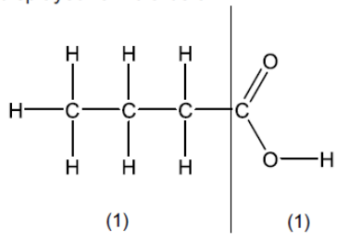
Marking Scheme : Organic (IGCSE 0620)

Question 1

7 (a) (i) butanoic acid/butyric acid [1]

displayed formula below [2]



(1) (1)

(ii) any **three** from:
same or similar chemical properties
(same) general (molecular) formula
(consecutive members) differ by CH_2
same functional group
common methods of preparation
physical properties vary in predictable manner/show trends/gradually change
or example of a physical property variation i.e. melting point/boiling point/volatility [3]

(iii) dissociates/ionises/splits up (into ions) [1]

partially/incompletely/slightly/not fully [1]

(donates) protons/(forms) H^+/H_3O^+(as the only positive ion) [1]

(b) (i) methyl propanoate [1]

$CH_3CH_2COOCH_3/CH_3CH_2CO_2CH_3/C_2H_5COOCH_3/C_2H_5CO_2CH_3$ [1]

(ii) methyl ethanoate [1]

(c) (i) $3C_4H_{10} + 5\frac{1}{2}O_2 \rightarrow 4C_2H_5COOH + 3H_2O$ [1]

(ii) propanol or propan-1-ol or propanal [1]

[Total: 14]

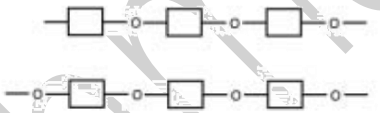
Question 2

5 (a) (i) M1 Contain carbon, hydrogen and oxygen (only) [1]

M2 hydrogen and oxygen is in a 2:1 ratio (or in the same ratio as water) [1]

(ii) M1 -O- linkage [1]

M2 3 monomer units with 3 blocks and 3 Oxygen atoms **Cond** [1]



Question 3

3 (a) (i) C_4H_8 only
CH_2 (Allow C_1H_2) [2]

(ii) Any unambiguous structural formula of methyl cyclopropane or but-1-ene or but-2-ene or methyl propene [1]

(iii) M1 same molecular formula [1]

M2 different structural formulae or different structures
or different arrangement of atoms [1]

(iv) If 'No':
one an alkane, the other an alkene
or
one is saturated / has single bonds, the other is unsaturated / has a double bond
ignore: references to the 'functional group'

If 'yes'
both alkanes **or** both saturated
ignore: references to the 'functional group' [1]

Question 4

(b) (i) M1 Action of heat or catalyst or thermal decomposition (on an alkane) [1]
Ignore steam. Ignore pressure.

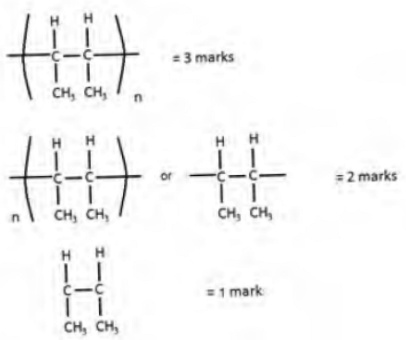
M2 Long-chained molecules or alkanes form smaller molecules (not smaller fraction) or forms smaller alkenes (or alkanes) [1]

(ii) $C_{10}H_{22}$ [1]

(c) (i) M1 Correct structure of one repeat unit [1]

M2 Continuation bonds **COND** on M1 [1]

M3 use of brackets and subscript 'n' **COND** on M1 and M2 [1]



(ii) dibromoethane or 1,2-dibromoethane [1]

Question 5

6 (a) (i) butanoic acid [1]
methanol [1]

(ii) number of moles of ethanoic acid = 0.1 [1]
number of moles of ethanol = 0.12(0) [1]
the limiting reagent is ethanoic acid [1]
number of moles of ethyl ethanoate formed = 0.1 [1]
maximum yield of ethyl ethanoate is 8.8 g [1]

(b) correct ester linkage [1]
two ester linkages (COND on M1) [1]
continuation (COND on M2) [1]

(c) (i) add bromine water/bromine [1]
turns colourless [1]
remains brown/orange/reddish brown/yellow [1]

ALLOW: potassium manganate(VII) (acidic or alkaline) [1]
correct colour colourless/green or brown ppt [1]
stays pink/purple [1]

(ii) ester 1 [1]
COND alkyl group is C_nH_{2n+1} which is NOT $C_{17}H_{33}$
or $C_{17}H_{35}$ is C_nH_{2n+1} **or** less hydrogen [1]

(iii) soap **or** (sodium) salt (of a carboxylic acid) **or** carboxylate [1]

alcohol [1]

[Total: 17]

Question 6

5 (a) protective / layer **and** of oxide [1]

(b) correct repeat unit [1]
continuation shown [1]

(c) (i) catalyst [1]
biological / protein [1]

(ii) hydrochloric acid / any strong acid / any strong alkali [1]

(iii) amino acids [1]

(iv) chromatography [1]

(v) nylon / kevlar [1]

(d) (i) non-biodegradable [1]

(ii) $CH_2=CH(C_6H_5)$ [1]

[Total: 11]

Question 7

7 (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 [1]
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]

Question 8

7 (a) (i) hydrogen (atoms) replaced by (atoms) of a different element e.g. chlorine [1]
NOT: substitute

(ii) light required [1]

(b) exothermic reaction gives out energy [1]
endothermic reaction absorbs
takes in energy [1]

Question 9

5 (a) (i) have same molecular formula / both are C_5H_{12} [1]
they have different structural formulae / different structures [1]

(ii) CH_3-CH_2-CH=CH-CH_3 / any other correct isomer [1]

(b) (i) CH_2-(Br)-CH_2Br [1]
NOT: $C_2H_4Br_2$
dibromoethane [1]
NOTE: numbers not required but if given must be 1, 2

(ii) CH_3-CH_2-CH_3 [1]
NOT: C_3H_8
propane [1]

(iii) CH_3-CH_2-CH_2-CH_2-OH / CH_3-CH_2-CH(OH)-CH_3 [1]
butanol [1]
numbers not required but if given must be correct and match formula

(c) (i) CH_3-CH=CH-CH_2-CH_3 [1]
CH_3-CH=CH-CH_3 [1]

(ii) pink / purple [1]
colourless [1]
NOT: clear

(d) -CH_2-CH(CN)-CH_2-CH(CN)- [1]
correct repeat unit CH_2-CH(CN)
COND: at least 2 units in diagram [1]
continuation [1]

[Total:16]

Question 10

(c) (i) amide / peptide; [1]

(ii) named strong acid / alkali; [1]
allow: HC*l* / enzymes

(iii) amino acid; [1]
allow: peptides

Question 11

5 (a) (i) add bromine water / bromine / aqueous bromine; [1]
colourless; [1]

or add potassium manganate(VII) / permanganate; (ignore acid or alkali) [1]
colourless; [1]

(ii) add metal / carbonate / insoluble base / strong alkali **allow:** ammonia with an indicator / use pH meter; [1]
COND: on reagent

metal - hydrogen given off / metal dissolves / effervescence / gas given off / burning splint pops;

carbonate - carbon dioxide given off / effervescence / gas given off / limewater milky;

insoluble base - solution formed / dissolves;

alkali - use of indicator to show neutralisation / temperature increase;

pH meter - gives pH less than 7 [1]

(b) ethyl propenoate; [1]
correct SF all bonds shown;; [2]
allow: [1] for correct displayed ester linkage

(c) (i) number of atoms of each element; [1]
in one molecule; [1]

(ii) 2; [1]

(iii) C=C [1]

(iv) $HOOC(CH_3)C=C(CH_3)COOH$

[Total: 12]

