

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

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

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



# CHEMISTRY 2202

*FINAL EXAMINATION  
June 2013*

**Value: 80 Marks  
Duration: 2 Hours**

## 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 – Selected Response (40 marks)**

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 (40 marks)**

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

## 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 I**  
**Selected Response**  
**Total Value: 40 Marks**

1. Which isotope has 9 protons and 10 neutrons?

- (A) fluorine-10
- (B) fluorine-19**
- (C) neon-10
- (D) neon-19

2. Which is defined as the amount of carbon atoms in a 12g sample of carbon-12?

- (A) Atomic mass
- (B) Avogadro's number**
- (C) Limiting reagent
- (D) Standard pressure

3. What is the number of hydrogen atoms in 2.3 moles of  $\text{NH}_3$ ?

- (A) 6.9
- (B) 9.2
- (C)  $1.4 \times 10^{24}$
- (D)  $4.2 \times 10^{24}$**

4. The imaginary element "jensenium" has two known isotopes, as shown by the data below.  
What is the average atomic mass of jensenium?

Isotope	Percentage Abundance (%)	Isotopic Atomic Mass (amu)
jensenium-272	80.00	271.9
jensenium-274	20.00	274.1

- (A) 271.9 amu
- (B) 272.3 amu**
- (C) 273.0 amu
- (D) 273.7 amu

5. What is the molar mass of  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ?
- (A) 136.15 g/mol
  - (B) 154.17 g/mol
  - (C) 156.19 g/mol
  - (D) 172.19 g/mol
6. A 30.61g sample of a compound with the chemical formula  $\text{NaClO}_x$  contains 0.2500mol. What is the identity of the compound?
- (A)  $\text{NaClO}$
  - (B)  $\text{NaClO}_2$
  - (C)  $\text{NaClO}_3$
  - (D)  $\text{NaClO}_4$
7. What is the number of moles in 4.00 g of magnesium?
- (A) 0.16
  - (B) 0.329
  - (C) 24.31
  - (D) 97.24
8. Which term represents the volume of one mole of gas at STP?
- (A) molar mass
  - (B) molar volume
  - (C) percent composition
  - (D) percent volume
9. What is the percentage of potassium by mass in  $\text{K}_2\text{S}$ ?
- (A) 29.08%
  - (B) 35.46%
  - (C) 58.16%
  - (D) 70.92%

10. A compound has an empirical formula of  $\text{CH}_2\text{O}$  and a molar mass of  $90.09\text{g/mol}$ . What is the molecular formula of the compound?

- (A)  $\text{CH}_2\text{O}$
- (B)  $\text{C}_2\text{H}_4\text{O}_2$
- (C)  $\text{C}_3\text{H}_6\text{O}_3$
- (D)  $\text{C}_4\text{H}_8\text{O}_4$

11. Which has low solubility in water?

- (A)  $\text{CaSO}_3$
- (B)  $\text{KNO}_3$
- (C)  $\text{MgS}$
- (D)  $\text{NaCl}$

12. What are the units for molar concentration?

- (A)  $\text{g/L}$
- (B)  $\text{L}$
- (C)  $\text{mg}$
- (D)  $\text{mol/L}$

13. What mass of sodium is contained in a  $250\text{ g}$  solution which has  $7.0\text{ ppm}$  of sodium?

- (A)  $3.6 \times 10^{-5}\text{ g}$
- (B)  $1.8 \times 10^{-3}\text{ g}$
- (C)  $2.8 \times 10^4\text{ g}$
- (D)  $1.7 \times 10^9\text{ g}$

14. What is the final concentration when  $1.60\text{ L}$  of  $2.5\text{ mol/L HCl(aq)}$  is diluted to a final volume of  $4.80\text{ L}$ ?

