This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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A1 (a) argon (1)  
(b) chlorine / sulfur dioxide (1)  
(d) ammonia (1)  
(c) ethene (1)  
(e) nitrogen(II) oxide (1)  
(f) oxygen (1)  

[Total: 6]

A2 (a) three pairs of bonding electrons between H and N (1)  
two non-bonding electrons on N (1)  
(b) propyl ethanoate (1)  

(c)  

\[
\begin{array}{|c|c|c|}
\hline
 & C & H & O \\
\hline
\text{mole ratio} & 76.60 / 12 & 6.38 / 1 & 17.02 / 16 \\
\text{simplified ratio} & 6.38 / 1.064 & 6.38 / 1.064 & 1.064 / 1 \\
\hline
\end{array}
\]

mole ratio line (1)  
simplified ratio or empirical formula (1)
(d) (i) sulfur dioxide \( \text{SO}_2 \) (1)
(sulfur dioxide) dissolves and is oxidised/reacts with (rain)water and oxygen (1)

(ii) any suitable example e.g. reacts with mortar/reacts with limestone/erodes buildings (made of carbonate rocks)/corrodes metalwork etc. (1)

(iii) \( \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} \) (2)
correct reactants and formulae (1)
correctly balanced equation (1)

[Total: 11]

A3 (a) (i) chlorofluorocarbons/CFCs (1)

(ii) ozone absorbs uv (radiation) (1)

too much uv increases incidence of skin cancer/cataracts etc. (1)

(b) (i) reaction catalysed by light/light involved in breakdown of chemicals (1)

(ii) \( 2\text{O}_3 \rightarrow 3\text{O}_2 \) (1)

(c) \( 2\text{Fe}^{2+} + 2\text{H}^+ + \text{O}_3 \rightarrow 2\text{Fe}^{3+} + \text{H}_2\text{O} + \text{O}_2 \) (1)

[Total: 6]

A4 (a) positive ions in regular layers with a minimum of two layers of ions (1)

electrons shown interspersed between the particles shown (1)

Marks can be awarded from correct description in writing or from labelled diagram.

(b) idea of layers of metal atoms/or ions (1)

can slide over each other (when force applied) (1)
(c) (i) correct $M_r$ of 128 or $(2 \times 64)$ as numerator of fraction
   OR
   correct $M_r (2 \times 64) + 12 + (16 \times 5) + (2 \times 1)$ or 222 as denominator (1)
   percentage $= \frac{57.65}{57.7}$ (1)

   (ii) add acid (1)
   gas evolved turns limewater milky (1)

(d) A is oxidation because electrons are lost (1)

   B is reduction because electrons are gained (1)

[Total: 10]

A5 (a) (i) ANY FOUR FROM:

   ammonia molecules/HBr molecules have enough energy to escape from the
   HBr(aq) or NH$_3$(aq) (1)
   diffusion (1)
   molecules move randomly/molecules spread out/molecules get mixed up
   (1)
   move from high to low concentration/move with the concentration gradient
   (1)
   solid formed where NH$_3$ and HBr react (1)
   HBr has higher $M_r$ than NH$_3$/molecules of HBr are heavier than molecules of
   NH$_3$ (1)
   NH$_3$ molecules move faster than HBr molecules/NH$_3$ diffuses faster (1)

   (b) higher pressure pushes molecules closer together

   [Total: 5]

A6 (a) mol of NaOH = 0.30 (1)

   energy released $= (0.30 \times 57.1) = 17/17.1(3)$ (kJ) (1)

   (b) mol of HCl = 2.19/36.5 OR = 0.06 (1)
   volume $= (0.06/0.2) = 0.3$ dm$^3/300$ cm$^3$ (1)

   (c) add nitric acid and silver nitrate (1)
   white precipitate/white solid formed (1)
(d) amphoteric (1) [1]

[Total: 7]

B7 (a) weak forces between layers / (weak) van der Waals' forces between layers (1) [2]
layers slide over each other (easily) (1)

(b) 5 protons and 6 neutrons (1) [1]

(c) giant structure / lattice (1) [2]
(all) bonds are strong / lot of energy needed to break the bonds / needs high temperature to break the bonds (1)

(d) (i) has delocalised electrons / free electrons / electrons can move (1) [1]
(ii) inert / does not react (with the electrolyte) (1) [1]

(e) (i) $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^-$ (1) [1]
(ii) $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ (1) [1]
(iii) the mole ratio of H to O in water is 2:1 / for every 2 moles of hydrogen produced only 1 mole of oxygen is liberated (1) [1]

[Total: 10]

B8 (a) (i) mol Mg (= 0.030 / 24) = $1.25 \times 10^{-3}$ (1) [3]
mol HCl (= 0.10 $\times$ 20 / 1000) = $2 \times 10^{-3}$ (1)
mol HCl required to react with $1.25 \times 10^{-3}$ mol Mg is $2.5 \times 10^{-3}$ so Mg in excess (1)

(ii) bubbles / effervescence / fizzing / tube gets hot / magnesium reduces on size (1) [1]

(b) mol of gas (= 24 / 24 000) = $1.0 \times 10^{-3}$ (1) [2]
mass of hydrogen (= 2 $\times$ 1.0 $\times$ 10$^{-3}$) = $2.0 \times 10^{-3}$ (g)

(c) greater surface area (1) [2]
more frequent collisions (of H$^+$ ions with Mg) (1)

(d) (i) $3\text{Mg(s)} + \text{N}_2(g) \rightarrow \text{Mg}_3\text{N}_2(s)$ (1) [1]
(ii) 3 – / – 3 (1)

B9 (a) arrangement: regularly arranged / in a set pattern / ordered / not random / fixed position (1)

motion: vibrating / do not move (from place to place) (1)

(b) (i) condensation (polymer) (1)

(ii) correct structure with minimum of two units (2)

e.g.

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{□} & \quad \text{□} \\
\text{O} & \quad \text{□} \quad \text{C} \quad \text{O} \quad \text{□} \quad \text{C} \quad \text{□}
\end{align*}
\]

(as minimum required)

(c) (i) moles methanal (= 1800 / 30) = 60 mol (1)

mass of glycolic acid (= 60 × 76) = 4560 (g) (1)

for 45% yield (= 4560 × 45 / 100) = 2052 (g) (1)

(ii) strong acid is fully ionised / fully dissociated in solution (1)

weak acid is partially ionised / incompletely dissociated in solution (1)

B10 (a) position of equilibrium moves to right / more products formed (1)

goes in direction of decreasing number of moles / goes in direction of smaller volume / fewer moles of products than reactants (1)

(b) position of equilibrium goes to the right / more products formed (1)

reaction is exothermic / backward reaction is endothermic / reaction goes to the exothermic direction (1)

(c) particles move slower / particles have less energy (1)

fewer particles have activation energy / fewer successful collisions / fewer fruitful collisions (1)

(d) (i) speeds up reaction (1)

by lowering the activation energy / providing an alternative reaction pathway (1)
(ii) **ANY TWO FROM:**

- form coloured compounds (1)
- have variable oxidation states/form ions with different charges (1)
- form complex ions (1)

[Total: 10]