Question 12

7 (a) (i) $C_nH_{2n+1}OH$ [1]

(ii) 116-17 = 99, 2n+1 = 99, n = 7
for any evidence of working out [1]
$C_7H_{15}OH$ [1]

(iii) 4bps around C; [1]
1 bp on each hydrogen; [1]
2bps and 2nbps on oxygen; [1]

(b) (i) increases yield / moves equilibrium to RHS / favours forward reaction; [1]
high pressure favours side with smaller number of (gas) molecules; [1]

(ii) any two from:
higher temperature / catalyst causes faster reaction;
comment about compromise conditions to give best rate and yield;
at 250°C (lower temp) higher yield / forward reaction favoured;
at 350°C (higher temp) lower yield / back reaction favoured; [3]

(c) (i) methanoic acid; [1]
correct SF showing all bonds; [1]
accept: -OH

(ii) methyl methanoate; [1]

[Total: 14]

Question 13

3 (a) (i) correct structure of an isomer e.g. 2-chloropropane; [1]

(ii) chlorine; [1]
light / heat / lead tetraethyl; [1]

(iii) could produce 2-chloropropane; [1]
could produce HCl; [1]
or
could produce dichloropropanes = [2]

(b) (i) add silver nitrate / lead nitrate; [1]
yellow precipitate; [1]
note: do not insist on presence of dilute nitric acid

(ii) propanol / propan-1-ol; [1]

(c) (i) for A;
reaction slower;
decreased collision rate;
less bromobutane present / concentration of bromobutane less / less reacting particles; [2]
any two
accept: reverse arguments for B

(ii) halogens Cl > Br > I reactivity / reactivity decreases down group; [1]
organic halides I > Br > Cl / reactivity increases down group; [1]
opposite without explanation = [1]

(iii) any three from:
less energy;
particles move slower;
less collisions / fewer particles have energy to react / fewer successful collisions;
slower rate; [3]

[Total: 15]

Question 14

6 (a) (i) amino acid / peptides; [1]
salt / carboxylate or soap / fatty acid or glycerine / alcohol; [1]
sugars or glucose; [1]
accept: named sugar

(ii) polyester; [1]
allow: named polyester
polyamide; [1]
allow: nylon

(b) one correct amide linkage; [1]
second amide linkage correctly orientated
– NHCO – followed by – NHCO –; [1]
note: monomers are amino acids not diamines or dicarboxylic acid

(c) bromine / bromine water / aqueous bromine; [1]
unsaturated - brown / orange to colourless **not:** clear [1]
saturated - stays brown / orange [1]

or: alkaline potassium manganate(VII);
from purple / pink to green / brown;
stays purple;
or: acidic potassium manganate(VII)
from purple / pink to colourless; **not:** clear
stays purple;

[Total: 10]

Question 15

4 (a) it is an alkane **or** hydrocarbon [1]
it is saturated **or** only C—C single bonds [1]
accept: no double bonds

(b) molecular formula C_6H_{12} [1]
empirical formula CH_2 [1]

(c) correct structural formula of cyclobutane [1]

(d) (i) C_6H_{12} [1]
accept: a correct structural formula

(ii) same molecular formula **not**: chemical formula [1]
different structural formulae / structures [1]

(e) add bromine (water) or (l) [1]

cond: (remains) brown **or** orange **or** red or yellow [1]

cond: changes from brown, etc. to colourless or decolourises [1]
not: clear

OR
potassium manganate(VII) [1]
note: oxidation state not essential but if given must be correct or [0]
accept: potassium permanganate

cond: remains pink / purple [1]

cond: changes from pink to colourless **(acidic)** [1]
not: clear

cond: change from pink to green / brown **(alkaline)**

[Total: 11]

Question 16

1 (a) (i) contains carbon and hydrogen [1]
cond: only / just [1]

(ii) (different) boiling points [1]
cond: separate [1]

(b) bitumen-making roads / roofs / water-proofing, etc. [1]

lubricating fraction – waxes / vaseline / grease, etc. or machinery example, e.g. (oil a) bike / hinges / reducing friction [1]

paraffin fraction – jet fuel / (home) heating or tractors or cooking or lighting [1]

gasoline fraction – petrol or fuel for cars / vans / trucks [1]

[Total: 8]

Question 17

8 (a) proton donor; [1]

(b) equal concentrations of both (solutions); [1]
add Universal indicator / determine pH / pH paper; [1]
ethylamine has lower pH / ORA; [1]
or
equal concentration of both (solutions); [1]
measure conductivity of aqueous ethylamine and sodium hydroxide; [1]
ethylamine will have lower conductivity / sodium hydroxide will have higher conductivity; [1]

(c) add strong(er) base / NaOH / KOH; [1]
warm / heat; [1]

(d) (ethylamine forms) hydroxide ions / OH^- (in water); [1]
hydroxide ions / OH^- reacts with iron(III) ions / Fe^{3+};
or
iron(III) hydroxide / $Fe(OH)_3$ (forms as a brown precipitate); [1]
note: balanced or unbalanced ionic equation i.e. $Fe^{3+} + (3)OH^- \rightarrow Fe(OH)_3$ scores both marks

Question 18

7 **(a) (i)** CH_2/H_2C [1]

(ii) same ratio of C:H (atoms) / all cancel to CH_2 / because general formula is C_nH_{2n} / same ratio of atoms or elements (in the compound) / C:H ratio is 1:2; [1]

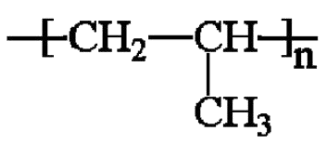
(b) (i) propanoic / propionic (acid); [1]
ethanoic / acetic (acid); [1]

(ii) formula of ethene / but-2-ene / any symmetrical alkene; [1]

(c) (i) $CH_3CH(Br)CH_2Br$ [1]

(ii) $CH_3CH(OH)CH_3$ / $CH_3CH_2CH_2OH$ / C_3H_7OH [1]

(d)



correct unit; [1]
accept: more than one repeat unit
continuation bonds at **both** ends; [1]

(e) if C_5H_{10} is given award 3 marks;;; [3]
if $C_{10}H_{20}$ is given award 2 marks;;
if 1:7.5:5 / 2:15:10 is given award 2 marks;;
in all other cases a mark can be awarded for moles of O_2 (= 2.4/32 =) 0.075 **AND** moles of CO_2 (= 2.2/44 =) 0.05;

$2C_5H_{10} + 15O_2 \rightarrow 10CO_2 + 10H_2O$ [1]
accept: multiples including fractions
allow: ecf for correct equation from any incorrect alkene

Question 19

5 **(a) (i)** correct -O- linkage; [1]
correct unit and continuation -O-□- (minimum); [1]

(ii) any name or correct formula of a (strong) acid / H^+; [1]

(iii) contain carbon hydrogen and oxygen /C, H and O; [1]

(b) (i) glucose → ethanol + carbon dioxide [1]

(ii) yeast is catalyst / provides enzymes / speeds up reaction / too slow without yeast; [1]
yeast cells grow / multiply / reproduce / undergo budding / breed; [1]

(iii) heat or high temperature would kill yeast (cells) / heat or high temperature denatures enzymes; [1]
not: enzyme killed / denatures yeast
reduces rate of reaction / slows reaction / (yeast or enzyme) no longer catalyses / no catalyst / stops reaction / no more product; [1]

(c) (i) would produce carbon dioxide or carboxylic or organic acids (if oxygen is present) / to prevent aerobic respiration / so products are not oxidised / anaerobic bacteria can't live with oxygen; [1]

(ii) fossil fuels have a reduced need / conserved / no need to import / will last longer / cracking hydrocarbons to make methane no longer required;
(methane) is renewable / carbon neutral;
reduce pollution of water or sea / prevents visual pollution / prevents need for waste disposal or accumulation (**accept:** any methods of waste disposal) / so that waste is recycled; **any two** [2]

