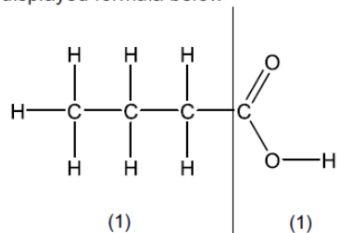


# Marking Scheme : Organic (IGCSE 0620)

## Question 1

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

displayed formula below [2]



(ii) any **three** from:  
 same or similar chemical properties  
 (same) general (molecular) formula  
 (consecutive members) differ by CH<sub>2</sub>  
 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<sup>+</sup>/H<sub>3</sub>O<sup>+</sup> (as the only positive ion) [1]

(b) (i) methyl propanoate [1]

CH<sub>3</sub>CH<sub>2</sub>COOCH<sub>3</sub>/CH<sub>3</sub>CH<sub>2</sub>CO<sub>2</sub>CH<sub>3</sub>/C<sub>2</sub>H<sub>5</sub>COOCH<sub>3</sub>/C<sub>2</sub>H<sub>5</sub>CO<sub>2</sub>CH<sub>3</sub> [1]

(ii) methyl ethanoate [1]

(c) (i) 3C<sub>4</sub>H<sub>10</sub> + 5 ½ O<sub>2</sub> → 4C<sub>2</sub>H<sub>5</sub>COOH + 3 H<sub>2</sub>O [1]

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

[Total: 14]

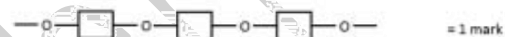
## Question 2

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<sub>4</sub>H<sub>8</sub> only [2]  
 CH<sub>2</sub> (Allow C<sub>1</sub>H<sub>2</sub>)

(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) Ignore steam. Ignore pressure. [1]

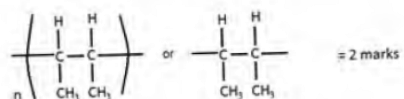
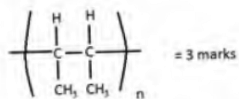
M2 Long-chained molecules or alkanes form smaller molecules (not smaller fraction) or forms smaller alkenes (or alkanes) [1]

- (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 8.8g [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  $C_{17}H_{33}$  [1]  
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  
hydrogen (atom) to oxygen (atom) ratio is 2:1  
**ALLOW:** C:H:O as 1:2:1 or  $C_n(H_2O)_n$  [1]  
[1]
- (ii) condensation [1]  
polymerisation [1]
- (b) (i) cells / micro-organisms / plants / animals / metabolic reactions  
obtaining energy from food / glucose / nutrients [1]  
[1]
- (ii)  $2C_2H_5OH + 2CO_2$  [1]  
allow:  $C_2H_6O$  for  $C_2H_5OH$   
not balanced = (1) only [2]
- (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 [1]  
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 [1]  
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  $CH_2-CH(CN)$  [1]  
**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:** HCl / 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 [1]  
 indicator / use pH meter;  
**COND:** on reagent
- metal - hydrogen given off / metal dissolves / effervescence / gas given off / [1]  
 burning splint pops;
- carbonate - carbon dioxide given off / effervescence / gas given off / limewater [1]  
 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)  $\text{HOOC}(\text{CH}_3)\text{C}=\text{C}(\text{CH}_3)\text{COOH}$  [1]

[Total: 12]

