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QUESTION 1

- 1.1 B
- 1.2 C
- 1.3 B
- 1.4 D
- 1.5 C
- 1.6 C
- 1.7 A
- 1.8 B
- 1.9 D
- 1.10 D

(10 x 2 = 20)

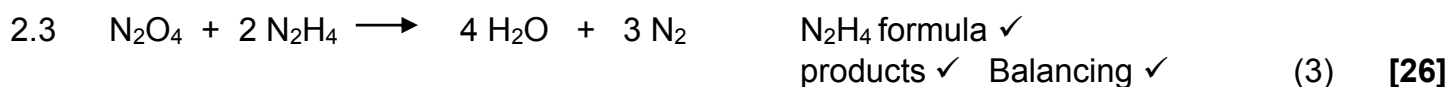
QUESTION 2

- 2.1.1 A **covalent bond** is a sharing of at least one pair of electrons ✓ by two atoms. ✓ (2)
- 2.1.2 **Non-polar covalent** (pure covalent) is an equal sharing of electrons ✓ (1)
- 2.1.3 N₂ ✓ (1)
- 2.1.4) a) dipole-dipole forces ✓ (1)
b) hydrogen bonds ✓ (1)
- 2.1.5
 - Carbon dioxide has a higher boiling point. ✓
 - Carbon dioxide is a larger molecule resulting in more electrons. ✓ (5)
 - This leads to larger temporary dipoles ✓ forming.
 - ∴ CO₂ has stronger London forces. ✓
 - Carbon dioxide requires more energy ✓ to overcome these stronger forces.
- 2.2.1 A **catalyst** is a substance that increases the rate of the reaction ✓ but remains unchanged at the end of the reaction ✓. (2)
- 2.2.2 A lot of energy ✓ is needed to break the many ✓ strong ✓ ionic bonds ✓ between the **ions**. (4)
- 2.2.3 MoS₂: $n = \frac{m}{M} = \frac{4}{160} \checkmark = 0,025 \text{ mols} \checkmark$

O₂: $n = \frac{V}{V_m} = \frac{2,24}{22,4} \checkmark = 0,1 \text{ mol} \checkmark$

MoS ₂ : O ₂ 2 : 7 0,025 : 0,0875 ✓ ∴ MoS ₂ is limiting reagent ✓	OR	MoS ₂ : O ₂ 2 : 7 ✓ 0,029 : 0,1
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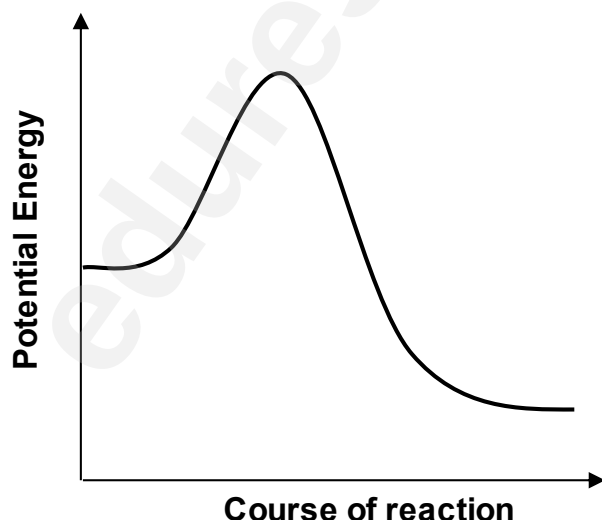
(6)



QUESTION 3

- 3.1 **Reaction rate** is the *CHANGE in concentration PER UNIT TIME* ✓ of either a reactant or product. ✓ (2)
- 3.2 Use a gas syringe ✓ and measure the volume of gas produced ✓ in a set time interval. ✓ (3)
- 3.3.1 Concentration of acid ✓ (1)
- 3.3.2 Temperature of solution ✓ and volume of acid ✓ (same mass and particle size of zinc pellets). (2)
- 3.3.3 Experiment 2 ✓ (1)
- 3.3.4 An increase in the concentration of the acid leads to:
- **More particles per unit volume** ✓
 - ∴ more collisions per unit time. ✓
 - Hence, a greater number of **EFFECTIVE** collisions per unit time ✓ (3)
- (An effective collision is one where the molecules are correctly orientated and have kinetic energy greater than or equal to the activation energy.)
- 3.4.1 Equal to ✓ (1)
- 3.4.2 Less than ✓ (1)
- 3.5.1 Experiment 1 ✓ (1)
- 3.5.2 $\frac{1}{2} \times$ ✓ (2)
- 3.6 **Exothermic reactions** are *reactions which transform chemical potential energy* ✓ *into thermal energy.* ✓ (2)

