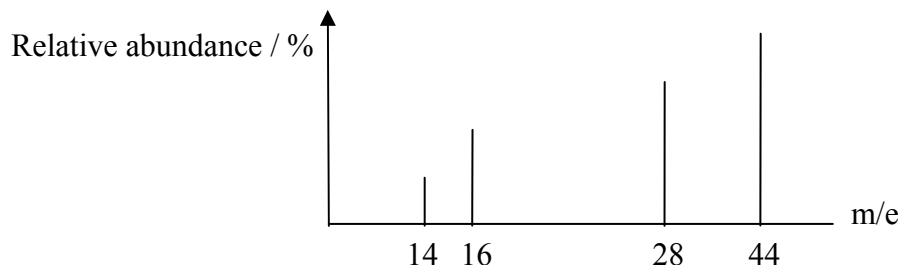


## Section A

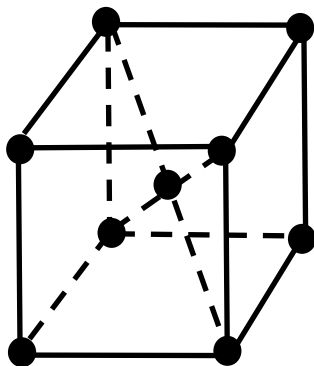
Four suggested answers labelled **A**, **B**, **C**, and **D** are given for each question. Choose one correct answer.

1



Which of the following substance is expected to give the above mass spectrum?  
[Relative atomic mass: H, 1.0; C, 12.0; N, 14.0; O, 16.0]

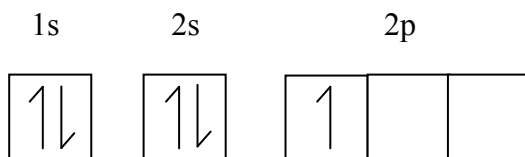
- A**  $\text{CO}_2$
  - B**  $\text{C}_3\text{H}_8$
  - C**  $\text{N}_2\text{O}$
  - D** Mixture of  $\text{N}_2$  and  $\text{O}_2$
- 2 The diagram below represents the unit cell of a body centred cubic structure. How many lattice particles are there per unit cell?



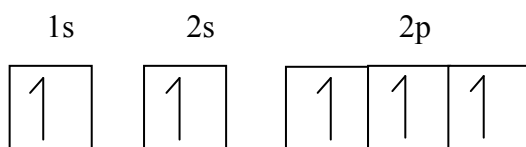
- A** 2
- B** 3
- C** 5
- D** 9

- 3 Which of the diagrams below represents the ground-state electron arrangement of a Nitrogen atom?

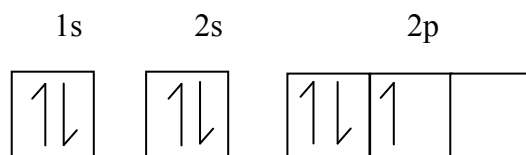
**A**



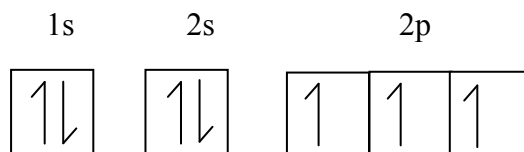
**B**



**C**



**D**



- 4 The first ionization energies for a series of elements with increasing proton number are as follows:

$$632, 661, 648, 653, 718 \text{ kJmol}^{-1}$$

This series of elements is:-

- A** Group 1
- B** Group 14
- C** Group 18
- D** d-block

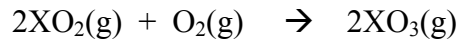
- 5 Which of the following statements correctly explains the decrease in ionic radii for the elements of Period 3 from sodium to aluminium?
- A Decreasing charge density of its ions.
  - B Increasing strength in the metallic bonds.
  - C Increasing polarization power for anions.
  - D Same number of electrons with increasing number of protons.
- 6 Which of the following elements has the strongest metallic bond?
- A Copper
  - B Calcium
  - C Sodium
  - D Potassium
- 7 Which of the following pairs of compounds has the same molecular shape?
- A  $\text{AlCl}_3$  and  $\text{BCl}_3$
  - B  $\text{CO}_2$  and  $\text{SO}_2$
  - C  $\text{BeCl}_2$  and  $\text{H}_2\text{O}$
  - D  $\text{CH}_3^+$  and  $\text{NH}_4^+$
- 8 The thermal decomposition of nitrogen monoxide as shown below is a second order reaction:



Which of the following is **true** of the reaction above?

- A The unit of the rate constant is  $\text{s}^{-1}$ .
- B The rate is quadrupled when the concentration of NO is doubled.
- C The half-life of the above reaction is independent of the initial concentration of NO.
- D A straight line graph is obtained when rate is plotted against the concentration of NO.

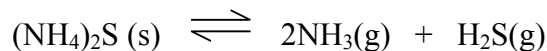
- 9 The table below shows the experimental results obtained for the following reaction:



Partial pressure (atm)		Relative rate
XO <sub>2</sub>	O <sub>2</sub>	
1.0	1.0	2a
0.5	1.0	a
<i>p</i>	0.5	$\frac{1}{2}a$
1.0	0.5	a

What is the value of *p* in the table above?

- A 0.20 atm  
 B 0.25 atm  
 C 0.50 atm  
 D 0.75 atm
- 10 The compound ammonium sulphide is a crystalline solid at room temperature that decomposes when heated according to the equation:



0.10 mol of ammonium sulphide was heated in a 2.0 dm<sup>3</sup> flask. When equilibrium was obtained, the total pressure in the flask was 0.63 atm. Calculate the equilibrium constant, *K<sub>p</sub>*, for the above reaction.

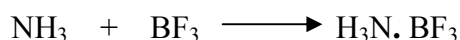
- A 0.019 atm<sup>3</sup>  
 B 0.037 atm<sup>3</sup>  
 C 0.056 atm<sup>3</sup>  
 D 0.074 atm<sup>3</sup>

- 11 For the following reaction:  $X_2Y(g) \rightleftharpoons 2X(g) + Y(g)$ , the numerical value of  $K_p$  at different temperatures is as follows:

Temperature	450 K	680 K
$K_p$	$1.62 \times 10^{-3}$	$3.09 \times 10^{-5}$

Which of the following statements is **correct**?

- A The units for  $K_p$  for the reverse reaction is  $\text{atm}^2$ .
- B The decomposition of  $X_2Y$  is an exothermic reaction.
- C A higher temperature favours the decomposition of  $X_2Y$ .
- D The amount of Y in the equilibrium mixture increases when a higher pressure is exerted.
- 12 The molecules ammonia and boron fluoride react together to form an adduct as follows:



What is the function of  $\text{BF}_3$  in the above reaction?

