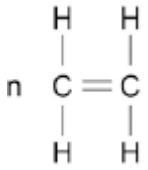
GCSE Chemistry

Synthetic and Naturally Occurring Polymers

Mark Scheme

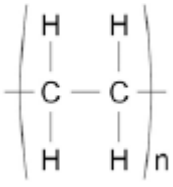
Time available: 60 minutes
Marks available: 57 marks

M1.(a) *(ethene)*



1

(polyethene)



1

(b) any **four** from:

- poly(ethene) produced by addition polymerisation whereas polyester by condensation polymerisation
- poly(ethene) produced from one monomer wheareas polyester produced from two different monomers
- poly(ethene) produced from ethene / alkene whereas polyester from a (di)carboxylic acid and a diol / alcohol
- poly(ethene) is the only product formed whereas polyester water also produced
- poly(ethene) repeating unit is a hydrocarbon whereas polyester has an ester linkage

4

[6]

M2.(a) any **one** from:

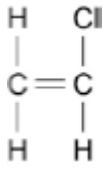
- disposal or does not decompose (in landfill sites) or collection or sorting for recycling

  ignore non-biodegradable alone
- lack of space or more landfill sites
- other specified problems with waste (eg. litter **or** eyesore **or** harm to animals **or** destroys habitats)

  ignore pollution unqualified.

1

(b)



*if 2 marks not awarded, award **1** mark for **one** of the following:*

- *a double bond between the two carbons and no additional trailing bonds*
- *two C atoms bonded together with three single bonds to hydrogen atoms and one single bond to a chlorine atom. no additional Cl or H.*

2

(c) intermolecular forces **or** forces between the chains

allow intermolecular bonds

1

(intermolecular forces are) weak

ignore references to no cross links between chains.

allow 1 mark for weak forces between layers.

1

which are easily overcome (by heat) **or** need little energy to overcome **or** chains / molecules can slide over one another (when heated)

*if weak bonds **or** breaking covalent bonds mentioned only the third marking point is available.*

1

(d) Monomer **A** – carboxylic acid

do not allow carbolic

1

Polymer **C** - ester (linkage)

1

[8]

M3.(a) any **four** from:

- (crude oil is) heated
- to evaporate / vaporise / boil (the substances / hydrocarbons)
- the column is hotter at the bottom or is cooler at the top
- (vapours / fractions) condense
- at their boiling points or at different levels.

marks can be taken from a diagram

max 3 marks for reference to cracking

allow fractional distillation allow vapours (enter the column)

allow temperature gradient or (vapours) cool as they rise

allow description e.g. vapour turns to liquid)

allow they have different boiling points

4

(b) acid rain is caused by

allow consequences of acid rain

1

sulfur dioxide or oxides of nitrogen

second marking point is dependent on first marking point

1

they react with / are neutralised by calcium carbonate or limestone
OR
global warming is caused by
carbon dioxide

carbon dioxide will react or dissolve in suspension of limestone

allow greenhouse effect is caused by or allow consequences of global warming

1

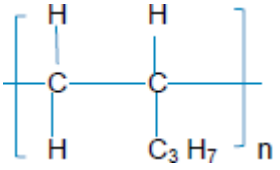
(c) (i) C_2H_4

must be formula

ignore any name

1

(ii) a single bond between carbon atoms



would score 3 marks

1

other four bonds linking hydrogen atoms and C_3H_7 group plus two trailing / connecting bonds

1

n at the bottom right hand corner of the bracket

1

(iii) has a shape memory

or

(a smart polymer) can return to original shape (when conditions change)

1

[12]

M4. (a) vaporise / evaporate

allow boil for vaporise

1

different condensing points / temperatures

accept condense at different levels

ignore different size molecules or different densities

*mention of cracking = max **1***

*allow boils at different temperatures and condenses for **2** marks*

if no other marks awarded allow

*fractional distillation for **1** mark*

1

(b) (i) 3 (C_2H_4)

accept +C_4H_8

1

(ii) (decane / naphtha / hydrocarbon) vaporise / evaporate

allow crude oil

allow boil for vaporise

1

(passed over) a catalyst / alumina / porous pot

ignore other names of catalysts

1

(c) any **two** from:

'they' must be clarified

- alkanes / butane (molecules) do not have a (carbon carbon) double bond / are saturated / have (carbon carbon) single bonds
- alkenes / ethene (molecules) have (carbon carbon) double bonds

or

are unsaturated

- alkenes / ethene molecules are able to bond to other molecules

2

(d) single bonds between carbon atoms

– C - C –

1

the -CH_3 group appears on each pair of carbons on the 'chain'

*NB any double bonds = **0** marks*

1

[9]

M5. (a) (i) many ethene / molecules / monomers

accept double bonds open / break

1

join to form a long hydrocarbon / chain / large molecule

accept addition polymerisation

ignore references to ethane

*correct equation gains **2** marks*

1

(ii) (can be deformed but) return to their original shape (when heated or cooled)

ignore 'it remembers its shape'

1

(iii) cross links / extra bonds in PEX

accept inter-molecular bonds

ignore inter-molecular forces

1

molecules / chains in PEX are held in position

accept rigid structure

1

molecules / chains in PEX unable to slide past each other / move

it = PEX throughout

1

(b) any **four** from:

- less (hydrocarbon) fuels used

  allow less energy

- less / no electrical energy used

  allow no electrolysis

- reduce carbon / carbon dioxide emissions

  allow less global warming

- reduce / no pollution by sulfur dioxide / acid rain

- continuous process
  allow less / no transportation
- conserve copper which is running out or only low-grade ores available
- reduce the amount of solid waste rock that needs to be disposed
  allow less waste
- reduce the need to dig large holes (to extract copper ores)
  allow less mining
  ignore costs / sustainability / non-renewable

4

[10]

M6. (a) any **two** from:

- naphtha has a different / low(er) boiling point
  accept different volatility
- condenses at a different temperature / height / place in the column / when it reaches it's boiling point
- different size of molecules

2

(b) (i) $C_{10}H_{22} \rightarrow C_6H_{14} + \mathbf{2}C_2H_4$
allow multiples

1

(ii) (hydrocarbon) heated / vapours

1

(passed over a) catalyst / alumina / porous pot
ignore other catalysts

1

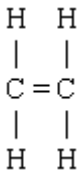
(iii) it / ethene is unsaturated **or** decane and hexane / they are saturated
accept decane and hexane are alkanes / C_nH_{2n+2}
***or** ethene is an alkene / C_nH_{2n}*
***or** different homologous series / general formula*

1

ethene has a double (carbon carbon) bond **or** decane and hexane have only single (carbon carbon) bonds
*accept ethene has a reactive double (carbon carbon) bond for **2** marks*

1

(c) <u>all</u> bonds drawn correctly



1

(d) **economic argument** against recycling

any **one** from:

- poly(ethene) / plastic must be collected / transported / sorted / washed
- this uses (fossil) fuels which are expensive

1

environmental argument against recycling

any **one** from:

- uses (fossil) fuels that are non-renewable / form CO_2 / CO / SO_2 / NO_x / particulates
  ignore pollution / harmful gases / etc
- washing uses / pollutes water

1

counter arguments

any **two** from:

- collect / transport alongside other waste
- use biofuels (instead of fossil)
- landfill is running out
- landfill destroys habitats
- incinerators are expensive to build
- saves raw materials / crude oil
- saves energy needed to make new plastic
- incinerators may produce harmful substances
- incinerator ash goes to landfill
- poly(ethene) is non-biodegradable
- poly(ethene) can be made into other useful items

- more jobs / employment for people

2

[12]