- (A)  $0.13\text{ mol/L}$
- (B)  $0.83\text{ mol/L}$
- (C)  $1.2\text{ mol/L}$
- (D)  $7.5\text{ mol/L}$

15. The solubility of NaCl in water is 359g/L at 25°C. Which term describes a NaCl solution which is 375g/L at 25°C?

- (A) concentrated
- (B) dilute
- (C) saturated
- (D) supersaturated**

16. Which is a volumetric flask?

(A)



(B)



(C)



**(D)**



17. Which term represents the amount of product obtained from a chemical reaction?

- (A) actual yield
- (B) excess reagent
- (C) limiting reagent
- (D) theoretical yield

18. For the reaction:  $\text{C}_3\text{H}_8(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 3 \text{CO}_2(\text{g}) + 4 \text{H}_2\text{O}(\text{g})$

How many moles of carbon dioxide are produced when 4.2 mol of oxygen reacts with sufficient propane?

- (A) 2.5
- (B) 3.4
- (C) 5.3
- (D) 7.0

19. Which is a metallic solid at room temperature?

- (A)  $\text{CS}_2$
- (B) CuZn
- (C) LiCl
- (D)  $\text{SiO}_2$

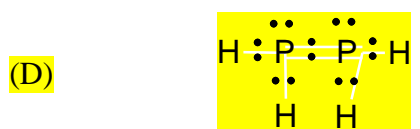
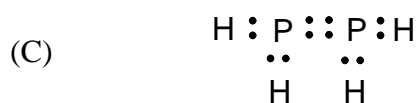
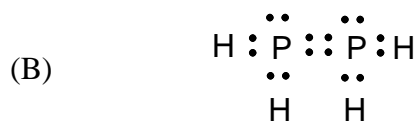
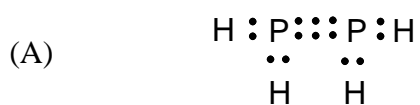
20. How many valence electrons are in an atom of nitrogen, N?

- (A) 2
- (B) 3
- (C) 5
- (D) 7

21. Which has a triple bond?

- (A)  $\text{Br}_2$
- (B)  $\text{H}_2$
- (C)  $\text{N}_2$
- (D)  $\text{O}_2$

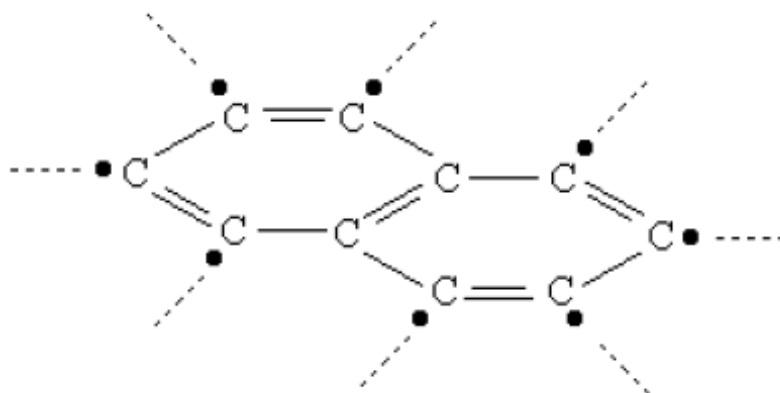
22. Which Lewis diagram is correct?



23. What is the shape around a central atom with 2 bonding groups and 2 lone pairs?

- (A) bent (v-shaped)
- (B) pyramidal
- (C) tetrahedral
- (D) trigonal planar

24. Which shape repeats in the macromolecule of Buckminsterfullerene?



- (A) bent (v-shaped)
- (B) pyramidal
- (C) tetrahedral
- (D) trigonal planar

25. Which contains London dispersion and dipole-dipole forces only?

- (A) C<sub>2</sub>H<sub>2</sub>
- (B) CO<sub>2</sub>
- (C) H<sub>2</sub>CO
- (D) NH<sub>3</sub>