Question 20

7 (a) burning
produces toxic gases / harmful to health
increases greenhouse gases / global warming
reduces visual pollution / litter
reduces risks to wildlife
shortage of landfill sites / reduces space needed in landfill sites / saves space
non-biodegradable / long time to rot / decompose / accumulates waste
burning source of energy / used to generate electricity

recycling
conserves petroleum / natural resources
difficult to recycle / expensive / takes much energy
problems over sorting
reduces need for landfill
quality of plastic is reduced each time it is recycled
four DIFFERENT valid points which are advantages or disadvantages of burning and/or recycling [4]

(b) (i) addition (polymerisation); [1]

(polymer) only product / no by-products; [1]

condensation (polymerisation); [1]

(polymer and) simple molecule / water / hydrogen chloride / one other product forms; [1]

(ii) a correct linkage (for a polyamide / polyester); [1]
two different monomers; [1]

[Total: 10]

Question 21

6 (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]

Question 22

(b) (i) correct structural or displayed formula of another chlorobutane / dichlorobutane / polychlorobutane [1]

(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**

Question 23

(b) (i) ester [1]

(ii) soap/sodium stearate or any acceptable salt/glycerol [1]

(iii) burning both fuels forms carbon [1]

growing plants to make biodiesel removes carbon dioxide from atmosphere [1]

(c) (i) correct SF of an octane [1]

(ii) add bromine (water)/bromine in an organic solvent [1]
result octane remains brown/orange/yellow/red [1]
result octane goes colourless/decolourises [1]
not clear/discolours
colour of reagent must be shown somewhere for [3] otherwise max [2]
accept equivalent test using $KMnO_4$ in acid or alkali

Question 24

8 (a) addition – polymer only product / only one product [1]
accept monomer has C=C
accept monomer and polymer have same empirical formula
accept no loss of material in polymerisation
not only one monomer

condensation – polymer and water / small molecule formed [1]

(b) $-CH_2 - CCl_2-$
repeat unit correct [1]
COND continuation [1]

(c) $CH_2=CHOOCCH_3$ [1]

(d) $-OC(CH_2)_4CONH(CH_2)_6NH-$
COND amide correct linkage [1]
correct repeat units [1]
continuation [1]
not NH_2 **or** COOH endings

Question 25

6 (a) (i) cracking / heat with catalyst [1]
to make butane [1]
butene reacts with steam/water / hydrated [1]
accept heat and catalyst for cracking but if specified: 450 to 800°C zeolites / aluminosilicates / silica / aluminium oxide/alumina / china / broken pot / porcelain / chromium oxide

(ii) glucose / sugar changed to alcohol / ethanol [2]
accept an unbalanced equation
(catalysed by) enzymes / yeast [1]

(b) butanoic acid [1]
$CH_3-CH_2-CH_2-COOH$ [1]
hydrogen atoms omitted from ends of bonds, penalise once

(c) (i) ester [1]

(ii) $C_6H_{12}O_2$
ignore $CH_3COOC_4H_9$ [1]

(iii) correct structural formula of butyl ethanoate showing all bonds [2]

Question 26

4	(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 500°C 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	[1]
			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	

Question 27

2	(a)	(i)	enzymes are proteins / come from living organisms / biological (catalysts)	[1]
			not enzymes are living or natural	
		(ii)	carbohydrates have 2H:1O ratio	[1]
			contain elements of water	[1]
			contain water = [1]	
			unless they state that carbohydrates contain water, this response scores 2 or 0	
	(b)		correct -O- linkage	[1]
			cond same correct monomer (this mark is lost if 2 different boxes are shown)	[1]
			cond continuation (i.e. bonds at **both** ends)	[1]
	(c)	(i)	(concentration or amount or mass etc.) of starch decreases (with time)	[1]
			(concentration etc.) of starch becomes zero / all starch gone	[1]
			colour (intensity) indicates how much starch is present (can be inferred)	[1]
		(ii)	enzyme denatured / destroyed	[1]
			not enzymes killed / don't work / saliva denatured	

Question 28

8 (a) biodegradable or breaks down naturally
made from a renewable source **or** does not use up petroleum

reduce visual pollution **or** reduces need for landfill sites **or** less danger to wildlife
any **TWO** [2]
ignore mention of toxic gases

(b) (i) ester [1]
accept polyester **or** fat **or** lipid **or** vegetable oil **or** carboxylic acid

(ii) acid **or** carboxylic acid **or** alkanoic acid [1]
alcohol **or** hydroxyl **or** alkanol [1]
NOT formulae **NOT** hydroxide

(iii) condensation [1]
COND because water is formed in reaction
or monomer does not have C=C bond [1]

(c) (i) lactic acid → acrylic acid + water [1]

(ii) add bromine (water) or bromine in an organic solvent [1]
remains brown/orange/yellow [1]
goes colourless **NOT** clear [1]
If mark 1 near miss e.g. bromide allow marks 2 and 3
Colour of reagent must be shown somewhere for [3] otherwise max [2]

OR acidified potassium manganate(VII)
purple/pink to colourless

OR alkaline potassium manganate(VII)
purple/pink to green
or purple/pink to brown precipitate

Question 29

(b) (i) fats **or** lipids [1]

(ii) -O- linkage, no other atoms in linkage [1]
COND same monomer [1]
COND continuation bonds at each end -A- [1]

(iii) **same** linkage **or** amide linkage **or** peptide **or** –CONH- [1]

differences
synthetic polyamide usually two monomers
protein many monomers
protein monomers are amino acids **or** proteins hydrolyse to amino acids **or** a protein monomer has one – NH_2 and one –COOH group
synthetic polyamide each monomer has 2 –NH_2 **or** 2COOH groups **or** monomers are dioic acid and diamine
accept diagrams **or** comments that are equivalent to the above
ANY **TWO** [2]

Question 30

(c) (i) biological catalyst [1]
accept protein catalyst

(ii) production of energy (from food) [1]
by living "things" **or** by cells, etc. [1]

(iii) "kill" yeast **or** denature enzymes (due to increase in temperature) [1]

(iv) all glucose used up [1]
yeast "killed" **or** denatured **or** damaged by ethanol/alcohol [1]

(v) filter **or** centrifuge [1]
fractional distillation [1]

Question 31

7 **(a)** butanol [1]
no number needed but if one is given it has to be 1

structural formula (all bonds shown) [1]
accept –OH **NOT** –HO

ethanoic acid [1]
structural formula (all bonds shown) [1]
accept –OH **NOT** –HO
no conseq marking
if all bonds are not shown (CH_3–CH_2–), penalise once

(b) **(i)** must have correct ester linkage [1]
COND continuation and a group on either side of the ester group [1]

Accept –COO–

(ii) accept any sensible suggestion
ropes, clothing, bottles, packaging, bags [1]

(c) **(i)** 8 [1]

(ii) double bond becomes single and 4 bonds per carbon atom [1]
COND a bromine atom on each carbon [1]
$C_2H_4Br_2$ ONLY [1]
accept a structural formula with hydrogen atoms

(iii) corn oil [1]

(d) 100g of fat react with 86.2g of iodine
884g of fat react with **762** g of iodine [1]
limit 762 x 2
one mole of fat reacts with 762/254 moles of iodine molecules
one mole of fat reacts with **3** moles of iodine molecules [1]

number of double bonds in one molecule of fat is **3** [1]
limit 6
consequential marking allowed provided the number of double bonds is an integer.

