Mark schemes

1

(a) C_5H_{12}

1

(b) Alkanes

1

(c) (3) CO_2

1

(4) H_2O

1

*allow for **1** mark*
4 CO_2 + 3 H_2O

(d) contains hydrogen and carbon

1

(hydrogen and carbon) <u>only</u>

1

(e) *(diesel)*
produces more oxides of nitrogen

allow converse answers in terms of petrol

1

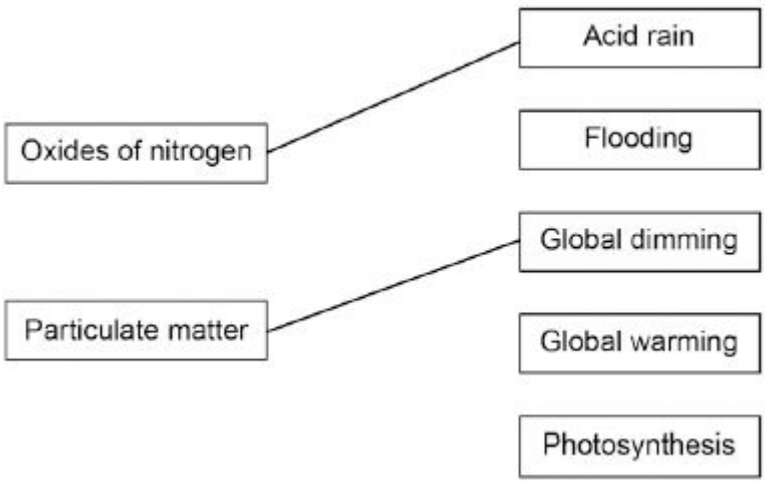
produces (more) particulate matter

1

produces less carbon dioxide

1

(f)



2

[11]

2 (a) all points correct

±1 small square

allow 1 mark for 6 or 7 plots

2

Year	Percentage (%) of bottles made from other materials
1975	5
1980	10
1985	22
1990	42
1995	70
2000	72
2005	90
2010	95

1

(b) **Level 3 (5–6 marks):**
A detailed and coherent argument is provided which considers a range of issues and comes to a conclusion consistent with the reasoning.

Level 2 (3–4 marks):
An attempt to describe the advantages and disadvantages of the production and uses is made, which comes to a conclusion. The logic may be inconsistent at times but builds towards a coherent argument.

Level 1 (1–2 marks):
Simple statements made. The logic may be unclear and the conclusion, if present, may not be consistent with the reasoning.

0 marks:
No relevant content.

Indicative content

- glass – 2 stages in production of soda-lime glass
- glass – second stage, heating sand, limestone and sodium carbonate
- HDPE – 3 stages in production
- HDPE – second stage, cracking of naphtha to obtain ethene
- HDPE – third stage, polymerisation of ethene
- fewer stages in glass production, may be quicker
- higher temperature in glass manufacture, therefore maybe higher energy requirement
- glass bottle can be reused
- consideration of collection / cleaning costs to reuse glass bottles
- other glass products can be made from recycled glass
- plastic has greater range of sizes
- both produced from limited raw materials
- higher percentage recycled materials in glass conserves raw materials

This indicative content is not exhaustive, other creditworthy responses should be awarded marks as appropriate.

6

[9]

3 (a) C_6H_{14}

1

(b) **A**

1

(c) **B**

1

(d) **C**

1

(e) Propanol

1

[5]

4 (a) (i) (conical) flask

1

(ii) measuring cylinder / pipette / burette

1

(b) (i) any **two** from:
- so anomalous results could be identified / ignored
- so a mean / average could be taken
- (to improve) accuracy

2

(ii) 19

1

(iii) increases / gets longer / gets bigger

1

(iv) anomalous / does not agree with other times for $C_{10}H_{22}$

1

(v) any **one** from:
- shorter hydrocarbon used
- volume of hydrocarbon too small
- started timing late
- stopped timing too early / when liquid left in funnel