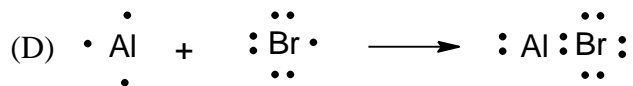
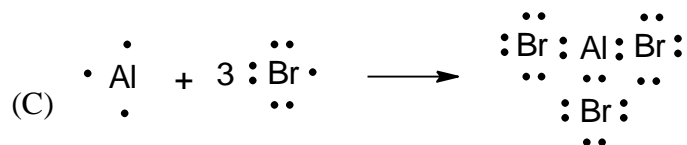
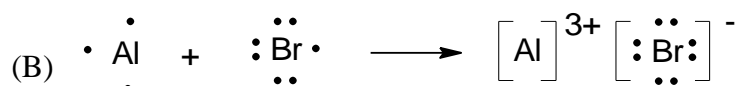
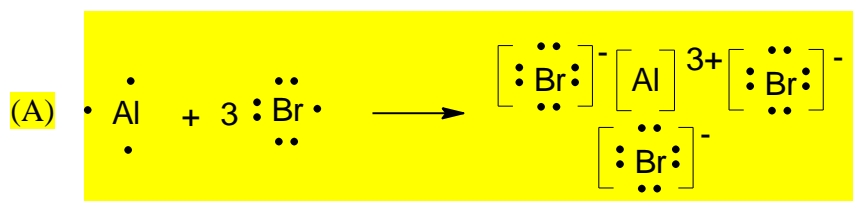
26. Which is ranked from lowest to highest bond polarity?

- (A) H – F → H – Cl → H – Br → H – H
- (B) H – F → H – H → H – Br → H – Cl
- (C) H – H → H – Br → H – Cl → H – F
- (D) H – H → H – F → H – Cl → H – Br

27. Which compound contains network covalent bonding?

- (A) CCl<sub>4</sub>
- (B) CsBr
- (C) H<sub>2</sub>CO
- (D) SiC

28. Which represents the bonding between aluminum, Al, atoms and bromine, Br, atoms?

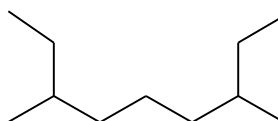


29. What explains the malleability of copper, Cu(s)?

- (A) cations attracted to anions
- (B) cations surrounded by a sea of electrons
- (C) network of covalent bonds
- (D) sharing of electrons between atoms

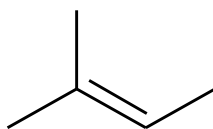


30. Which compound would have the highest boiling point?  
(A) *cis*-dichloroethene  
(B) ethene  
(C) ethyne  
(D) *trans*-dichloroethene
31. The synthesis of which compound led to the modern definition of organic chemistry?  
(A) benzene  
(B) DNA  
(C) polyester  
(D) urea
32. Which is an aliphatic hydrocarbon?  
(A) alkene  
(B) amine  
(C) ether  
(D) ketone
33. Which is an alkane?  
(A)  $C_6H_6$   
(B)  $C_6H_{10}$   
(C)  $C_6H_{12}$   
(D)  $C_6H_{14}$
34. What is the name of the compound below?

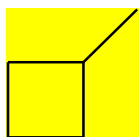


- (A) 2,6-diethylheptane  
(B) 2-ethyl-3-methyloctane  
(C) 2-ethyl-6-methyloctane  
(D) 3,7-dimethylnonane

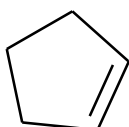
35. Which is a structural isomer of this molecule?