[Total: 14]

Question 32

1 **(a)** **(i)** coal **or** coke **or** peat [1]
NOT wood **or** charcoal

(ii) natural gas **or** methane **or** propane **or** butane **or** petroleum gases **or** calor gas **or** refinery gas [1]

(b) **(i)** petrol **or** gasoline
paraffin **or** kerosene
diesel
aviation fuel **or** jet fuel
fuel oil
heavy fuel oil
heating oil
Any **TWO** [2]
NOT a named alkane e.g. octane

(ii) waxes **or** grease **or** lubricants **or** polishes **or** bitumen (tar, asphalt) **or** naphtha [2]
Any **TWO** from the primary or secondary distillation of petroleum

(iii) (liquid) air **or** ethanol and water **or** alkenes (made by cracking) **or** Noble Gases [1]

[Total: 7]

Question 33

7 **(a)** **(i)** any correct equation **[1]**

(ii) structural formulae from but-1-ene, but-2-ene, methylpropene **or** cyclobutane Any **TWO** **[2]**

(b) **(i)** light **or** 200°C **or** lead tetraethyl **[1]**

(ii) substitution **or** photochemical **or** chlorination **or** free radical or halogenation **[1]**

(iii) 1-chlorobutane, 2-chlorobutane, dichlorobutane etc. Any **TWO** **[2]**

(c) **(i)** $CH_3CH_2CH_2OH$ **or** $CH_3CH(OH)CH_3$ **[1]**

(ii) $CH_3CH(Br)CH_2Br$ **NOT** 1,3-dibromopropane **[1]**

(d) moles of CH_3-CH = CH_2 reacted = 1.4/42 = 0.033 **[1]**
conseq
maximum moles of CH_3-CH(I)-CH_3 that could be formed = 0.033 **[1]**
conseq
maximum mass of 2-iodopropane that could be formed = 5.61 g **[1]**
accept 170 x 0.033 = 5.61 and 170 x 0.033333 = 5.67
conseq unless greater than 100%
percentage yield 4.0/5.67 x 100 = 70.5% **[1]**
Do not mark consequently to a series of small integers. There has to be a serious attempt to answer the question, then consequential marking is appropriate.

[TOTAL = 13]

Question 34

(iv) amide linkage **[1]**
COND different monomers **[1]**
continuation **[1]**
Accept hydrocarbon part of chain as boxes
If nylon 6 then only one monomer [1] **NOT** different monomers

(b) correct structure as syllabus (box representation) **[1]**
correct linkage --O-- **[1]**
continuation **[1]**

(c) **(i)** $C_6H_{12}O_6 = 2C_2H_5OH + 2CO_2$ **[2]**
not balanced [1]
Accept C_2H_6O

(ii) gives out energy **or** equivalent **[1]**
NOT heat
N.B. a total of [1] not [2]

(iii) glucose used up **or** yeast 'killed' by ethanol **[1]**
NOT yeast used up **NOT** reactant used up

(iv) oxidise alcohol to acid **or** to ethanoic acid **[1]**
or to carbon dioxide and water
or if oxygen present aerobic respiration
or cannot have anaerobic respiration in presence of oxygen
NOT it is anaerobic respiration, must be additional comment

(v) fractional distillation **[1]**

Question 35

3	(a)	(i)	CH_3-CH==CH_2	[1]
		(ii)	**conseq** to **(i)** correct repeat unit **COND** evidence of continuation	 [1] [1]
		(iii)	monomer **COND** because it has a double bond **or** unsaturated **or** alkene **NOT** addition	[1] [1]
	(b)	(i)	to remove fibres **or** remove solid **NOT** precipitate, **NOT** impurities, **NOT** to obtain a filtrate	[1]
		(ii)	because silver atoms have lost electrons **OR** oxidation number increased	[1]
		(iii)	silver chloride	[1]
	(c)	(i)	name of an ester formula of an ester if they do not correspond MAX [1] **Accept** name - terylene for formula ester linkage and continuation If a 'fat' complete structure must be correct e.g. $C_{17}H_{35}$ etc. Mark for formula only - [1]	[1] [1]
		(ii)	alcohol **or** alkanol **NOT** a named alcohol	[1]
	(d)	(i)	acid loses a proton base accepts a proton **OR** same explanation but acid loses a hydrogen ion (1) and base gains hydrogen ion (1)	[2] [1]
		(ii)	only partially ionised **or** poor hydrogen ion donor **or** poor proton donor **NOT** does not form many hydrogen ions in water **or** low concentration of hydrogen ions **NOT** pH	[1]

Question 36

6.	(a)	(i)	correct repeat unit **COND** evidence of polymer chain	[1] [1]
		(ii)	glucose **or** maltose	[1]
		(iii)	addition (polymerisation) **or** no other product except polymer condensation (polymerisation) **or** polymer and water	[1] [1]
	(b)	(i)	sodium hydroxide **COND** ammonia **or** alkaline gas **or** litmus red to blue If aluminium added wc =0	[1] [1]
		(ii)	measure pH more than 1 and less than 7 **or** correct colour eg orange **or** yellow **NOT** red **NOT** green **OR** add magnesium **or** calcium carbonate weak acid reacts slowly	[1] [1] [1]
	(c)	(i)	ethyl acrylate ester **or** alkene	[1] [1]
		(ii)	brown to colourless (**NOT** clear) correct formula for acid **NOT** ester	[1] [1]

Question 37

3	(a) (i)	Correct equation For giving correct formula of alkane and alkene [1] only Accept alkene and hydrogen		[2]
	(ii)	chlorine **COND** light **or** 200°C **or** heat **or** lead tetraethyl **or** high temperature MAX 1000°C ignore comment 'catalyst'		[1] [1]
	(b) (i)	same molecular formula different structures **or** structural formulae		[1] [1]
	(ii)	but-2-ene or cyclobutane corresponding structural formula NOT 2-butene		[1] [1]
	(c)	butanol butane dibromobutane	ignore numbers ignore numbers ignore numbers	[1] [1] [1]
	(d) (i)	propene		[1]
		CH_3—CH==CH_2		[1]
	(ii)	Correct structure of repeat unit ignore point of attachment of ester group COND upon repeat unit shows continuation If chain through ester group [0] out of [2]		[1] [1]
	(iii)	do not decay or non-biodegradable shortage of sites or amount of waste per year visual pollution forms methane Any TWO		[2]
	(iv)	form poisonous **or** toxic gases **or** named gas CO, HCl HCN NOT carbon dioxide, harmful, sulphur dioxide		[1]

Question 38

6	(a) (i)	heat (energy)		[1]
	(ii)	exothermic		[1]
	(iii)	$C_2H_5OH + 3O_2 = 2CO_2 + 3H_2O$ For $CO_2 + H_2O$ **ONLY** [1]		[2]
	(iv)	plotting points correctly straight line between –2640 and –2700kJ/mol **NOTE** minus sign needed		[1] [1] [1]
	(v)	general (molecular) formula same functional group consecutive members differ by CH_2 similar chemical properties **or** react same way **NOT** a comment about physical properties **ANY TWO**		[2]
	(b)	CH_3- CH(OH)-CH_3 **NOT** C_3H_7OH propan-2-ol "2" is needed **NOTE** the name and the formula must correspond for both marks accept full structural formula – all bonds shown correctly accept formulae of the ether **NOT** CH_3- CH(HO)-CH_3		[1] [1]

(c) (i) cracking
heat (alkane) **or** (alkane) and catalyst
NOTE thermal cracking or catalytic cracking [2]
alkane = alkene + hydrogen
ANY TWO [2]

OR steam reforming
$CH_4 + H_2O = CO + 3H_2$ [2]
or water/steam [1]
catalyst **or** heat [1]

(ii) combustion **or** burning [1]
incomplete **or** insufficient oxygen/air [1]
OR ACCEPT steam reforming as above [2]

(iii) high pressure [1]
COND forward reaction volume decrease
or volume of reactants greater than that of products
or fewer moles of gas on the right
or fewer gas molecules on right [1]
NOTE accept correct arguments about either reactants **or** products

