Digital Teachers

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525/1

S6 CHEMISTRY

Exam 24

PAPER 1

DURATION: 2 HOUR 45 MINUTES

Instructions:
1. Answer all questions in the spaces provided
2. Illustrate your answers with equations wherever possible
3. A graph paper and periodic table are attached at the end of the paper.

1. Complete the following equations and give the IUPAC name of the main organic product

(a) $CH_3CH_2Br + HC \equiv \overline{C}Na^+$ $\xrightarrow{\text{liq.}NH_3}$ $CH_3CH_2C{\equiv}CH$ (2m)

But -1-yne

(b) $nCH_3CH = CH_2$ $\xrightarrow{\text{catalyst.}}$ $-[CH(CH_3) - CH_2]_n-$ (2m)

Polypropene

2. Element X, Y and Z have the following ionisation energies ($kJmol^{-1}$)

Ionisation energy	1st	2nd	3rd	4th
X	738	1450	7730	10550
Y	495	4653	6912	9540
z	800	2427	3658	25024

Select the element that shows

(i) a valency of +2 (½ m)
X

(ii) forms a covalent chloride (½ m)
Z

(iii) forms an ionic univalent chloride (1 m)
Y

(b) Explain why the first ionisation energy of Boron is less that that of Beryllium, whereas the second ionisation energy of Boron is greater than that of Beryllium (3m)

The first ionization energy of boron is less than that of beryllium because the first electron of beryllium is removed from stable 2s-full orbital whereas that of boron is removed from unstable less than half-full p-orbital.

The second ionization energy of boron is higher than that of beryllium because the second electron of boron is removed from stable full 2s-orbital while that of beryllium is removed from unstable orbital.

3. (a) State Raoult's law (2)

States that the partial pressure of a component in a mixture is the product of the mole fraction of the component and the vapour pressure of the pure component at the same temperature.

(b) The vapour pressure of a solution containing 4g of a sugar Q in 100g of water is 3.1545 kPa at 25^{o}C. Calculate the relative molecular mass of Q given that the vapour pressure of pure water at 25^{o}C is 3.167 kPa. (3m)

Let the formula mass of Q be M

$$\frac{3.167-3.1545}{3.167} = \frac{4}{M} \; x \; \frac{100}{18}$$

5630

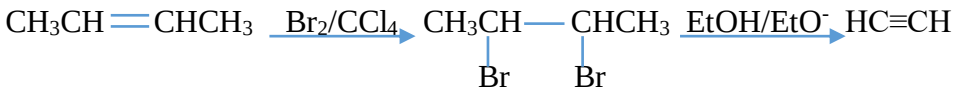
4. The molecular formula of a hydrocarbon X is C_4H_8

(a) Write the IUPAC names and structural formula of all possible isomers of x (3)

$CH_3CH_2CH=CH_2$ But-1-ene
$CH_3CH=CHCH_3$ but -2-ene
$(CH_3)_2C=CH_2$ 2-methylpropene

(b) Ozonolysis of x followed by hydrolysis gave only one compound. Identify the compound (1m)
But-2-ene

(c) Write equation to show how x can be converted to alkyne. (2m)



5. (a) Define the term partition coefficient (2m)

It is a ratio of concentration of a solute in two immiscible solvents at equilibrium

(b) 200cm^3 of an aqueous solution contains 8gm of Y. Calculate the mass of Y left in the aqueous layer by shaking the solution with

(i) 50cm^3 of trichloromethane. (The partition coefficient of Y between trichloromethane and water is 12) (4m)

Let the mass of Y that remained in water be x
The mass of Y extracted = (8 – x)

$$K_D = \frac{(8-x)/50}{x/200} = 12$$
$$x = 2g$$

(ii) twice with 25cm^3 of trichloromethane (4m)

Let the mass of Y that remained in aqueous solution after the first extraction be k
The mass that is extracted = (8 – k)

$$K_D = \frac{(8-k)/25}{k/200} = 12$$
$$k = 3.2g$$

Let the mass of Y that remained in aqueous solution after the second extraction be q
The mass that is extracted = (3.2 – q)

$$K_D = \frac{(3.2-q)/25}{q/200} = 12$$
$$q = 1.28g$$

∴ the mass that remained = 1.28g

6. (a) (i) State what is meant by an azeotropic mixture (2m)

It is a constant boiling mixture.

(ii) Give two reasons why an azeotropic mixture is not considered a pure substance (1m)

- Composition of azeotrope varies with pressure
- Azeotropes can be separated by other physical means

(b) ethanol and water forms an azeotropic mixture. Explain (3m)

Cohesive forces of ethanol or water molecules are stronger than adhesive forces between ethanol and water molecules. This promotes evaporation of either component giving vapour pressure higher than expected.