### Question 12

- 7 (a) (i)  $\text{C}_n\text{H}_{2n+1}\text{OH}$  [1]
- (ii)  $116-17 = 99$ ,  $2n+1 = 99$ ,  $n = 7$  [1]  
 for any evidence of working out [1]  
 $\text{C}_7\text{H}_{15}\text{OH}$  [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: [1]  
 higher temperature / catalyst causes faster reaction; [1]  
 comment about compromise conditions to give best rate and yield; [1]  
 at 250°C (lower temp) higher yield / forward reaction favoured; [1]  
 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;  
could produce HCl;  
**or**  
could produce dichloropropanes = [2] [1]
- (b) (i) add silver nitrate / lead nitrate;  
yellow precipitate;  
**note:** do not insist on presence of dilute nitric acid [1]
- (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;  
any two  
**accept:** reverse arguments for B [2]
- (ii) halogens  $Cl > Br > I$  reactivity / reactivity decreases down group;  
organic halides  $I > Br > Cl$  / reactivity increases down group;  
opposite without explanation = [1] [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 [1]  
polyamide; [1]  
**allow:** nylon
- (b) one correct amide linkage; [1]  
second amide linkage correctly orientated [1]  
– NHCO – followed by – NHCO –;  
**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 [1]
- (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 [1]
- OR**
- potassium manganate(VII) [1]  
**note:** oxidation state not essential but if given must be correct or [0]  
**accept:** potassium permanganate [1]
- cond:** remains pink / purple [1]  
**cond:** changes from pink to colourless (**acidic**) [1]  
**not:** clear [1]  
**cond:** change from pink to green / brown (**alkaline**) [1]

[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 /  $Fe^{3+}$ ; [1]  
**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 [1]

### Question 18

- 7 (a) (i)  $\text{CH}_2/\text{H}_2\text{C}$  [1]  
 (ii) same ratio of C:H (atoms) / all cancel to  $\text{CH}_2$  / because general formula is  $\text{C}_n\text{H}_{2n}$  / 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)  $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{Br}$  [1]  
 (ii)  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$  /  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$  /  $\text{C}_3\text{H}_7\text{OH}$  [1]
- (d)
- $$\left[ \text{CH}_2 - \underset{\text{CH}_3}{\text{CH}} \right]_n$$
- correct unit; [1]  
**accept:** more than one repeat unit [1]  
 continuation bonds at **both** ends; [1]
- (e) if  $\text{C}_5\text{H}_{10}$  is given award 3 marks;; [3]  
 if  $\text{C}_{10}\text{H}_{20}$  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  $\text{O}_2$  ( $= 2.4/32 =$ ) 0.075 **AND** moles of  $\text{CO}_2$  ( $= 2.2/44 =$ ) 0.05;
- $2\text{C}_5\text{H}_{10} + 15\text{O}_2 \rightarrow 10\text{CO}_2 + 10\text{H}_2\text{O}$  [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 /  $\text{H}^+$ ; [1]  
 (iii) contain carbon hydrogen and oxygen / C, H and O; [1]
- (b) (i) glucose  $\rightarrow$  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 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]
<b>not</b> clear/discolours	
colour of reagent must be shown somewhere for [3] otherwise max [2]	
<b>accept</b> equivalent test using $\text{KMnO}_4$ in acid or alkali	

### Question 24

8 (a) addition – polymer only product / only one product	[1]
<b>accept</b> monomer has $\text{C}=\text{C}$	
<b>accept</b> monomer and polymer have same empirical formula	
<b>accept</b> no loss of material in polymerisation	
<b>not</b> only one monomer	
condensation – polymer and water / small molecule formed	[1]
(b) $-\text{CH}_2 - \text{CCl}_2-$	[1]
repeat unit correct	[1]
<b>COND</b> continuation	[1]
(c) $\text{CH}_2=\text{CHOOCCH}_3$	[1]
(d) $-\text{OC}(\text{CH}_2)_4\text{CONH}(\text{CH}_2)_6\text{NH}-$	[1]
<b>COND</b> amide correct linkage	[1]
correct repeat units	[1]
continuation	[1]
<b>not</b> $\text{NH}_2$ or $\text{COOH}$ endings	

### Question 25

6 (a) (i) cracking / heat with catalyst	[1]
to make butane	[1]
butene reacts with steam/water / hydrated	[1]
<b>accept</b> 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]
<b>accept</b> an unbalanced equation	
(catalysed by) enzymes / yeast	[1]
(b) butanoic acid	[1]
$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{COOH}$	[1]
hydrogen atoms omitted from ends of bonds, penalise once	
(c) (i) ester	[1]
(ii) $\text{C}_6\text{H}_{12}\text{O}_2$	
<b>ignore</b> $\text{CH}_3\text{COOC}_4\text{H}_9$	[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]  
 bromide 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 / aluminosilicates / silicon dioxide) [1]  
**not** nickel/platinum
- (c) (1,2)dibromobutane [1]  
 if numbers given must be correct [1]  
 butane [1]  
 butanol [1]  
**accept** butan-1-ol or butan-2-ol **not** but-1-ol / but-1-anol / butanol