3.7



✓ y – axis label

✓ x – axis label

✓ shape

(3)

[22]

QUESTION 4

4.1 **A closed system** (in chemistry) is *one in which mass is conserved inside the system ✓ but energy can enter or leave the system freely. ✓* (2)

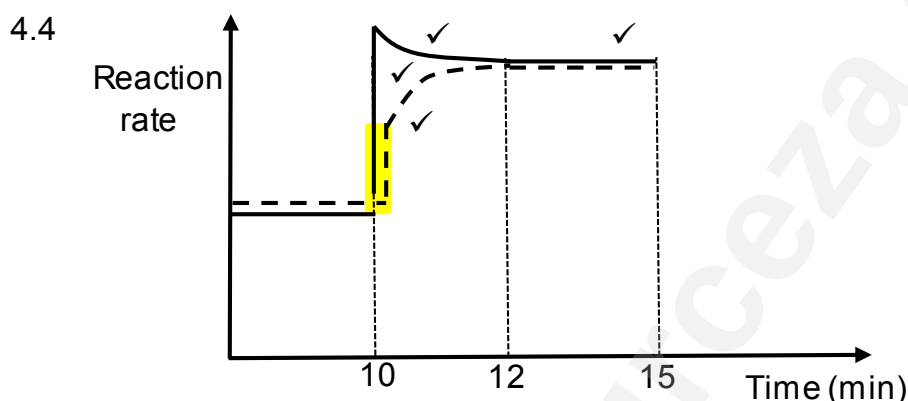
4.2.1 Increase } (2)
4.2.2 Decrease } (2)

4.3 Stress: Increase in pressure

Response: Favour **reverse** reaction ✓

Reason: Increase in pressure favours the production of less mols of gas ✓ to decrease the pressure in the system. ✓ and hence relieve the stress.

Answer: The yield of ethyne gas would **decrease**. ✓ (4)



4.5 No effect ✓ (1)

4.6.1 $N_o = n \times N_A$ ✓ = $1,6 \times (6,02 \times 10^{23})$ ✓ = **$9,63 \times 10^{23}$** molecules ✓ (3)

4.6.2 $K_c = \frac{[C_2H_2][H_2]^3}{[CH_4]^2}$ ✓ (2)

4.6.3 **Mol Table**

	CH ₄	C ₂ H ₂	H ₂
Ratio	2	1	3
Initial mol	1,6	0	0
Change mol	0,6	0,3	0,9
Eqm mol	1,0	0,3	0,45 x 2 = 0,9
Eqm Conc	0,5	0,15	0,45

Marks

÷ or x vol ✓

Apply ratio to change ✓

Eqm ✓

Subst [eqm] into K_c ✓

Ans ✓

OR Concentration table

	CH ₄	C ₂ H ₂	H ₂
Ratio	2	1	3
Initial	$1,6/2 = 0,8$ ✓	0	0
Change	-0,3	+0,15	+0,45
Eqm	0,5 ✓	0,15	0,45

$$K_c = \frac{[0,15][0,45]^3}{[0,5]^2}$$

$$= \mathbf{0,055} \quad \checkmark$$

(5)

4.6.4 $m = c \times M \times V$ ✓✓ = $0,15 \times 26 \checkmark \times 2 \checkmark \text{sub} = \mathbf{7,8 \text{ g}}$ ✓ (4)