- A Ligand
- B Lewis base
- C Lewis acid
- D Bronsted-Lowry base
- 13 The solubility product,  $K_{sp}$  for magnesium hydroxide in pure water at  $25^\circ\text{C}$  is  $2.0 \times 10^{-11} \text{ mol}^3 \text{ dm}^{-9}$ . What is the solubility of magnesium hydroxide, when excess solid magnesium hydroxide is shaken with  $1 \text{ dm}^3$  of  $0.2 \text{ mol dm}^{-3}$  potassium hydroxide solution?
- A  $4.0 \times 10^{-12} \text{ mol dm}^{-3}$
- B  $5.0 \times 10^{-11} \text{ mol dm}^{-3}$
- C  $1.0 \times 10^{-10} \text{ mol dm}^{-3}$
- D  $5.0 \times 10^{-10} \text{ mol dm}^{-3}$

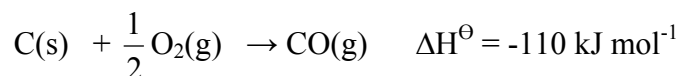
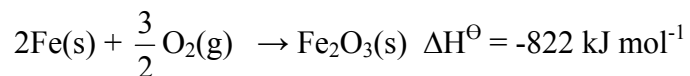
- 14 What will be the concentration of a sulphuric acid solution if the hydroxide ion concentration is  $5.0 \times 10^{-12} \text{ mol dm}^{-3}$  at  $25^{\circ}\text{C}$ ?  
[ Ionic product of water,  $K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$  at  $25^{\circ}\text{C}$ ]
- A  $1.0 \text{ mol dm}^{-3}$   
B  $5.0 \times 10^{-1} \text{ mol dm}^{-3}$   
C  $1.0 \times 10^{-3} \text{ mol dm}^{-3}$   
D  $2.0 \times 10^{-3} \text{ mol dm}^{-3}$
- 15 When  $250 \text{ cm}^3$  of an aqueous solution of an organic acid Q of concentration  $20.0 \text{ g dm}^{-3}$  is shaken with  $100 \text{ cm}^3$  of ether, the mass of Q extracted is 2.2g. After this first extraction, the aqueous solution is again shaken with  $100 \text{ cm}^3$  of fresh ether. Calculate the mass of Q extracted by this second extraction.
- A 0.51 g  
B 1.23 g  
C 1.96 g  
D 2.20 g
- 16 The standard electrode potentials of  $\text{Ag}^+(\text{aq})/\text{Ag}(\text{s})$  and  $\text{Zn}^{2+}(\text{aq})/\text{Zn}(\text{s})$  are +0.80 V and -0.76 V respectively. Which of the following conclusions can be drawn from these data?
- A Silver is an oxidizing agent.  
B Zinc ions can act as a reducing agent.  
C Silver displaces zinc from a solution containing zinc ions.  
D Zinc has a greater tendency than silver to form positively charged ions.
- 17 The standard redox potential for the half-cell reaction  
$$\text{Fe}^{3+}(\text{aq}) + \text{e} \rightleftharpoons \text{Fe}^{2+}(\text{aq}) \quad E^{\circ} = +0.77 \text{ V}.$$
Which of the following electrochemical cells could be used to determine this standard value?
- A Fe electrode in  $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$  against Fe electrode in  $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$ .  
B Pt electrode in  $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$  against Pt electrode in  $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$ .  
C Pt electrode in  $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$  and  $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$  against a standard hydrogen electrode.  
D Fe electrode in  $1 \text{ mol dm}^{-3} \text{ Fe}^{3+}$  and  $1 \text{ mol dm}^{-3} \text{ Fe}^{2+}$  against a standard hydrogen electrode.

- 18 During electrolysis under suitable conditions, 0.015 mol of chromium is deposited on one of the electrodes when 0.090 mol of electrons is passed through a chromium-containing electrolyte.

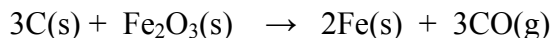
Which of the following substances could have been the electrolyte?

- A CrF<sub>4</sub>
- B CrF<sub>5</sub>
- C CrCl<sub>3</sub>
- D Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>

- 19 The enthalpy changes for two reactions are given by the equations below,



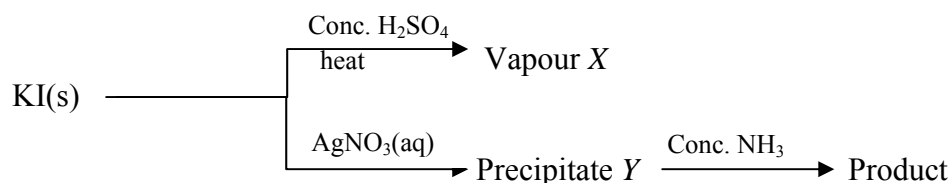
What is the enthalpy change for the following reaction?



- A +492 kJ
  - B +712 kJ
  - C -492 kJ
  - D -712 kJ
- 20 P, Q and R are Period 3 elements. The oxide of P reacts with hydrochloric acid while the oxide of Q reacts with potassium hydroxide. The oxide of R reacts with both sulphuric acid and sodium hydroxide. What is the order of increasing proton numbers for these elements?
- A P < Q < R
  - B Q < R < P
  - C P < R < Q
  - D R < P < Q

- 21 Aqueous aluminium chloride solution has a pH less than 7 because
- A the aluminium ion undergoes hydrolysis.
  - B the charge density of the aluminium ion is high.
  - C aluminium chloride is a covalent compound.
  - D aluminium chloride undergoes partial dissociation in water.
- 22 Which of the following statements about the oxides of Group 14 is **true**?
- A All the oxides are thermally stable.
  - B All the oxides are amphoteric or basic.
  - C All the oxides are solid at room temperature.
  - D The general formulae of the oxides are MO and MO<sub>2</sub>.
- 23 Which of the following statements is due to the inert pair effect?
- A The reactivity of the Group 14 elements increases when going down the group.
  - B The boiling point of the Group 14 tetrachlorides increases when going down the group.
  - C The oxides of the Group 14 elements becomes more acidic with increase in proton number.
  - D The +2 oxidation state of the Group 14 elements becomes more stable when going down the group.
- 24 When excess of aqueous ammonia is added to aqueous copper (II) ion, the [Cu(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup> species is formed. Which of the following statements is **true**?
- A Ammonia acts as a Lewis base.
  - B The [Cu(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup> ion is unstable.
  - C Water molecules are unable to displace ammonia from [Cu(NH<sub>3</sub>)<sub>4</sub>]<sup>2+</sup>.
  - D Copper and nitrogen each donate one electron in the formation of the Cu – N bond.

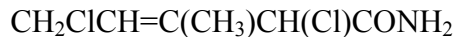
- 25 The scheme below shows the reactions between potassium iodide with hot concentrated sulphuric acid, and with aqueous silver nitrate, as well as the solubility of the precipitate *Y* in concentrated aqueous ammonia.



Which of the following is correct with regards to the colour of vapour *X*, colour of the precipitate *Y*, and the solubility of *Y* in concentrated ammonia?

- |          | <i>Colour of X</i> | <i>Colour of Y</i> | <i>Solubility of Y in conc. NH<sub>3</sub></i> |
|----------|--------------------|--------------------|--|
| <b>A</b> | Brown              | White              | Soluble  |
| <b>B</b> | Purple             | Yellow             | Soluble  |
| <b>C</b> | Purple             | White              | Insoluble                                      |
| <b>D</b> | Purple             | Yellow             | Insoluble                                      |
- 26 Which of the following statements about transition elements is **correct** ?
- A** All transition elements exhibit oxidation state +1 to +7.
- B** The  $\text{Cr}^{3+}$  and  $\text{Mn}^{2+}$  ions are stable in aqueous solution in the presence of oxygen.
- C** The oxidation state of the transition element in  $\text{Cr}_2\text{O}_7^{2-}$  and  $\text{Cu}(\text{H}_2\text{O})_4^{2+}$  is more than +5.
- D** The stability of the oxidation state of a transition element in a complex does not depend on the nature of the ligand.
- 27 Which element below forms the complex ion  $[\text{XCl}_4]^-$
- A** Lead
- B** Copper
- C** Silicon
- D** Chromium

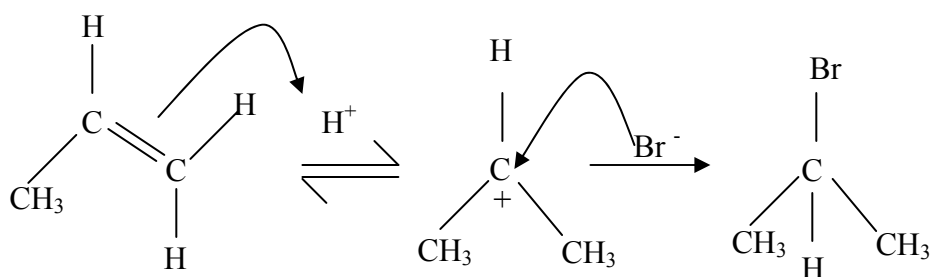
28 The structural formula of an organic compound **M** is shown below.