*must suggest why the result is **lower** than the others.*

*allow the temperature was higher **or** the students used a wider funnel.*

1

(c) (i) flammable

1

(ii) suitable safety precaution

1

reason that links the safety precaution to the hazard symbols

eg:
- *wear gloves*
- *(because) it is hazardous to health / harmful / toxic / irritant*

or
- *do not pour down sink **or** dispose of properly*
- *(because) it is harmful to the environment / kills fish*

or
- *wear a mask or do it in the fume cupboard or a well-ventilated area*
- *respiratory irritant*

1

(d) (i) points plotted correctly (within half small square)

*all six points correct scores **2***

*3, 4 or 5 points correct scores **1***

2

smooth curve of best fit

1

(ii) point at 46 °C circled

allow point furthest from the line as drawn

1

(iii) working shown on graph

1

value read from graph line drawn (within half small square)

1

(iv) the higher the temperature the lower the viscosity

*allow the higher the temperature the lower / shorter the time taken for **1** mark*

2

non-linear **or** change gets smaller as temperature gets higher

*answer relating temperature to time taken can score a maximum of **2** marks.*

1

(v) identifying source of the error

1

method of avoiding the error

eg:

- *the temperature will drop*
- *insulate the funnel*

or

- *runs out before all added*
- *put a tap on the funnel*

1

[22]

5 (a) circle round any one (or more) of the covalent bonds

any correct indication of the bond − the line between letters

1

(b) Methane contains atoms of two elements, combined chemically

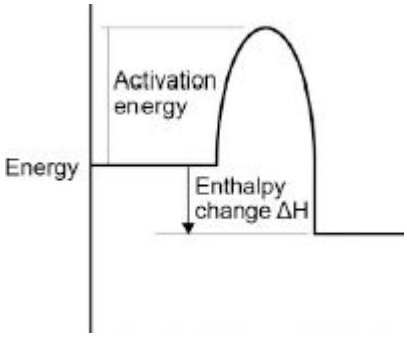
1

(c) (i) activation energy labelled from level of reagents to highest point of curve

ignore arrowheads

1

enthalpy change labelled from reagents to products



*arrowhead **must** go from reagents to products only*

1

(ii) 2 O_2

1

2 H_2O

*if not fully correct, award **1** mark for all formulae correct.*

ignore state symbols

1

(iii) carbon monoxide is made

1

this combines with the blood / haemoglobin **or** prevents oxygen being carried in the blood / round body **or** kills you **or** is toxic **or** poisonous

dependent on first marking point

1

(iv) energy is taken in / required to break bonds

accept bond breaking is endothermic

1

energy is given out when bonds are made

accept bond making is exothermic

1

the energy given out is greater than the energy taken in

this mark only awarded if both of previous marks awarded

1

(d) (i) energy to break bonds = 1895

calculation with no explanation max = 2

1

energy from making bonds = 1998

1

1895 − 1998 (= −103)
or
energy to break bonds = 656
energy from making bonds = 759
656 − 759 (= −103)

allow:

bonds broken − bonds made =

413 + 243 − 327 − 432 = -103 for 3 marks.

1

(ii) The C — Br bond is weaker than the C — Cl bond

1

[15]

6 (a) (i) mixture (of different substances)

1

(ii) boiling (points)

1

(iii) distillation

1

(b) (i) combustion

1

(ii) (reactant)

oxygen

allow correct formulae

1

(products)

products in any order

carbon dioxide

allow carbon or carbon monoxide

and

water

allow water vapour or steam or hydrogen oxide

1

(iii) (burning sulfur) produces sulfur dioxide / $S0_2$

allow it / sulfur reacts with oxygen ignore sulfur oxide

1

causes acid rain

1

(c) (i) propane is a fuel

1

(ii) double bond drawn between carbon atoms

do not allow any other bonds or symbols

1

(iii) orange to colourless

1

(iv) poly(pentene)

allow polymer(s)

1

[12]

7

(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

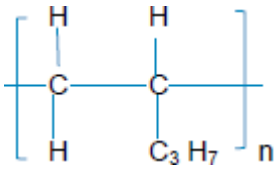
(c) (i) C_2H_4

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]

8

(a) (i) Neutron (top label)

1

Electron (bottom label)

1

(ii) 13

1

(iii) electrons

1

(b) (i) compound

1

hydrogen

1

bond

1

(ii) C_4H_{10}

1

[8]

9

(a) (i) ethanol

1

(ii) oxidised

1

(iii) **Test**

add any named carbonate or hydrogen carbonate
the first mark is for the test; the second is for the result
if the test is incorrect award 0 marks.