4.6.5 Low ✓ c.o.e. from 4.6.3 (1)

4.6.6 Remain the same ✓ (1) [30]

QUESTION 5

5.1.1 Acid is a proton donor ✓ (1)

5.1.2 An acid that donates 2 H⁺ ions. ✓ (1)

5.1.3 H(COO)₂¹⁻ ✓ and H₃O⁺ ✓ (2)

5.1.4 Hydrochloric acid is a strong acid ✓ which results in it ionising completely in solution ✓. This causes it to have a higher concentration of ions ✓ which means it will be a better electrical conductor. ✓ (4)

5.1.5 Should oxalic acid be very concentrated ✓ it may have a higher concentration of H₃O⁺ ions ✓ than a dilute solution of hydrochloric acid. ✓ This would result in it having a lower pH than HCl. ✓ (4)

5.1.6 a) Increase ✓ (1)

b) Stress: Increase [(COO)₂²⁻]

Response: **Reverse** reaction favoured ✓

Reason: Reverse reaction will use up excess [(COO)₂²⁻] ions to relieve the stress ✓ therefore decreasing the [H₃O⁺] ions ✓ which results in an increase in pH. (3)

5.2.1 $n = cV$
 $= 0,2 \times 0,0276$ ✓ conv
 $= 5,52 \times 10^{-3}$ mols ✓

NaOH : H₂SO₄
 2 : 1

0,01104 : 5,52 x 10⁻³ ✓ Applying ratio

$V = \frac{n}{c} = \frac{0,01104}{0,32}$ ✓
 $= \underline{0,0345 \text{ dm}^3}$ ✓ (5)

5.2.2 NH₄⁺ + H₂O ⇌ H₃O⁺ + NH₃ ✓ reactants ✓ products ✓ double arrow (3)

5.2.3 Methyl orange ✓ (1)

[25]

QUESTION 6

6.1.1 chemical energy ✓ to electrical energy ✓ (2)

6.1.2 positive ✓ (1)

6.1.3 $E^0_{\text{cell}} = E^0_{\text{cathode}} - E^0_{\text{anode}}$ ✓
 $0,63 = - 0,13 - X$ ✓
X = -0,76 V ✓ therefore anode is Zinc / Zn ✓ (4)

6.1.4 a) **An electrolyte** is a substance that can conduct electricity ✓ by forming free ions when molten or dissolved in solution ✓ (2)

b) $\text{Pb}(\text{NO}_3)_2$ $\text{Pb}^\vee (\text{NO}_3)_2$ ✓ (2)

c) High concentration of ions ✓ is required to make the electrolyte more conductive. ✓ (2)

6.1.5 a) Decrease ✓ (1)

b) Na^+ ✓ (1)

c) NO_3^- ✓ (1)

6.2.1 Electrolytes have a concentration of 1 mol.dm^{-3} ✓
 (Electrolytes have a) temperature of 25°C ✓
 Pressure of F_2 gas must be at 1 atm ($1,01 \times 10^5 \text{ Pa}$) ✓ (3)

6.2.2 Pt ✓ (1)

6.2.3 $\text{Pb(s)} \mid \text{Pb}^{2+}(\text{aq}) \parallel \text{F}_2(\text{g}) \mid \text{F}^-(\text{aq}) \mid \text{Pt(s)}$ ✓ anode ✓ cathode
 ✓ salt bridge ✓ Pt on outside (4)

[24]

QUESTION 7

7.1 The **cathode** is the **ELECTRODE** ✓ where reduction takes place. ✓ (2)

7.2 $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}$ ✓✓ (2)

7.3 The electrolyte would be lighter in colour ✓✓ (2)

7.4

- $[\text{Cr}^{3+}]$ decreases ✓
- Chromium anode oxidises ✓ ($\text{Cr} \rightarrow \text{Cr}^{3+} + 3\text{e}^-$)
- $\therefore$ replenishing / replacing lost Cr^{3+} ions ✓ (maintaining constant $[\text{Cr}^{3+}]$) (3)