How many stereoisomers does **M** have?

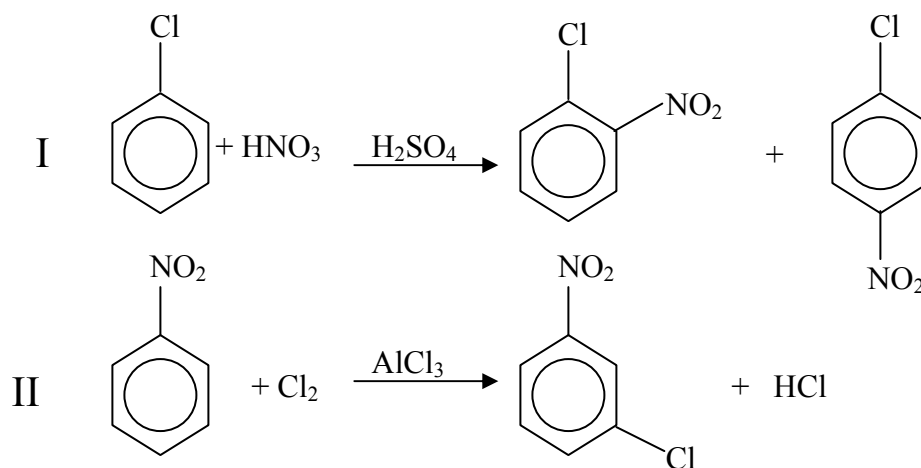
- A 2
- B 3
- C 4
- D 6

29 What is the name of the mechanism that is shown below?



- A Nucleophilic addition
- B Nucleophilic substitution
- C Electrophilic addition
- D Electrophilic substitution

30 The equations below show the products formed in two separate experiments.



Why are different chloronitrobenzene products obtained?

- A** The type of catalyst used in both reactions are different.
- B** The chloro group is an ortho and para director whereas the nitro group is a meta director.
- C** The chloro group is an activating whereas the nitro group is deactivating.
- D** Compared to  $-\text{NO}_2$ ,  $-\text{Cl}$  strongly deactivates the ring, thus encouraging multiple products.
- 31 Which of the compounds below is obtained from the reaction between  $\text{CH}_3\text{CH}_2\text{MgBr}$  and  $\text{HCHO}$ ?
- A**  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- B**  $\text{CH}_3\text{CH}_2\text{COOH}$
- C**  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- D**  $\text{CH}_3\text{CH}=\text{CHCH}_3$
- 32 Which of the following reagents can be used to convert  $\text{C}_2\text{H}_5\text{OH}$  to  $\text{C}_2\text{H}_5\text{Cl}$ ?
- A** Chlorine gas
- B** Sodium chloride
- C** Sulphur dichloride oxide
- D** Dilute hydrochloric acid

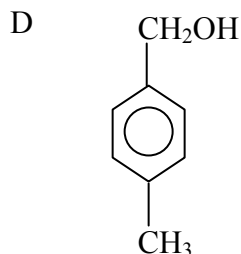
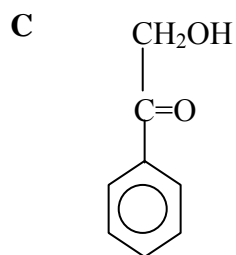
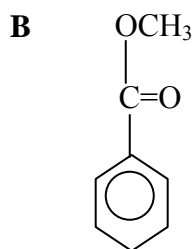
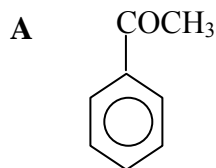
33 Which of the following compounds reacts with hydrogen cyanide to form an optically active compound?

- A HCHO  
 B CH<sub>3</sub>CHO  
 C CH<sub>3</sub>CO<sub>2</sub>CH<sub>3</sub>  
 D CH<sub>3</sub>CH<sub>2</sub>COCH<sub>2</sub>CH<sub>3</sub>

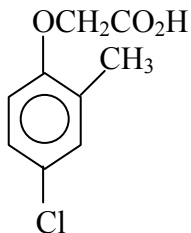
34 A compound **R** has all the following properties:

- (i) It is neutral.  
 (ii) It gives an orange precipitate with 2,4 dinitrophenylhydrazine.  
 (iii) It evolves hydrogen chloride when treated with PCl<sub>5</sub> in the cold.

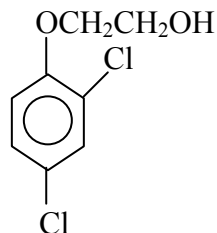
Which of the following compounds could be **R**?



35 MCPA and 2,4-D are two widely used selective weedkillers.



*MCPA*



*2,4-D*

Which of the following reagents will be able to distinguish MCPA from 2,4-D ?

- A Sodium
  - B  $\text{Na}_2\text{CO}_3(\text{aq})$
  - C acidified  $\text{AgNO}_3$
  - D Fehling's solution
- 36 Which of the following compounds is a product of the reaction between phenylmethanol and ethanoyl chloride?
- A  $\text{C}_6\text{H}_5\text{COCH}_3$
  - B  $\text{C}_6\text{H}_5\text{OCOCH}_3$
  - C  $\text{C}_6\text{H}_5\text{CH}_2\text{COCl}$
  - D  $\text{C}_6\text{H}_5\text{CH}_2\text{OCOCH}_3$
- 37 Which of the following statements explains why  $\text{C}_6\text{H}_5\text{NH}_2$  is a weaker base than  $\text{CH}_3\text{NH}_2$ ?
- A  $\text{C}_6\text{H}_5\text{NH}_2$  is less volatile than  $\text{CH}_3\text{NH}_2$ .
  - B The  $-\text{CH}_3$  group is smaller than the  $-\text{C}_6\text{H}_5$  group.
  - C The benzene ring in  $\text{C}_6\text{H}_5\text{NH}_2$  is electron-releasing.
  - D The lone pair of electrons in  $\text{C}_6\text{H}_5\text{NH}_2$  is delocalized into the benzene ring.



## Section B

For each of the questions in this section one or more of the three numbered statements 1 to 3 may be correct. Decide whether each of the statements is or is not correct. The responses A to D should be selected on the basis of the following.

A	B	C	D
1 only is correct.	1 and 2 only are correct.	2 and 3 only are correct.	1, 2, and 3 are correct.

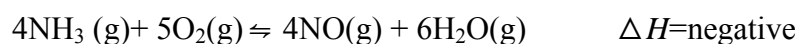
- 41 Which statements about an element X with the electronic configuration:  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$  is /are **true**?
- X forms complex ions.
  - X forms  $X^{2+}$  and  $X^{3+}$  ions.
  - X is in Group 2 of the Periodic Table.
- 42 Which of the following molecules can receive a pair of electrons to form a dative bond?
- $AlCl_3$
  - $NH_3$
  - $C_2H_5OH$
- 43 A buffer solution contains a mixture of aqueous ammonia and ammonium chloride solution. The addition of  $1.0 \text{ cm}^3$  of  $1.0 \text{ mol dm}^{-3}$  hydrochloric acid will
- increase the pH of the buffer solution slightly.
  - increase the concentration of the ammonium ion slightly.
  - decrease the concentration of the ammonia solution slightly.
- 44 A mixture of phenylamine (boiling point  $184^\circ\text{C}$ ) and water is heated until the mixture boils. Which of the following statements is / are **true**?
- The mixture boils at a temperature lower than  $100^\circ\text{C}$ .
  - The total pressure of the boiling liquid is equal to the atmospheric pressure.
  - The distillate consists of a mixture of water and phenylamine.

