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CAPS

Physical Sciences

Chemistry exemplar examination memo

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Chemistry exemplar examination paper memorandum

SECTION A

Question 1

1.1 B **1.2** A

1.3 C **1.4** C

1.5 D **1.6** C

1.7 D **1.8** A

1.9 B **1.10** A [20]

SECTION B

Question 2

2.1.1 A, F (2)

2.1.2 A, D (2)

2.1.3 B, E (2)

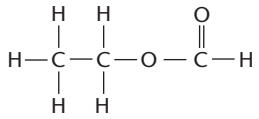
2.1.4 E (1)

2.1.5 C (1)

2.2.1 Pentan-2-ol (2)

2.2.2 Carboxylic acid (1)

2.3 (2)



[13]

Question 3

3.1.1 Liquid (1)

3.1.2 Lower than

Isomers of A will have more branching/molecules more compact/smaller surface area over which the intermolecular forces can act

Weaker intermolecular forces

Less energy needed to overcome intermolecular forces (4)

3.1.3 $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ (3)

3.1.4 Compound B contains a carbonyl group and is a polar molecule (dipole); stronger intermolecular forces exist between its molecules (2)

3.2 Compound D has two sites for hydrogen bonding, stronger forces, higher boiling point

Compound C has one site for hydrogen bonding, weaker forces, lower boiling point (2)

[12]

Question 4

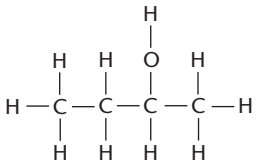
4.1.1 Elimination/dehydrohalogenation (1)

4.1.2 Heat; concentrated NaOH or KOH

OR heat; NaOH dissolved in ethanol

OR hot ethanolic NaOH (2)

4.1.3



(2)

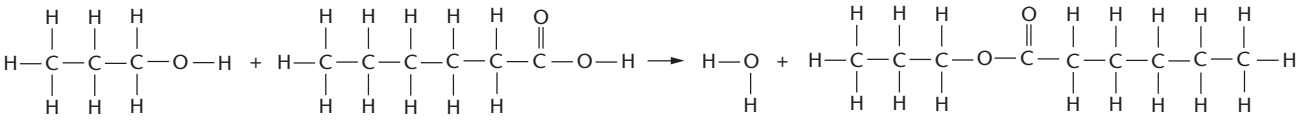
4.1.4 Water (1)

4.1.5 Addition/hydration (1)

4.2.1 Propan-1-ol (2)

4.2.2 Catalyst (1)

4.2.3



(5)

4.2.4 Alcohols are flammable. (1)

4.2.5 Food flavourant (1)

[17]

Question 5

5.1 28 kJ (1)

5.2.1 −36 kJ (1)

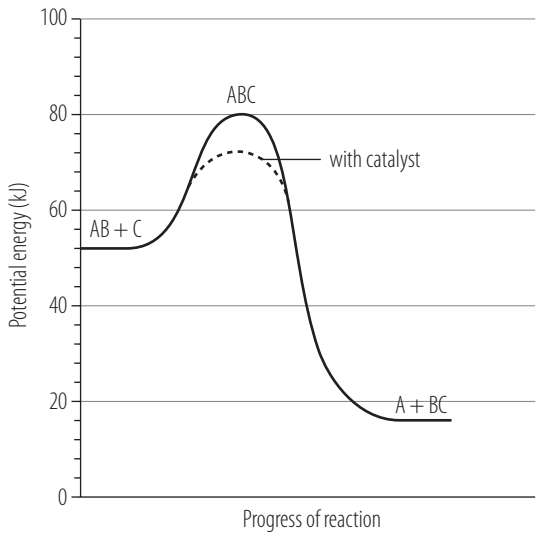
5.2.2 +36 kJ (1)

5.3 B–C (1)

5.4 Endothermic (1)

5.5 No effect (1)

5.6



(2)

5.7 No effect (1)

5.8 They bounce off each other unchanged. (1)

5.9 They are not correctly orientated. (1)

[11]

Question 6

6.1 Low temperature and high pressure (2)

6.2 It increases the rate of reaction so that dynamic equilibrium is reached more rapidly. (2)

6.3 It is expensive to engineer a plant to work safely at pressures significantly above atmospheric pressure. Maintaining a high pressure is also expensive due to energy costs. (2)

6.4 High reactant concentrations shift the equilibrium to the right, increasing the yield of sulfur trioxide. For economic reasons the concentration of the cheaper, more abundant reactant is kept high. (2)

6.5.1 V_2O_5 (1)

6.5.2 The hollow form increases the surface area so that the molecules of gas are more likely to collide with the surface of the catalyst. (1)

6.5.3 The catalyst does not affect the position of equilibrium, but the state of dynamic equilibrium is reached more rapidly. (1)