### Question 27

- 2 (a) (i) enzymes are proteins / come from living organisms / biological (catalysts) [1]  
**not** enzymes are living or natural [1]
- (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**  
ignore mention of toxic gases [2]
- (b) (i) ester [1]  
**accept** polyester **or** fat **or** lipid **or** vegetable oil **or** carboxylic acid
- (ii) acid **or** carboxylic acid **or** alkanolic acid [1]  
alcohol **or** hydroxyl **or** alkanol [1]  
**NOT** formulae **NOT** hydroxide
- (iii) condensation [1]  
**COND** because water is formed in reaction [1]  
**or** monomer does not have C=C bond
- (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<sub>2</sub> and one -COOH group  
synthetic polyamide each monomer has 2 -NH<sub>2</sub> **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<sub>3</sub>–CH<sub>2</sub>–), 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 [1]  
ropes, clothing, bottles, packaging, bags
- (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<sub>2</sub>H<sub>4</sub>Br<sub>2</sub> ONLY [1]  
accept a structural formula with hydrogen atoms
- (iii) corn oil [1]
- (d) 100g of fat react with 86.2g of iodine [1]  
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 [1]  
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 [1]  
paraffin **or** kerosene [1]  
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)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$  or  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$  [1]
- (ii)  $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{Br}$  [1]  
**NOT** 1,3-dibromopropane [1]
- (d) moles of  $\text{CH}_3\text{-CH}=\text{CH}_2$  reacted =  $1.4/42 = 0.033$  [1]  
**conseq**  
 maximum moles of  $\text{CH}_3\text{-CH(I)-CH}_3$  that could be formed = 0.033  
**conseq**  
 maximum mass of 2-iodopropane that could be formed = 5.61 g  
 accept  $170 \times 0.033 = 5.61$  and  $170 \times 0.033333 = 5.67$   
**conseq unless greater than 100%**  
 percentage yield  $4.0/5.67 \times 100 = 70.5\%$  [1]  
**Do not mark consequentially 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
- (c) (i)  $\text{C}_6\text{H}_{12}\text{O}_6 = 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$  [2]  
 not balanced [1]  
**Accept**  $\text{C}_2\text{H}_6\text{O}$
- (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)  $\text{CH}_3\text{-CH}=\text{CH}_2$  [1]  
 (ii) **conseq** to (i)  
 correct repeat unit [1]  
**COND** evidence of continuation [1]  
 (iii) monomer [1]  
**COND** because it has a double bond **or** unsaturated **or** alkene [1]  
**NOT** addition [1]
- (b) (i) to remove fibres **or** remove solid [1]  
**NOT** precipitate, **NOT** impurities, **NOT** to obtain a filtrate [1]  
 (ii) because silver atoms have lost electrons [1]  
**OR** oxidation number increased [1]  
 (iii) silver chloride [1]
- (c) (i) name of an ester [1]  
 formula of an ester [1]  
 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.  $\text{C}_{17}\text{H}_{35}$  etc.  
 Mark for formula only - [1]
- (ii) alcohol **or** alkanol [1]  
**NOT** a named alcohol [1]
- (d) (i) acid loses a proton [2]  
 base accepts a proton [1]  
**OR** same explanation but acid loses a hydrogen ion (1)  
 and base gains hydrogen ion (1)
- (ii) only partially ionised **or** poor hydrogen ion donor **or** poor proton donor [1]  
**NOT** does not form many hydrogen ions in water **or** low concentration of hydrogen ions  
**NOT** pH

