This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published Report on the Examination.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates’ scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the Report on the Examination.

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Section A

Maximum 45 marks

A1 four names at (1) each: penalise correct formulae once only

(a) nitrogen dioxide

(b) silicon dioxide

(c) aluminium oxide

(d) lead(II) iodide [Total: 4]

A2 (a) iron has positive ions and delocalised electrons (1)
the electrons are free to move (1)
moving electrons is an electric current (1) [3]

(b) high carbon steels are strong or are brittle (allow harder) (1)
low carbon steels are soft or are more easily shaped
(allow more malleable) (1) [2]

(c) (i) conditions are air (oxygen) and water or moist air (1)
(ii) magnesium is above iron in the reactivity series
(or is more reactive) (1)
hence it corrodes before the iron (1) [3]

(d) any two from:
coloured compounds/variable oxidation states/can act as
 catalysts/valency/form complex ions [2]

(e) calculation
for idea of dividing by correct Ar (1)
dividing by the smallest (1)
for final formula only if first 2 fully correct (1)

\[
\begin{array}{cccccc}
\text{K} & 0.547/39 & \text{Fe} & 0.195/56 & \text{C} & 0.252/12 \\
0.0140 & 1 & 0.00348 & 0.0210 & 6 & 0.0210 & 6 \\
\end{array}
\]

i.e. \( \text{K}_4\text{FeC}_6\text{N}_6 \) or \( \text{K}_4\text{Fe(CN)}_6 \) [3]

[Total: 13]
A3 (a) Group 0 or the noble gas group or Group 8 [1]

(b) Any two sensible suggestions at (1) each e.g. Mendeleev's table has:
- Groups and periods reversed (only allow once)
- no A_r
- no transition metals
- periods 4 and/or 5 and all or a specific group has two elements
- group numbers Arabic rather than Roman [2]

(c) Any two observations at (1) each
- fizzes/runs on the surface/flame/dissolves/explodes/melts
- equation (1)
  \[ 2 \text{Rb} + 2 \text{H}_2\text{O} \rightarrow 2 \text{RbOH} + \text{H}_2 \] [3]

[Total: 6]

A4 (a) boiling point [1]

(b) (i) making chemicals or feedstock or make petrol not make plastics (1) [2]

(ii) for road surfaces (1)

(c) (i) saturated is single bonds or no double/triple bonds or maximum number of hydrogen atoms (1)

(ii) correct methane structure (all dots = 1) (2)

(d) Any two ideas at (1) each:
- enables supply to match demand (allow more useful)
- make more petrol
- make hydrogen
- make alkenes e.g. ethene [2]

[Total: 9]

A5 (a) (i) hydrogen is below sodium in the reactivity series (1)

(ii) chloride ions are removed (leaving hydroxide ions) (1) [2]

(b) (i) chlorine bleaches litmus or turns starch/iodide paper blue (1)

(ii) hydrogen pops with a burning splint (1) [2]

(c) chlorine kills bacteria (not just sterilises the water) [1]

(d) burning hydrogen does not produce pollutants or only forms water or hydrogen is not a finite resource, is renewable [1]
(e) (i) no products or no reaction (1)

(ii) sodium chloride and bromine, both needed for (1)
(allow NaCl and Br₂) [2]

[Total: 8]

A6 (a) sodium ion shown as 2.8 (1)
chloride ion shown as 2.8.8 (1)
(charges not needed. Outer shell only = 0) [2]

(b) (i) strong attraction between oppositely charged ions (1)

(ii) higher charges on the ions (1)
 hence stronger attraction (1)
(independent marks) [3]

(c) ions cannot move in the solid but can move in the melt [1]

[Total: 6]

[Section A: score any 45 from 46]
Section B

Answer any three questions

B7  (a)  ozone is formed by photochemical reactions
       (or sparks in air, u.v on O₂)  [1]