7.5 $\text{e}^- : \text{Cr}$
 $3 : 1$
 $\checkmark 0,09 : 0,03$

$$\begin{aligned} q &= nF \\ &= 0,09 \times 96\,500 \checkmark \quad \text{Both formulae} \checkmark \\ &= 8685 \text{ C} \end{aligned}$$

$$\begin{aligned} q &= It \\ t &= \frac{q}{I} = \frac{8685}{0,6} \checkmark \\ &= 14\,475 \text{ s } \checkmark \\ &= \frac{14\,475}{3600} \\ &= \underline{\underline{4,02 \text{ hours}}} \checkmark \end{aligned}$$

(6)

[15]

QUESTION 8

8.1 3-chloro-2,4-dimethylpentane 3-chloro✓ -2,4-dimethyl✓ pent✓ ane✓ (4)

8.2 An **unsaturated compound** is a compound in which there is at least one double and/or triple bond✓ between carbon atoms.✓ (2)

8.3.1

$ \begin{array}{cccc} & \text{H} & & \text{H} \\ & & & \\ \text{H} & \text{O} & \text{O} & \text{H} \\ & & & \\ \text{H} - \text{C} - & \text{C} - & \text{C} - & \text{C} - \text{H} \\ & & & \\ \text{H} & \text{Br} & \text{H} & \text{H} \end{array} $	4 C✓ Br position✓ OH position✓ 7 H✓	(4)
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8.3.2 Saturated✓ (1)

8.4.1 Elimination✓ (1)

8.4.2 $\text{CH}_3\text{CHFCH}_2\text{CH}_3 \rightarrow \text{CH}_3\text{CHCHCH}_3 + \text{HF}$ ✓
 OR $\text{CH}_2\text{CHCH}_2\text{CH}_3$
 ✓reactants

OR $\text{CH}_3\text{CHFCH}_2\text{CH}_3 + \text{NaOH} \rightarrow \text{CH}_3\text{CHCHCH}_3 + \text{NaF} + \text{H}_2\text{O}$ (3)
 OR $\text{CH}_2\text{CHCH}_2\text{CH}_3$

8.4.3 React the product with Br_2 /bromine solution✓ and it would rapidly✓ decolourise✓ the solution from red/brown to colourless. (3)

[18]

QUESTION 9

9.1 Concentrated sulfuric acid ✓ (1)

9.2 Use (blue) litmus paper (or other indicator). ✓ Whichever solution changes the colour of the litmus (to pink) is the acid. ✓ (2)

9.3 **Homologous series** is a series of similar compounds which have the same functional group and have the same general formula, ✓ in which each member differs from the previous one by a single CH_2 unit. ✓ (2)

9.4 Carboxylic acid ✓ (1)

9.5 Hydroxyl ✓ (1)

9.6

$$\begin{array}{ccccccc}
 & \text{H} & \text{H} & & & & \\
 & | & | & & & & \\
 \text{H} & - \text{C} & - \text{C} & - \text{C} & & & \\
 & | & | & // & & & \\
 & \text{H} & \text{H} & \text{O} & & & \\
 & & & \backslash & & & \\
 & & & \text{O} & - & \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{H} \\
 & & & & & | & | & | & | & \\
 & & & & & \text{H} & \text{H} & \text{H} & \text{H} &
 \end{array}$$

✓Link ✓ rest correct (2)

9.7

propyl butanoate	}	ANY 1 ✓✓
ethyl pentanoate		
pentyl ethanoate		
methyl hexanoate		
hexyl methanoate		

(2)

9.8 $\text{C}_4\text{H}_{10}\text{O} + 6 \text{O}_2 \longrightarrow 4 \text{CO}_2 + 5 \text{H}_2\text{O}$ (3)

9.9 Butan-1-ol and propanoic acid both have H-bonds between their molecules.
 Butan-1-ol forms 1 H-bond per molecule
 Propanoic acid forms 2 H-bonds per molecule) forming a dimer
 The dimer is a bigger molecule with more electrons $\therefore$ forms larger temporary dipoles than butan-1-ol
 $\therefore$ propanoic acid has stronger London forces than butan-1-ol
 The intermolecular forces (IMFs) (H-bonds and London forces) are stronger between propanoic acid molecules.
 More energy is needed to overcome the stronger IMFs between propanoic acid molecules hence the higher boiling point. (5)

[19]

Total: 200 marks