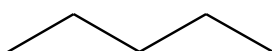
(A)



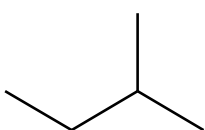
(B)



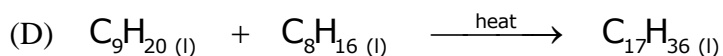
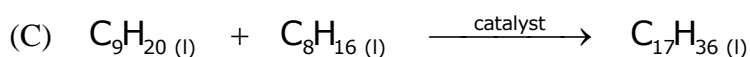
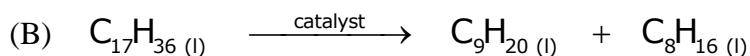
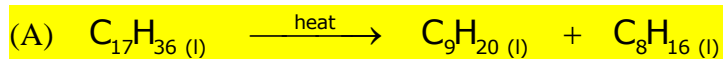
(C)



(D)



36. Which reaction represents thermal cracking?



37. Which contains a carboxyl functional group?

(A) propanoic acid

(B) propanol

(C) propanone

(D) propylamine

38. What possible product(s) form from the reaction of 2-pentene with hydrogen bromide, HBr?

(A) 2,3-dibromopentane

(B) 2-bromopentane and 3-bromopentane

(C) 2-methyl-2-bromobutane

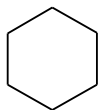
(D) ethane and 1-bromopropane

39. Which structure has delocalized electrons?

(A)



(B)



(C)

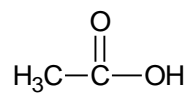


(D)

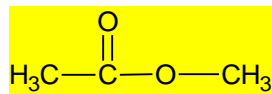


40. Which is a product of esterification?

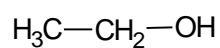
(A)



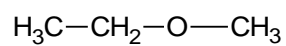
(B)



(C)



(D)



*End of Part I*

**Part II**  
**Constructed Response**  
**Total Value: 40 Marks**

Answer ALL questions in the space provided. Show all workings and report all final answers with correct significant digits and units.

**Value**

- 2      41.(a) Calculate the mass of 9.75L of neon, Ne(g), at STP.

Answer:

$$n_{\text{Ne}} = \frac{V}{22.4\text{L/mol}} = \frac{9.75\text{L}}{22.4\text{L/mol}} = 0.435\text{mol} \quad \mathbf{1 \text{ point}}$$

So:

$$m_{\text{Ne}} = n_{\text{Ne}} \cdot M = 0.435\text{mol} \cdot 20.18\text{g/mol}$$

$$m_{\text{Ne}} = 8.78\text{g} \quad \mathbf{1 \text{ point}}$$

- 2      (b) Calculate the percent composition of a pure substance that contains 6.01g of copper, 3.02g of sulfur and 5.97g of oxygen.

Answer:

$$\text{total mass} = 6.01\text{g} + 3.02\text{g} + 5.97\text{g} = 15.00\text{g} \quad \mathbf{0.5 \text{ point}}$$

$$\% \text{Cu} = \frac{6.01\text{g Cu}}{15.00\text{g total}} \times 100 = 40.1\% \text{Cu} \quad \mathbf{0.5 \text{ point}}$$

$$\% \text{S} = \frac{3.02\text{g S}}{15.00\text{g total}} \times 100 = 20.1\% \text{S} \quad \mathbf{0.5 \text{ point}}$$

$$\% \text{O} = 100\% - (40.1\% + 20.1\%) = 39.8\% \text{O} \quad \mathbf{0.5 \text{ point}}$$

**Value**

41. (continued)

- 3 (c) Calculate the empirical formula of a compound with the percent composition of 88.80% C and 11.20% H.

Answer: Assuming a 100g sample,Percent to mass:  $m_C = 88.80\text{g C}$ ;  $m_H = 11.20\text{g H}$ ;**0.5 point**

Mass to moles:

$$n_C = \frac{m_C}{M_C} = \frac{88.80\text{g C}}{12.01\text{g/mol C}} = 7.394\text{mol C}$$

$$n_H = \frac{m_H}{M_H} = \frac{11.20\text{g H}}{1.01\text{g/mol H}} = 11.09\text{mol H}$$

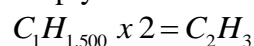
**1 point**

Divide by lowest:

$$\frac{C_{7.394}H_{11.09}}{7.394 \quad 7.394} = C_1H_{1.500}$$

**1 point**

Multiply until whole. In this case, we need to multiply by 2.

