A1 (a) **E** [1]

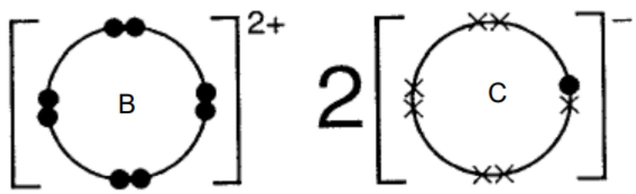
(b) **C** and **D** [1]

(c) **A** and **B** [1]

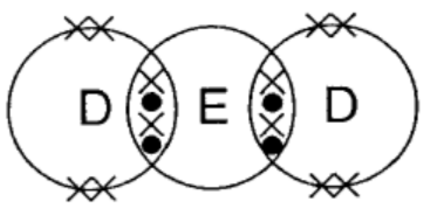
(d) **BO** [1]
C_2O [1] [2]

(e) Oxidation state of Group 0 elements is 0 and hence do not appear in the table. [1]
Atoms of Group 0 elements have stable electronic structure. These atoms do not form bonds with atoms of other elements / lose or gain electrons to form ions [1] [2]

(f) (i) [1]



(f) (ii) [2]



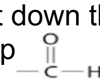
A2 (a) 46% [1]

(b) The reaction of nitrogen and hydrogen to produce ammonia is reversible AND some of ammonia produced will be converted back to nitrogen and hydrogen. [1] [1]

(c) The yield decreases when the operating temperature increases [1]
However when the temperature is too low, rate of reaction is too low [1] [2]

(d) - reduce the wastage of large amounts of precious raw materials hydrogen and nitrogen
- to reduces energy /fuel required to process the raw materials to obtain nitrogen from fractional distillation of liquefied air or cracking of hydrocarbons to obtain hydrogen [2]

(e) $N_2 + 3H_2 \rightarrow 2NH_3$ [3]
No. of moles of hydrogen = 90 000 000 / 2 = 45000000
No of moles of ammonia = 90 000 000/3 × 2 = 60 000 [1]
Theoretical mass of ammonia = 60 000 000 × 17 = 1020 000g= 1.02 ton [1]
Actual mass of ammonia = 50% × 1.02 = 0.51 ton [1]

A3 (a) Any two of the following [2]
- Members have the same general formula $C_nH_{2n}O$
- There is gradual increase in boiling point down the series
- Members have the same functional group  OR -CHO

(b) name: propanal [1] [2]
structural formula: CH_3CH_2CHO [1]

(c) M_r of methanal = 30 [2]
No. of moles of methanal = 1/30 = 0.033333 [i]
Enthalpy change of combustion = 0.033333 × -571 [i]
= - 4000 kJ[1]
working 2[i] [1]

(d) As the number of carbon atoms in the alcohol homologous series increases the number of moles of CO_2 and H_2O molecules produced increases [1] [2]
the number of C=O and O-H bonds made increases [1] amount of energy given out in bond making increases

(e) The number and type of bonds to be broken (i.e. 8C-H, 3C-C, 1C=O and 11/2 O=O) and made (i,e, 8C=O and 8O-H) are the same for both [1] Energy absorbed to break the bonds and give out to form new bonds are same [1] [2]

A4 (a) exothermic [1] [2]
Heat is given out to the aqueous reaction mixture [1] causing the temperature of the reaction mixture to increase

(b) (i) The further apart the reactivity of magnesium and the metal, the higher the temperature rise. [1]

(ii) temperature rise: 23°C (accept 24 - 32°C) [2]
reason: Iron is less reactive than zinc but more reactive than lead [1]
Hence the temperature rise should be more than 14°C and less than 32°C

(iii) $Mg(s) + Fe^{2+}(aq) \rightarrow Fe(s) + Mg^{2+}(aq)$ [1] [1]
Reject if no state symbols.