Question 36

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

Question 37

- 3 (a) (i) Correct equation [2]  
For giving correct formula of alkane and alkene [1] only  
Accept alkene and hydrogen
- (ii) chlorine [1]  
**COND** light **or** 200°C **or** heat **or** lead tetraethyl  
**or** high temperature MAX 1000°C [1]  
ignore comment 'catalyst'
- (b) (i) same molecular formula [1]  
different structures **or** structural formulae [1]
- (ii) but-2-ene or cyclobutane [1]  
corresponding structural formula [1]  
NOT 2-butene
- (c) butanol ignore numbers [1]  
butane ignore numbers [1]  
dibromobutane ignore numbers [1]
- (d) (i) propene [1]  
 $\text{CH}_3\text{—CH=CH}_2$  [1]
- (ii) Correct structure of repeat unit [1]  
ignore point of attachment of ester group  
**COND** upon repeat unit  
shows continuation [1]  
If chain through ester group [0] out of [2]
- (iii) do not decay or non-biodegradable [1]  
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 [1]  
NOT carbon dioxide, harmful, sulphur dioxide

Question 38

- 6 (a) (i) heat (energy) [1]
- (ii) exothermic [1]
- (iii)  $\text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 = 2\text{CO}_2 + 3\text{H}_2\text{O}$  [2]  
For  $\text{CO}_2 + \text{H}_2\text{O}$  **ONLY** [1]
- (iv) plotting points correctly [1]  
straight line [1]  
between -2640 and -2700kJ/mol [1]  
**NOTE** minus sign needed
- (v) general (molecular) formula [2]  
same functional group  
consecutive members differ by  $\text{CH}_2$   
similar chemical properties **or** react same way  
**NOT** a comment about physical properties  
**ANY TWO**
- (b)  $\text{CH}_3\text{—CH(OH)—CH}_3$  [1]  
**NOT**  $\text{C}_3\text{H}_7\text{OH}$  [1]  
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**  $\text{CH}_3\text{—CH(O)—CH}_3$

- (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  
 $\text{CH}_4 + \text{H}_2\text{O} = \text{CO} + 3\text{H}_2$  [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  $\text{---O---}$   
 same unit as in glucose as on question paper that is rectangles [1]  
 (iii) chromatography [1]
- (b) (i)  $\text{--NHCO--}$  linkage  
 different units  
 $\text{-NH}$  and  $\text{-CO}$  on same monomer unit  
 All three [2] two points [1] [2]  
 (ii) amino acids [1]
- (c) (i) propanol + ethanoic acid = propyl ethanoate + water  
 reactants [1] products [1] [2]  
 (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 [1]  
 (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)  
 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

**TOTAL = 11**

Question 43

6	(a) (i)	correct structure $\text{CH}_2=\text{CCl}_2$	[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 COND polymer chain showing different monomers and continuation -OOC-C <sub>6</sub> H <sub>4</sub> -COOCH <sub>2</sub> CH <sub>2</sub> O-	[1] [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 <b>NOT</b> carbon monoxide, sulphur dioxide. If gas named has to be a correct one eg HCl, HCN dangerous to animals Any <b>TWO</b>	[2]
	(ii)	conserve petroleum or save energy <b>NOT</b> cheaper	[1]
			<b>TOTAL = 10</b>

Question 44

(b) (i)	CO <sub>2</sub> and H <sub>2</sub> O balanced $2\text{CH}_3\text{OH} + 3\text{O}_2 = 2\text{CO}_2 + 4\text{H}_2\text{O}$	[1] [1]
(ii)	methyl ethanoate water	[1] [1]
(iii)	Methanoic (acid) accept formic acid	[1]

Question 45

4	(a) (i)	in which something dissolves	[1]
	(ii)	correct formula $\text{CH}_3\text{COOC}_2\text{H}_5$ or full structural formula	[1]

NOT C<sub>4</sub>H<sub>8</sub>O<sub>2</sub>

(iii) steam **or** water **or** hydration  
heat **or** catalyst

**OR** bubble into (concentrated) sulphuric acid  
add water


oxidised  
by air **or** dichromate **or** manganate(VII)


(iv) ethanoic acid and butanol

(b) (i) CH<sub>2</sub>OH  
CHOH  
CH<sub>2</sub>OH

(ii) soap **or** detergent

(c) (i) polyester **or** condensation polymer **NOT** terylene

(ii) HOOC —  — COOH

HO —  — OH

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

(d) (i) protein **or** poly peptide **or** polyamide

(ii) peptide **or** amide

(iii) amino acids are colourless **or** become visible/coloured  
**or** to develop it

