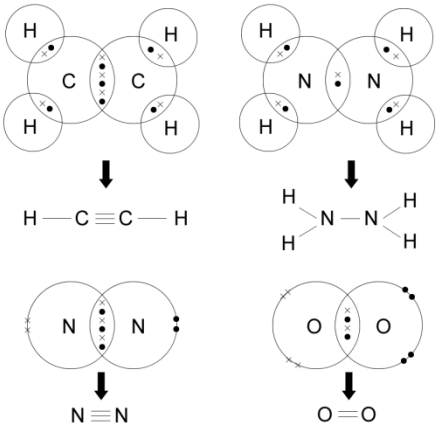
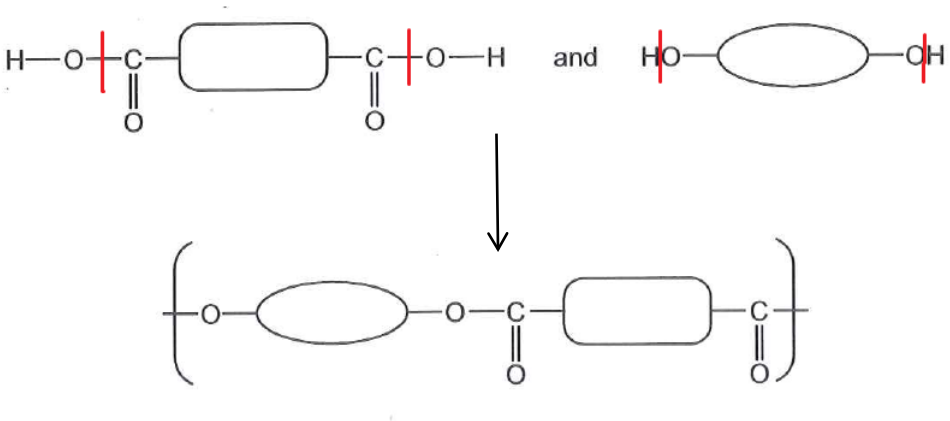
#	Ans	Workings / Remarks
1	B	Atomic mass and temperature affects the rate of diffusion of gas. The lower the atomic mass, the lighter the substance. The higher the temperature, the higher the rate of collision frequency. Therefore, rate of diffusion will be faster.
2	D	Water and oil are immiscible liquids. Thus, a separating funnel can be used.
3	C	Blue litmus paper is to test for the acidity of a substance. Option A: carbon dioxide is acidic. It will turn blue litmus paper red. Option B: chlorine will bleach blue litmus paper. Option C: ammonia is basic. It cannot turn blue litmus paper red. Option D: hydrogen chloride is acidic. It will turn blue litmus paper red.
4	D	In the first reaction, nitrogen monoxide has lost oxygen (reduction) and octane has lost hydrogen (oxidation). Thus it is a redox reaction. In the second reaction, carbon monoxide has gained oxygen (oxidation) and nitrogen monoxide has lost oxygen (reduction). Thus it is also a redox reaction.
5	D	K has 19 electrons while K^+ has 18 electrons. Thus K has more electrons than K^+.
6	A	$AsBr_3$ is a covalent compound with weak intermolecular forces of attraction, thus its melting point is low and it does not conduct electricity due to the absence of free mobile electrons.
7	C	1) Iron exists in compound X as Fe^{3+} ion. 2) Molecular mass of Fe_2 and O_3 are $2 \times 56 = 112$ g and $3 \times 16 = 48$ g respectively. 3) The simplest formula is Fe_2O_3. 4) 3 moles of oxygen **atoms** are needed to make one mole of X. $\therefore$ Statements 2 and 3 are true.
8	D	Boiling point is related to attractive force between molecules. The weaker the attractive force between molecules, the lower the boiling point and the farther the distance between molecules.
9	A	Ethyne has a C ≡ C triple bond. Nitrogen has a triple bond, and oxygen has a double bond. 
10	A	While both options A and D are feasible to prepare sodium nitrate salt, sodium metal is a reactive metal and thus it is not safe to prepare using Sodium metal and acid. As such, titration is recommended in which an aqueous acid (nitric acid) and a base (sodium hydroxide) can be used to prepare sodium nitrate.