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
1 only is correct.	1 and 2 only are correct.	2 and 3 only are correct.	1, 2, and 3 are correct.

- 45 The discharge at the cathode of 1.00 mol of gold ions from an aqueous solution of a gold salt requires  $2.90 \times 10^5$  C of electricity.  
Which of the following conclusions can be drawn from the above statement?  
[Faraday constant,  $F = 9.65 \times 10^4$  C]

- 1 Gold is a d-block element.
- 2 The gold ions are positively charged.
- 3 The magnitude of the charge on the gold ions is three times the charge of an electron.

- 46 The first step in the Ostwald process for the manufacture of nitric acid is the oxidation of ammonia. The typical conditions used are 4 to 10 atm and 1000 K.



Which of the following is/are **true** regarding the Ostwald process?

- 1 The process produces pure nitric acid as the final product.
  - 2 Platinum is used as a catalyst in this reaction.
  - 3 A higher temperature is not used because ammonia will get oxidised to nitrogen instead of nitrogen monoxide.
- 47 Which of the following statements is / are **true** of the complex ion  $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$ ?
- 1 The ethanedioate ion is a bidentate ligand.
  - 2 This name of the complex ion is trioxalatoferrate (III) ion.
  - 3 The oxidation state of iron in this complex ion is +2.

- 48 Which of the following statements about the reaction between bromine and ethene is / are **correct**?

- 1 The above reaction produces 1,2-dibromoethane.
- 2 The above reaction in the presence of dilute sodium chloride will produce a mixture of 1,2-dibromoethane and 1-bromo-2-chloroethane.
- 3 The above reaction in water as solvent will produce 1,2-dibromoethane as the main product.

<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
1 only is correct.	1 and 2 only are correct.	2 and 3 only are correct.	1, 2, and 3 are correct.


49 An organic compound, **X**, has the following chemical properties:

- (i) Forms a sweet-smelling compound when it reacts with  $\text{CH}_3\text{COOH}$ .
- (ii) Produces effervescence when sodium metal is added to it.
- (iii) Forms a yellow precipitate when alkaline iodine solution is added to it.

Which of the following compounds is / are **X**?

- 1  $\text{CH}_3\text{CH}_2\text{OH}$
- 2  $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$
- 3  $\text{C}_6\text{H}_5\text{OH}$

50 When an alcohol, **P** is warmed with acidified potassium manganate(VII) solution, the final product is a carbonyl compound that reacts with alkaline iodine solution to give a yellow precipitate. Which of the following compounds is/ are **P**?

- 1  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- 2   $\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- 3  $(\text{CH}_3)_3\text{C}-\text{OH}$

Section A [40 marks]

Answer **all** questions in this section.

- 1 (a) A container of volume  $25 \text{ dm}^3$  contains 0.50 mol of hydrogen gas, 0.10 mol of oxygen gas and an unknown amount of helium gas. The pressure of 1 mol of gas in the container at room temperature is 100kPa.

- (i) If the total pressure in the container is 88 kPa, determine the number of moles of helium gas in the container.

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[2 marks]

- (ii) The mixture of gases in the container is then ignited. What is the number of moles of each gas left in the container after the ignition?

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[1 mark]

- (iii) After ignition, the container is allowed to cool to room temperature. What is the partial pressure of helium gas in the container?

---

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[1 mark]

- (iv) If the vapour pressure of water in the container at room temperature is 2.4 kPa, what is the total pressure in the container?

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[1 mark]

- (v) Write a balanced equation for the reaction that has taken place.

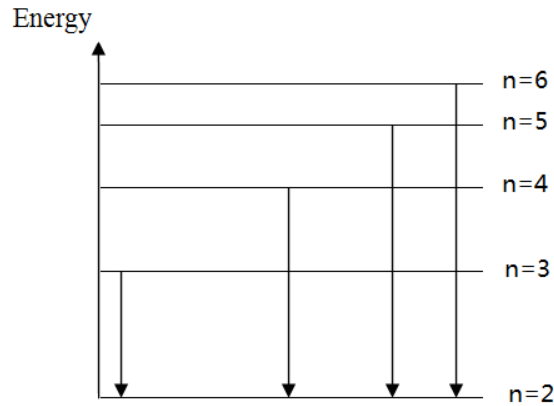
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[1 mark]

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(b) The diagram below shows four electronic transitions in the hydrogen atom.



- (i) Which electronic transition emits electromagnetic radiation with the *shortest* wavelength?

---

[1 mark]

- (ii) In which region of the electromagnetic spectrum are these lines formed? What is the name of this line series in the emission spectrum of hydrogen?

---

---

[2 marks]

- (iii) Determine the *maximum* number of lines that can be formed in this line emission spectrum involving the the energy levels n=2 to n=6

---

[1 mark]

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2 (a) Carbon dioxide and nitrogen dioxide are gaseous combustion products of liquid hydrocyanic acid, HCN at 298K and 1 atm pressure. Water is also formed in the combustion.

(i) Define the standard enthalpy change of combustion of hydrocyanic acid and write a thermochemical equation for this enthalpy change.

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---

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[2 marks]

(ii) The standard enthalpy change of combustion of hydrocyanic acid is  $-1628 \text{ kJ mol}^{-1}$ . The standard enthalpy change of formation of carbon dioxide, nitrogen dioxide, and water are respectively  $-393 \text{ kJ mol}^{-1}$ ,  $-89 \text{ kJ mol}^{-1}$  and  $-286 \text{ kJ mol}^{-1}$ . Calculate the standard enthalpy change of formation of hydrocyanic acid.

[3 marks]

(iii) Name the shapes of the underlined species.

---

---

[2 marks]

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(b) An aqueous solution of  $0.100 \text{ mol dm}^{-3}$  sulphuric acid is electrolysed in an electrolytic cell using graphite electrodes. Calculate the time of electrolysis required to produce  $140 \text{ cm}^3$  of gas at the anode at s.t.p when the current used is  $1.25 \text{ A}$ . Refer to the Data Booklet for all other necessary data.

[3 marks]

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3 (a) Aqueous ammonia is added to aqueous aluminium sulphate slowly until in excess.

(i) What will be observed when aqueous ammonia is added slowly?

\_\_\_\_\_

[1 mark]

(ii) Write an equation for your observation in (a)(i).

\_\_\_\_\_

[1 mark]

(iii) What will be observed at the end of the reaction after excess ammonia is added? Write the formula of the aluminium species at the end of the reaction.

\_\_\_\_\_

\_\_\_\_\_

[2 marks]

(b) The following table shows two iron complexes.

Complex	Colour	Name
$[\text{Fe}(\text{CN})_6]^{4-}$	Yellowish Green	
$[\text{Fe}(\text{SCN})(\text{H}_2\text{O})_5]^{2+}$	Red	

(i) Write the names of the iron complexes in the table above.

[2 marks]

(ii) State *two* properties of iron that enables it to form complex ions.

\_\_\_\_\_

\_\_\_\_\_

[2 mark]

(i) Why are transition metal complex ions coloured?

\_\_\_\_\_

\_\_\_\_\_

[2 marks]

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4 (a) An unsymmetrical alkene **X** reacts with hydrogen bromide to form 2-bromobutane.

(i) Name the alkene **X** in the above reaction.

---

[1 mark]

(ii) Name and outline the mechanism for the above reaction.

*Name of mechanism*

---

*Mechanism*

[3 marks]

(b) 3-methyl-1-butene reacts with steam under high temperature and pressure to produce an alcohol.

(i) Name the alcohol produced.

---

[1 mark]

(ii) The alcohol produced shows a type of stereoisomerism. State the type of isomerism shown here and draw the structures of the two isomers.