(d) (i) methyl ethanoate [1]

(ii) propanoic acid **or** propanal [1]

(iii) ethene [1]

[Total: 20]

Question 39

8 (a) (i) biological catalyst [1]

(ii) linkage ----O----
same unit as in glucose as on question paper that is rectangles [1]

(iii) chromatography [1]

(b) (i) --NHCO—linkage
different units
-NH and -CO on same monomer unit
All three [2] two points [1] [2]

(ii) amino acids [1]

(c) (i) propanol + ethanoic acid = propyl ethanoate + water [2]
reactants [1] products [1]

(ii) ester linkage correct [1]
rest of molecule correct [1]

(iii) bromine water [1]
fat 1 orange **or** yellow **or** brown to colourless [1]
fat 2 remains orange **or** yellow **or** brown [1]
Accept Potassium Manganate(VII) with corresponding colour changes

(iv) soap or sodium salts (of carboxylic acids)/sodium stearate [1]
alcohol/glycerol [1]

[TOTAL = 15]

Question 40

Question 4

(a)(i) general molecular formula
same functional group
physical properties show trend — bp increase with n
same chemical properties
common methods of preparation
any **TWO** **[2]**

(ii) $C_8H_{17}OH$ Mass of one mole = 130 (g) **[2]**
if formula correct but mass wrong **[1]**

(b) propan-1-ol **or** propan-2-ol **[1]**
corresponding structural formula **[1]**
name and formula must correspond for **[2]** if not **ONLY [1]**

(c)(i) structural formula of isomer **[1]**

(ii) carbon dioxide and water **[1]**
pentene **[1]**
pentanoic acid **[1]**

TOTAL = 10

Question 41

(b)(i) calcium ethanoate + hydrogen **[1]**

(ii) zinc oxide **or** hydroxide **[1]**

(c) $CH_3COOH + NaOH \rightleftharpoons CH_3COONa + H_2O$ **[2]**
reactants **[1]** products **[1]**

Question 42

8 (a) (i) C_6H_{12} **[1]**
between 60 to 65°C **[1]**

(ii) $C_{12}H_{24}$ **[1]**
COND giving some indication of the method **[1]**

(b) add bromine water **or** potassium manganate(VII) **[1]**
butene it goes from brown/orange/yellow to colourless
or manganate (VII) from pink to colourless **[1]**
NOT clear
Cyclobutane it remains brown/orange/yellow **or** manganate (VII) stays pink
or no colour change **[1]**
Accept does not react
Provided colour of reagent somewhere in the answer [3] is possible

(c) (i) alcohol **[1]**

(ii) CH_3-CH_2-CHCl-CH_3 **[1]**

(iii) -$CH(CH_3)$-$CH(CH_3)$- **[2]**
or any equivalent diagram
[1] for repeat unit and [1] for continuation

Question 43

6	(a)	(i)	correct structure $CH_2=CCl_2$	[1]
		(ii)	because it has a lower M_r **or** density **or** its molecules move faster it is lighter ONLY [1] only comment - smaller molecules [0] answer implies or states sieve idea then [0]	[2]
	(b)	(i)	ester linkage	[1]
			COND polymer chain showing different monomers and continuation $-OOC-C_6H_4-COOCH_2CH_2O-$	[1]
		(ii)	fats **or** lipids	[1]
		(iii)	does not decompose easily when heated accept similar statements	[1]
	(c)	(i)	does not decompose **or** non-biodegradable shortage of landfill sites **or** of space visual pollution poisonous/toxic/harmful gases when burnt **NOT** carbon monoxide, sulphur dioxide. If gas named has to be a correct one eg HCl, HCN dangerous to animals Any **TWO**	[2]
		(ii)	conserve petroleum or save energy **NOT** cheaper	[1]
				TOTAL = 10

Question 44

	(b)	(i)	CO_2 and H_2O	[1]
			balanced $2CH_3OH + 3O_2 = 2CO_2 + 4H_2O$	[1]
		(ii)	methyl ethanoate	[1]
			water	[1]
		(iii)	Methanoic (acid) accept formic acid	[1]

Question 45

4	(a)	(i)	in which something dissolves	[1]
		(ii)	correct formula $CH_3COOC_2H_5$ **or** full structural formula	[1]

NOT $C_4H_8O_2$

(iii) steam **or** water **or** hydration [1]
heat **or** catalyst [1]

OR bubble into (concentrated) sulphuric acid [1]
add water [1]

oxidised [1]
by air **or** dichromate **or** manganate(VII) [1]

(iv) ethanoic acid and butanol [1]

(b) (i) CH_2OH [1]
CHOH
CH_2OH

(ii) soap **or** detergent [1]

(c) (i) polyester **or** condensation polymer **NOT** terylene [1]

(ii) HOOC – [ ] – COOH [1]

HO – [ ] – OH [1]

If wrong way around [1] Point of attachment of functional group to "box" not important

(d) (i) protein **or** poly peptide **or** polyamide [1]
(ii) peptide **or** amide [1]
(iii) amino acids are colourless **or** become visible/coloured **or** to develop it [1]
(iv) using colour **or** from position **ONLY** [1]
OR discussion of Rf [2]
OR compare with known amino acids [2]

TOTAL = 17

Question 46

(ii) measure rate in different light levels and comment [1]
accept if dark no reaction

(c) (i) $+6O_2$ [2]
not balanced that is just O_2 **ONLY** [1]
(ii) linkage ---O---- [1]
chain [1]
minimum to be accepted

Question 47

5 (a) molecular formula [1]
Must be able to give isomers, need not be alkenes
two corresponding isomers [2]
If do not correspond then MAX [2] out of [3]

(b) (i) ethanol [1]
structure [1]

(ii) ethane [1]
structure [1]

(c) (i) many simple molecules **or** monomers [1]
form one large one **or** macromolecule or chain [1]

(ii) addition polymer only one product- the polymer [1]
condensation - polymer and water etc [1]

(iii) correct unit [1]
COND evidence of polymer in structure eg shows continuation such as terminal bonds [1]

(d) (i) water proof **or** impervious **or** flexible **or** good adhesion **or** non-biodegradable **or** unreactive [1]

(ii) steel in contact with water **or** air [1]

(iii) zinc more reactive
oxygen /water reacts with zinc not iron
sacrificial protection
zinc anodic
steel receives electrons from zinc
zinc forms cations
cell
TWO valid points [3]

TOTAL = 17

Question 48

8 **(a)** same general formula
same chemical properties
same functional group
physical properties vary in predictable way
common methods of preparation
consecutive members differ by CH_2
any **two** [2]
mark first two
ignore others unless it contradicts a point which has been awarded a mark

(b) **(i)** $2HCOOH + CaCO_3 \rightarrow Ca(HCOO)_2 + CO_2 + H_2O$ [2]
not balanced = [1]

(ii) zinc + methanoic acid → zinc methanoate + hydrogen [2]
[1] for each product

(iii) protected by oxide layer [1]

(c) butanoic acid [1]
$CH_3\text{-}CH_2\text{-}CH_2\text{-}COOH$ / $C_4H_8O_2$ / C_3H_7COOH / C_4H_7OOH [1]
C_2H_4O [1]
mark **ecf** to molecular formula

Question 49

4 (a) (i) ethanol [1]
CH_3-CH_2-OH [1]

propanoic acid [1]
CH_3-CH_2-COOH [1]
independent marking, no ecf
accept C_2H_5
not – HO

(ii) type of compound – salt / sodium carboxylate / alkanoate [1]
not soap / sodium stearate etc
use – soap / cleaning / detergent [1]

(iii) terylene / PET / Dacron / diolen / mylar / crimplene [1]

(b) (i) polyamide / amide / peptide / polypeptide [1]