11	A	Option A: $2Al^{3+} + 3O^{2-} \rightarrow Al_2O_3$ (Each Al transfers 3 electrons) Option B: $Fe^{2+} + O^{2-} \rightarrow FeO$ (Fe transfers 2 electrons) Option C: $Mg^{2+} + O^{2-} \rightarrow MgO$ (Mg transfers 2 electrons) Option D: $2Na^{+} + O^{2-} \rightarrow Na_2O$ (2Na transfers 2 electrons)
12	B	Since 2 moles of X gives 1 mole of oxygen and 2 moles of chlorine, the balance equation above shows that the molecular formula of X is **Cl_2O.** 2 **Cl_2O** → $O_2 + 2Cl_2$ Thus, the total number of reactants must be equal to the total number of products.
13	A	Cathode attracts cations. For options B, C and D, the cation that preferentially discharged is H. For option A, however, since Cu is lower than H in the electrochemical series, copper ions will be preferentially discharged (as a pink copper precipitate) which contributes to the increase of mass of the cathode.
14	A	Number of moles of hydrogen → 2 g ÷ 2 = 1 mol Volume of hydrogen → 1 mol × 24 dm^3 = 24 dm^3 Number of moles of methane → 16 g ÷ 16 = 1 mol Volume of methane → 1 mol × 24 dm^3 = 24 dm^3 Ratio of volume of hydrogen : methane → 24 : 24 = 1:1
15	D	There is a trend shown in the ΔH that it has a constant increase or 630 kJ/mol. Thus a release of 3900 kJ will correspond to Hexanol. Using the general formula of $C_nH_{2n+1}OH$ will give 6 carbon (C) atoms and 2 × 6 + 1 + 1 = 14 hydrogen (C) atoms.

No. of C atoms			No. of H atoms	ΔH kJ / mol
C_1	methanol	CH_3OH	4H	–750
C_2	ethanol	C_2H_5OH	6H	–1380 = –750 – 630
C_3	propanol	C_3H_7OH	8H	–2010 = –1380 – 630
C_4	butanol	C_4H_9OH	10H	–2640 = –2010 – 630
C_5	pentanol	$C_5H_{11}OH$	12H	–3270 = –2640 – 630
C_6	hexanol	$C_6H_{13}OH$	14H	–3900 = –3270 – 630

16	D	N has valency of 3, O has valency of 2, Hydrogen has valency of 1 and Mg has valency of 2. (knowledge of valency is important for this question) Thus to combine H and N, 3 Hydrogen atoms needed to balance 1 Nitrogen atoms to ensure that the valency is balanced $NZ_3 \rightarrow NH_3$ Using the similar method for the rest of the compounds, $NQ_2 \rightarrow NO_2$ $Y_3N_2 \rightarrow Mg_3N_2$ $X_3N \rightarrow Na_3N$
17	C	$MCl_2 \rightarrow M^{2+} + Cl^-$ Options A and B are eliminated since the charge of M is 2+. Hence M^{2+} will be discharged as M.

		At **high concentrations**, Cl^- will be discharged instead of OH^- to form Cl_2.
18	B	When forming a hydrogen molecule, the bonds formed between the hydrogen atoms causes energy to be released ⇒ exothermic reaction.
19	D	$CH_3COOH \rightarrow H^+ + CH_3COO^-$ ⇒ 2 ions released from ethanoic acid Ethanol doesn't dissociate in water ⇒ no ions released $NaOH \rightarrow Na^+ + Cl^-$ ⇒ 2 ions released from sodium hydroxide. $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$ ⇒ 3 ions released from sulfuric acid.
20	A	Barium chloride will react with sulphuric acid to form a white precipitate of barium sulphate. On the other hand, no visible reaction is seen in a reaction between barium chloride and nitric acid, since barium chloride is colourless. Therefore, barium chloride can be used to distinguish between nitric acid and sulphuric acid.
21	D	In process 1, electricity is due to the movement of electrons not ions. Process 2 involves the transfer of copper ions. In process 3, hydrogen ions are discharged as hydrogen gas. Therefore movement of ions are involved in only processes 2 and 3.
22	A	Catalysts speed up reactions by lowering the activation energy of a reaction.
23	C	Hydrochloric acid mixed with lead(II) nitrate form lead(II) chloride, which is an insoluble white salt.
24	B	It should be **one nitrogen molecule reacting with three hydrogen molecules** to form 2 molecules of ammonia i.e. $3H_2 + N_2 \rightarrow 2NH_3$
25	A	Excess chlorine gas will bleach blue litmus paper. It displaces iodine in potassium iodide to form potassium chloride and iodine which turns colourless potassium iodide brown.
26	C	Chlorine, being a non-metal, and sodium, being a metal, will form an ionic compound instead of a mixture of alloy.
27	B	Metal X is likely to be magnesium (the preferred sacrificial metal for underwater pipes / reacts vigorously & rapidly with dilute hydrochloric acid) Metal Y is likely to be silver (used for jewellery) Metal Z is likely to be calcium (reacts rapidly with water). As Metal Z (Calcium) and Metal X (Magnesium) are more reactive than carbon, they can only be extracted by electrolysis. Metal Y (Silver) is less reactive than carbon so it can be extracted by reduction of carbon.
28	C	Effects of various pollutants: 1. CFCs cause the depletion of the ozone layer. 2. Methane is a greenhouse gas, which contributes to global warming. 3. Nitrogen dioxide contributes to acid rain by converting to nitric acid in the in presence of oxygen and water vapour.
29	A	$Ca(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$ ⇒ Hydrogen gas is liberated. Note: Copper, being lower than hydrogen in the reactivity series, does not react with an acid to liberate hydrogen.

30	D	Sand contains silicon dioxide, which is an impurity not an essential raw material.
31	D	Only transitional metals will form coloured compounds. Group I-II metals, in general, are clear when dissolved and white when precipitated e.g. sodium chloride. Note that mercury possesses all the common properties of metal, including being ductile and malleable, when it is in solid form.
32	D	Since copper is less reactive than zinc, no displacement reaction will occur.
33	B	In a **complete** combustion, carbon compound burns to form steam and carbon dioxide while nitrogen burns in air to form nitrogen dioxide. For example, a complete set of equations for combustion of methane in air is as follow: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ $N_2 + O_2 \rightarrow 2NO$ $N_2 + 2O_2 \rightarrow 2NO_2$ Only when there is **incomplete** combustion (due to insufficient supply of oxygen) will some carbon be converted to carbon monoxide e.g. $2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$
34	D	The dicarboxylic acid will release OH while the diol compound will release H to form a water molecule i.e. eliminate –OH from acid group and –H from alcohol group (see below).  These compounds will form ester linkage. Please take note of the matching shape.
35	B	Propanol will be oxidized to propanoic acid (hint: eliminate options A & C by counting the total number of carbon atoms): Propanol + Oxygen → propanoic acid + water $CH_3CH_2CH_2OH + O_2 \rightarrow CH_3CH_2COOH + H_2O$

36	C	Meth represents 1 carbon, Eth represents 2 carbons, Prop represents 3 carbons and Buts represent 4 carbons. Thus, perform a simple arithmetic addition of the total number of carbon (C) atoms: Option A: 4C + 3C = 7C Option B: 2C + 2C = 4C Option C: 2C + 3C = 5C (Eth (2C) +Prop (3C) = 5 carbons) Option D: 3C + C = 4C
37	B	Propane, being the smaller molecule with a shorter carbon-chain compared to pentane, will have weaker intermolecular forces of attraction. As such, less energy is required to break its attractive force and thus it has a lower boiling point.
38	B	Polyunsaturated compounds will consist of at least 1 C=C double bond. Hence, as vegetable oil contains C=C double bonds, it will undergo an additive reaction with **hydrogen** in the presence of a nickel catalyst to form a saturated solid compound, margarine.
39	C	The monomer of the polymer is propene. Alkene compounds can react with bromine, water and hydrogen but cannot react with metals.
40	B	From the equation $HCl + AgNO_3 \rightarrow AgCl + HNO_3$, the number of mole of limiting reactant will determine the mass of AgCl. From the table below, option B produces the greatest number of mole (0.015 moles) of AgCl.

Option	**Number of moles of HCl**	**Number of moles of $AgNO_3$**	**Limiting reactant**	**Number of moles of AgCl produced.**
A	0.01	0.01	Any	0.01
B	0.015	0.02	HCl	0.015
C	0.005	0.01	HCl	0.005
D	0.0125	0.02	HCl	0.0125