Our country, our future

525/1

S6 CHEMISTRY

Exam 4

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions:
- Attempt all questions in section A and six questions in section B
- All questions are to be answered in the spaces provided.

SECTION A:
Attempt all questions in this section .

1. The standard electrode potential E of lead and magnesium are shown below

	E^{θ} /Volts
$Pb^{2+} + 2e^{-} \longrightarrow Pb$	– 0.13
$Mg^{2+} + 2e^{-} \longrightarrow Mg$	– 2.40

(a) Write the cell convention for the cell that can be formed (1m)

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(b) Write the equation for the

(i) reaction taking place at each electrode (2m)

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(ii) overall reaction (1m)

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(c) Calculate the e.m.f of the cell (1m)

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2. Complete the following equations and in each case write a mechanism for the reaction

(a) $CH_3CH_2CH_2OH \xrightarrow[180^oC]{\text{Conc. } H_3PQ_4}$ (3m)

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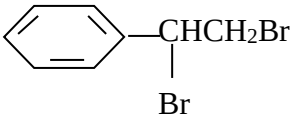
(b)  $\xrightarrow[\text{heat}]{EtO^-/Et\,OH}$ (2)

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3. (a) (i) What is meant by the term ionisation energy of an element? (2)

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(ii) Write an equation to show the first ionisation of magnesium (1 ½)

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(b) The second and third ionisation energies of magnesium are 1450 $kJmol^{-1}$ and 7730 $kJmol^{-1}$ respectively. Give a reason for the large difference between the second and the third ionisation energies of magnesium. (2)

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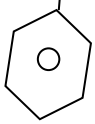
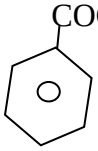
4. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagents reacted with components

(a)  and  (3)

Reagent

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Observation

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(b) $CH_3CH_2CH_2CH_2OH$ and $(CH_3)_3$ COH. (3 m)

Reagent

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Observation

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5. The Ostotic pressure of a solution containing 1.4g of a polymer x per $100cm^3$ of a solution is 1200 Nm^{-2} at 25°C.

(a) Calculate the relative molecular mass of x

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(b) Determine the number of monomers in x (The molecular mass of the monomer of x is 28) (1m)

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6. (a) One of the properties of transition metals complex ion formation

(i) Define the term 'Complex ion' (2m)

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(ii) Explain why transition metals form many complexes (2m)

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(b) $Fe(CN)_6^{3-}$ and $(CuCl_4)^{2-}$ are complexes formed by iron and copper respectively. State:

(i) the oxidation state of

iron

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copper

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(1m)

(ii) the co-ordination number of

iron

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copper (1m)

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7. $1.00dm^3$ of aqueous solution contains 5.00g of butanoic acid. Calculate the mass of butanoic acid extracted when the solution was shaken:

(a) with $50cm^3$ of a solvent R. (The distribution coefficient K_D of butanoic acid between R and water is 40) (2 ½)

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(b) Twice with 25cm^3 of solvent R (2)

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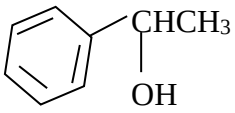
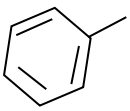
8. Name one reagent that can be used to distinguish between each of the following pairs of compounds and state what would be observed in each case if the reagent is reacted with the compounds

(a)  and  (2 ½ m)

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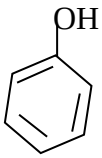
(b)  and $CH_3CH_2CH_2CH_2OH$

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9. When 142cm^3 of a hydrocarbon Q, of molecular mass 58 was exploded with excess oxygen and cooled to room temperature, the volume of the residual gas was 694cm^3. After addition of concentrated potassium hydroxide, the volume decreased to 126cm^3

   (a) Determine the molecular formula of Q (3m)

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   (b) Write the names and the structural formulae of all isomers of Q (2m)

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SECTION B:

Answer only six questions in this section

10. (a) An organic compound A contains carbon, hydrogen and oxygen only. On combustion, 0.463g of A gave 1.1g carbon dioxide and 0.563g of water. Determine the empirical formula of A (3 ½)

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(b) When vaporised 0.1g of A occupies 54.5cm^3 at 208^{o}C and 98.3 kPa. Determine the molecular formula (2 ½)

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(c) A reacts with sodium metal with evolution of a gas. Write the structural formula of all possible isomers of A. (2)

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(d) A reacts with anhydrous zinc chloride and concentrated hydrochloric acid to give a cloudy solution in about 5 minutes

(i) identify A

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(ii) show how A could be synthesised from but 2 - ene (½)

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11. The solubility product, Ksp, of zinc hydroxide is 4.5×10^{-17} at 25°C.

(a) Write an expression for the solubility of zinc hydroxide

(b) Determine the concentration in moles per litre of zinc and hydroxide ions in a saturated solution of zinc hydroxide at 25°C. (3)

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(c) State how the solubility of zinc hydroxide would change if its saturated solution is treated separately with

(i) aqueous zinc sulphate (1)

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(ii) ammonia (1)

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(d) Briefly explain your answers in (c) (3)

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12. (a) Name a reagent that can be used to distinguish between the following pairs of ions. In each case, state what is observed if each ion is separately treated with the reagent.

(i) Ba^{2+} and Ca^{2+} (3)

Reagent

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Observation

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(ii) NO_2^- and NO_3^- (3)

Reagent

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Observation

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(b) Write ionic equations for the reaction between sodium hydroxide and

(i) BeO (1 ½)

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(ii) SiO_2 (1 ½)

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13. A compound, B has an empirical formula of C_3H_6O. Oxygen gas diffuses 1.345 times faster than B.

(a) (i) Determine the molecular formula of B (2)

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(ii) Write the structural formulae of all the possible isomers of B (1)

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(b) (i) B does not Fellings' Solution, using equations, show how B can be formed from propene (2 ½)

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(ii) Write an equation for the reaction of B with sodium hydrogen sulphite and write the mechanism (2 ½)

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14. (a) Define the term a ‘buffer solution’. (2)

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(b) Calculate the mass of sodium ethanoate that should be added to 1 litre of a 0.1M ethanoic acid solution in order to produce a solution of pH = 4.0

(ka for ethanoic acid = 1.8×10^{-5}) (5)

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(c) State what would happen to the pH of the solution in (b) if a small amount of the following were added

(i) sodium hydroxide solution

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(ii) hydrochloric acid

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(d) State one biological application of a buffer solution

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15. Compound Y, C_3H_6O reacts with 2,4 – dinitro phenyl hydrazine to give a yellow solid.

(a) Write the structural formulae and JUPAC names of all the isomers of Y

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(b) When Y is heated with Fehling's solution, a red precipitate is formed

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(c) Write a mechanism for the reaction that would take place between Y and hydroxylamine, NH_2OH (3)

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(d) Write equations to show how Y can be converted to an alkene (3)

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16. (a) An aqueous solution containing 7.2g of a non-cyclic substance Q in 250g of water freezes at – 0 .744^{o}C. The freezing point constant, K, for water is 1.86^{o}C mol $^{-1}$ kg $^{-1}$

Calculate the molecular mass of Q (3)

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(b) If Q contains carbon, 66.7% hydrogen 11.1% and oxygen 22.2%;

(i) Calculate the simplest formula of Q (2)

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(ii) Determine the molecular formula of Q (1)

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(iii) Write the structures of all the possible isomers of Q (1 ½)

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(c) Q forms a yellow precipitate with phenylhydrozine and iodine solution in the presence of sodium hydroxide. Identify Q. (½)

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17. State what would be observed and write equations for the reactions that take place when the following compounds are reacted.

(a) Aqueous potassium dichromate (VI) with hydrogen sulphite (3)

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(b) Aqueous iron (III) chloride with sodium carbonate (3 ½)

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(c) Aqueous copper (II) sulphate with potassium iodide (2 ½)

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END