7. 2 -Bromo-2-methyl propane reacts with aqueous sodium hydroxide.
(a) (i) Write an equation for the reaction (1m)

$(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$

(ii) Write the rate equation for the reaction (1m)

Rate = $K[(CH_3)_3CBr]$

(iii) State the molecularity of the reaction (1m)

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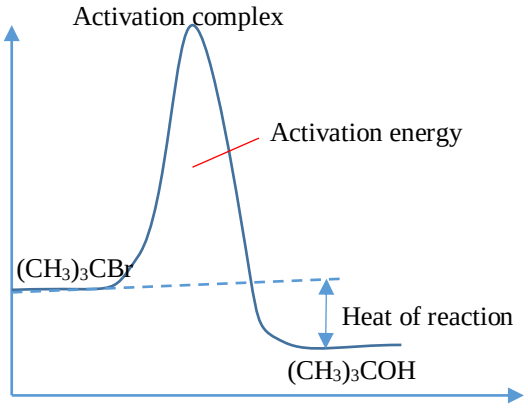
(b) Draw the energy diagram for the reaction (3m)



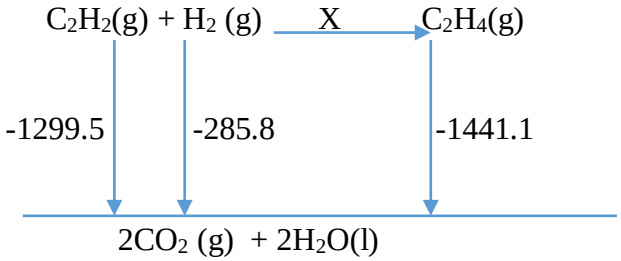
8. (a) State Hess' law (2m)

Enthalpy change of a reaction is the same irrespective of the route followed from the reactants to the products

(b) State four factors that affect the enthalpy change of any system. (2m)

- amount of reactant
- temperature at which the reaction takes place
- pressure
- pH

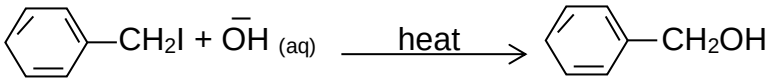
(c) The enthalpy of combustion of ethene is – 1441.1 kJmol^{-1} while that of ethyne is – 1299.5 kJmol^{-1} and that of hydrogen is – 285.8 kJmol^{-1} Calculate the enthalpy change of hydrogenation of ethyne to ethene. (4 m)



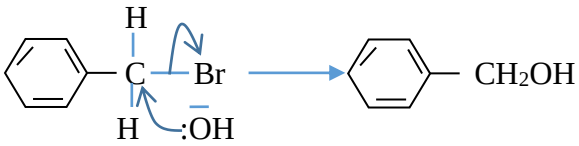
-1299.5 -285.8 = X – 1441.1

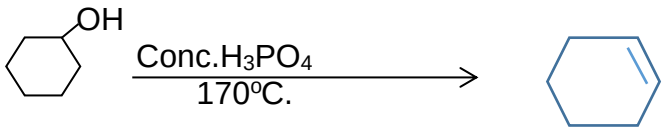
X – 144.2kJmol^{-1}

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

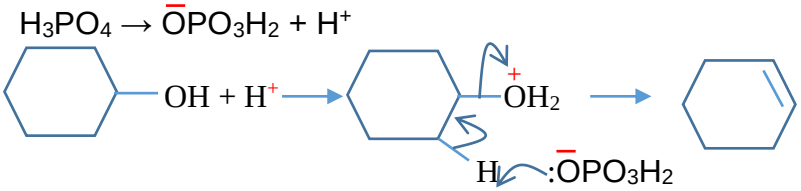
(a) 

(3m)



(b) 

(3m)



10. (a) Explain what is meant by steam distillation. (Diagram not required (3m)

It is a technique of separation of a volatile substance immiscible with water from non-volatile substances using steam

(b) Calculate the percentage composition by mass of water when aniline ($C_6H_5NH_2$) is steam distilled at 760mm Hg and 98°C and the vapour pressure of water at 98°C is 734 mmHg. (3m)

Formula mass of $C_6H_5NH_2$ = 12 x 6 + 5 + 14 +2 = 93
Vapour pressure of aniline = 760 – 734 = 26
Formula mass of water = 18
Let percentage of aniline be x
Percentage of water = (100 –x)

$$\frac{x}{(100-x)} = \frac{93\ x\ 26}{18\ x\ 734}$$

x = 15.5%

11. 0.80g of a metal oxide of the type MO was dissolved in 50.0cm^3 of 1M hydrochloric acid. The resulting mixture was made to 250cm^3 with distilled water. 25.0cm^3 of this solution required 21.4cm^3 of 0.1M sodium hydroxide solution for neutralisation.
Calculate the
(a) the number of moles of excess hydrochloric acid in 250cm^3 (3m)

Moles of sodium hydroxide that reacted hydrochloric acid in 25cm^3

$$= \frac{21.4\ x\ 0.1}{1000} = 0.00214\text{moles}$$

Mole of excess HCl in 25cm^3 = mole of sodium hydroxide = 0.00214

Moles of excess HCl in 250cm^3 = $\frac{0.00214\ x\ 250}{25}$ = 0.0214moles

∴ excess moles of HCl in 250cm^3 = 0.0214moles

(b) (i) The mass of oxide MO that reacted with the acid (2m)

