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QUESTION 1

1.1 C✓✓

1.2 C✓✓

1.3 B✓✓

1.4 A✓✓

1.5 A✓✓

1.6 D✓✓

1.7 B✓✓

1.8 C✓✓

1.9 D✓✓

1.10 B✓✓ [20]

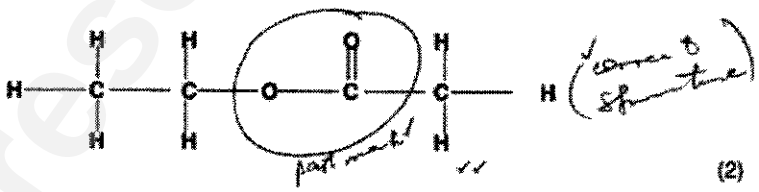
QUESTION 2

2.1 $C_4H_8O_2$ ✓✓ (2)

2.2 Compounds with the same molecular formulae, but different functional groups/homologous series. ✓✓ (2)

2.3 R, T ✓✓ or S, T (**NB.** All marks or nothing) (2)

2.4



(2)

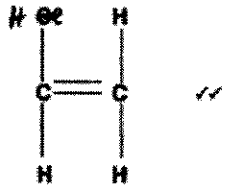
2.5 Methanol✓ and propanoic acid. ✓ (2)

2.6 1,4✓-butandiol✓ or butan-1,4-diol (2)

2.7 Esters. ✓ (1)

2.8 Chloroethene ✓ (1)

2.9



✓✓ (2)

2.10 Addition ✓ (1)
[17]

QUESTION 3

3.1

3.1.1 –O – H ✓ B

3.1.2 –COOH✓ or $-CO_2H$ C (2)

3.2 Boiling point – the temperature at which the vapour pressure of a substance equals atmospheric pressure.✓✓ (2)

3.3 Compound **F** has a higher molecular mass/size than compound **A.** ✓
Compound **F** will have greater intermolecular forces than compound **A,** ✓
hence **F** has a higher boiling point than **A.** ✓ (3)

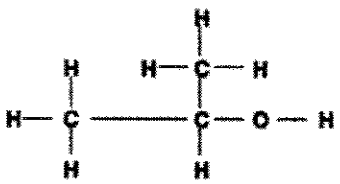
3.4 **A** ✓✓ (2)

3.5 **A** is an alkane with London/Van der Waal's forces. ✓ **B** is an alcohol with hydrogen bonding. ✓ **A** has weaker intermolecular forces than **B.** ✓Less energy is needed to overcome the intermolecular forces in **A** than in **B.** ✓ (4)
[13]

QUESTION 4

4.1. Hydration. ✓ (1)

4.2



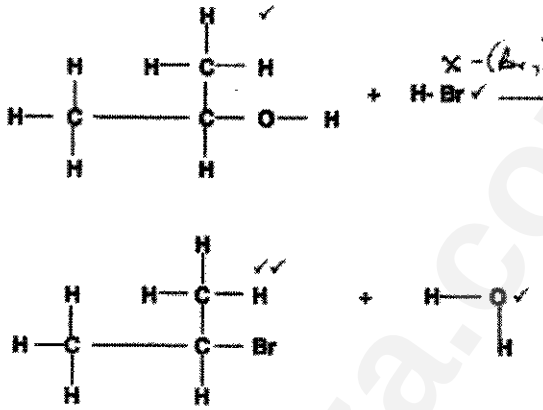
NB. Marking criteria:

- O-H ✓
- O-H on carbon number 2 ✓
- Whole structure correct ✓

(3)

4.3 Secondary alcohol ✓✓ (2)

4.4



(5)

4.5 2 - bromopropane ✓✓ (2)

[13]

QUESTION 5

5.1 The change in amounts of reactants/products per unit time. ✓✓ (2)

OR

The rate of change of concentration of reactants / products.

OR

The change in concentration of reactants / products per unit time.

5.2

5.2.1

Criteria for investigative question	Mark
The dependent and the independent variables are stated.	✓
Asks a question about the relationship between the dependent and the independent variables.	✓

Example:

How will the concentration (of HCℓ) influence the rate of the reaction? ✓✓ (2)

OR

What is the relationship between the concentration (of HCℓ) and the rate of the reaction?

5.2.2 Concentration.✓ (1)

5.2.3 Rate of reaction. ✓ (1)

5.2.4 Temperature/Mass of Zn/ State of Zn.✓ (1)

5.3 LOWER THAN ✓ (1)

5.4

5.4.1 The rate of the reaction will increase. ✓ (1)

5.4.2 Increasing temperature increases the average kinetic energy (of the reacting particles). ✓ More effective collisions per unit time✓, thus increase in the rate of the reaction. ✓ (3)
[12]

QUESTION 6

6.1. EXORTHERMIC. ✓ Heat accompanies the products/heat is released to the surrounding.✓ ✓ (3)

6.2

6.2.1 Ammonia will be less. ✓/Lower yield ✓ (1)

6.2.2 More ammonia is formed(High yield of ammonia) ✓ (1)

6.3.