(c) Magnesium is less reactive than calcium and sodium [1] and hence unable to displace sodium and calcium from aqueous solutions of their ions. [1] [2]

(d) temperature rise: 17°C (accept 15 - 20°C) [3]
reason: Hydrochloric acid is monobasic while sulfuric acid is dibasic
Hence the number of moles of H+ ions in hydrochloric acid is half that in sulfuric acid[1]
and the amount of heat given off for HCl is half that for H2SO4.[1]

A5 (a) anode protection - anode [;] [1]
cathodic protection - cathode [;]
2[;] [1]

(b) Metal such as zinc is more reactive than iron [;] acts as a sacrificial metal [;] and corrode preferentially in place of steel [;] by oxidising more readily to form metallic ions [2]
3[;] [2]

(c) (i) The layer of metal acts as a barrier [1]
Prevents steel beneath from coming into contact with water and oxygen in surroundings

(ii) Cathodic protection uses reactive metal which will react with the corrosive liquids [1]

(iii) Iron is more reactive than copper [;] and would oxidise more readily by losing electrons,[;] hence corroding faster [1]
2[;][1]

A6 [4]

Name of salt	Formula of salt	Names of compounds used to make salt
Silver nitrate	$AgNO_3$	silver carbonate/oxide/hydroxide[;] and nitric acid [;]
potassium ethanoate	CH_3COOK	potassium hydroxide and ethanoic acid
ammonium sulfate	$(NH4)_2SO_4$ [;]	sulfuric acid and aqueous ammonia / aq. ammonium carbonate [;]
zinc carbonate	$ZnCO_3$	sodium carbonate (or any aqueous carbonate) [;] and zinc nitrate or any aqueous zinc salts [;]

7[;] [4]
5-6 [;] [3]
3-4 [;] [2]
1-2 [;] [1]

B7	(a)		Any three of the following: • Elements in Mendeleev's were arranged in order of increasing atomic mass while the elements in the modern Periodic Table in order of increasing proton/atomic number. • There are no noble gases found in Mendeleev's unlike the modern Periodic Table. • In the modern Periodic Table the transition elements are listed out as a separate block while in Mendeleev's the transition elements are listed with the main elements • There are about 114 elements in the modern Periodic Table as compared to Mendeleev's with only about slightly over 60 elements. • Mendeleev left gaps for elements yet to be discovered while most of the gaps are filled up in the main Periodic Table. • Except for Group II elements, the same period in the modern Periodic Table occurs in the same column in Mendeleev's.	[3]
	(b)		I [1]	[1]
	(c)		Either F, Na, Mg OR Cℓ, K, Ca	[1]
	(d)		The atomic radii of elements decrease across the period [1] Across the period, the atomic number increases and hence the attraction of the nucleus for the outer electrons increases[1] while the amount of screening remains the same as the number of inner shells is the same across the period. [1]	[3]
	(e)		I agree. The atomic radius of Group I elements and halogens increases down the group. [;] Hence the attraction for the outer electron increases down the group [;] – 2; [1] Down Group I, the ease to lose the outer electron to from positive ion decreases, AND hence the reactivity of alkali metals increases down the group. [1] Down Group VIII, the ease to gain an additional electron to from negative ion decreases, AND hence the reactivity of halogens decreases down the group. [1]	[3]
	(f)		Transition elements	[1]
B8	(a)	(i)	oxygen [1] $4OH^{-}(aq) \rightarrow 2H2O(l) + O2(g) + 4e^{-}$ [1]	[2]

(ii) Chlorine turned moist blue litmus red and then bleached.[1] [1]

(b) Heating is required to concentrate the sodium hydroxide solution contaminated with sodium chloride produced by the diaphragm cell [;] Fuels are combusted to supply the heat and carbon dioxide is released as product. [;]
2; [1] [1]

(c) In the membrane cell, hydroxide ions cannot pass through the membrane and hence sodium hydroxide would not come into contact with chlorine produced at anode [1]
While in the diaphragm cell, the liquid in the left compartment is maintained higher so the flow of liquid is always from left/anode to right/cathode compartment and preventing any of the sodium hydroxide solution formed finding its way back to where chlorine is being produced. [1] [2]