Total moles of HCl = $\frac{50\ x\ 1}{1000}$ = 0.05 moles
Moles of HCl that reacted with metal oxide = 0.05 – 0.0214
= 0.0286 moles

(ii) formula mass of MO (1m)

Moles of MO = ½ x moles of HCl
= 0.5 x 0.0286 = 0.0143 moles
Formula mass of MO = $\frac{0.8}{0.0143}$ = 56

(iii) the relative atomic mass of M (1m)
M = 56 – 16 = 40

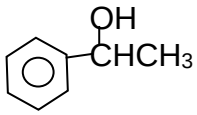
12. Give reaction scheme by which the following conversions can be effected

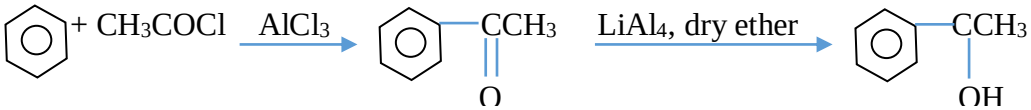
(a) Methane from chloroethane (3m)

$CH_3CH_2Cl \xrightarrow{^-OH} CH_3CH_2OH \xrightarrow{Cr_2O_7^{2-}/H^+} CH_3COOH$

Then

$CH_3COOH \xrightarrow{\text{soda lime, heat}} CH_4$

(b)  from  (3m)



13. (a) Fill in the blanks in the following radioactive decay series

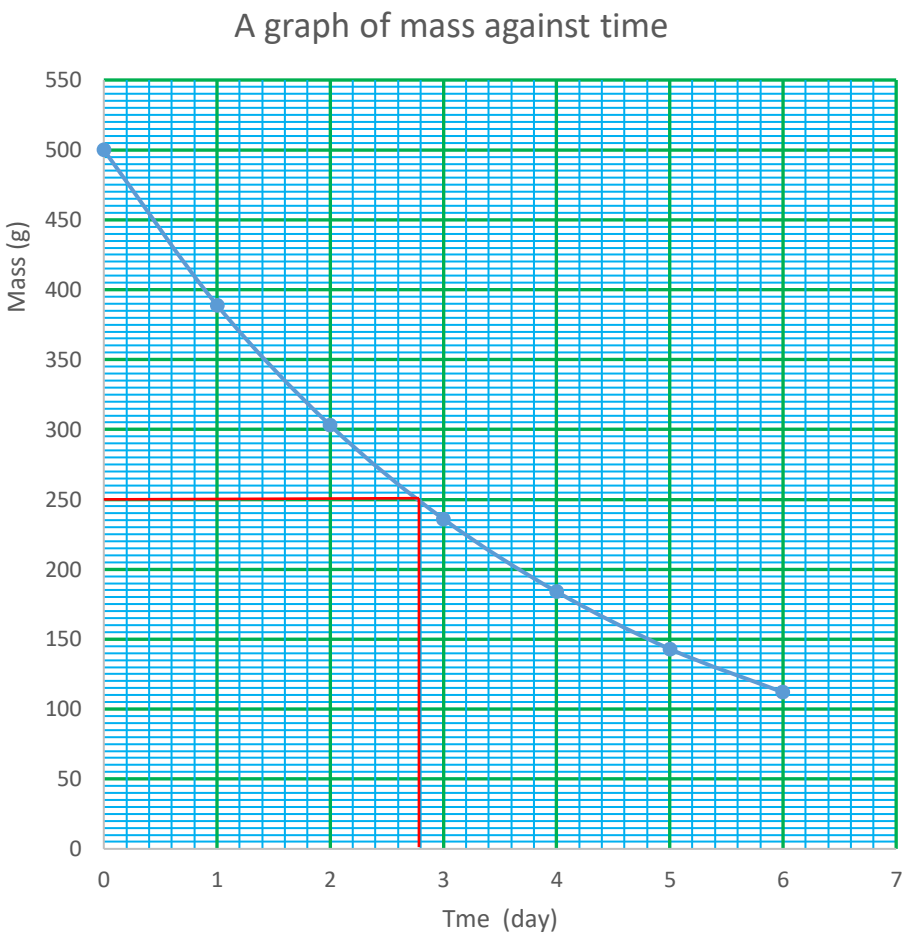
(i) $^{235}_{92}U \xrightarrow{\alpha} {}^{231}_{90}Th \xrightarrow{\beta} {}^{231}_{91}Pa \xrightarrow{\alpha} {}^{227}_{89}Ac$ (2m)

(ii) $^{235}_{93}Np \xrightarrow{\alpha} {}^{231}_{91}Pa \xrightarrow{\beta} {}^{231}_{92}U \ \alpha \ {}^{227}_{90}Th$ (2m)

(b) A radioactive substance decays as follows:

Time (day)	0	1	2	3	4	5	6
Mass (g)	500	389	303	236	184	143	112

(i) Plot a graph of time against mass



(ii) Determine the decay constant and half life of the reaction

Half life = 2.8days

Decay constant = $\frac{In\ 2}{2.8}$ = 0.25day^{-1}

END

Good luck