**0.5 point**The empirical formula is  $C_2H_3$ 

- 2 (d) Calculate the mass of lithium sulfide,  $Li_2S$ , required to prepare 500.0 mL of 0.250 mol/L  $Li_2S(aq)$  solution.

Answer:Switch volume to litres:  $500.0\text{mL} = 0.5000\text{L}$ **0.5 point**

Calculate moles:

$$n = CV = (0.250\text{mol/L})(0.5000\text{L}) = 0.125\text{mol } Li_2S$$

**0.5 point**Aside: Get molar mass of  $Li_2S$ :

$$2 \times Li = 2 \times 6.94 \text{ g/mol} = 13.88\text{g/mol}$$

$$1 \times S = 1 \times 32.07\text{g/mol} = \underline{32.07\text{g/mol}}$$

$$= 45.95\text{g/mol } Li_2S$$

**0.5 point**

Calculate mass:

$$m = n \cdot M = (0.125\text{mol})(45.95\text{g/mol}) = 5.74\text{g } Li_2S$$

**0.5 point**

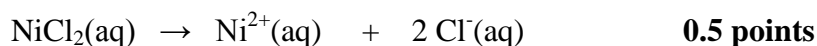
**Value**

41. (continued)

- 2 (e) A solution of  $\text{NiCl}_2(\text{aq})$  has a chloride ion concentration of  $0.378\text{mol/L}$ . What is the  $\text{NiCl}_2(\text{aq})$  concentration? (Include a balanced chemical equation with your response.)

Answer:

Dissociation:

Given:  $V = 0.5000\text{L}$ 

Given:

Want:  $C = ? \text{NiCl}_2$  $C = 0.378\text{mol/L}$ 

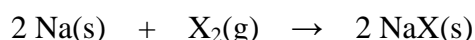
Mole ratio, using concentrations:

$$C_{\text{Cl}^{-}} = C_{\text{NiCl}_2} \left( \frac{2 \text{ mol Cl}^{-}}{1 \text{ mol NiCl}_2} \right) \quad \mathbf{1 \text{ point}}$$

$$C_{\text{NiCl}_2} = \left( \frac{0.378 \cancel{\text{mol}} / \cancel{\text{L}} \text{Cl}^{-}}{2 \cancel{\text{mol}} \text{Cl}^{-}} \right) (1 \text{ mol NiCl}_2)$$

$$C_{\text{NiCl}_2} = 0.189 \text{ mol} / \text{L NiCl}_2 \quad \mathbf{0.5 \text{ point}}$$

- 3 (f) Sodium metal,  $\text{Na}(\text{s})$ , reacts with an unknown gas,  $\text{X}_2(\text{g})$ , according to the balanced reaction below:



When  $21.00\text{g}$  of the gas reacts,  $13.62\text{g}$  of sodium metal is required for a complete reaction. What is the identity of the gas?

Answer:

Get moles:

$$n_{\text{Na}} = \frac{m_{\text{Na}}}{M_{\text{Na}}} = \frac{13.62 \text{ g Na}}{22.99 \text{ g/mol Na}} = 0.592 \text{ mol Na} \quad \mathbf{1 \text{ point}}$$

Mole Ratio:

$$n_{\text{X}_2} = (0.5916 \text{ mol Na}) \left( \frac{1 \text{ mol X}_2}{2 \text{ mol Na}} \right) = 0.2962 \text{ mol X}_2 \quad \mathbf{1 \text{ point}}$$

Convert to Molar Mass:

$$M_{\text{X}_2} = \frac{m_{\text{X}_2}}{n_{\text{X}_2}} = \frac{21.00 \text{ g X}_2}{0.2962 \text{ mol X}_2} = 70.89 \text{ g/mol X}_2 \quad \mathbf{0.5 \text{ point}}$$