       (b)  ozone removed by reaction with chlorine (atoms) (1)
            derived from CFC’s (1)
            ozone loss causes skin cancers or cataracts or crop damage
            or skin diseases or eye damage (1)
            (allow O₃ + CFC for (1))  [3]

       (c)  (i)  bond breaking is endothermic/absorbs energy (1)
            and bond forming is exothermic/releases energy
            more energy released than absorbed (only if first point scored) (1)

            (ii) as temperature increases molecules move faster
                 or increased k.e. (1)
                 hence more frequent collisions
                 or more molecules energy exceeds the activation energy (1)

            (iii) calculation
                 48 g ozone releases 143 kJ (1)
                 16 g ozone releases 47.66 kJ or 47.7 kJ (1)
                 (answer alone (1), units needed)
                 (if 6 x 16 = 96 g ozone used, then (0))
                 (if 0.33 used, answer = 47.2)  [6]

       [Total: 10]

B8  (a)  calculation (2)
       143.5 g AgCl contains 108 g Ag
       0.287 g AgCl contains 0.216 g Ag
       (answer alone (1), units needed)  [2]

       (b)  oxidation is electron loss or an increase in O.N. (1)
            copper(I) is oxidised because it loses an electron
            or its O.N. increases (1)
            chlorine is reduced because it gains an electron
            or its O.N. decreases (1)  [3]

       (c)  equation (1)
            Ag + CuCl₂ → AgCl + CuCl  [1]

       (d)  (i)  equation (1)  state symbols (1)
            CuCl₂(aq) + 2 NaOH(aq) → Cu(OH)₂(s) + 2 NaCl(aq),
            (or ionic, Cu²⁺ + 2OH⁻ → Cu(OH)₂ )
            (scores (1) for states)

            (ii) name is copper(II) hydroxide (allow copper hydroxide) (1)
                 colour is blue or blue-green (1)
                 (colour only for correct name)  [4]

       [Total: 10]
B9  (a) (i) the catalyst is iron or Fe₂O₃  (1)

(ii) equation
\[ \text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3 \]  (1)

(iii) the temperature is 280 °C  (1)
the pressure is 400 atmos  (1)

(iv) higher temperature gives faster reaction  (1)
(higher yield = -1)  [5]

(b) a catalyst increases reaction rate  (1)
(not alters the rate)
(a lower activation energy  (1)
hence saves energy  (1)
(third mark only if \( E_a \) given)  [3]

(c) equation  (1)
\[ \text{Ca(OH)}_2 + 2\text{NH}_4\text{NO}_3 \rightarrow \text{Ca(NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NH}_3 \]
ammonia lost as a gas  (1)  [2]

[Total: 10]

B10  (a) name is butanoic acid (not butenoic)  (1)

(b) formula is \( \text{C}_5\text{H}_{11}\text{CO}_2\text{H} \) (not \( \text{C}_6\text{H}_{12}\text{O}_2 \))  (1)

(c) structure of ethyl ethanoate  (1)
allow full structure or condensed version, \( \text{CH}_3\text{CO}_2\text{C}_2\text{H}_5 \)

(d) allow any suitable named oxidising reagent  (1)
e.g. (acidified) potassium dichromate(VI) or air or oxygen
(allow formula)  [(a) to (d) 4]

(e) equation  (1)
\[ \text{Mg} + 2\text{CH}_3\text{CO}_2\text{H} \rightarrow \text{Mg(CH}_3\text{CO}_2)_2 + \text{H}_2 \]
calculation  (2)
50 cm³ acid is 0.05 mol
0.025 mol Mg needed
\[ 24 \times 0.025 = 0.60 \text{ g} \]
(answer alone  (1), unit needed)  [3]

(f) ethanoic acid is weak and hydrochloric is strong  (1)
lower \([\text{H}^+]\) concentration in ethanoic acid  (1)  [2]

(g) ionic equation  (1)
\[ \text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} \]  [1]

[Total: 10]