1 **(a) (i)** contains only carbon, hydrogen and oxygen [1]
hydrogen (atom) to oxygen (atom) ratio is 2:1 [1]
ALLOW: C:H:O as 1:2:1 or $C_n(H_2O)_n$

(ii) condensation
polymerisation [1]

(b) (i) cells / micro-organisms / plants / animals / metabolic reactions [1]
obtaining energy from food / glucose / nutrients [1]

(ii) $2C_2H_5OH + 2CO_2$ [2]
allow: C_2H_6O for C_2H_5OH
not balanced = (1) only

(iii) to prevent aerobic respiration / to get anaerobic respiration / to prevent ethanoic acid / lactic acid / carboxylic acids being formed / to prevent oxidation of ethanol [1]

(c) displayed formula of methyl butanoate [2]
NOTE: all bonds must be shown
NOTE: award (1) if error in alkyl groups but correct displayed structure of –COO–

(d) (i) alcohol, e.g. glycerol, circled [1]
ALLOW: if only part of glycerol molecule is circled as long as it involves an OH group

(ii) saturated
correct reason based on group $C_{17}H_{35}$ / all C–C bonds / no C = C bonds [1]

(iii) salt / carboxylate / alkanoate [1]
(making) soap [1]
ACCEPT: detergent / washing

(e) at least one correct amide linkage –CONH– [1]
continuation shown at both ends of chain [1]
diagram showing three (different) amino acid residues [1]

[Total: 18]

2 **(a** $10\,cm^3$; [1]
$65\,cm^3$; [1]

(b) (i) chlorination / substitution / photochemical / exothermic / halogenation / free radical; [1]

(ii) (compounds) same molecular formula; different structural formulae; [2]

(iii) $CH_3–CH_2–CH_2–CH_2–Cl$ [1]
$CH_3–CH_2–CH(Cl)–CH_3$ [1]

(c) (i) potassium manganate(VII) / potassium dichromate(VI) / copper(II) oxide; [1]
note: do not insist on oxidation numbers but if given must be correct

(ii) butanoic acid; [1]

(iii) butyl ethanoate; [1]

correct formula all bonds shown = [2]
if alkyl groups incorrect then correct ester linkage showing bonds = [1] [2]

[Total: 12]

3 **(a) (i)** (to avoid) carbon monoxide formation/so complete combustion occurs/avoid incomplete combustion So that CO_2 is produced [1]

CO does not dissolve/react with alkali [1]

(ii) CO_2 is acidic [1]

(iii) volume of gaseous hydrocarbon 20 cm^3
volume of oxygen used = 90 cm^3 [1]
volume of carbon dioxide formed = 60 cm^3 [1]

no mark for 20 cm^3 of hydrocarbon.

(iv) $2C_3H_6(g)/2CxHy(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$

OR … $C_3H_6(g) + 9/2O_2(g) \rightarrow 3CO_2(g) + 3H_2O(l)$

C_3H_6 [1]

C_3H_6 can be given in the equation for the second mark

(b) (i) correct structural or displayed formula of another chlorobutane / dichlorobutane / polychlorobutane

(ii) light / 200 °C / lead tetraethyl [1]

(iii) cracking is the decomposition/breaking down of an alkane/hydrocarbon/petroleum [1]
heat/high temperature / Temperature between 450 °C to 800 °C
OR catalyst / named catalyst [1]
to give a simpler alkane and alkene [1]

word equation or equation as example [1]

to make polymers / to increase petrol fraction / organic chemicals/petrochemicals / hydrogen [1]
any **four**

4 **(a** fraction is the distillate collected [1]
between 40–100 °C / in the stated range [1]

(b) (i) $C_8H_{18} + 25/2O_2 \rightarrow 8CO_2 + 9H_2O$ [2
accept: double the above / 12.5 in front of oxygen

(ii) poisonous / toxic / damages health / brain / kidneys [1]
note: must relate to people
not: just harmful

(iii) dibromo 2 bromine atoms (per molecule)
not: Br_2
accept: 2 bromide groups
eth 2 carbon atoms (per molecule)
ane a C-C single bond / no C=C / group C_nH_{2n+1} / saturated
ignore: any reference to alkanes
all three correct [2] two correct only [1] [2]

(iv) position of bromine atom(s) [1]

(c) 0.104/0.026 [1]
n = 4 [1]

(d) (oxides of nitrogen) change carbon monoxide into carbon dioxide [1]
oxides of nitrogen then become nitrogen [1]
(oxides of nitrogen) change hydrocarbons into carbon dioxide and water [1]
accept: balanced equations for first two marks
$2NO + 2CO \rightarrow N_2 + 2CO_2$ **and** $2NO \rightarrow N_2 + O_2$ [2]
oxygen changes hydrocarbons into carbon dioxide and water [1]

5 **(a) (i)** same molecular formula / same number of C and H atoms [1]
different structural formula or structure [1]
same compound = [1]

(ii) correct **formula** of but-2-ene / methylpropene / methyl cyclopropane [1]

(iii) bromine / bromine water / aqueous bromine [1]
brown to colourless **not** clear [1]
stays brown [1]
brom**ide** loses the first mark only

OR alkaline potassium manganate(VII) [1
from purple/pink to green/brown [1]
stays purple [1]

OR acidic potassium manganate(VII) [1
from purple/pink to colourless **not** clear [1]
stays purple [1]

(b) heat / high temperature (temperature need not be stated, but if it is stated it must be 500ºC or above) [1]

catalyst (need not be named, but if they are named accept any metal oxide or zeolite / aluminosillicates / silicon dioxide) [1]
not nickel/platinum

(c) (1,2)dibromobutane
if numbers given must be correct
butane [1]
butanol [1]
accept butan-1-ol or butan-2-ol **not** but-1-ol / but-1-anol / buthanol