CH2

SECTION A

1. $(1s^2)2s^22p^6$ [1]

2. 8 electrons in outer shell of all species/ 8 in two F and 0 in Ca (1)

   2+ on calcium ion and 1- on fluoride ions (1) [2]

3. (Electronegativity of an atom is) the tendency of electrons in a covalent bond to be drawn to that atom [1]

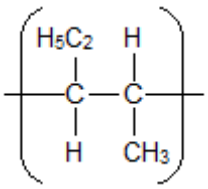
4. Cs^+ and Cl^- (or names caesium and chlor**id**e) with Cl^- at each corner and Cs^+ in centre of cube [1]

5. Reagent: acidified potassium dichromate / $Cr_2O_7^{2-}$ and H^+
   or acidified manganate(VII) / MnO_4^- and H^+ (1)

   Colour change: from orange to green
   or from purple to colourless (1) [2]

6. 2-chlorobut-1-ene [1]

7. $C_{20}H_{42} \rightarrow C_5H_{10} + C_6H_{12} + C_9H_{20}$ [1]

8. 

   [1]

Total Section A [10]

SECTION B

9. (a) (i) Potassium bursts into flames sodium does not / potassium darts about surface **more** vigorously than sodium [1]

(ii) 1st ionisation energy decreases as group is descended / as element has higher A_r (1)

(Atom) becomes larger / outer electron further from nucleus / more shielding / less effective nuclear charge (1) [2]

(iii) As group descended outer electron more easily lost [1]

(b) (i) Electronegativity (difference between the atoms) (1)

The bigger the difference the more likely is an ionic bond / ORA for covalent (1) [2]

(ii) Ionic: high electron density centred round ions / shown on diagram (1)

Covalent: high electron density between nuclei/atoms / shown on diagram (1)

Intermediate: high electron density between nuclei/atoms but higher nearer one of them / ions with electron distortion of negative ion (1) [3]

(c) (i) Calcium [1]

(ii) Calcium chloride/ $CaCl_2$ – error carried forward (ecf) from (i) [1]

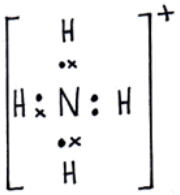
(iii) White precipitate/ solid – ecf from (i) [1]

(iv) $Ca^{2+} + 2OH^- \rightarrow Ca(OH)_2$ (ignore state symbols) – ecf from (i) [1]

Penalise incorrect metal once only in (c)

Total [13]

10. (a) The last/valence electron entered a p orbital/sub-shell [1]

(b) (i) 

do not penalise missing + sign [1]

(ii) 109° – 110° (1)

Pairs of electrons move towards positions of minimum repulsion/ of maximum separation (1) [2]

(iii) $\mathbf{4}NH_3 + \mathbf{5}O_2 \rightarrow \mathbf{4}NO + \mathbf{6}H_2O$ [1]

(c) (i) In this reaction nitrogen (1) has been reduced because its oxidation number has changed from (+) 5 to (+) 3 (1) [2]

(ii) Moles $NaNO_3$ = 4.40/ 85 = 0.0518 (1)

Moles oxygen = 0.0259 (1)

Volume of oxygen = 0.0259 × 24 = 0.62 (dm^3) (1)

Ecf throughout [3]

(d) Mass in solution at 30°C = 96/2 = 48 (g) (1)

Mass that crystallised = 65 – 48 = 17 (g) (1) [2]

Total [12]

11. (a) (i) $\delta-$ on Br and $\delta+$ on C attached (1)

Arrow from lone pair on OH^- to $\delta+$ on C (1)

Arrow from C-Br bond to Br (1)

Correct alcohol + Br^- (1) [4]

(ii) Nucleophilic substitution [1]

(iii) The bond breaks and both the electrons go to one of the bonded atoms/ the bond breaks and ions are formed. [1]

(b) (i) Sodium hydroxide in ethanol/ alcohol [1]

(ii) Elimination/ dehydrohalogenation [1]

(iii) Structural formulae for but-1-ene (1)

and but-2-ene (1) [2]

(c) A is non-miscible with water/ does not mix with water and B is miscible/ mixes with water/ is soluble in water (1)

A has a longer carbon chain/ is bigger (1)

Hydrogen bonding (1)

Between the OH in alcohol and water (1)

In large alcohols non-polar/ hydrophobic part of molecule is large / OH is less significant part of molecule (1) [5]

QWC: organisation of information clearly and coherently; use of specialist vocabulary such as intermolecular force/ hydrogen bond/ hydrophobic/ non-polar/ miscible [1]

Total [16]

12. (a) Any 3 from 4 points:

Bonding is metallic (1)

This is **attraction** between the sea/ delocalised electrons and the positive ions (1)

Al^{3+} has more electrons in the sea than Na^+ / Al^{3+} has a higher charge density than Na^+ (1)

More energy is needed to overcome forces in Al (1) [3]

QWC: legibility of text; accuracy of spelling, punctuation and grammar; clarity of meaning [1]

(b) (Brown) iodine is formed (1)

Equation: $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ / $Cl_2 + 2KI \rightarrow 2KCl + I_2$ (ignore state symbols) (1)

Chlorine is a better oxidising agent than iodi**ne**/ has a greater affinity for the electron/ chlorine has oxidised iod**ide** (1) [3]

(c) Ammonia is easily liquefied because it has a high boiling temperature (compared with ethane) (1)

Ammonia contains hydrogen bonds (1)

Ethane has van der Waals forces/ induced dipole-induced dipole forces (1)

Hydrogen bonds are stronger than van der Waals forces (1) [4]

(d) Reaction produces a mixture of halogenocompounds/ more than one halogen can be substituted / ethane (1)

The mechanism is (free) radical (1)

Any equation with product a polychloromethane/ ethane (1) [3]

QWC: selection of a form and style of writing appropriate to purpose and to complexity of subject matter [1]

Total [15]

13. (a) (i) Mass C = 1.79 × 12/44 = 0.488 (g) [1]

(ii) Mass O = 0.65 (g) ecf from part (i) [1]

(iii) C : H : O = 0.488/12 : 0.061/1 : 0.65/ 16 = 0.0407 : 0.061 : 0.0406 (1)

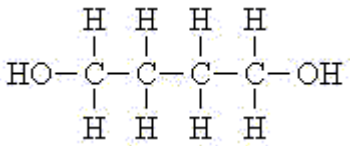
= 2:3:2 empirical formula is $C_2H_3O_2$ (1)

No ecf from incorrect ratios [2]

(iv) *M*r of empirical formula = 59 so molecular formula is $C_4H_6O_4$ so **F** is acid 2/ molecular formula acid 1 is $C_5H_8O_2$ so empirical formula is not $C_2H_3O_2$ molecular formula acid 2 is $C_4H_6O_4$ so empirical formula is $C_2H_3O_2$ [1]

(v) Bromine turns from brown/red-brown to colourless for Acid 1 [1]

(vi)



[1]

(b) (i) *M*r / molecular ion (is 46) [1]

(ii) CH_3 (present) [1]

(iii) OH (present) [1]

(c) Ethene to ethanol: steam (1)

H_3PO_4 (catalyst) (1)

Ethanol to ethene: conc H_2SO_4/ Al_2O_3/ pumice (1)

High temperature > 150°C for H_2SO_4
> 300°C for Al_2O_3/ pumice (1) [4]

Total [14]

Total Section B [70]