6.6.1 The forward reaction is exothermic. (1)

6.6.2 Higher temperatures favour the reverse reaction, which would decrease the yield of sulfur trioxide. (1)

6.6.3 To ensure that as much oxygen and sulfur dioxide react as possible. (1)

6.7 According to the balanced equation: 2 mol SO_2 produce 2 mol SO_3

80% conversion: 80% of 1,5 moles = 1,2 moles SO_3 produced

	$2SO_2$	O_2	$2SO_3$
n_i (mol)	1,5	0,9	0
n_i (mol)	1,2	0,6	1,2
n_f (mol)	0,3	0,3	1,2
c_{eq} (mol·dm^{-3}) $c = \frac{n}{V}$	$= \frac{(0,3 \text{ mol})}{(10 \text{ dm}^3)}$ $= 0,03$ mol·dm^{-3}	$= \frac{(0,3 \text{ mol})}{(10 \text{ dm}^3)}$ $= 0,03$ mol·dm^{-3}	$= \frac{(1,2 \text{ mol})}{(10 \text{ dm}^3)}$ $= 0,12$ mol·dm^{-3}

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = \frac{(0,12 \text{ mol·dm}^{-3})^2}{(0,03 \text{ mol·dm}^{-3})^2(0,03 \text{ mol·dm}^{-3})} = 533,33 \quad (6)$$

[20]

Question 7

7.1.1 $n = \frac{m}{M} = \frac{0,7 \text{ g}}{40 \text{ g·mol}^{-1}} = 0,0175$ mol (2)

7.1.2 $n = cV = (0,5 \text{ mol·dm}^{-3})(0,015 \text{ dm}^3) = 0,0075$ mol (2)

7.2 No, equivalent mole amounts were not present. NaOH is in excess. (2)

7.3 Amount of NaOH in excess = 0,0175 − 0,0075 = 0,01 mol

$[OH^-]$: $c = \frac{n}{V} = \frac{0,01 \text{ mol}}{(0,035 + 0,015 \text{ dm}^3)} = 0,2$ mol·dm^{-3}

$K_w = [H_3O^+][OH^-]$

$10^{-14} = [H_3O^+](0,2 \text{ mol·dm}^{-3})$

$5 \times 10^{-14} = [H_3O^+]$

$pH = -\log[H_3O^+] = -\log 5 \times 10^{-14} = 13,3$ (5)

[11]

Question 8

8.1 A strong acid ionises completely in water. (1)

8.2 $HClO_4(aq) + NaOH(aq) \rightarrow NaClO_4(aq) + H_2O(\ell)$ (2)

8.3 $n_a = cV = (0,06 \text{ mol·dm}^{-3})(0,02 \text{ dm}^3) = 1,2 \times 10^{-3}$ mol

$n_b = cV$

$(1,2 \times 10^{-3} \text{ mol}) = (0,04 \text{ mol·dm}^{-3})(V)$

$V = 0,03 \text{ dm}^3 = 30 \text{ cm}^3$ (4)

8.4 $HClO_4(aq)$ and $NaClO_4(aq)$ (2)

8.5 $NaClO_4(aq)$ (1)

8.6 Strong acid – strong base titration: therefore pH = 7 (1)

8.7 The base is corrosive. (1)

[12]

Question 9

9.1 Concentrations of electrolytes: 1 mol·dm^{-3}

Temperature: 25 °C (2)

9.2 $Ni(s) \mid Ni^{2+}(aq)(1\ mol{\cdot}dm^{-3}) \mid\mid Ag^{+}(aq)(1\ mol{\cdot}dm^{-3}) \mid Ag(s)$ (3)

9.3 Reduction: $Ag^{+} + e^{-} \rightarrow Ag(s)$

The concentration of the Ag^{+} ions decreases and consequently the potential difference across the two half-cells decreases. (2)

9.4 Nickel: $Ni \rightarrow Ni^{2+} + 2e^{-}$ (2)

9.5 $E^{\circ}_{cell} = E^{\circ}_{OA} - E^{\circ}_{RA} = E_{Ag/Ag^{+}} - E_{Ni/Ni^{2+}}$

$= 0{,}8\ V - (-0{,}25\ V) = +1{,}05\ V$ (3)

[12]

Question 10

10.1 Gold, silver and mercury are very weak reducing agents compared to iron and zinc. They will not react with ions and other compounds that can be found in foodstuffs. (2)

10.2 Aluminium is a strong reducing agent. A 'voltaic cell' is formed and a potential difference is created between the amalgam metal and aluminium. A small electric current flows through the tooth, which is registered as pain. (3)

[5]

Question 11

11.1 Fractional distillation of liquid air (2)

11.2.1 N_2 (1)

11.2.2 H_2 (1)

11.2.3 HNO_3 (1)

11.3.1 Catalytic oxidation of ammonia (1)

11.3.2 $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ (3)

11.3.3 NO_2 (1)

11.4.1 Ammonium nitrate (1)

11.4.2 It has a high percentage of nitrogen/N/ is a primary nutrient and has high solubility. (2)

11.5.1 Fertilisers must replenish nutrients used up/depleted each year by growing crops. (2)

11.5.2 Damage to crops/soil resulting in small or no harvest/less income

Excessive fertiliser seeps into groundwater and contaminates drinking water

Excessive fertiliser runs off into rivers and dams and causes eutrophication that may result in less income/starvation/poor quality of drinking water/ fewer recreation areas (2)

[17]

TOTAL:150