(iv) using colour **or** from position

**OR** discussion of R<sub>f</sub>

**OR** compare with known amino acids

TOTAL = 17

Question 46

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

(c) (i) +6O<sub>2</sub>  
not balanced that is just O<sub>2</sub> **ONLY**

(ii) linkage ---O---

chain

minimum to be accepted

Question 47

5 (a) molecular formula

Must be able to give isomers, need not be alkenes

two corresponding isomers

If do not correspond then MAX [2] out of [3]

(b) (i) ethanol  
structure

(ii) ethane  
structure

(c) (i) many simple molecules **or** monomers

form one large one **or** macromolecule or chain

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

[1]

**ONLY** [1]

[2]

[2]

[1]

[2]

[1]

[1]

[1]

[2]

[1]

[1]

[1]

[1]

[1]

[1]

- (ii) addition polymer only one product- the polymer  
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  $\text{CH}_2$   
any **two** [2]  
**mark first two**  
**ignore** others unless it contradicts a point which has been awarded a mark
- (b) (i)  $2\text{HCOOH} + \text{CaCO}_3 \rightarrow \text{Ca}(\text{HCOO})_2 + \text{CO}_2 + \text{H}_2\text{O}$  [2]  
**not** balanced = [1]
- (ii) zinc + methanoic acid  $\rightarrow$  zinc methanoate + hydrogen [2]  
[1] for each product
- (iii) protected by oxide layer [1]
- (c) butanoic acid [1]  
 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COOH}$  /  $\text{C}_4\text{H}_8\text{O}_2$  /  $\text{C}_3\text{H}_7\text{COOH}$  /  $\text{C}_4\text{H}_7\text{OOH}$  [1]  
 $\text{C}_2\text{H}_4\text{O}$  [1]  
mark **ecf** to molecular formula

Question 49

4 (a) (i) ethanol CH <sub>3</sub> -CH <sub>2</sub> -OH	[1] [1]
propanoic acid CH <sub>3</sub> -CH <sub>2</sub> -COOH independent marking, no ecf accept C <sub>2</sub> H <sub>5</sub> not - HO	[1] [1]
(ii) type of compound – salt / sodium carboxylate / alkanoate 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 <u>NHCO then CONH</u> cond to mark 1, 2 monomers (different shading in box) cond continuation (to <b>ONE</b> correct linkage)	[1] [1] [1]
OR nylon 6 only one linkage – NHCO cond only one monomer cond continuation (to correct linkage)	[1] [1] [1]
(iii) use locating agent measure distance travelled by sample / travelled by solvent front cond this is R <sub>f</sub> = 0.5 for mark 3, either mark 1 or mark 2 must be awarded	[1] [1] [1]
accept run a chromatogram of glycine [1] compare with sample same position [1] max [2]	

Question 50

(iii) chlorine not chlorine water cond light / UV / heat / high temperature if numerical value given about 200°C / lead tetraethyl not warm	[1] [1]
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Question 51

6 (a) (i) C and H <u>only</u> (1)	[1]
(ii) only single bonds (1)	[1]
(b) (i) C <sub>n</sub> H <sub>2n+2</sub> (1)	[1]
(ii) C <sub>14</sub> H <sub>30</sub> (1) (14 × 12) + 30 = 198 (g) (1)	[2]
(c) (i) C <sub>8</sub> H <sub>20</sub> + 14 O <sub>2</sub> → 9CO <sub>2</sub> + 10H <sub>2</sub> O (2)	[2]
(ii) Volume ratio C <sub>x</sub> H <sub>y</sub> (g) + O <sub>2</sub> (g) → CO <sub>2</sub> (g) + H <sub>2</sub> O(l) 20            160            100 1                8                5 C <sub>5</sub> H <sub>12</sub> + 8O <sub>2</sub> → 5CO <sub>2</sub> + 6H <sub>2</sub> O For evidence of method (1) for equation as above (2)	all in cm <sup>3</sup> mole ratio [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 <sub>10</sub> H <sub>22</sub> → C <sub>8</sub> H <sub>16</sub> + C <sub>2</sub> H <sub>4</sub> + H <sub>2</sub> (1)	[1]
(e) (i) light or lead tetraethyl/catalyst/high temperature (1)	[1]
(ii) CH <sub>3</sub> -CHCl-CH <sub>3</sub> (1)	[1]
	[Total: 16]