Note: Since this is diatomic,  $M_{\text{X}} = \frac{70.89 \text{ g/mol}}{2} = 35.45 \text{ g/mol X}$

This molar mass matches chlorine, Cl. The gas is  $\text{Cl}_2(\text{g})$   $\mathbf{0.5 \text{ point}}$

**Value**

41. (continued)

- 4 (g) For the reaction:  $\text{CaO(s)} + 2 \text{HF(aq)} \rightarrow \text{CaF}_2\text{(aq)} + \text{H}_2\text{O(l)}$   
 12.5g of calcium oxide, CaO(s), is reacted with 0.475L of 0.800mol/L hydrofluoric acid, HF(aq). Determine the limiting reagent.

- (i) Determine the limiting reagent.  
 (ii) Calculate the concentration of CaF<sub>2</sub> (aq) produced.

Answer: Limiting reagent problem. Get moles for each reagent, and do a mole ratio for each reagent.

Get moles, CaO:

$$n_{\text{CaO}} = \frac{m_{\text{CaO}}}{M_{\text{CaO}}} = \frac{12.5 \text{ g CaO}}{56.08 \text{ g/mol CaO}} = 0.223 \text{ mol CaO} \quad \mathbf{0.5 \text{ point}}$$

$$\begin{aligned} \text{Aside: } 1 \times \text{Ca} &= 1 \times 40.08 \text{ g/mol} = 40.08 \text{ g/mol} \\ 1 \times \text{O} &= 1 \times 16.00 \text{ g/mol} = \underline{16.00 \text{ g/mol}} \\ &= 56.08 \text{ g/mol CaO} \quad \mathbf{0.5 \text{ point}} \end{aligned}$$

Mole Ratio of product CaF<sub>2</sub>, based upon CaO:

$$n_{\text{CaF}_2} = (0.223 \text{ mol CaO}) \left( \frac{1 \text{ mol CaF}_2}{1 \text{ mol CaO}} \right) = 0.223 \text{ mol CaF}_2 \text{ (from CaO)} \quad \mathbf{0.5 \text{ point}}$$

Get moles, HF:

$$n_{\text{HF}} = CV_{\text{HF}} = (0.800 \text{ mol/L}) \cdot (0.475 \text{ mol}) = 0.380 \text{ mol HF} \quad \mathbf{0.5 \text{ point}}$$

Mole Ratio of product CaF<sub>2</sub>, based upon HF:

$$n_{\text{CaF}_2} = (0.380 \text{ mol HF}) \left( \frac{1 \text{ mol CaF}_2}{2 \text{ mol HF}} \right) = 0.190 \text{ mol CaF}_2 \text{ (from HF)} \quad \mathbf{0.5 \text{ point}}$$

Compare the results from each mole ratio; conclude that the theoretical yield is 0.190mol of CaF<sub>2</sub>. This means that the limiting reagent is HF. **0.5 point**

- (ii) Calculate the concentration of CaF<sub>2</sub>(aq) that would be produced.

$$C = \frac{n}{V} = \frac{0.190 \text{ mol}}{0.475 \text{ L}} = 0.400 \text{ mol/L CaF}_2 \quad \mathbf{(0.5 \text{ point})}$$

Science communication:

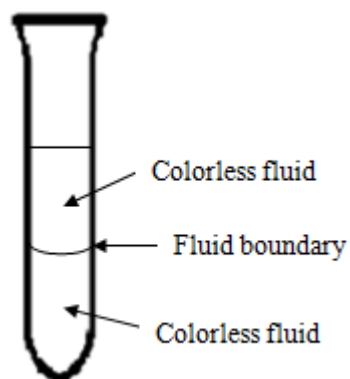
For any two of: significant figures, units, or use of formulas. **(0.5 point)**

3 42.(a) Complete the following table for methanol CH<sub>3</sub>OH.

