}_4$  or NaCl
- 1 c. Which of the six substances in (b) has the lowest boiling point? \_\_\_\_\_

42. (Continued)

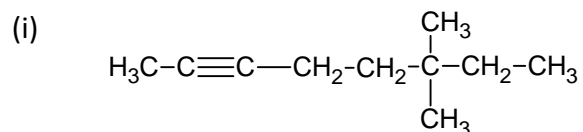
Value

- 4 d. A molecule consists of carbon, nitrogen, and hydrogen. It has one multiple bond, one carbon atom and one nitrogen atom.

Draw two possible Lewis diagrams for this molecule.

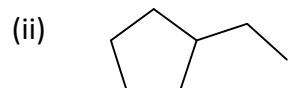
43. a. **Name** each compound using the IUPAC naming rules.

2



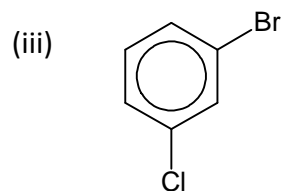
Name: \_\_\_\_\_

2



Name: \_\_\_\_\_

2



Name: \_\_\_\_\_

43. (Continued)

Value

- b. Draw a structural diagram for each compound.
- 2 (i) 3-ethylheptane
- 2 (ii) butanal
- 2 (iii) 3-methyl-2-hexanol
- 4 c. Ethene reacts with hydrogen gas to produce Compound A.
- $$\text{Ethene} + \text{H}_2(\text{g}) \rightarrow \text{A}$$
- Compound A reacts with fluorine gas to produce Compound B and Compound C.
- $$\text{A} + \text{F}_2(\text{g}) \rightarrow \text{B} + \text{C}$$
- Use structural diagrams to identify Compounds A, B, and C.