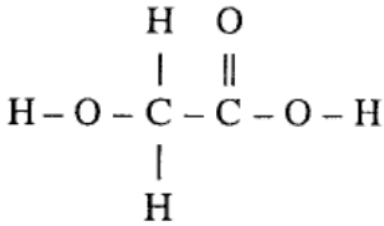
(d) The oxidation state of chlorine increases from 0 in Cl2 to +1 in NaOCl. Hence chlorine is oxidised. [1]
The oxidation state of chlorine decreases from 0 in Cl2 to -1 in NaCl. Hence chlorine is reduced.[1] [2]

B9 E (a) (i) [4]

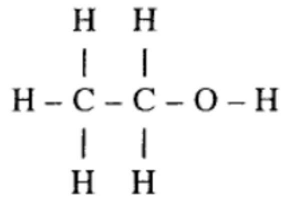
Organic Compound	Aqueous Bromine	Aqueous sodium carbonate	Potassium Manganate(VII)
A	No visible change	Effervescence observed	Purple acidified potassium manganate(VII) turned colourless.
B	No visible change	No visible change	Purple acidified potassium manganate(VII) turned colourless.
C	No visible change	Effervescence observed	No visible change
D	Reddish brown aqueous bromine decolourised rapidly	No visible change	No visible change

aq. bromine: Correct description of observation for D [1]
aq. sodium carbonate: Correct description of observation for A and C [1] acidified potassium manganate(VII): Correct description of observation for A and B [1]
No visible change for the remaining [1]

(ii) [2]

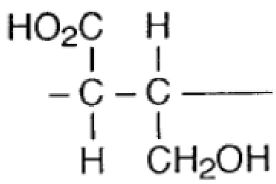


[1] and



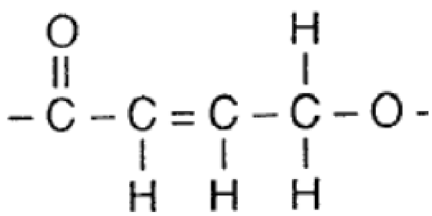
[1]

(b) (i) [1]



(ii) Mr of repeat unit = 102 [2]
49 000 / 102 < No. of repeat unit < 60 000/102
480 .4 < No of repeat units < 588.2
Range of repeat units is 481 to 588

(iii) [1]



B9 O (a) (i) When the engine is idling, the air intake is lower/insufficient oxygen [;] than when the car is cruising, there is greater extent incomplete combustion of petrol [;] [3]
producing greater amounts of carbon monoxide

When the engine is idling, the temperature in the engine compartment is lower [;] than when car is cruising,
rate of reaction of nitrogen and oxygen is lower [;]
Hence lesser oxides of nitrogen produced.
4; [3]
2-3 [2]
1 [;]

(ii) A catalyst provides an alternative reaction pathway of lower activation energy [;] [3]
Hence, more NO and CO molecules collide with energy equivalent or more than the activation energy, [;] hence increasing the frequency of effective collisions.

2[;] [1]

At high temperature , the NO and CO molecules have higher kinetic energy and move about at higher speeds.[;]
More molecules also possess energy equal to or greater than the activation energy needed to react. [;] Hence there is a greater frequency of effective collisions between CO and NO molecules. [;]

3[;] [2]

(iii) Formation Nitrogen oxides can react with water and oxygen in the atmosphere to form dilute nitric acid and fall as acid rain. [1] [2]

Effects (any one) [1]
• Acid rain can erode limestone buildings and metal structures such as bridges
• makes the pH of lakes and rivers too low and hence kill aquatic life
• leaches nutrients from the soil and causes plants to wither and die

(b) Volume of SO_2 = 3.4/100 × 2 = 0.068 dm^3 [2]
No of moles of SO_2 = 0.068/24 = 0.002833 [1]
No of moles of $Cr_2O_7^{2-}$ = 0.002833 / 3 = 0.0009443
Volume of solution = 0.0009443 / 0.1 = 0.00944 dm^3 [1]