(ii) correct amide linkage NHCO then CONH [1]
cond to mark 1, 2 monomers (different shading in box) [1]
cond continuation (to **ONE** correct linkage) [1]

OR nylon 6
only one linkage – NHCO [1]
cond only one monomer [1]
cond continuation (to correct linkage) [1]

(iii) use locating agent [1]
measure distance travelled by sample / travelled by solvent front [1]
cond this is $R_f = 0.5$ [1]
for mark 3, either mark 1 or mark 2 must be awarded

accept run a chromatogram of glycine [1]
compare with sample
same position [1] max [2]

Question 50

(iii) chlorine [1]
not chlorine water
cond light / UV / heat / high temperature if numerical value given about 200°C / lead tetraethyl [1]
not warm

Question 51

6 (a) (i) C and H only (1) [1]

(ii) only single bonds (1) [1]

(b) (i) C_nH_{2n+2} (1) [1]

(ii) $C_{14}H_{30}$ (1)
$(14 \times 12) + 30 = 198$ (g) (1) [2]

(c) (i) $C_9H_{20} + 14\ O_2 \rightarrow 9CO_2 + 10H_2O$ (2) [2]

(ii) Volume ratio

$C_xH_y(g)$	+ $O_2(g)$	→ $CO_2(g)$	+ $H_2O(l)$	
20	160	100		all in cm^3
1	8	5		mole ratio

$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$
For evidence of method (1)
for equation as above (2) [3]

(d) (i) alkanes in petrol / fuel / solvent (1)
alkenes to make alcohols / plastics / polymers / solvents (1)
hydrogen to make ammonia / fuel / fuel cells, etc. (1) [3]

(ii) a correct equation for example:
$C_{10}H_{22} \rightarrow C_8H_{16} + C_2H_4 + H_2$ (1) [1]

(e) (i) light **or** lead tetraethyl / catalyst / high temperature (1) [1]

(ii) CH_3–CHCl–CH_3 (1) [1]

[Total: 16]

Question 52

(b) correct linkage (1)
rest of molecule correct **and** continuation shown (1)
(other product is) water (1) [3]

Question 53

4 (a) (i) butanoic/butyric acid (1)

$CH_3CH_2CH_2COOH / C_2H_5CH_2COOH$ (1) [2]

(ii) any **three** from:

(same) general formula (1)

(consecutive members) differ by CH_2 (1)

same functional group (1)

common methods of preparation (1)

physical properties vary in predictable manner/show trends/gradually change
or example of a physical property variation i.e. melting point/boiling point/volatility (1) [3]

(b) (i) displayed formula of propan-1-ol, all bonds shown separately (1) [1]

(ii) acidified (1)

potassium manganate(VII)/potassium permanganate/$KMnO_4$ **or** potassium dichromate(VI)/$K_2Cr_2O_7$/potassium dichromate (1) [2]

(c) (i) zinc + propanoic acid → zinc propanoate (+ hydrogen) (1) [1]

(ii) calcium oxide + propanoic acid → calcium propanoate + water (1) [1]

(iii) $LiOH + CH_3CH_2COOH \rightarrow CH_3CH_2COOLi + H_2O$ (1) [1]

(d) (i) concentration (of acid in C) is less/halved **or** concentration of A is more/doubled. (1)

less collisions **or** more collisions in A (than in C) (1) [2]

(ii) (higher temperature in B particles/molecules/atoms) move faster/have more energy/more have E_a **or** (particles/molecules/atoms) in A move slower/have less energy/less have E_a (1)

more collisions **or** less collisions in A (than in B) (1) [2]

(iii) It (D) has strong (acid) **and** A has weak acid/(D) stronger/(D) ionises more/(D) dissociates more **or** A is weaker/A ionises less/A dissociates less (1)

It (D) has higher concentration of hydrogen ions **or** A has a lower concentration of hydrogen ions (1)

more collisions (in D) **or** fewer collisions in A (1) [3]

[Total: 18]

Question 54

2 (a) (i) substance/material/compound/element/mixture (burnt) to produce/release energy **or** heat (1) [1]

(ii) Any **two** from:
coal
coke
peat
petroleum/ crude oil
refinery gas/LPG
gasoline/petrol
naptha
kerosene/paraffin
diesel (oil)/gas oil
fuel oil
propane
butane [2]

(iii) wood/charcoal/animal dung/biomass/Uranium/U/plutonium/Pu (1) [1]

(b) (i) any **two** from:
water/steam/water vapour/H_2O (1)
carbon dioxide/CO_2 (1)
carbon monoxide/CO (1) [2]

(ii) any **two** from:

limited or finite resource/non-renewable/will run out/depleted (1)

greenhouse effect/gas(es)/climate change/(cause) global warming (1)

acid rain (1)

production of poisonous/toxic gases (1) [2]

[Total: 8]

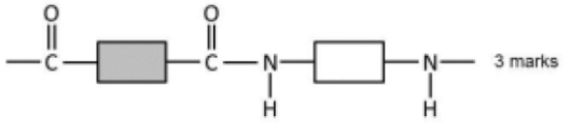
Question 55

8 (a) (i) $CH_3–CH=CH–CH_3$ (1) [1]

(ii) one correct amide linkage between two rectangles (1)

correct sequencing of a second amide link and monomers (1)

two correct amide links **and** rest of structure correct (including additional monomers if seen) **and** correct continuation bonds (1) [3]



3 marks

(iii) protein **or** polypeptide **or** named protein (1) [1]

(iv) addition: **only** the polymer **or** one product is formed (1)

condensation: the polymer **and** a small molecule / water / HC*l* is formed (1) [2]

(b) (i) does not break down **or** rot **or** decompose (1)

by microbes **or** fungi **or** bacteria **or** by living organisms (1) [2]

(ii) Any **three** from: [3]
visual pollution (1)

(shortage of) landfill sites (1)

danger to wildlife / animals (including at sea) (1)

toxic gases when burnt **or** greenhouse gases produced when burned (1)

(c) Any **two** from: [2]
resistant to corrosion / unreactive to water / more durable (1)

lighter / less dense (1)

easier to manufacture / can be moulded (1)

good insulator / keeps the water cold (1)

[Total: 14]

Question 56

7 (a) (i) $CH_3COOCH_2CH_3$ / $CH_3CO_2CH_2CH_3$ / $CH_3COOC_2H_5$ / $CH_3CO_2C_2H_5$ / $C_2H_5OOCCH_3$ / $CH_3CH_2OOCCH_3$ **not:** –OCO– linkage [1]
note: formulae can be displayed or semi-displayed
note: penalise sticks (i.e. any missing atoms)

(ii) butyl methanoate [1]

(b) (i) fats / vegetable oils / triglycerides / lipids [1]

(ii) two correct ester linkages, e.g. –OOC / $–O_2C$ and –COO / $–CO_2$ [1]

contents of the 'boxes' being C_6H_4 and C_2H_4 or CH_2CH_2 [1]
continuation bonds at **both** ends [1]

Question 57

5 (a) (i) does not decay **or** non-biodegradable **or** flexible **or** bendable **or** easily moulded **or** low density / light / lightweight **or** waterproof / insoluble in water **or** does not corrode **or** durable [1]

(ii) any two from: [2]
chlorine
hydrogen chloride
carbon monoxide

(b) (i) $CH_3—CH = CH_2$ [1]
note: can be fully or semi-displayed, C = C must be shown

(ii) correct repeat unit [1]
$–CH(C_6H_5)–CH_2–$

continuation shown [1]

(c) glucose two products (polymer and water) / condensation (polymerisation) / (small) molecules removed [1]

phenylethene one product (polymer) / addition (polymerisation) [1]

Question 58

(b) (i) $C_8H_{18} \rightarrow 2C_4H_8 + H_2$ [1]