1

Result

A will effervesce (carbon dioxide) **or B** will not effervesce.
if the result is incorrect, award the first mark only

1

or

candidates do not have to name a gas but penalise an incorrect gas.

Test

add a named (magnesium, aluminium, zinc, iron or tin) metal

give credit to any test that will work.

Result

A will effervesce (hydrogen), **B** will not

*allow a test that would identify **B**.*

or

Test

add an acid-base indicator

Result

credit any acid colour for that indicator eg for universal indicator allow red, yellow or orange

give credit for the neutral colour for **B**

or

Test

add an alcohol (+ acid catalyst)

Result

sweet or fruity smell of esters.

(b) (i) H_2O

1

(ii) ethyl ethanoate

1

(iii) any **one** from:

- flavourings
- perfumes
- solvents
- plasticisers

allow any correct use of esters

1

[7]

10 (a) Sulfur dioxide causes acid rain.

1

(b) red / orange / yellow

*do **not** accept any other colours*

1

because sulfur dioxide (when in solution) is an acid

1

(c) (there are) <u>weak</u> forces (of attraction)

*do **not** accept any reference to covalent bonds breaking*

1

between the molecules

*do **not** accept any other particles*

1

(these) take little energy to overcome

award third mark only if first mark given

1

(d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 – 2 marks)
A relevant comment is made about the data.

Level 2 (3 – 4 marks)
Relevant comparisons have been made, and an attempt made at a conclusion.

Level 3 (5 – 6 marks)
Relevant, detailed comparisons made and a justified conclusion given.

examples of the points made in the response

effectiveness

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

material used

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

waste materials

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

6

[12]

11 (a) (i) D

1

(ii) B

1

(iii) A

1

(iv) E

1

(v) E

1

(b) (i) high temperature

ignore hot / heat

allow temperature quoted (range 300-900 °C)

1

catalyst **or** steam

1

(ii) C_8H_{18} smaller molecule

It = C_8H_{18}

1

therefore there are weaker intermolecular forces

allow intermolecular bonds

*do **not** accept breaking covalent bonds / bonds*

or

weaker intermolecular forces in C_8H_{18} (1)

allow intermolecular bonds

so less energy to break (1)

1

(c) add bromine water

1

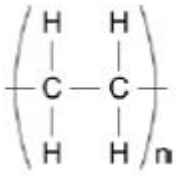
turns (from orange / yellow / red / brown) to colourless **or** decolourises

do not accept discoloured

*ignore clear incorrect test = **0** marks*

1

(d)



single C – C bond

1

four carbon-hydrogen bonds in place and two trailing bonds

1

structure in brackets and n at bottom right

1

[14]

12 (a) hydrocarbons **or** hydrocarbon

1

(b) (i) distillation

1

(ii) evaporation

1

(iii) condensation

1

(c) (i) bond

1

(ii) $(C_6H)_{14}$

1

(iii) cracking

1

(d) (i) poly(butene)

allow with or without brackets

1

(ii) Advantage = energy is released

*do **not** accept more than one tick in the advantage column*

1

Disadvantage = carbon dioxide is produced

*do **not** accept more than one tick in the disadvantage column*

1

[10]

13 (a) (i) 2,4 drawn (as dots / crosses / e^-)

1

(ii) Water (vapour) / steam

allow hydrogen oxide / H_2O

*do **not** accept hydroxide*

1

(b) any **two** pairs from:

carbon dioxide (1)

causes global warming (1)

allow greenhouse effect / climate change / sea level rise / melting of polar ice caps

or

carbon (particles) / soot (1)

allow particulates

causes global dimming (1)

allow blocks out sunlight / smog / prevents plant growth / causes breathing difficulties

or

carbon monoxide (1)

is toxic (1)

or

sulfur dioxide (1)

causes acid rain (1)

allow kills plants / erosion / acidifies water

4

[6]

14 (a) Methane has the lowest melting point and icosane has the highest boiling point

1

Decane and icosane are liquid at 100°C

1

(b) water / H_2O

either order

1

carbon dioxide / CO_2

allow hydrogen oxide

1

(c) (i) fermentation

1

(ii) any **two** from:

- sugar cane / plants absorb carbon dioxide
  ignore oxygen released
- growing sugar cane / plants reduces global warming
  allow ethanol from plants is carbon neutral
- renewable resource / sustainable
  accept conserves fossil fuels / petrol

2

(iii) any **two** from:

- destruction of habitats / forests (to grow sugar cane/crops)
- fermentation releases carbon dioxide
- production plants cause visual pollution
- pollution from the transportation of sugar cane / Ethanol
- growing sugar cane / plants uses a lot of land

2

[9]

15 (a) heat to vaporise (the crude oil)
*do **not** accept cracking / burning*

1

vapours condense

1

at different temperatures
allow they have different boiling points

1

(b) (alkanes) are hydrocarbons **or** are compounds of hydrogen and carbon only

1

alkanes are saturated **or** have only (carbon-carbon) single bonds
accept have no (carbon-carbon) double bonds
*accept general formula is C_nH_{2n+2} for **2** marks*

1

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a basic description of at least one advantage or one disadvantage of extracting petroleum products from oil sands.

Level 2 (3-4 marks)
There is a clear description of an advantage and a disadvantage of extracting petroleum products from oil sands.

Level 3 (5-6 marks)
There is a detailed description of both advantages and disadvantages of extracting petroleum products from oil sands.

Examples of the chemistry/environmental/economic/social points made in the response

Advantages:

- the oil sands are needed because crude oil is running out
- this crude oil is needed because demand is increasing
- the oil sands contain a large amount of crude oil
- the oil sands could improve Canada's economy
- the oil sands provide employment for a lot of people
- the trees / forest are used for wood products / fuel

Disadvantages:

- destruction of environment / habitats
- fewer trees / forests to absorb carbon dioxide
- specified pollution, for example, visual, noise, atmospheric (including dust), water (including river or drinking) with cause, e.g. gases / particulates from burning diesel
- large amounts of methane (natural gas) are used to provide energy
- energy / fuel needed for cracking and fractional distillation
- burning fuel releases carbon dioxide
- crude oil / natural gas contains locked up carbon
- crude oil is non-renewable

6

[11]

16 (a) (i) wood

1

(ii) 30 (kJ)

1

(iii) 3 / three (g)

1

(b) carbon / C

or hydrogen / H

or sulfur / S

allow oxygen / O

1

(c) releases most energy

accept releases a lot of energy / burns rapidly

ignore references to cost

1

no harmful gases / no or less pollution formed / no global warming / no climate change / no greenhouse gas

accept produces water (only) / steam

accept does not produce sulfur dioxide / carbon dioxide / carbon monoxide / particles / smoke

1

[6]

17 (a) (i) C_2H_4

1

(ii) poly(ethene)

1

(b) (i) is not biodegradable

1

(ii) not enough landfill sites / space

*accept landfill sites are filling up **or** plastics remain for years **or** plastics not broken down*

ignore cost / waste of resources / not biodegradable / wildlife

1

(iii) recycle / burn

accept reduce the amount of packaging used

ignore reused

1

[5]

18 (a) any **two** from:

asks for cause therefore no marks for just describing the change

must link reason to a correct change in a gas

carbon dioxide has decreased due to:

accept idea of 'used' to indicate a decrease

- plants / microorganisms / bacteria / vegetation / trees
- photosynthesis

  ignore respiration
- 'locked up' in (sedimentary) rocks / carbonates / fossil fuels
- dissolved in oceans

  ignore volcanoes

oxygen has increased due to:

accept idea of 'given out / produced'

- plants / bacteria / microorganisms / vegetation / trees
- photosynthesis

  ignore respiration

nitrogen increased due to:

accept idea of 'given out / produced'

- ammonia reacted with oxygen
- bacteria / micro organisms

  ignore (increase in) use of fossil fuels / deforestation

2

(b) (because methane's) boiling point is greater than the average / surface temperature **or** Titan's (average / surface) temperature is below methane's boiling point

*ignore references to nitrogen **or** water*

1

any methane that evaporates will condense

accept boils for evaporates

accept cooling and produce rain for condensing

1

(c) C_nH_{2n}

1

[5]

