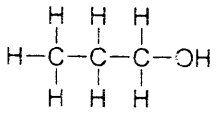
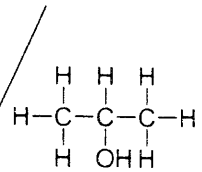
1.

(a)(i) ÷ each by its own A_r to give 5 : 13.3 : 1.67 ✓ [1]

÷ each by 1.67 to give 3 : 8 : 1 ✓ [1]

(ii) Evidence of working e.g. 36 + 8 + 16 = 60 / that C_3H_8O adds up to 60 ✓ [1]

(b) unambiguous structure/formula of propan-1-ol & propan-2-ol to include:

 or $CH_3CH_2CH_2OH$  or $CH_3CH(OH)CH_3$ or $(CH_3)_2CHOH$

✓ [2]

(c)(i) dichromate/ $Cr_2O_7^{2-}$ /MnO_4^- ✓ [1]

(ii) orange to green ✓✓ [2]
purple to green/brown/black/pink/colourless

(iii) continuous boiling/evaporation **and** condensation /
heating & return of liquid to reaction flask/
simple sketch showing vertical condenser & heat ✓ [1]
(any reference to a closed system negates the mark)

(d)(i) OH/alcohol/hydroxy/hydroxyl – not hydroxide ✓ [1]

(ii) C=O/carbonyl – not CO ✓ [1]

(iii) carboxylic acid/-CO_2H/-COOH ✓ [1]

(e) propan-1-ol (no marks)
propan-1-ol oxidised to a carboxylic acid/ ✓ [1]

(f) $C_3H_8O + 2[O] \rightarrow CH_3CH_2COOH$ / $C_3H_6O_2 + H_2O$ ✓✓ [2]
1 mark available if, CH_3CH_2COOH & H_2O *present in the equation*

[Total : 15]

2.

(a)(i) 1,1-dibromoethene ✓ [1]

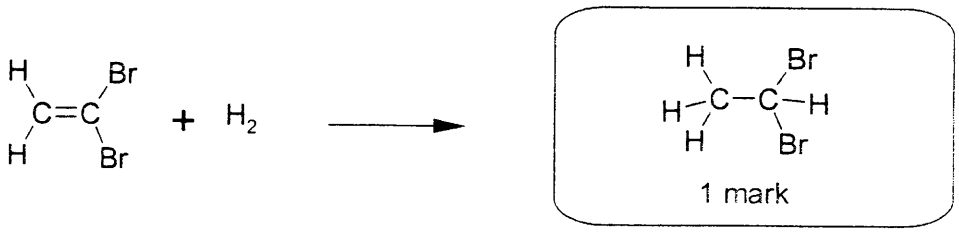
(ii) CHBr ✓ [1]

(b)(i) (Br_2 is) decolourised ✓ [1]

(ii) electrophilic ✓ [1]
addition ✓ [1]

(c) allow names & unambiguous formulae throughout part (c)

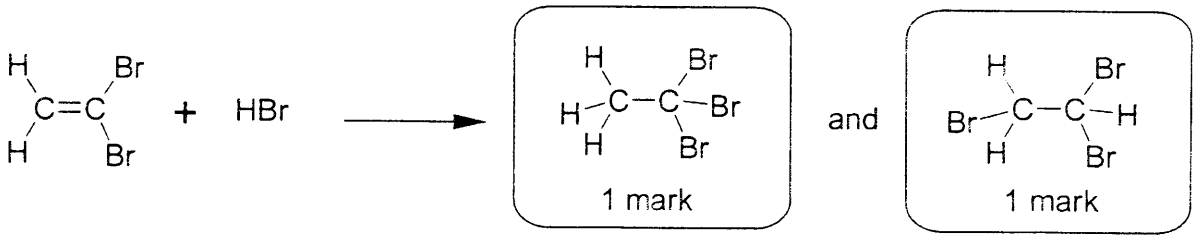
(i) Isomer **C** reacts with H_2.



✓ [1]

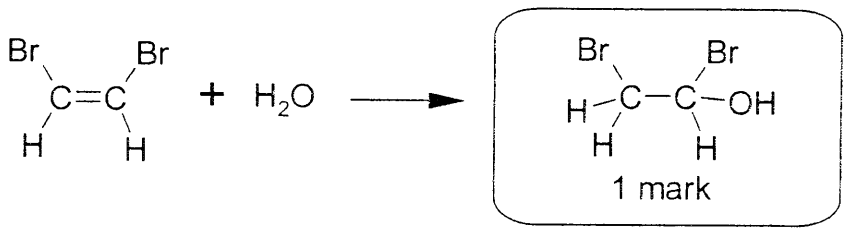
conditions suitable catalyst such as Ni/Pt/Pd ✓ [1]

(ii)



✓✓ [2]

(iii)



✓ [1]

conditions phosphoric acid (catalyst) ✓ [1]
temp ≥ 100 °C/ steam ✓ [1]

[Total : 12]

3.

(a) non-polar ✓ [1]

hence particles not attracted to methane ✓ [1]

(b)

- (free radical) substitution ✓ [1]
- $CH_4 + Br_2 \rightarrow CH_3Br + HBr$ ✓ [1]
- ultra violet/UV light ✓ [1]
- $Br_2 \rightarrow 2\ Br\bullet$ ✓ [1]
- homolysis/ homolytic fission ✓ [1]
- $Br\bullet + CH_4 \rightarrow \bullet CH_3 + HBr$ ✓ [1]
- $\bullet CH_3 + Br_2 \rightarrow CH_3Br + Br\bullet$ ✓ [1]
- any two free radicals $2\ Br\bullet \rightarrow Br_2$ ✓ [1]

free rads are difficult to control/react with anything/very reactive ✓ [1]

identifies one of CH_2Br_2/ $CHBr_3$/ CBr_4 or can be polysubstituted ✓ [1]

[10 max = 9]

1 QWC mark is available for using specific chemical terms.

chemical terms: initiation, propagation, termination, free radical substitution, homolysis/ homolytic fission, photochemical

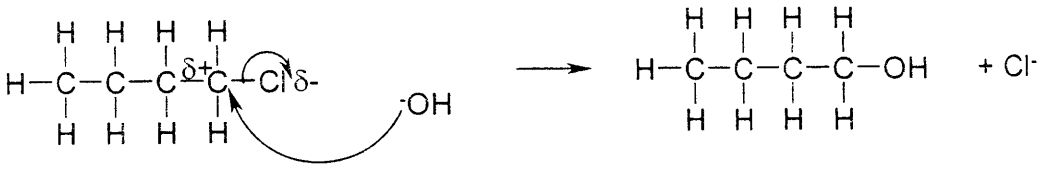
*any **two** terms used correctly* ✓ [1]

[Total : 11]

4.

(a) (i) $C_4H_9Br + OH^-/NaOH/H_2O \rightarrow C_4H_9OH/\ C_4H_{10}O + Br^-/NaBr/HBr$ ✓ [1]

(ii)



marking points:

dipoles

curly arrow from OH^- to $C^{\delta+}$

curly arrow from C-Cl bond to Cl

✓✓✓ [3]

(b)(i) Fastest – 1-iodobutane & slowest 1-chlorobutane ✓ [1]

(ii) C-I has the weakest bond/ C-Cl has the strongest bond ✓ [1]

[Total : 6]

5.

(a) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ ✓ [1]

(b) (i) M_r of $C_6H_{12}O_6$ = 180 ✓ [1]

200 moles (0.2 will be a common error) ✓ [1]

(ii) 400 moles/ ecf to (a)(ii) *2 ✓ [1]

(iii) 50 moles ✓ [1]

(iv) (iii)/(ii) x 100 = 12.5% ✓ [1]

(c) (i) (must **name**) aldehyde/carbonyl ✓ [1]

(i) CH_3CO_2H/ CO_2 ✓ [1]

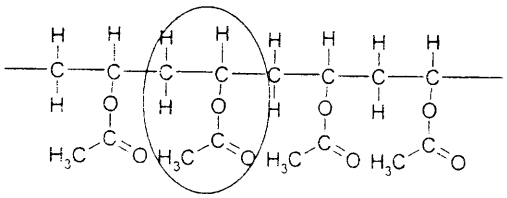
(d) $CH_3OH + [O] \rightarrow HCHO/CH_2O + H_2O$ ✓✓ [2]
✓

(e)(i) $CH_3OH + 1^1/_2 O_2 \rightarrow CO_2 + 2H_2O$ /$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ ✓ [1]

(ii) burns more cleanly/ reduces CO(g) emissions / reduces benzene emissions/ less pollutants/ higher octane rating(number)/less knocking/ / improves combustion/ better fuel/ burns more cleanly/ absorbs free radicals/ oxygenates ✓ [1]

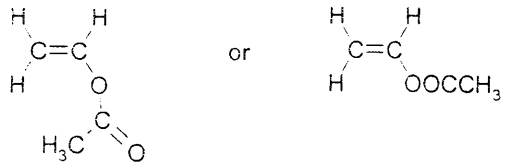
(f)(i) $CH_3OH + CO \rightarrow CH_3CO_2H$ ✓ [1]

(ii)



✓ [1]

(iii)



✓ [1]

[Total : 15]