(ii) $2H^+ + 2e \rightarrow H_2$ [2]

or $2H_3O^+ + 2e \rightarrow H_2 + 2H_2O$
accept: –2e on right hand side accept: e^-
note: not balanced = 1

Question 59

7 (a) (i) a compound which contains carbon and hydrogen **only** [1]

(ii) alkanes contain **only** C-C single bonds
or they are saturated (hydrocarbons)
or have the general formula C_nH_{2n+2} [1]

alkenes contain at least one C=C double bond
or they are unsaturated (hydrocarbons)
or have the general formula C_nH_{2n} [1]

(b) $C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + \mathbf{C_8H_{18}}$ [1]

(c) (i) any unambiguous structure of $BrCH_2CH_2Br$ [1]
NOT just $C_2H_4Br_2$

(ii) $CH_3\text{-}CH{=}CH\text{-}CH_3$ [2]
For any butene [1] only

(iii) $(CH_3\text{-}CH_2\text{-}CH{=}CH_2) + H_2O$ [1] $\rightarrow$ $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2OH$ [1] [2]
ALLOW $CH_3\text{-}CHOH\text{-}CH_2\text{-}CH_3$
butene reacts with **water/steam** (to form butanol) **ONLY [1]**

(iv) $C_6H_{12} + H_2 \rightarrow C_6H_{14}$ [2]
alkenes react with **hydrogen** [1] **ONLY**

(d) volume of oxygen used = 150 cm^3 [1]

volume of carbon dioxide formed = 100 cm^3 [1]
any equation of the combustion of an alkene
e.g. $2C_5H_{10} + 15O_2 \rightarrow 10CO_2 + 10H_2O$
formulae [1]
COND balancing [1]

Question 60

6 (a) (i) measure melting point **NOT** just heating [1]
pure sample would melt at 135 °C [1]
OR impure would melt lower than 135 °C

(ii) $C_3H_4O_4$ [1]

(iii) $C_2H_4O_2$ **OR** CH_3COOH [1]
ethanoic **OR** acetic acid [1]
both marks are independent of each other

(iv) ester **NOT** organic, covalent [1]

(b) (i) malonic is a weaker acid/less dissociated
OR sulfuric acid is a stronger acid/more dissociated [1]
NOT sulfuric acid is a strong acid

(ii) add piece of suitable metal, e.g. Mg **ALLOW** Al, Ca **NOT** K, Na, Cu [1]

sulfuric acid reacts fast**er** **OR** malonic reacts slow**er** [1]

OR
as above add a piece of $CaCO_3$, if soluble carbonate then [1] only

OR measure electrical conductivity [1]
sulfuric acid is the bett**er** conductor
OR malonic acid poor**er** conductor [1]
NOT sulfuric acid is a good conductor

(c) (i) sodium malonate **and** water [1]

(ii) $CuSO_4$
H_2O [2]

(iii) $CH_2(COO)_2Mg$
H_2 [2]

(iv) K_2SO_4
CO_2 **and** H_2O **NOT** H_2CO_3 [2]

[Total: 16]

Question 61

7	(a)	correct method shown i.e. 126/14 (= 9) **or** 14x = 126 **or** x = 9 **or** (12 × 9) + 18 = 126	[1]
		C_9H_{18} **note:** correct formula only = 1	[1]
	(b) (i)	all hydrogen atoms 1bp	[1]
		C—C bond atoms 1bp	[1]
		C=C 2 bp	[1]
	(ii)	correct repeat unit	[1]
		continuation	[1]
	(iii)	bonds broken H-H +436 (kJ/mol) C=C +610 = +1046 (kJ/mol)	[1]
		bonds formed 2C-H −415 × 2 kJ/mol C-C −346 = −1176 (kJ/mol)	[1]
		−130 kJ/mol / more energy released than absorbed	[1]
		or: bonds broken 3882 (kJ/mol)	[1]
		bonds formed 4012 (kJ/mol)	[1]
		−130 kJ/mol / more energy released than absorbed	[1]
		allow: ecf for final mark as long as the answer is not positive **note:** units not necessary	
	(c) (i)	butan-1-ol or butan-2-ol or butanol	[1]
	(ii)	CH_3-CH_2-CH(Br)-CH_2Br $C_4H_8Br_2$ = 1 **note:** any other dibromobutane = 0	[2]
	(iii)	HI	[1]

Question 62

2	(a) (i)	molecule / unit / simple compound / building block **and** used to make a polymer / big molecule / long chain / macromolecule	[1]
		formation of a polymer / big molecule / long chain / macromolecule **or** joining of monomers **and** elimination / removal / formation of a simple or small molecule / H_2O / HCl **note:** two points needed for 1 mark in both parts	[1]
	(ii)	-O- linkage	[1]
		three correct monomer units	[1]
		continuation	[1]
	(b) (i)	catalyst **and** from living organism **accept:** biological catalyst / protein catalyst	[1]
	(ii)	enzyme denatured / destroyed	[1]
	(iii)	chromatography	[1]
		locating agent / description of locating agent	[1]
		measure R_f / compare with standards	[1]

Question 63

7 **(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]

Question 64

5 **(a)** $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}OH$ [1]
88 [1]
156 to159 °C [1]

(b) any two from:
(same) general (molecular) formula
same functional group
consecutive members differ by $–CH_2$
common methods of preparation

(c) correct structure **and** 4bp around carbon [1]
2bp and 2nbp around oxygen [1]
1bp on hydrogens [1]

(d) **(i)** correct structural formula for propanoic acid [1]
allow: OH but all other bonds to be shown

(ii) air / oxygen [1]
bacteria / microbes / micro-organisms [1]
accept: mother of vinegar
not: yeast

(e) propyl ethanoate [1]
allow: $CH_3COOC_3H_7$ **not:** $C_5H_{10}O_2$ [1]

Question 65

6 (a) (i) correct structural formula of ethanoic acid [1]
allow: –OH **not:** –COOH

(ii) correct structural formula of ethanol [1]
allow: –OH

(b) (i) ethyl ethanoate [1]

(ii) $-OC_6H_4COOCH_2CH_2O-$
correct ester linkage [1]
correct repeat units [1]
continuation [1]
accept: boxes if it is clear what the box represents

(iii) any **two** from:
long time to decay
landfill sites
visual pollution / litter
danger to animals
poisonous gases when burnt [2]
accept: any correct suggestion

(c) synthetic – only two monomers [1]
protein – many different monomers [1]
or:
protein has 1 C=O and 1N–H [1]
nylon has 2 C=O / 2N–H [1]
or:
synthetic – one monomer is a dicarboxylic acid and the other is a diamine [1]
protein all monomers are amino acids [1]

Question 66

5 (a) (i) many (simple) molecules form one (large) molecule / monomer molecules form one polymer molecule [1]

(ii) addition - polymer is the only product [1]
accept - nX → Xn
condensation polymer and simpler molecules formed [1]
accept nX → Xn + nHC*l* / H_2O

(b) (i) $C_{12}H_{26} \rightarrow C_8H_{18} + 2C_2H_4$ [1]
/ any other correct version

(ii) ethane and chlorine give range of products [1]
/ ethene more readily available than ethane
/ waste half chlorine as hydrogen chloride
/ ethene more reactive than ethane

(iii) electrolysis [1]
aqueous sodium chloride [1]

(iv) must have **three** correct units [1]
cond continuation [1]
accept –(CH2–CH(C*l*))n–

[Total: 9]

Question 67

6 **(a)** same general formula
consecutive members differ by CH_2
same chemical properties
same functional group
physical properties vary in predictable way / give trend – mp increases with n etc.
common methods of preparation
any **THREE** [3]

(b) **(i)** they have the same molecular formula [1]
not general formula
different structures / structural formulae [1]