19 (a) (i) hydrogen / H and carbon / C

answers can be in either order

if letters given, must be capital H

1

(ii) C_nH_{2n+2}

1

(b) (most) crude oil <u>vaporises / evaporates</u> **or** crude oil enters as a <u>vapour</u>

1

(vapour) cools as it rises up the tower / column **or** tower / column cooler at the top **or** negative temperature gradient

1

the fractions have different boiling / condensation points / ranges

accept the larger the molecules, the higher the boiling point / condensation point

1

so they will condense at different levels in the tower

allow will collect at different levels if condensation mentioned

allow will condense to give different fractions

*if no other mark is gained allow **1** mark for mention of heating*

1

(c) (i) C_8H_{18}

if one answer is given C_8H_{18} is the only acceptable answer

credit any correct combination of alkanes and alkenes, eg C_5H_{12} and C_3H_6

1

(ii) hot / high temperature

accept any temperature in the range 300 − 900 °C

'heat' is insufficient

1

catalyst

*accept a named catalyst − alumina **or** zeolites **or** aluminosilicates **or** broken pot*

ignore other named catalysts

allow (mixing with) steam as an alternative to second marking point

ignore pressure

1

[9]

20 (a) (i) CH_4

allow H_4C

*do **not** allow lower-case h*

*do **not** allow superscript*

1

(ii) single

1

(iii) alkanes

1

(b) (i) carbon / C

any order

1

hydrogen / H

allow phonetic spelling

1

sulfur / sulphur / S

1

(ii) air / atmosphere

1

(iii) acid rain

1

damages trees / plants **or** kills aquatic organisms **or** damages buildings / statues **or** causes respiratory problems

allow harmful to living things

1

(c) carbon / C

accept soot / particulates / charcoal

1

(d) any **four** from:

- (supports hypothesis) because when the fuel contained more carbon the temperature of the water went up more / faster (in 2 minutes)
- (does not support hypothesis as) temperature change per gram decreases as the number of carbons increases
- (does not support hypothesis) because the more carbon in the fuel the more smoke **or** the dirtier / sootier it is
- only tested hydrocarbons / alkanes / fuels with between 5 and 12 carbon atoms
- valid, justified, conclusion

accept converse statements

4

(e) (i) 0.15

*correct answer with or without working gains **2** marks*

*if answer incorrect, M_r carbon dioxide = 44 gains **1** mark*

*allow 0.236 / 0.24 / 0.2357142 (ecf from M_r of 28) for **1** mark*

2

(ii) 0.4(0)

1

(iii) C_3H_8

*correct formula with or without working scores **2** marks*

0.15 / 0.05 = 3

*allow ecf from **(e)(i)***

and

0.4 / 0.05 = 8 (1)

*allow ecf from **(e)(ii)***

*allow **1** mark for correct empirical formula from their values*

If use 'fall-back-values:

0.50 / 0.05 = 10

and

0.20 / 0.05 = 4

1 mark

C_4H_{10}

1 mark

*if just find ratio of C to H using fall-back values, get C_2H_5 allow **1** mark*

2

[19]

21 (a) (i) red

ignore pink

1

(ii) add silver nitrate (solution)

1

white precipitate

dependent on addition of silver nitrate

ignore addition of another acid

*if hydrochloric acid added max **1** mark*

1

(b) suitable named alkali / sodium hydroxide solution in burette

1

add alkali solution until (indicator) becomes pink / red

1

*if acid to acid titration described, first two marking points **not** available*

any **two** from:

- wash / rinse equipment
- add dropwise or slowly (near end point)
- swirl / mix
- read (meniscus) at eye level
- white background
- read start and final burette levels / calculate the volume needed
- repeat

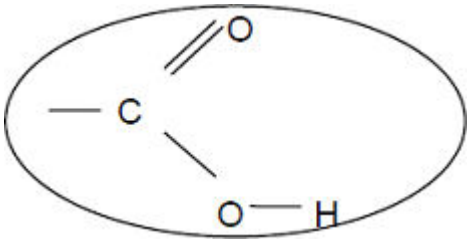
2

(c) does not ionise / dissociate completely

allow <u>for acids of the same concentration</u>, weak acids have a higher pH or fewer hydrogen ions

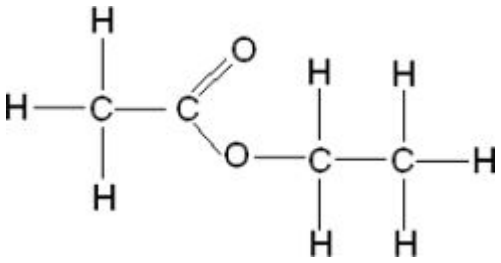
1

(d) (i) ring round COOH

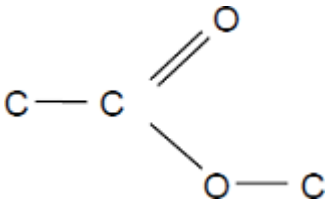


1

(ii)



*if not fully correct, allow **1** mark for correct ester group − minimum*



2

[11]

22 (a) oxygen

must be name

*do **not** accept oxide or dioxide*

1

(b) (i) 2 x C–C

and

5 x C–H

all single (line) bonds

1

(ii) $C_3 H_8$

must be formula

*do **not** accept lower case h*

1

(iii) water

1

(c) ethane and butane boil at temperatures less than 20°C

1

ethene and hexene each have a carbon-carbon double bond

1

[6]

23 (a) (i) exothermic

accept combustion
*allow burning **or** oxidation **or***
redox

1

(ii) carbon monoxide / *CO* (is produced)

allow monoxide (is produced) ignore carbon oxide

1

because there is incomplete / partial combustion (of the fuel)

accept because there is insufficient oxygen / air (to burn the fuel)

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a statement that crude oil is heated **or** that substances are cooled. However there is little detail and any description may be confused or inaccurate.

Level 2 (3-4 marks)
There is some description of heating / evaporating crude oil **and either** fractions have different boiling points **or** there is an indication of a temperature difference in the column.

Level 3 (5-6 marks)
There is a reasonable explanation of how petrol is or fractions are separated from crude oil using evaporating **and** condensing.

If cracking is given as a preliminary or subsequent process to fractional distillation then ignore.

However, if cracking / catalyst is given as part of the process, maximum is **level 2**.

Examples of chemistry points made in the response could include:

- Some / most of the hydrocarbons (or petrol) evaporate / form vapours or gases
- When some of / a fraction of the hydrocarbons (or petrol) cool to their boiling point they condense
- Hydrocarbons (or petrol) that have (relatively) low boiling points and are collected near the top of the fractionating column or hydrocarbons with (relatively) high boiling points are collected near the bottom of the fractionating column
- The process is fractional distillation
- Heat the crude oil / mixture of hydrocarbons or crude oil / mixture is heated to about 350°C
- Some of the hydrocarbons remain as liquids
- Liquids flow to the bottom of the fractionating column
- Vapours / gases rise up the fractionating column
- Vapours / gases cool as they rise up the fractionating column
- The condensed fraction (or petrol) separates from the vapours / gases and flows out through a pipe
- Some of the hydrocarbons remain as vapours / gases
- Some vapours / gases rise out of the top of the fractionating column
- There is a temperature gradient in the fractionating column or the fractionating column is cool at the top and hot at the bottom

6

[9]

24 (a) any **one** advantage from:

- conserves resources (of crude oil / metal ores)
  ignore can be made into other items
  allow the materials (in the pen) are non-renewable
  allow less expensive than producing from the raw material
- reduces use of landfill
  ignore less waste
- less use of fuels/energy
- less carbon dioxide produced
  ignore global warming unqualified

1

any **one** disadvantage from:

- made of different polymers / alloys / materials
- difficulty / cost of separating the different materials
  allow not all the materials can be recycled

1

(b) hard / strong / durable

1

resistant to corrosion **or** unreactive
allow do not rust
*do **not** allow corrosive*

1

(c) (i) vapours (of decane)
ignore pressure / hot / heat
allow high temperature (≥150 °C)

1

passed over a catalyst **or** porous pot **or** aluminium oxide
allow catalyst even if incorrectly named

1

or
mixed with steam (1)
at a (very) high temperature (1)
if temperature quoted, must be ≥ 500 °C