*Type of isomerism*

---

*Structures*

[3 marks]

(c) Propene reacts with oxygen in the presence of heated silver catalyst.

(i) Write an equation for the reaction.

---

[1 mark]

(ii) Name the product obtained.

---

[1 mark]

## Section B [60 marks]

Answer any **four** questions in this section.

- 5 (a) The boiling points of three fluorides are as follows :

Fluoride	Boiling point / $^{\circ}\text{C}$
$\text{SiF}_4$	$-86^{\circ}\text{C}$
$\text{PF}_5$	$-75^{\circ}\text{C}$
$\text{SF}_6$	$-64^{\circ}\text{C}$

- (i) Explain in terms of structure and bonding why these compounds are all gases at room temperature and pressure [2 marks]
- (ii) Draw diagrams to show the shapes and bond angles of each of these compounds  $\text{SiF}_4$ ,  $\text{PF}_5$ , and  $\text{SF}_6$ . [3 marks]
- (iii) Both oxygen and sulphur are in the same group in the Periodic Table. State why compound  $\text{OF}_6$  does not exist. [1 mark]
- (iv) Xenon reacts with fluorine to form the compound  $\text{XeF}_4$ . State whether the  $\text{Xe}-\text{F}$  bond is polar or non-polar and hence explain the polarity of  $\text{XeF}_4$  molecule. [3 marks]
- (b) Carbon monoxide,  $\text{CO}$ , nitrogen monoxide,  $\text{NO}$  and oxygen react together to produce nitrogen dioxide,  $\text{NO}_2$  as one of the product. Several experiments were carried out to determine the rate equation for the reaction. The results are shown in the table below.

Experiment	$[\text{CO}(\text{g})]/\text{mol dm}^{-3}$	$[\text{NO}(\text{g})]/\text{mol dm}^{-3}$	$[\text{O}_2(\text{g})]/\text{mol dm}^{-3}$	Initial rate/ $\text{mol dm}^{-3} \text{ s}^{-1}$
1	$1.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$1.00 \times 10^{-1}$	$4.40 \times 10^{-4}$
2	$2.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$1.00 \times 10^{-1}$	$4.40 \times 10^{-4}$
3	$2.00 \times 10^{-3}$	$3.00 \times 10^{-3}$	$1.00 \times 10^{-1}$	$3.96 \times 10^{-3}$
4	$5.00 \times 10^{-3}$	$1.00 \times 10^{-3}$	$3.00 \times 10^{-1}$	$1.32 \times 10^{-3}$

- (i) Write an equation for the reaction between  $\text{CO}$ ,  $\text{NO}$  and  $\text{O}_2$ . [1 mark]
- (ii) Determine the order of the reaction with respect to each of the reactants and hence the rate equation [4 marks]
- (iii) Determine the rate constant,  $k$  for the reaction. [2 marks]

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- 6 (a) Carbonic acid,  $\text{H}_2\text{CO}_3$  is formed when carbon dioxide dissolves in water. It is a weak acid with the following dissociation constants:

$$K_1 = 4.5 \times 10^{-7} \text{ mol dm}^{-3}$$
$$K_2 = 5.6 \times 10^{-11} \text{ mol dm}^{-3}$$

- (i) Write expressions for  $K_1$ ,  $K_2$  and the acid dissociation constant,  $K_a$  for  $\text{H}_2\text{CO}_3$ .  
[3 marks]
- (ii) By using the expression for  $K_1$ , calculate the pH of carbonic acid.  
[2 marks]
- (iii)  $20.0 \text{ cm}^3$  of  $0.100 \text{ mol dm}^{-3}$  carbonic acid is added to  $15.0 \text{ cm}^3$  of  $0.100 \text{ mol dm}^{-3}$  sodium hydroxide solution. State and explain one important application of the solution formed.  
[2 marks]
- (b) Hydrogen bromide (boiling point  $-67^\circ\text{C}$ ) and water forms an azeotropic mixture with a boiling point of  $126^\circ\text{C}$ . The azeotrope contains 47% by mass of hydrogen bromide.
- (i) Explain the term 'azeotrope'.  
[1 mark]
- (ii) Sketch a fully labelled boiling point – composition diagram for the mixture of hydrogen bromide and water.  
[2 marks]
- (iii) A mixture containing 60% by mass of hydrogen bromide is subjected to fractional distillation. What is the composition of the first and second distillate?  
[2 marks]
- (iv) What kind of deviation from ideality is shown by such a mixture? Describe the different kinds of forces that exist before and after mixing.  
[3 marks]

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7. (a) Oxides of Period 3 elements are classified as basic, amphoteric and acidic. Describe the reactions of Period 3 elements with oxygen to form the above types of oxides.

[7 marks]

- (b) The table below gives the standard reduction potentials,  $E^0$  for Group 2 elements.

Element	Be	Mg	Ca	Sr	Ba
$E^0 / \text{Volt}$	-1.85	-2.38	-2.87	-2.89	-2.90
$M^{2+}(\text{aq}) + 2e^- \rightarrow M(\text{s})$					

Explain the reactivity of the Group 2 elements towards water by referring to above standard reduction potential values.

[4 marks]

- (c) State and explain the thermal stability of the nitrates when descending Group 2 of the Periodic table

[4 marks]

8. (a) (i) It has been stated that, for lead, the +2 oxidation state is more stable than the +4 state whereas the reverse is true for tin.

By referring to the Data Booklet and by considering their oxides and/or their chlorides, comment on the experimental evidence for this statement.

- (ii) State and explain which Group 14 metal forms divalent ions that readily decolourise acidified aqueous potassium manganate(VII).

[8 marks]

- (b) The industrial manufacture of nitric acid involves the following three processes:

- Ammonia and oxygen are passed over a platinum-rhodium catalyst at 900 °C. Nitrogen monoxide and steam are formed.
- The gases are cooled and more oxygen is added. The nitrogen monoxide is converted to nitrogen dioxide.
- Nitrogen dioxide is mixed with more oxygen and absorbed into water, forming nitric acid.

- (i) Write balanced equations for the above three processes.
- (ii) Calculate the maximum mass of nitric acid that can be obtained when 1.0 tonne of ammonia is used.
- (iii) Nitrogen oxides can also be found in vehicle exhaust fumes. Most cars are fitted with catalytic converters to remove these oxides from car exhausts. What chemical reaction occurs in a catalytic converter to remove nitrogen monoxide from exhaust fumes. Write an equation for this reaction

[7 marks]

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9. (a) (1-methylethyl)benzene or cumene is an important intermediate used in the industrial manufacture of phenol. (1-methylethyl)benzene is produced by a Friedel-Crafts reaction between benzene and a suitable alkene.

(i) Write an equation to show the formation of cumene and name the catalyst used. [2 marks]

(ii) Describe with the aid of equations how cumene is converted to phenol [4 marks]

(b) Suggest explanations for the following reactions.

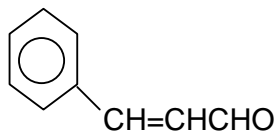
(i) Phenol can be nitrated by dilute nitric acid to give a mixture of monosubstituted phenol, whereas benzene is only nitrated by a mixture of concentrated nitric and concentrated sulphuric acids.

(ii) Heating 2-butanol with excess concentrated sulphuric acid produces a mixture of three isomeric alkenes.