Question 52

(b) correct linkage (1) rest of molecule correct and continuation shown (1) (other product is) water (1)	[3]
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### Question 53

- 4 (a) (i) butanoic/butyric acid (1)  
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}/\text{C}_2\text{H}_5\text{CH}_2\text{COOH}$  (1) [2]
- (ii) any three from:  
 (same) general formula (1)  
 (consecutive members) differ by  $\text{CH}_2$  (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)
- (b) (i) displayed formula of propan-1-ol, all bonds shown separately (1)  
 (ii) acidified (1)  
 potassium manganate(VII)/potassium permanganate/ $\text{KMnO}_4$  or potassium dichromate(VI)/ $\text{K}_2\text{Cr}_2\text{O}_7$ /potassium dichromate (1) [2]
- (c) (i) zinc + propanoic acid  $\rightarrow$  zinc propanoate (+ hydrogen) (1) [1]  
 (ii) calcium oxide + propanoic acid  $\rightarrow$  calcium propanoate + water (1) [1]  
 (iii)  $\text{LiOH} + \text{CH}_3\text{CH}_2\text{COOH} \rightarrow \text{CH}_3\text{CH}_2\text{COOLi} + \text{H}_2\text{O}$  (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]

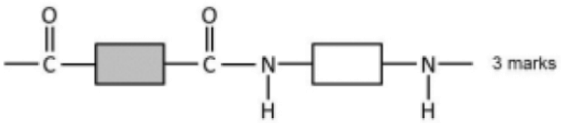
### Question 54

- 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  
 naphtha  
 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/ $\text{H}_2\text{O}$  (1)  
 carbon dioxide/ $\text{CO}_2$  (1)  
 carbon monoxide/ $\text{CO}$  (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)  $\text{CH}_3\text{-CH=CH-CH}_3$  (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)
- 
- (iii) protein **or** polypeptide **or** named protein (1)
- (iv) addition: **only** the polymer **or** one product is formed (1)  
condensation: the polymer **and** a small molecule/water/HCl is formed (1)
- (b) (i) does not break down **or** rot **or** decompose (1)  
by microbes **or** fungi **or** bacteria **or** by living organisms (1)
- (ii) Any **three** from:  
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:  
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)  $\text{CH}_3\text{COOCH}_2\text{CH}_3$  /  $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_3$  /  $\text{CH}_3\text{COOC}_2\text{H}_5$  /  $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$  /  $\text{C}_2\text{H}_5\text{OOCCH}_3$  /  $\text{CH}_3\text{CH}_2\text{OOCCH}_3$  **not**:  $-\text{OCO}-$  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.  $-\text{OOC}$  /  $-\text{O}_2\text{C}$  and  $-\text{COO}$  /  $-\text{CO}_2$  (1)  
contents of the 'boxes' being  $\text{C}_6\text{H}_4$  and  $\text{C}_2\text{H}_4$  or  $\text{CH}_2\text{CH}_2$  (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:  
chlorine (2)  
hydrogen chloride  
carbon monoxide
- (b) (i)  $\text{CH}_3\text{-CH=CH}_2$  (1)  
**note**: can be fully or semi-displayed, C = C must be shown
- (ii) correct repeat unit  
 $-\text{CH}(\text{C}_6\text{H}_5)-\text{CH}_2-$  (1)  
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)  $C_{20}H_{42} \rightarrow 2C_4H_8 + 2C_2H_4 + C_8H_{18}$  [1]
- (c) (i) any unambiguous structure of  $BrCH_2CH_2Br$   
**NOT** just  $C_2H_4Br_2$  [1]
- (ii)  $CH_3-CH=CH-CH_3$   
 For any butene [1] only [2]
- (iii)  $(CH_3-CH_2-CH=CH_2) + H_2O$  [1]  $\rightarrow$   $CH_3-CH_2-CH_2-CH_2OH$  [1]  
**ALLOW**  $CH_3-CHOH-CH_2-CH_3$   
 butene reacts with **water/steam** (to form butanol) **ONLY** [1] [2]
- (iv)  $C_6H_{12} + H_2 \rightarrow C_6H_{14}$  [2]  
 alkenes react with **hydrogen** [1] **ONLY** [2]
- (d) volume of oxygen used =  $150\text{ cm}^3$  [1]
- volume of carbon dioxide formed =  $100\text{ cm}^3$  [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  $135^\circ\text{C}$  [1]  
**OR** impure would melt lower than  $135^\circ\text{C}$
- (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 faster **OR** malonic reacts slower [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 better conductor [1]  
**OR** malonic acid poorer 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  $(12 \times 9) + 18 = 126$   
 $C_9H_{18}$   
**note:** correct formula only = 1
- (b) (i) all hydrogen atoms 1bp  
C—C bond atoms 1bp  
C=C 2 bp
- (ii) correct repeat unit  
continuation
- (iii) bonds broken  
H-H +436 (kJ/mol) C=C +610 = +1046 (kJ/mol)  
bonds formed  
2C-H  $-415 \times 2$  kJ/mol C-C  $-346 = -1176$  (kJ/mol)  
 $-130$  kJ/mol / more energy released than absorbed  
**or:**  
bonds broken  
3882 (kJ/mol)  
bonds formed  
4012 (kJ/mol)  
 $-130$  kJ/mol / more energy released than absorbed  
**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
- (ii)  $CH_3-CH_2-CH(Br)-CH_2Br$   
 $C_4H_8Br_2 = 1$   
**note:** any other dibromobutane = 0
- (iii) HI