	$N_2(g)$	$3H_2(g)$	$2NH_3(g)$
Initial mol	5	8	0
Moles reacted	1	3	2✓
Moles present after t sec	4	5✓	2
Concentration after t sec			

Mole ratio✓

$c = \frac{n}{v}$ = divide by 5

At t seconds:

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓

$= \frac{(0,4)^2}{(0,8)(1)^2}$ ✓ (positive mark)

$= 0,2$✓ (7)

OR

	$N_2(g)$	$3H_2(g)$	$2NH_3(g)$
Initial concentration	1	1,6	0
Change in concentration at time (t) seconds	0,2	0,8	0,4✓
Concentration after time (t) seconds			

$c = \frac{n}{V}$ = divide by 5 ✓

Mole ratio✓

At t seconds:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} \quad ✓$$

$$= \frac{(0,4)^2}{(0,8)(1)^2} \quad ✓$$

$$= 0,2✓$$

No K_c expression, correct substitution: Max 3/4

Wrong K_c expression: Max 4/4

No K_c expression: Max 3/4

6.4

6.4.1 INCREASE ✓ (1)

6.4.2 If the temperature is decreased, the forward✓ exothermic✓ reaction is favoured. More products are formed. ✓ (3)

[16]

QUESTION 7

7.1

7.1.1. A base that dissociates/ionises slightly/partially/incompletely when dissolved in water (solution). ✓✓ (2)

7.1.2 It is a proton acceptor. ✓✓ (2)

7.1.3 NH_4^+ ✓ (1)

7.1.4. $NH_4^+(aq) + H_2O(\ell) \rightleftharpoons NH_3(g) + H_3O^+(aq)$✓✓ (2)

7.2

7.2.1. H_3O^+ ✓ (1)

7.2.2. $pH = -\log[H_3O^+]$ ✓

$3,5 = -\log[H_3O^+]$

$[H_3O^+] = 10^{-3,5}$✓

$= 0,0003 \text{ mol.dm}^{-3}$ or $3 \times 10^{-4} \text{ mol.dm}^{-3}$✓ (3)

7.2.3 The reaction of an acid and a base to form salt and water. ✓✓ (2)

7.2.4 $n(HCl) : \frac{1}{2}\, n(Na_2CO_3)$✓

$n(HCl) = cV = 0,003(1)$ mol✓

$n(Na_2CO_3) = \frac{0,0003}{2} = 0,00015$ mol✓

$m(Na_2CO_3) = nM$✓

$= (0,00015)(106)$ ✓

$= 0,0159$ g✓

Marking guideline
- Mole ratio
- n(HCl)
- $n(Na_2CO_3)$
- m= nM
- $M(Na_2CO_3)$
- Answer with units.

(6)

OR

From the balanced equation:

2 moles of HCl= 1mole of Na_2CO_3✓

$n(HCl) = cV = 0,003(1)$ mol✓

$(Na_2CO_3) = \frac{0,0003}{2} = 0,00015$ mol ✓

$m(Na_2CO_3) = nM$✓

$= (0,00015)(106)$ ✓

$= 0,0159$ g✓

7.2.5. The water tasted salty due to the formation of NaCl. ✓✓ (2)

7.3

7.3.1. BASIC ✓ (1)

7.3.2 The carbonate ion (CO_3^{2-}) hydrolysis to produce hydroxyl ion(OH^-) in solution. (2)

[24]

QUESTION 8

8.1

8.1.1 *At* is more reducing than Cu ✓ therefore *At* (container) is oxidised✓ hence the container corrodes. ✓ (3)

8.1.2 $2At(s) + 3Cu^{2+}(aq)$ ✓ → $2At^{3+}(aq) + 3Cu(s)$ ✓ bal✓ (3)

8.1.3 It becomes colourless. ✓✓ (1)

8.2

8.2.1 Ag (silver) ✓ (1)

8.2.2 **OPTION 1**

$E^{\ominus}_{cell} = E^{\ominus}_{reduction} - E^{\ominus}_{oxidation}$ ✓

$0,93 = 0,80 - (-E^{\ominus}_{oxidation})$ ✓

$0,93 = 0,80 + E^{\ominus}_{oxidation}$ ✓

$E^{\ominus}_{oxidation} = -0,13$ V ✓

Therefore the electrode is Pb (Lead). ✓ (5)

OPTION 2

✓ $2Ag \rightarrow 2Ag^{+} + 2e^{-}$ $E^{\ominus} = 0,80$ (V) ✓

$M^{2+} + 2e^{-} \rightarrow M$ $E^{\ominus} = -0,13$ (V)

$E^{\ominus} = 0,93$ (V) ✓

Thus : $E^{\ominus}_{oxidation} = -0,13$ (V) ✓

M is Pb (Lead) ✓

Note
Give mark for Pb/lead ONLY if concluded from – 0,13 V.

8.3 Zero (0 V) (1)
[14]

QUESTION 9

9.1 Electrical energy is converted to chemical energy. ✓✓ (2)

9.2

9.2.1 $At^{3+}(l) + 3e^{-} \rightarrow At(l)$ ✓✓ (2)

9.2.2 To reduce melting point of aluminium (from 2000 °C to 1000 °C).✓✓(2)

9.3 Carbon in the electrodes reacts with O_2 gas produced, forming CO_2. ✓
Carbon is used up✓ causing electrodes to disintegrate.

$C + O_2 \rightarrow CO_2$ ✓✓ (4)

9.4 -Lots of electrical energy is used in this process✓
-The regular replacement of the anode increases the cost of the plant
-The plant takes up much land space. (1)
[11]

QUESTION 10

10.1

10.1.1 Contact process. ✓ (1)

10.1.2 Obtained from fractional distillation of liquid air. ✓ (1)

10.1.3 Pt or Platinum. ✓ (1)

10.2 Fertiliser 1 - Ammonium sulphate ✓
Fertiliser 2 - Ammonium nitrate✓ (2)

10.3 ~~Ammonium nitrate is very explosive~~ ✓✓ neutralisation. (2)

10.4 $2NO + O_2$ ✓ ⇌ $2NO_2$✓ bal ✓ (3)
[10]

TOTAL: 150