Lewis Diagram	<p style="text-align: right;">(1 mark)</p>	
VSEPR Shape diagram	<p style="text-align: right;">(1 mark)</p>	
Name of shape around each central atom	Tetrahedral (0.5 mark)	Bent (0.5 mark)

2 (b) i) Water, H<sub>2</sub>O (l) is poured into a test tube containing carbon tetrachloride, CCl<sub>4</sub>(l). The test tube is shaken and then allowed to settle.

The test tube is shown below. Explain why the layers form.



Answer

CCl<sub>4</sub> is nonpolar (0.5 mark)

H<sub>2</sub>O is polar (0.5 mark)

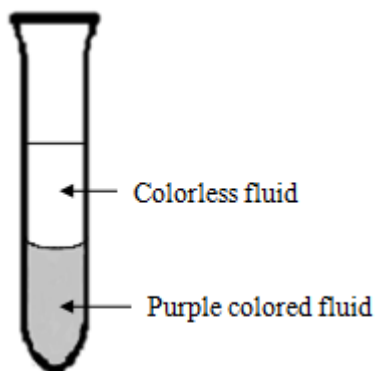
“like dissolves like” therefore polar substances are immiscible in nonpolar substances (1 mark)



**Value**

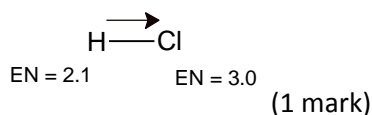
42. (continued)

- 2 (b) ii) To determine which layer is water and which layer is  $\text{CCl}_4(\text{l})$ , a Chemist adds purple iodine crystals,  $\text{I}_2(\text{s})$  to the same test tube. The test tube is shaken and allowed to settle for a second time. Based on the results you see below, how can you be certain the fluid in the bottom layer is  $\text{CCl}_4(\text{l})$ ? Explain.

Answer

Upper layer is water (0.5 mark).  $\text{I}_2$  is nonpolar substance (0.5 mark) therefore will be miscible in nonpolar solvent ( $\text{CCl}_4$ ) (1 mark).

- 2 (c) Explain why a molecule of HCl is polar. Justify your answer with a diagram.

Answer

In the HCl molecule a bond dipole exists between the H and the Cl as a result of the difference in electronegativity between the H and Cl. The shared pair of electrons is partially pulled toward the more electronegative Cl resulting in a charge separation between the H and Cl. The overall effect is a polar bond toward the Cl.

**Value**

42. (continued)

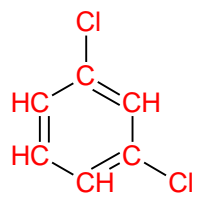
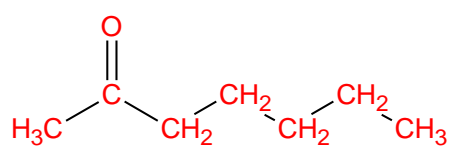
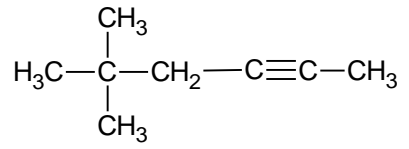
- 3 (d) Rank the following substances in order of increasing boiling points. Justify your answer.

potassium chloride, KCl  
 fluoroethene, C<sub>2</sub>H<sub>3</sub>F  
 ethene, C<sub>2</sub>H<sub>4</sub>

Answer: We first realize that KCl is ionic; fluoroethene and ethane are molecular. This immediately places KCl at the higher boiling point. The relative ranking of the fluoroethene and ethane then comes down to the relative sizes of their intermolecular forces:

C <sub>2</sub> H <sub>6</sub> (0.5 mark)	<	C <sub>2</sub> H <sub>5</sub> F (0.5 mark)	<	KCl (0.5 mark)
Low LD (16e <sup>-</sup> ); no DD (0.5 mark)		Higher LD (24e <sup>-</sup> ), has DD (0.5 mark)		ionic (0.5 mark)

- 3 43.(a) Complete the table with either a structural diagram or IUPAC name.