### 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 /  $H_2O$  /  $HCl$  [1]
- note:** two points needed for 1 mark in both parts
- (ii) -O- linkage [1]  
three correct monomer units [1]  
continuation [1]
- (b) (i) catalyst **and** from living organism [1]  
**accept:** biological catalyst / protein catalyst
- (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 between 40–100 °C / in the stated range [1]  
[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) [2]  
**not:** Br<sub>2</sub>  
**accept:** 2 bromide groups  
eth 2 carbon atoms (per molecule)  
ane a C-C single bond / no C=C / group C<sub>n</sub>H<sub>2n+1</sub> / saturated  
**ignore:** any reference to alkanes  
all three correct [2] two correct only [1]
- (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<sub>3</sub>-CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>-OH [1]  
88 [1]  
156 to 159 °C [1]
- (b) any two from: [1]  
(same) general (molecular) formula  
same functional group  
consecutive members differ by -CH<sub>2</sub>  
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 [1]
- (ii) air / oxygen [1]  
bacteria / microbes / micro-organisms [1]  
**accept:** mother of vinegar  
**not:** yeast
- (e) propyl ethanoate [1]  
**allow:** CH<sub>3</sub>COOC<sub>3</sub>H<sub>7</sub> **not:** C<sub>5</sub>H<sub>10</sub>O<sub>2</sub> [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)  $-\text{OC}_6\text{H}_4\text{COOCH}_2\text{CH}_2\text{O}-$  [1]  
 correct ester linkage [1]  
 correct repeat units [1]  
 continuation [1]  
**accept:** boxes if it is clear what the box represents
- (iii) any **two** from: [2]  
 long time to decay  
 landfill sites  
 visual pollution / litter  
 danger to animals  
 poisonous gases when burnt  
**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** -  $nX \rightarrow X_n$   
 condensation polymer and simpler molecules formed [1]  
**accept**  $nX \rightarrow X_n + n\text{HCl} / \text{H}_2\text{O}$
- (b) (i)  $\text{C}_{12}\text{H}_{26} \rightarrow \text{C}_8\text{H}_{18} + 2\text{C}_2\text{H}_4$  [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**  $-(\text{CH}_2-\text{CH}(\text{Cl}))_n-$  [1]

[Total: 9]