(ii) CH_3-CH_2-CH(OH)-CH_3 / $(CH_3)_3C$-OH [1]
not ether-type structures
NOTE butan-2-ol and 2-methylpropan-2-ol acceptable

(c) **(i)** air/oxygen / (acidified) potassium chromate(VI) /
(acidified) potassium manganate(VII) [1]
must have oxidation states

(ii) carboxylic acid / alkanoic acid [1]
CH_3-CH_2-CH_2-COOH / C_3H_7COOH / $C_4H_8O_2$ [1]
accept C_4H_7OOH

(d) **(i)** measure <u>volume</u> of carbon dioxide [1]
time [1]
accept day / hour for time mark

(ii) increase in temperature / more yeast present / yeast multiplies [1]

(iii) glucose used up [1]
accept sugar **not** reagent / reactant

concentration of ethanol high enough to kill/poison yeast / denature enzymes [1]
not kill enzymes

(iv) to prevent aerobic respiration [1]
/ ethanol would be oxidised / ethanoic acid/ acid formed / lactic acid formed / carbon dioxide and water formed

[Total: 15]

Question 68

5 **(a)** **(i)** contains carbon, hydrogen and oxygen [1]
accept example
ratio 2H : 1O [1]
not contains water
ignore comments about carbon

(ii) living organism / plants and animals / cells [1]
<u>obtain energy</u> from food [1]
not burn negates energy mark

(iii) carbohydrates contain oxygen [1]

(iv) as a fertiliser / manure [1]

(b) **(i)** 80 cm^3 of oxygen therefore 40 cm^3 of methane [1]
40/60 × 100 = 66.7 % [1]
accept 66 % and 67 %
no ecf

(ii) add sodium hydroxide(aq) / alkali [1]
carbon dioxide dissolves, leaving methane [1]

[Total: 10]

Question 69

7 (a) (i) lighter / light / lightweight / lower density [1]
does not corrode / rust / oxidised [1]
ignore cheaper / easier to mould

(ii) credit any two sensible suggestions e.g. rope / clothing / netting / string / carpets / fishing line / fishing nets / parachutes / tyres / tents / bottles / thread / umbrellas / curtains / toothbrushes / cassettes / video tapes [2]

(iii) non-biodegradeable / do not rot / do not decompose / persist for years / accumulate
landfill sites limited / getting filled up
visual pollution
danger to fish / animals
(burn to form) toxic gases / harmful gases / pollutant gases / acidic gases / CO / HC*l* / HF / HCN
not oxides of nitrogen / sulfur
any three [3]

(b) (i) propene / propylene [1]
accept prop-1-ene
not prop-2-ene
CH_3-CH=CH_2 [1]
double bond must be shown

(ii) correct repeat unit (one or more **whole** repeat units must be given) [1]
cond continuation [1]

(c) (i) amide / peptide / polypeptide [1]

(ii) protein / polypeptide [1]

(iii) $H_2N(CH_2)_6NH_2$ [1]
$HOOC(CH_2)_8COOH$

[Total: 15]

Question 70

5 (a) (i) $Mg + 2CH_3COOH \rightarrow (CH_3COO)_2Mg + H_2$ [1]
correct formula of magnesium ethanoate [1]
ignore charges

sodium ethanoate + water [1]

(ii) ethyl ethanoate [1]
displayed formula [1]

(b) (i) add up to 5.8 g [1]

(ii) moles of C atoms = 2.4/12 = 0.2
moles of H atoms = 0.2/1 = 0.2
moles of O atoms = 3.2/16 = 0.2
all three correct = 2 [2]
two correct = 1
empirical formula CHO [1]

(iii) 116/29 = 4 [1]
$C_4H_4O_4$ [1]
correct formula with no working scores both marks.

(iv) HOOCCH=CHCOOH / CH_2=C(COOH)$_2$ [2]

[Total: 13]

Question 71

7	(a)	(i)	heat catalyst	[1] [1]
		(ii)	an equation that gives: alkene + alkane **or** alkene + alkene + hydrogen	[1]
			a correct and balanced equation for the cracking of decane, $C_{10}H_{22}$ but not but-1-ene	[1]
		(iii)	water **or** steam	[1]
	(b)	(i)	$C_4H_9OH + 6O_2 \rightarrow 4CO_2 + 5H_2O$ If only error is balancing the oxygen atoms	[2] [1]
		(ii)	butanol + methanoic acid → butyl methanoate + water correct products **or** reactants ONLY	[2] [1]
	(c)	(i)	correct structural formulae [1] each accept either propanol and –OH in alcohol and acid penalise once for CH_3 type diagrams For either C_3H_8O **or** $C_3H_6O_2$ [0]	[2]
		(ii)	to conserve petroleum **or** reduce greenhouse effect	[1]
	(d)		have same boiling point	[1]
				[Total: 13]

Question 72

	(c)	(i)	structural formula of Ge_4H_{10} all bonds shown	[1]
		(ii)	germanium(IV) oxide water	[1] [1]

Question 73

7	(a)	(i)	$35\,cm^3$ $40\,cm^3$	[1] [1]
		(ii)	forms carbon monoxide	[1]
			poisonous **or** toxic **or** lethal **or** prevents blood carrying oxygen **or** effect on haemoglobin **NOT** just harmful	[1]
	(b)	(i)	chlorobutane **or** butyl chloride number not required but if given must be 1, it must be in correct position	[1]
		(ii)	light **or** UV**or** 200°C **or** lead tetraethyl	[1]
		(iii)	any correct equation for example 2-chlorobutane **or** dichlorobutane	[1]
	(c)	(i)	correct repeat unit **COND** continuation $-(CH(CH_3)-CH_2)-$	[1] [1]
		(ii)	butan-1-ol **or** butan-2-ol **or** butanol if number given then formula must correspond for second mark and number must be in correct position	[1]
			structural formula of above $CH_3-CH_2-CH_2-CH_2OH$ **or** $CH_3-CH(OH)-CH_2-CH_3$ **NOT** C_4H_9OH if first mark not awarded then either formula will gain mark [1] **ACCEPT** either formula for "butanol"	[1]
		(iii)	$CH_3-CH(Cl)-CH_3$ **or** $CH_3-CH_2-CH_2-Cl$ **NOT** C_3H_7Cl response must not include HCl if equation given look at RHS only	[1]
				[Total: 12]

Question 74

(b)	**(i)**	sterilise/disinfect water **or** kill microbes/germs bacteria, etc. **NOT just** to make it safe to drink **or** purify it **or** clean it treat above as neutral they do not negate a correct response	[1]
	(ii)	ammonia **or** methanol **or** hydrogen chloride **or** margarine **NOT** nylon	[1]
	(iii)	fat **or** lipid **or** triester **or** named fat **or** glyceryl stearate **or** vegetable oil heat	[1] [1]

Question 75

4	**(a)** **(i)**	C_6H_5COOH **or** $C_6H_5CO_2H$ **NOT** $C_7H_6O_2$ /C_6H_6COO	[1]
	(ii)	sodium hydroxide + benzoic acid = sodium benzoate + water correct spelling needed **NOT** benzenoate **ACCEPT** correct symbol equation	[1]
	(iii)	sodium carbonate **or** oxide **or** hydrogencarbonate any **TWO** **NOT** Na	[2]
	(b) **(i)**	7.7%	[1]
	(ii)	for any number: equal number ratio for example 1:1 **or** 6:6	[2]
	(iii)	empirical formula is CH molecular formula is C_6H_6 no e.c.f., award of marks not dependent on **(ii)**	[1] [1]
	(c) **(i)**	$C_6H_8O_6$	[1]
	(ii)	carbon – carbon double bond **or** alkene alcohol **or** hydroxyl **or** hydroxy **NOT** hydroxide hydroxide and alcohol = 0	[1] [1]
			[Total: 12]