1. What is the isotope name of $^{68}_{29}Cu$?

(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) C_{60} (B) C_{70} (C) C_{829} (D) C_{853}

3. What is the molar mass of calcium hydroxide, $Ca(OH)_2$?

(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) 4.98×10^{-24} (B) 2.01×10^{23}

(C) 6.02×10^{23} (D) 1.81×10^{24}

5. What is the mass of 0.300 mol of $CaSO_4$ (molar mass = 136.15 g/mol)?

(A) 2.20×10^{-3} g (B) 40.8 g

(C) 48.9 g (D) 4.54×10^{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) 5.07×10^{-26} (B) 3.05×10^{-2} (C) 1.84×10^{22} (D) 1.97×10^{25}

7. Given the balanced chemical equation,

$$4\ Ag_{(s)} + 2\ H_2S_{(g)} + O_{2(g)} \rightarrow 2\ Ag_2S_{(s)} + 2\ H_2O_{(g)}$$

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:

$$2\ AgNO_{3(aq)} + Cu_{(s)} \rightarrow 2\ Ag_{(s)} + Cu(NO_3)_{2(aq)}$$

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 $C_6H_{14(l)}$?

$$2\ C_6H_{14(l)} + 19\ O_{2(g)} \rightarrow 12\ CO_{2(g)} + 14\ H_2O_{(g)}$$

(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 $Ca_3(PO_4)_2$ (molar mass = 310.18 g/mol)?

(A) 2.02×10^{-3} mol/L (B) 3.22×10^{-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, $CaSO_4 \cdot 2\ H_2O$, 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) 2.50×10^{-2} g (B) 1.00 g (C) 16.0 g (D) 1.00×10^{2} g

14. At $\mathbf{25.0\ ^{\circ}C}$ and **100.0 kPa**, the molar volume of a gas is **24.8 L/mol**. What volume would 4.85×10^{23} molecules 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) $K_3PO_{4(s)} \rightarrow 3K^{+}_{(aq)} + PO^{3-}_{4(aq)}$

(B) $K_3PO_{4(s)} \rightarrow K^{+}_{3(aq)} + PO^{3-}_{4(aq)}$

(C) $K_3PO_{4(s)} \rightarrow 3K^{+}_{(aq)} + P^{3-}_{(aq)} + 4O^{2-}_{(aq)}$

(D) $K_3PO_{4(s)} \rightarrow K^{3+}_{(aq)} + PO^{3-}_{4(aq)}$

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

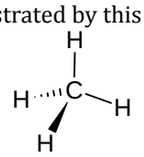
21. Which substance has the highest melting point?

(A) Fe (B) H_2O (C) NaCl (D) SiO_2

22. Which substance should have high solubility in water?

(A) CCl_4 (B) CH_4 (C) CH_3Cl (D) CO_2

23. Which molecular shape is illustrated by this diagram?

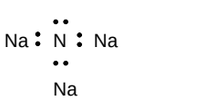


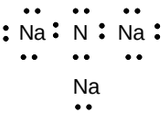
(A) bent (B) pyramidal (C) tetrahedral (D) trigonal planar

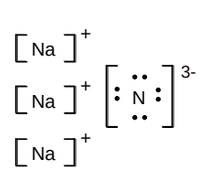
24. What is the shape around the central atom in CSF_2?

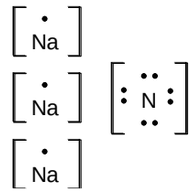
(A) bent (B) pyramidal (C) tetrahedral (D) trigonal planar

25. Which Lewis Diagram best represents sodium nitride?

(A) 

(B) 

(C) 

(D) 

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) $CH_3Br_{(g)}$ (B) $CH_3Cl_{(l)}$ (C) $CH_3I_{(g)}$ (D) $CH_3OH_{(l)}$

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?

	X	Y
(A)	$Fe_{(s)}$	$SiC_{(s)}$
(B)	$NaI_{(s)}$	$C_6H_{12}O_{6(S)}$
(C)	$Ca(OH)_{2(s)}$	$I_{2(s)}$
(D)	$C_{30}H_{62(s)}$	$Pb_{(s)}$

30. Which substance has the strongest London dispersion forces?

(A) CO_2 (B) HF (C) H_2O (D) 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) $C_6H_{12}O_6$ (B) $FeCl_3$ (C) SiC (D) V

32. Which compound is organic?

(A) CH_3OH (B) $CaCO_3$ (C) $NaClO_3$ (D) NCl_3

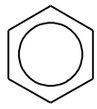
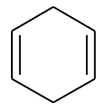
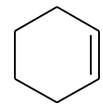
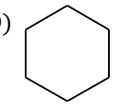
33. Which is an alkane?

(A) benzene (B) ethyne (C) hexene (D) propane

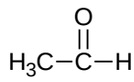
34. Which is a hydrocarbon?

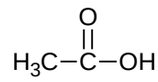
(A) CH_3COOH (B) CH_3OH (C) CH_4 (D) CH_3Cl

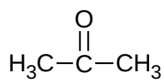
35. Which is benzene?

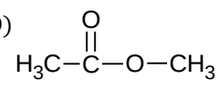
(A)  (B)  (C)  (D) 

36. Which represents a carboxylic acid?

(A) 

(B) 

(C) 

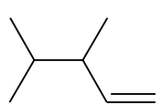
(D) 

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

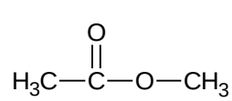
(C) 3,4-dimethyl-2-pentene (D) 2,3-dimethyl-5-pentene

39. A student picks up a bottle containing four hydrocarbons. If the cover is left off the bottle, which hydrocarbon will vaporize 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

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 C_2H_4. Determine the molecular formula of the compound.

3 c. Calculate the volume of 10.0 g of nitrogen dioxide, $NO_{2(g)}$ at STP.

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

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

4 e. (i) A student reacts 50.0 g of $SiO_{2(s)}$ with excess $HF_{(aq)}$. Calculate the theoretical yield of $H_2O_{(l)}$ in grams.

$$SiO_{2(s)} + 4HF_{(aq)} \rightarrow SiF_{4(g)} + 2H_2O_{(l)}$$

2 (ii) If the actual yield of $H_2O_{(l)}$ produced in part (i) was 24.6 g, determine the percent yield.

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 $NaCl_{(aq)}$ and a precipitate formed.

In test tube B the student added a few drops of $Na_2SO_{4(aq)}$ 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.

42. a. For the molecule CH_3F:

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 CH_3F a polar molecule? Explain.

b. For each pair of substances, predict which will have the higher boiling point. Justify each prediction.

2 (i) CF_4 or CBr_4

2 (ii) SiO_2 or Pb

2 (iii) CH_4 or $NaCl$

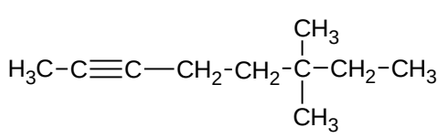
1 c. Which of the six substances in (b) has the lowest boiling point? _____

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.

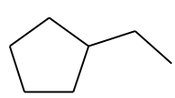
43. a. **Name** each compound using the IUPAC naming rules.

2 (i)



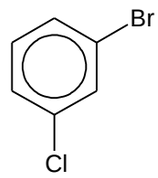
Name: _____

2 (ii)



Name: _____

2 (iii)



Name: _____

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.

$$\text{Ethene} + H_2(g) \rightarrow A$$

Compound A reacts with fluorine gas to produce Compound B and Compound C.

$$A + F_2(g) \rightarrow B + C$$

Use structural diagrams to identify Compounds A, B, and C.