Question 67

- 6 (a) same general formula  
consecutive members differ by  $\text{CH}_2$   
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  
**not** general formula  
different structures / structural formulae [1]
- (ii)  $\text{CH}_3\text{-CH}_2\text{-CH(OH)-CH}_3$  /  $(\text{CH}_3)_3\text{C-OH}$   
**not** ether-type structures [1]  
**NOTE** butan-2-ol and 2-methylpropan-2-ol acceptable
- (c) (i) air/oxygen / (acidified) potassium chromate(VI) /  
(acidified) potassium manganate(VII)  
must have oxidation states [1]
- (ii) carboxylic acid / alkanolic acid [1]  
 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COOH}$  /  $\text{C}_3\text{H}_7\text{COOH}$  /  $\text{C}_4\text{H}_8\text{O}_2$   
**accept**  $\text{C}_4\text{H}_7\text{OOH}$  [1]
- (d) (i) measure volume 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 [1]  
ratio 2H : 1O  
**not** contains water  
**ignore** comments about carbon
- (ii) living organism / plants and animals / cells [1]  
obtain energy from food [1]  
**not** burn negates energy mark
- (iii) carbohydrates contain oxygen [1]
- (iv) as a fertiliser / manure [1]
- (b) (i)  $80\text{ cm}^3$  of oxygen therefore  $40\text{ cm}^3$  of methane [1]  
 $40/60 \times 100 = 66.7\%$  [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-biodegradable / 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 / HCl / HF / HCN  
**not** oxides of nitrogen / sulfur  
**any** three [3]
- (b) (i) propene / propylene [1]  
**accept** prop-1-ene  
**not** prop-2-ene  
 $\text{CH}_3\text{-CH=CH}_2$   
 double bond must be shown [1]
- (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)  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$  [1]  
 $\text{HOOC}(\text{CH}_2)_8\text{COOH}$  [1]

[Total: 15]

Question 70

- 5 (a) (i)  $\text{Mg} + 2\text{CH}_3\text{COOH} \rightarrow (\text{CH}_3\text{COO})_2\text{Mg} + \text{H}_2$  [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 [1]  
 empirical formula CHO [1]
- (iii)  $116/29 = 4$  [1]  
 $\text{C}_4\text{H}_4\text{O}_4$  [1]  
 correct formula, with no working scores both marks.
- (iv)  $\text{HOOCCH=CHCOOH}$  /  $\text{CH}_2=\text{C}(\text{COOH})_2$  [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 <sub>10</sub> H <sub>22</sub> but not but-1-ene	[1]
(iii)	water or steam	[1]
(b) (i)	C <sub>4</sub> H <sub>9</sub> OH + 6O <sub>2</sub> → 4CO <sub>2</sub> + 5H <sub>2</sub> O 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 <sub>3</sub> type diagrams For either C <sub>3</sub> H <sub>8</sub> O or C <sub>3</sub> H <sub>6</sub> O <sub>2</sub> [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 <sub>4</sub> H <sub>10</sub> all bonds shown	[1]
(ii)	germanium(IV) oxide	[1]
	water	[1]

### Question 73

7 (a) (i)	35 cm <sup>3</sup> 40 cm <sup>3</sup>	[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 <sub>3</sub> )-CH <sub>2</sub> )-	[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 <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -CH <sub>2</sub> OH or CH <sub>3</sub> -CH(OH)-CH <sub>2</sub> -CH <sub>3</sub> NOT C <sub>4</sub> H <sub>9</sub> OH if first mark not awarded then either formula will gain mark [1] ACCEPT either formula for "butanol"	[1]
(iii)	CH <sub>3</sub> -CH(Cl)-CH <sub>3</sub> or CH <sub>3</sub> -CH <sub>2</sub> -CH <sub>2</sub> -Cl NOT C <sub>3</sub> H <sub>7</sub> Cl 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. [1]  
**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
- (ii) ammonia **or** methanol **or** hydrogen chloride **or** margarine [1]  
**NOT** nylon
- (iii) fat **or** lipid **or** triester **or** named fat **or** glyceryl stearate [1]  
**or** vegetable oil [1]  
heat [1]

Question 75

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

[Total: 12]