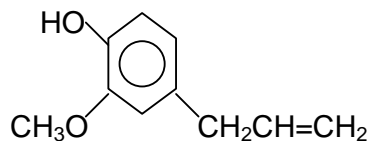
[9 marks]

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10. The structural formulas for the organic compounds Cinnamaldehyde and Eugenol are as follows:



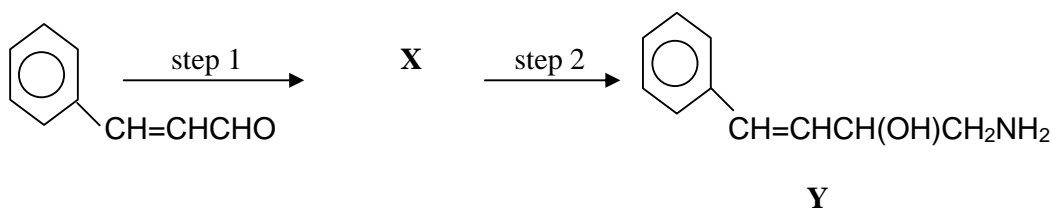
Cinnamaldehyde



Eugenol

- (a) Give a chemical test to distinguish between Cinnamaldehyde and Eugenol [3 marks]

- (b) Cinnamaldehyde is used to synthesise an organic compound, **Y** via the following route



What are the reagents for steps 1 and 2? Give the identity of **X**. Cold nitrous acid is now added to **Y**. Describe what is observed and write an equation for it.

[5 marks]

- (c) Eugenol reacts with ethanoyl chloride to form product **M**. **M** undergoes hydrolysis with sodium hydroxide.
- (i) Write an equation for the reaction between Eugenol and ethanoyl chloride to form **M** [1 mark]
- (ii) Write the formulas for all the organic products of the hydrolysis of **M** by sodium hydroxide [2 marks]
- (d) Eugenol is treated with the following reagents:
- bromine water
  - concentrated acidified potassium manganate(VII) solution.

In each case, describe what is observed and write the formulas of the products obtained

[4 marks]

**ANSWERS NEGERI SEMBILAN TRIAL STPM CHEMISTRY PAPER 1 2010**

<b>NO</b>	<b>ANS</b>	<b>NO</b>	<b>ANS</b>
1	C	26	B
2	A	27	D
3	D	28	C
4	D	29	C
5	D	30	B
6	A	31	A
7	A	32	C
8	B	33	B
9	C	34	C
10	B	35	B
11	B	36	D
12	C	37	D
13	D	38	A
14	C	39	C
15	B	40	C
16	D	41	B
17	C	42	A
18	D	43	C
19	A	44	D
20	C	45	C
21	A	46	C
22	D	47	B
23	D	48	B
24	A	49	A
25	D	50	B

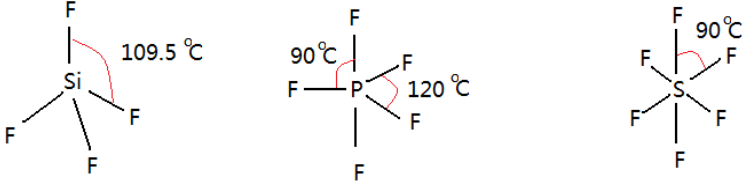
Answers to Section A

Q	Answer	Mark	Total marks
1(a) (i)	0.88 – 0.50 – 0.10 = 0.28 mole He	1 1	6
(ii)	0.30 mole H <sub>2</sub> <b>and</b> 0.28 mole He (both mentioned)	1	
(iii)	28 kPa	1	
(iv)	2.4 + 28 + 30 (working) <b>OR</b> 60.4 kPa (final answer)	1	
(v)	2H <sub>2</sub> + O <sub>2</sub> → H <sub>2</sub> O	1	
1(b)(i)	n = 6 to n = 2	1	4
(ii)	visible light Balmer Series	1 1	
(iii)	10 lines	1	
			10 marks

Q	Answer	Mark	Total Marks
2(a) (i)	Heat given out when 1 mol of hydrocyanic acid is burnt completely in excess oxygen (air) under standard conditions of 1 atm pressure and 298K.  $\text{HCN(l)} + 9/4 \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + \text{NO}_2\text{(g)} + 1/2 \text{H}_2\text{O(l)}$ [Note: state symbols must be given to get mark]	1  1	2
(a) (ii)	Expression: $\Delta H_{\text{rxn}} = \sum \Delta H_f(\text{products}) - \sum \Delta H_f(\text{reactants})$  Substitution: $-1628 \text{ kJ} = (-393\text{kJ}) + (-89.0\text{kJ}) + 1/2(-286\text{kJ}) - (x + 0)$ $x = -625 \text{ kJ} + 1628 \text{ kJ}$ $= +1003 \text{ kJ}$  Answer: Hence $\Delta H_f$ of HCN is $+1003 \text{ kJ mol}^{-1}$  <i>Or alternative method (algebraic / energy cycle)</i>	1  1  1	3
(a) (iii)	CO <sub>2</sub> : Linear shape  NO <sub>2</sub> : bent / V-shape	1  1	2
(b)	At anode: $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$ <b>OR</b> $2\text{H}_2\text{O} \rightarrow \text{O}_2 + 4\text{H}^+ + 4\text{e}^-$  1 mol of O <sub>2</sub> gas requires 4 F of electricity to produce 22,400 cm <sup>3</sup> of O <sub>2</sub> gas is produced by 4 x 96,500 C 140 cm <sup>3</sup> of O <sub>2</sub> gas is produced by $\frac{140 \times 4 \times 96,500}{22,400}$ $= 2412.5 \text{ C}$ $2412.5 \text{ C} = 1.25 \text{ A} \times t(\text{s})$ $t = \frac{2412.5}{1.25}$ ..... $= 1930 \text{ s}$  $= \text{OR } 1.93 \times 10^3 \text{ s}$	1  1  1  1	(max3)
			Max 10

Q. 3	Answer	Mark	Total Marks
(a)(i)	A white precipitate is formed	1	
(ii)	$[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow [\text{Al}(\text{OH})_3(\text{H}_2\text{O})_3] + 3\text{H}_2\text{O}$ <b>OR</b> $\text{Al}^{3+} + 3\text{OH}^- \rightarrow \text{Al}(\text{OH})_3$	1	
(iii)	Observation: The <i>white precipitate dissolves</i> in excess ammonia  Formula: $[\text{Al}(\text{OH})_4]^-$	1  1	4
(b)(i)	$[\text{Fe}(\text{CN})_6]^{4-}$ - Hexacyanoferrate(II)  $[\text{Fe}(\text{SCN})(\text{H}_2\text{O})_5]^{2+}$ - Pentaquathiocyanatoiron(III)	1  1	
(ii)	Have empty <b>d</b> orbitals / (valence orbitals) to accept lone pair electrons from ligands  Has high charge density	1  1	
(iii)	Splitting of d orbitals  d-d electronic transitions. <b>OR</b> Energy is absorbed when electrons from the lower energy <b>d orbitals</b> are promoted to higher energy <b>d orbitals</b>	1  1	6
			10 marks

Q. 4	Answer	mark	Total marks
(a) (i)	1-butene	1	
(a) (ii)	<p>Name of mechanism : electrophilic addition</p> <p>Mechanism</p> <p>Step 1:</p> $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2 + \text{H}-\text{Br}$ $\rightarrow \text{CH}_3\text{CH}_2\text{CH}^+\text{CH}_3 + :\text{Br}^-$ <p>Step 2:</p> $\text{CH}_3\text{CH}_2\text{CH}^+\text{CH}_3 + :\text{Br}^-$ $\rightarrow \text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{CH}_3$	1  1	4
(b)(i)	3-methyl-2-butanol	1	
(ii)	<p>Type of isomerism: optical isomerism</p> <p>Structures:</p>	1  1 + 1	4
(c) (i)	$2 \text{CH}_3\text{CH}=\text{CH}_2 + \text{O}_2 \rightarrow 2 \text{CH}_3\text{CH}-\text{CH}_2$	1	
(ii)	Epoxypropane	1	2
			10 marks

Q. 5	Answer	Mark	Total marks
(a) (i)	All are simple covalent molecules / simple molecular structure  <i>Weak</i> van der waals forces between molecules	1  1	
(ii)		1 +1 +1	
(iii)	O atom has no d orbitals to extend its octet	1	
(iv)	Xe—F bond is polar because F more electronegative than Xe  Since the bonds are arranged symmetrically / symmetrical shape dipoles in each Xe—F bond cancel each other / no net dipole therefore the molecule is non-polar	1  1	8
(b) (i)	$\text{CO(g)} + \text{NO(g)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + \text{NO}_2\text{(g)}$	1	
(ii)	<p>Expression: Rate = <math>k[\text{CO}]^x [\text{NO}]^y [\text{O}_2]^z</math></p> <p>Working: Exp 2 <math>4.40 \times 10^{-4} = k [2.00 \times 10^{-3}]^x [1.00 \times 10^{-3}]^y [1.00 \times 10^{-1}]^z</math> Exp 1 <math>4.40 \times 10^{-4} = k [1.00 \times 10^{-3}]^x [1.00 \times 10^{-3}]^y [1.00 \times 10^{-1}]^z</math> x = 0 if working shown</p> <p>Working: Exp 3 <math>3.96 \times 10^{-3} = k [2.00 \times 10^{-3}]^x [3.00 \times 10^{-3}]^y [1.00 \times 10^{-1}]^z</math> Exp 2 <math>4.40 \times 10^{-4} = k [2.00 \times 10^{-3}]^x [1.00 \times 10^{-3}]^y [1.00 \times 10^{-1}]^z</math> y = 2 if working shown</p> <p>Working: Exp 2 <math>4.40 \times 10^{-4} = k [2.00 \times 10^{-3}]^x [1.00 \times 10^{-3}]^y [1.00 \times 10^{-1}]^z</math> Exp 4 <math>1.32 \times 10^{-3} = k [5.00 \times 10^{-3}]^x [1.00 \times 10^{-3}]^y [3.00 \times 10^{-1}]^z</math> z = 1 if working shown</p> <p>Rate = <math>k[\text{NO}]^2 [\text{O}_2]^1</math></p>	1  1  1  1  1	
(iii)	<p>Using exp. 1 <math>k = \frac{\text{Rate}}{[\text{NO}]^2 [\text{O}_2]}</math></p> <p><math>= \frac{4.40 \times 10^{-4}}{(1.00 \times 10^{-3})^2 (1.00 \times 10^{-1})}</math></p> <p><math>= 4400 \text{ mol}^{-2} \text{ dm}^6 \text{ s}^{-1}</math></p>	1  1	

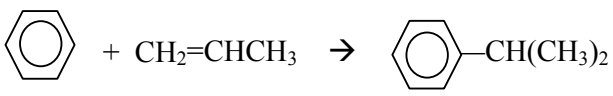
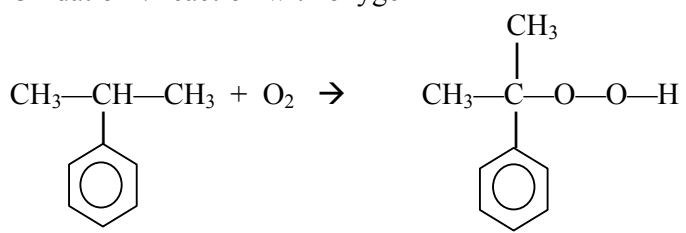
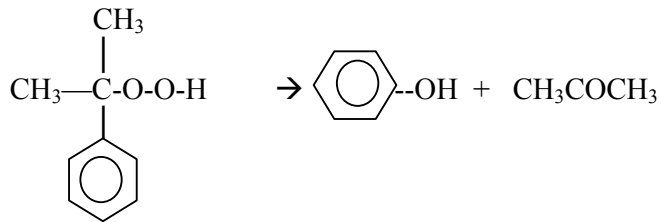
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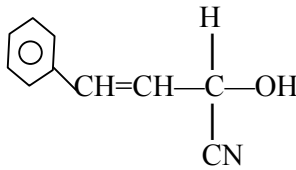
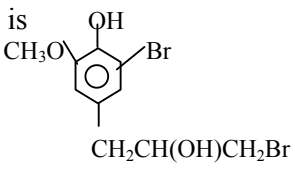
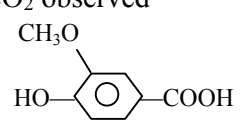
Q6	Answer	Mark	Total marks
(a) (i)	$\text{H}_2\text{CO}_3 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{HCO}_3^-$ $K_1 = \frac{[\text{H}_3\text{O}^+][\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]} \longrightarrow$ $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CO}_3^{2-}$ $K_2 = \frac{[\text{H}_3\text{O}^+][\text{CO}_3^{2-}]}{[\text{HCO}_3^-]} \longrightarrow$ $K_a = K_1 \times K_2$ $= \frac{[\text{H}_3\text{O}^+]^2[\text{CO}_3^{2-}]}{[\text{H}_2\text{CO}_3]} \longrightarrow$	1  1  1	3
(a) (ii)	$K_1 = \frac{[\text{H}_3\text{O}^+][\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]}$ $[\text{H}_3\text{O}^+] = [\text{HCO}_3^-]$ $K_1 = \frac{[\text{H}_3\text{O}^+]^2}{[\text{H}_2\text{CO}_3]}$ $[\text{H}_3\text{O}^+] = \sqrt{K_1 \times [\text{H}_2\text{CO}_3]}$ $= \sqrt{(4.5 \times 10^{-7})(0.100)}$ <p><b>OR</b> = <math>\sqrt{4.5 \times 10^{-8}}</math>  <b>OR</b> = <math>2.12 \times 10^{-4} \text{ mol dm}^{-3}</math></p> $\text{pH} = -\lg [\text{H}^+]$ $= -\lg (2.12 \times 10^{-4})$ $= 3.7$	1  1	2
(a) (iii)	<p>The resultant mixture contains <math>\text{CO}_3^{2-}</math> and <math>\text{HCO}_3^-</math> and is a <u>buffer</u></p> <p>This buffer helps to <u>maintain the pH of human blood</u></p>	1  1	

			2
(b) (i)	An azeotrope is a constant boiling point mixture whereby the composition of the vapour is same as the composition of the liquid.	1	
(b) (ii)	<p>0% -----&gt; %HBr -----&gt; ----- 100%  100% .---&lt;-- %H<sub>2</sub>O -----&lt;---- 0%  composition</p>	<p>correct shape } 1  curves labelled }  axes labelled } 1  100, 126, -67 }  47% }</p>	2
(b) (iii)	<p>The composition of the first distillate is pure HBr or 100% HBr</p> <p>The composition of second distillate is 47% HBr and 53% H<sub>2</sub>O / or azeotrope.</p>	1 1	2
(b) (iv)	<p>A mixture of HBr and H<sub>2</sub>O shows negative deviation from Raoult's law.</p> <p>In pure HBr – the forces are van der waals between HBr molecules  <b>AND</b>  In pure H<sub>2</sub>O – forces are hydrogen bonds between H<sub>2</sub>O molecules</p> <p>When mixed together,  There are ion –dipole forces between H<sup>+</sup> and H<sub>2</sub>O molecules  and  between Br<sup>-</sup> ions and H<sub>2</sub>O molecules.</p> <p>Ion-dipole forces stronger than hydrogen bonds</p>	<p>} 1  } 1  } 1  1</p>	3

Q.7	Answers	marks	Total marks
(a)	<p>Statement: Sodium and magnesium burn in oxygen to form basic oxides.</p> <p>Equation:  <math>4\text{Na}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{Na}_2\text{O}_{(g)}</math>  <b>OR</b>  <math>2\text{Mg}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{MgO}_{(g)}</math></p> <p>Aluminium burns in oxygen to produce aluminium oxide, an amphoteric oxide.</p> $4\text{Al}_{(s)} + 3\text{O}_{2(g)} \rightarrow 2\text{Al}_2\text{O}_3(g)$ <p>Silicon, phosphorous and sulphur burn in oxygen to form acidic oxides</p> $\left. \begin{array}{l} \text{Si}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{SiO}_{(g)} \\ \text{P}_{4(s)} + 3\text{O}_{2(g)} \rightarrow \text{P}_4\text{O}_{6(l)} \\ \text{P}_{4(s)} + 5\text{O}_{2(g)} \rightarrow \text{P}_4\text{O}_{10(l)} \\ \text{S}_{(s)} + \text{O}_{2(g)} \rightarrow \text{SO}_{2(g)} \end{array} \right\} \text{ (any one equation)}$ <p>Chlorine does not react with oxygen.</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>7</p>
(b)	<p>All Group 2 elements react with water according to the following equation.</p> <p>[given any equation]: <math>\text{M}_{(s)} + 2\text{H}_2\text{O} \rightarrow \text{M}(\text{OH})_2 + \text{H}_2</math></p> <p>In the reaction, the Group 2 element acts as reducing agents.</p> <p>Going down Group 2, the reducing power of the element increases as the <math>E^0</math> values become more negative.</p> <p>Magnesium reacts only with steam,  Calcium reacts rapidly with hot water, but slowly with cold water  Strontium and barium react vigorously with cold water,</p> <p><b>OR</b>  Reactivity increases down the group.</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>8</p>
(c)	<p>[Equation]: <math>2\text{M}(\text{NO}_3)_2 \rightarrow 2\text{MO} + 4\text{NO}_2 + \text{O}_2</math></p> <p>Going down Group 2, the size of the cation increases while the charge remains the same /  Charge density of cation decreases.</p> <p>The polarizing power of the cations towards <math>\text{NO}_3^-</math> ion decreases making the nitrates more stable to heat</p> <p>Thermal stability increase down the group</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>	<p>8</p>

8(a)(i)	$\text{Pb}^{4+} + 2\text{e} = \text{Pb}^{2+} \quad E = +1.69 \text{ V}$ $\text{Sn}^{4+} + 2\text{e} = \text{Sn}^{2+} \quad E = +0.15 \text{ V}$ <p>The +4 oxidation state of both Pb and Sn tend to be less stable than the +2 oxidation state</p> <p>PbO<sub>2</sub> is highly unstable and decomposes readily to PbO While SnO readily combines with O<sub>2</sub> to form SnO<sub>2</sub></p> <p style="text-align: center;">OR</p> $\text{PbO}_2 \rightarrow \text{PbO} + \frac{1}{2} \text{O}_2$ $\text{SnO} + \frac{1}{2} \text{O}_2 \rightarrow \text{SnO}_2$ <p>Pb combines readily with Cl<sub>2</sub> to form the more stable PbCl<sub>2</sub> / PbCl<sub>4</sub> decomposes slowly at room temperature to PbCl<sub>2</sub> Sn combines with Cl<sub>2</sub> to give the more stable SnCl<sub>4</sub></p> <p style="text-align: center;">OR</p> $\text{Pb} + \text{Cl}_2 \rightarrow \text{PbCl}_2 / \text{PbCl}_4 \rightarrow \text{PbCl}_2 + \text{Cl}_2$ $\text{Sn} + 2\text{Cl}_2 \rightarrow \text{SnCl}_4$	1 1 1 1 1 1	6
(ii)	<p>Sn</p> $2\text{MnO}_4^-(\text{aq}) + 16\text{H}^+(\text{aq}) + 5\text{Sn}^{2+}(\text{aq}) \rightarrow 2\text{Mn}^{2+}(\text{aq}) + 8\text{H}_2\text{O}(\text{l}) + 5\text{Sn}^{4+}(\text{aq})$ <p style="text-align: center;">( states of species not needed)</p> $E_{\text{cell}} = +1.52 - (+0.15)$ $= +1.37 \text{ V}$	1 1 1	3
(b)(i)	$4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$ $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$ $4\text{NO}_2 + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{HNO}_3$	1 1 1	
(ii)	<p>1 mole of NH<sub>3</sub> gives 1 mole of HNO<sub>3</sub></p> <p style="text-align: center;">OR</p> <p>17 g of NH<sub>3</sub> gives 63 g of HNO<sub>3</sub></p> <p>1 tonne of NH<sub>3</sub> gives 63/17 tonnes of HNO<sub>3</sub></p> <p style="text-align: center;">OR 3.7 tonnes</p>	1 1	
(iii)	<p>Reduction</p> $2\text{NO} \rightarrow \text{N}_2 + \text{O}_2$ <p style="text-align: center;">OR</p> $2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$	1 1	7 Total 16 Max 15

9(a)(i)		1	
	Catalyst : phosphoric acid / H <sub>3</sub> PO <sub>4</sub>	1	2
(ii)	Oxidation / reaction with oxygen	1	
		1	
	Decomposition of hydroperoxide with dilute sulphuric acid	1	
		1	4
(b)(i)	-OH in phenol is a ring activating group ./ Lone pair electrons on oxygen atom in -OH group can be delocalized into the benzene ring / donated to the benzene ring	1	
	Phenol more easily attacked by an electrophile (or NO <sub>2</sub> <sup>+</sup> ) compare to benzene	1	
	Equation to form nitrobenzene	1	
	Equation to form 2-nitrophenol <b>and</b> 4-nitrophenol	1	4
(ii)	Elimination reaction / dehydration	1	
	To form but-1-ene (1-butene) <b>and</b> 2-butene	1	
	Any 1 equation to form 2-butene / 1-butene	1	
	2-butene exists as pair of cis-trans isomers / shows geometrical isomers	1	
	[Draw structure of the cis <b>and</b> trans isomers and labelled them]	1	5
			15

Q	Answer	Mark	$\Sigma$
10 (a)	<p><b>Describe</b> test using either one of the following reagents: Tollens reagent / Fehlings solution / iron(III) chloride (cannot use Br<sub>2</sub>(aq) or KMnO<sub>4</sub>)</p> <p>Observation:</p> <p>Equation:</p>	1 1 1	3
(b)	Step 1 : reagent : hydrogen cyanide / HCN	1	
	<p>Step 2: reagent : LiAlH<sub>4</sub> in ether solvent / NaBH<sub>4</sub> / Na in ethanol</p> <p>Identity of X</p>  <p>Observation: bubbles of nitrogen gas obtained</p> $\text{C}_6\text{H}_5\text{-CH=CHCH(OH)CH}_2\text{NH}_2 + \text{HNO}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O}$ $\text{C}_6\text{H}_5\text{-CH=CHCH(OH)CH}_2\text{OH}$	1 1 1 1	5
(c) (i)	$\text{CH}_3\text{-C(=O)-Cl} + \text{HO-C}_6\text{H}_3(\text{OCH}_3)\text{-CH}_2\text{CH=CH}_2 \rightarrow$ $\text{CH}_3\text{-C(=O)-O-C}_6\text{H}_3(\text{OCH}_3)\text{-CH}_2\text{CH=CH}_2 + \text{HCl}$	1	
(ii)	Products are CH <sub>3</sub> COO <sup>-</sup> Na <sup>+</sup> and Na <sup>+</sup> O <sup>-</sup> -C <sub>6</sub> H <sub>3</sub> (OCH <sub>3</sub> )-CH <sub>2</sub> CH=CH <sub>2</sub>	1 + 1	
(d) (i)	<p>Observation: brown colour of Br<sub>2</sub> decolourised / and white ppt</p> <p>Formula is</p> 	1 1	
(ii)	<p>Observation: purple colour of MnO<sub>4</sub><sup>-</sup> is decolourised / and bubbles of CO<sub>2</sub> observed</p> <p>Formula</p> 	1 1	4