IUPAC Name	Structural Diagram
1,3-dichloro benzene	
2-heptanone	
5,5-dimethyl-2-hexyne	

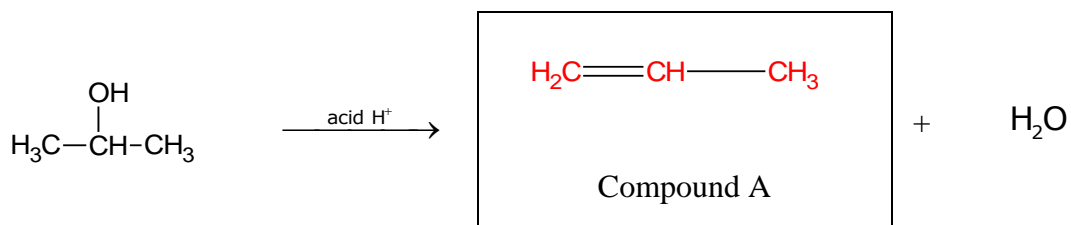
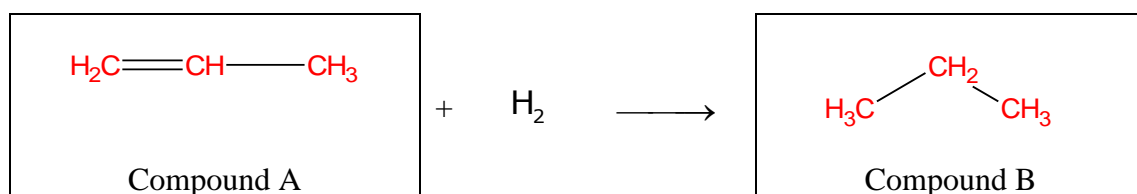
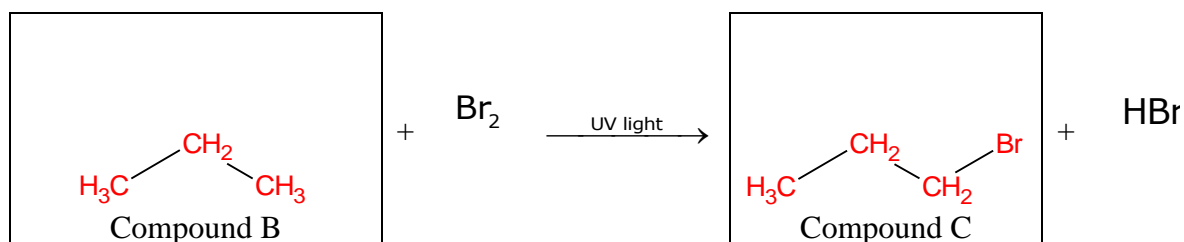
**Value**

43. (continued)

4 (b) Draw and name two isomers for C<sub>2</sub>H<sub>6</sub>O.

<p>Structure 1:</p> $\begin{array}{c} \text{OH} \\   \\ \text{H}_2\text{C}-\text{CH}_3 \end{array}$ <p>(1 mark)</p> <p>Name: <b>ethanol</b> (1 mark)</p>	<p>Structure 2:</p> $\begin{array}{c} \text{H}_3\text{C} \quad \text{CH}_3 \\ \quad \diagdown \quad / \\ \quad \text{O} \end{array}$ <p>(1 mark)</p> <p>Name: <b>dimethyl ether or methoxy methane</b> (1 mark)</p>
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c) From the reactions given, draw the structures for compounds A, B and C.

**Step 1:****Step 2:****Step 3:****Note:** It is possible that there are two possible answers for Compound C

Two possible isomers for Compound C:

