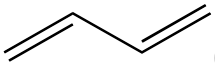
1. (i) Any two realistic fragments,
e.g. CH_3^+: 15; $C_2H_5^+$: 29; $C_3H_7^+$: 43; $C_4H_9^+$: 57; OH^+: 17, *etc*. **(1) (1)**
Do not penalise missing charge. 2

(ii) breathalysers/monitoring of air pollution, MOT emission testing, *etc*. **(1)** 1

[3]

2. mole ratio = 88.89/12 : 11.1/1 = 7.41 : 11.1 **(1)**
empirical formula = C_2H_3 **(1)**
relative mass of C_2H_3 = 27.
M_r = 2 × 29 so molecular formula = C4H6 **(1)**
X reacts with 2 mol H_2 so there are 2 double bonds **(1)**

Possible structure = 1,3-butadiene /



(1)

[5]

3. (a) (i) H^+ 1
$Cr_2O_7^{2-}$ 1

(ii) Orange to green/black/blue 1

(b) (i) contains a C=O/aldehyde, ketone, carboxylic acid and ester/ carbonyl/carbonyl in an aldehyde 1

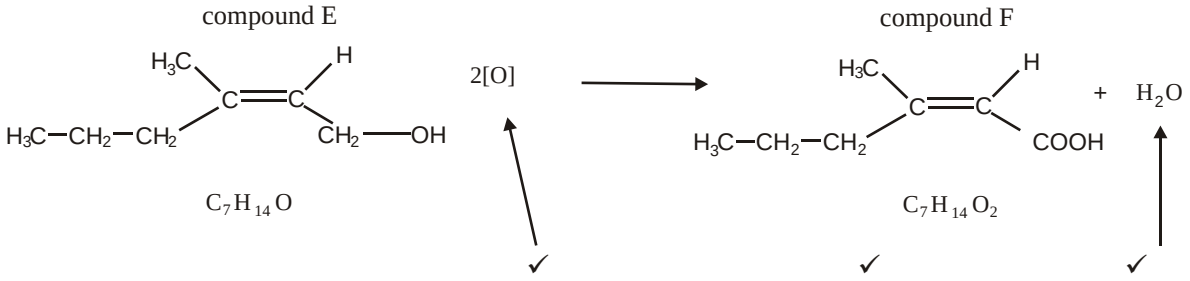
(ii) does **not** contain a O–H/ (hydrogen bonded in a) carboxylic acid 1

(iii) distillation (no mark) **because** distillation allows loss of volatile components /removes butanal from oxidising mixture 1
prevents formation of RCOOH/ partial oxidation would be achieved or reverse argument for reflux not being used in that reflux prevents loss of volatile components hence complete oxidation would be achieved/RCOOH would be formed ✓ 1

[7]

4. (i) H^+ ✓ $Cr_2O_7^{2-}$ 2

(ii)



✓ ✓ ✓

3

(iii) carboxylic acid would have an absorption between
1680 – 1750 cm^{-1} /1700 cm^{-1} or 2500 – 3300 cm^{-1}. 1

[6]

5. (a) (i) (volatile components) can escape/distil out 1

ethanal is most volatile/b pt less than 60°C/partial oxidation 1

(ii) (volatile components) cannot escape/ refluxed 1

complete oxidation will be achieved/oxidised to the acid 1

(b) $C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$
($CH_3COOH + H_2O$ ✓) 2

(c) spectrum C 1

spectrum C only shows absorption at 1700 cm^{-1} for the C=O 1

the other two spectra contain the OH group absorption at approx 3000 cm^{-1} 1

[9]

6. acrylic acid 1

approx 1700 cm^{-1} (range 1650 – 1750) indicates C=O 1

approx 3000 cm^{-1} (range 2500- 3300) indicates O-H 1

not 3230 – 3550 cm^{-1}

[3]

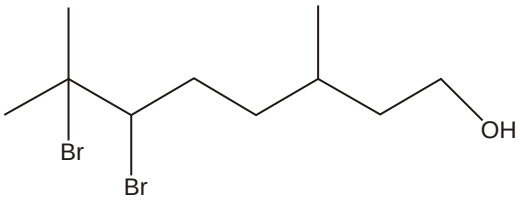
7. (a) (i) alkene ✓ 1

alcohol/hydroxy/hydroxyl ✓ 1

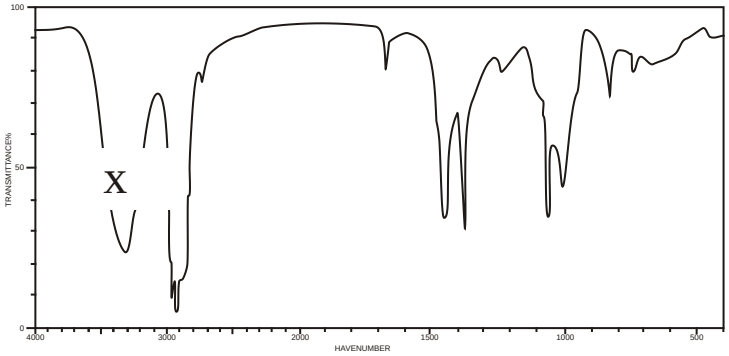
(b) (i) I = alkene & II = alcohol… both are needed ✓ 1

(ii) decolourised / colourless ✓ 1

(iii) ✓ 1



(iv) **X** as shown below ✓ 1



(c) (i) Ni/Pt/Rh/Pd ✓ 1

(ii) compound **B** is $C_{10}H_{22}O$ ✓ 1

(iii) $C_{10}H_{20}O + H_2 \rightarrow C_{10}H_{22}O$ ✓ 1

[9]

8. (a) (i) Alkene/C=C ✓ 1

Alcohol/ROH/hydroxy/hydroxyl/OH (not OH^- or hydroxide) ✓ 1

(ii) One of the C in both C=C is joined to two atoms or groups that are the same ✓ 1

(b) Observation — decolourisation (of Br_2) ✓ 1

Molecular formula — $C_{10}H_{18}OBr_4$ ✓✓ 2

$C_{10}H_{18}OBr_2$ gets 1 mark

(c) reagent — CH_3COOH ✓ 1

catalyst — $H_2SO_4/H^+/HCl$ (aq) *or dilute loses the mark* ✓ 1

(d) (i) $C_{10}H_{18}O + 2[O] \rightarrow C_{10}H_{16}O_2 + H_2O$ ✓✓ 2

1 mark for H_2O and 1 mark for 2[O]

(ii) The infra-red spectrum was of compound **Y**

because absorption between 1680 – 1750 cm^{-1} indicates a C=O ✓ 1

and the absence of a peak between 2500 – 3300 cm^{-1} shows the absence of the OH hydrogen bonded in a carboxylic acid ✓ 1

[12]

J ¤