(ii) <u>many</u> monomers **or** <u>many</u> ethene molecules

1

join / bond

allow addition polymerisation for second mark

1

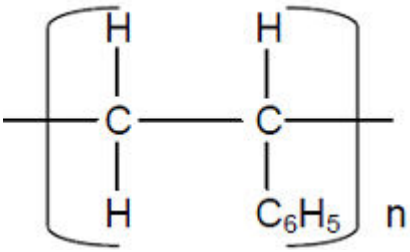
OR

monomers / ethene molecules (1)

form chains **or** very large molecules (1)

*if no other mark awarded allow double bond breaks / opens up **or** double bond forms a single bond for **1** mark*

(d)



allow bonds that do not extend through brackets

7 single bonds are used and are in the correct places with no additional atoms (1)

the brackets and the n are in the correct place (1)

2

[10]

25 (a) ethanol is made up of only one type of molecule **or** ethanol is a compound

allow ethanol is pure

1

diesel / petrol / rapeseed oil are mixtures

accept composition of diesel / petrol / rapeseed oil varies / changes

allow different hydrocarbons have different melting points

ignore diesel, petrol and rapeseed oil are impure

1

(b) (i) sugar is mixed with / dissolved in water

accept sugar cane for sugar

1

yeast (is added)

allow enzymes are added

*if no other mark awarded, allow correct word or chemical equation for **1** mark*

1

(ii) (growing sugar cane / rapeseed) plants absorbs carbon dioxide

accept carbon for carbon dioxide

accept carbon dioxide is used for photosynthesis

1

which is released (when the biofuel burns)

*do **not** accept <u>no</u> carbon dioxide is released (when biofuels burn)*

1

(c) nitrogen / N_2 **and** oxygen / O_2 (in the air)

*do **not** accept fuels contain nitrogen*

1

react in the hot engine / at high temperature

1

(d) any **three** from:

ignore references to melting point

3

- ethanol needs a higher temperature to burn than petrol **or** ethanol has a higher flashpoint than petrol
- ethanol releases less energy (per litre) than petrol
- sugar is renewable **or** crude oil is non-renewable / will run out
- sugar cane growth is unreliable / slow **or** crude oil is a reliable supply

  *allow ethanol is not readily available **or** petrol is readily available*
- ethanol is made by a batch / slow process **or** petrol is made by a continuous / fast process
- ethanol is carbon neutral **or** petrol contains 'locked up' carbon dioxide
- sugar / sugar cane should be used for food not for fuels

  accept idea of food shortages

a justified conclusion that adds value

*accept one **additional** point from the list above as long as one comparison of replacing petrol with ethanol is made*

1

[12]

26 (a) (i) hydrocarbons

1

(ii) ethane has the smallest molecules

1

heptadecane has the highest boiling point

1

(iii) evaporating

1

condense

1

(b) (i) **W**

1

Y

1

(ii) floats

if no answer written on line, allow correct answer indicated in the box

1

(iii) open the tap

allow let the water out

ignore remove water

1

stop the flow of liquid when the water has run out

allow until oil is left behind

ignore filter

1

[10]

27 (a) (i) C_7H_{16}

mark answer line first

answer may be given in the table

1

(ii) C_nH_{2n+2}

1

(b) (i) carbon monoxide

*do **not** accept carbon oxide*

*do **not** accept water*

ignore CO

1

(ii) because of partial / incomplete combustion (in reaction 2) **or** complete combustion (in reaction 1)

*allow because there is less / insufficient oxygen (in reaction 2) **or** sufficient oxygen (in reaction 1) allow different amounts of oxygen used (in the reactions) **or** $19O_2$ (in reaction 1) **and** $13O_2$ (in reaction 2)*

ignore air

1

(c) (i) 15 (%)

ignore units

1

(ii) water (vapour)/steam

allow H_2O / OH_2 / hydrogen oxide

1

(iii) sulfur in petrol / crude oil (reacts with oxygen)

it = sulfur dioxide

1

(ii) because nitrogen **and** oxygen (are in the air and) react

*allow nitrogen **and** oxygen burn*

*accept nitrogen + oxygen → nitrogen oxide **or** symbol equation*

ignore air

1

at high temperature (inside a petrol engine)

allow heat / hot (engine)

1

(d) because carbon dioxide / it causes global warming **or**

allow because carbon dioxide / it causes greenhouse effect / climate change

1

because carbon dioxide / it has an impact on oceans

because this carbon dioxide / carbon / it was '<u>locked up</u>' (in fossil fuels) **or**

because the percentage/amount of carbon dioxide / it in the atmosphere is <u>increasing</u>

1

[11]

28 (a) (i) $C_{11}H_{24}$

1

it does not have a (carbon carbon) double bond **or** it has only single (carbon carbon) bonds.

*linked to first mark point accept it is an alkane **or** it is (a) saturated (hydrocarbon)*

accept converse statement

1

(ii) ethene 4 x single C-H bonds

1 x double C=C bond

1

ethanol 5 x single C-H bonds

1 x single C-C bond

*if additional bonds are given on water molecule then both ethene and ethanol must be correct for **1** mark*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.
Examiners should also apply a 'best-fit' approach to the marking.

0 marks

No relevant content.

Level 1 (1-2 marks)
There is a simple description of advantages **and** / **or** disadvantages of environmental or economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane.
There is a weak or no conclusion.

Level 2 (3-4 marks)
There a clear description of advantages **and** / **or** disadvantages of environmental **and** economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane.
There is a conclusion based on the factors described.

Level 3 (5-6 marks)
There is a detailed description of the advantages **and** / **or** disadvantages of environmental **and** economic or social factors why Brazil should produce ethanol from crude oil or from sugar cane, considering both processes.
There is a justified conclusion.

examples of the chemistry points made in the response

Sugar cane

Advantage

Environmental:

- it is renewable / sustainable
- it grows absorbing CO_2 which makes it 'carbon neutral'

Economical / **Social:**

- growing it is labour intensive so provides (local, rural) employment
- low amount of energy / fuel needed so process costs are low
- simple / low technology process so process / investment costs are low

Disadvantage

Environmental:

- destruction of habitats / biodiversity to provide land to grow sugar cane

Economical / **Social:**

- land should be used to grow food (shortage / cost / population increase)

- growing or process is slow / batch / unreliable (crop failure)

Crude oil

Disadvantage

Environmental:

- it is non-renewable / will run out
- it contains 'locked up' carbon / CO_2 **or** when released increases global warming
- destruction of marine habitats caused by accidents / spillages

Economical / Social:

- process requires small number of trained workers
- high amount of energy / fuel needed so process costs are high
- complex / high tech process so process / investment costs are high

Advantage

Environmental:

- does not use land as it is offshore

Economical / Social:

- no loss of food crops
- extracting or process is fast / continuous / reliable

6

[10]

29 (a) (i) bar drawn between 84 and 86

1

(ii) sulfur dioxide linked to acid rain

1

carbon particles linked to global dimming

1

(b) (i) any **one** from:

- plants / trees absorb (carbon dioxide)
- coal ' locks up' (carbon dioxide)

1

(ii) it <u>increases</u> the amount (of CO_2)

1

because carbon in coal (forms carbon dioxide)

accept because carbon / coal burns / reacts <u>with oxygen</u> (to produce CO_2)

1

[6]

30 (a) (i) *use of carbon throughout = **max 1***

<u>burning biodiesel</u> releases CO_2

ignore burning trees

1

CO_2 is <u>absorbed</u> / <u>used</u> by the crops/plants (used to produce the biodiesel)

allow CO_2 <u>absorbed</u> / <u>used</u> by trees

1

(ii) *allow use of carbon for carbon dioxide throughout*

<u>increases</u> CO_2 / greenhouse effect

accept causes global warming

OR

allow causes climate change

<u>less</u> $CO_2$is absorbed (from atmosphere)

ignore other correct effects

1

because <u>burning</u> trees releases CO_2

accept <u>fewer</u> trees to absorb CO_2

***or** crops / plants do not absorb as much CO_2 as trees*

OR

because there is <u>less</u> photosynthesis

ignore habitats / biodiversity

*if no other mark awarded global dimming because of smoke / particles gains **1** mark*

1

(b) any **one** from:

ignore carbon neutral / cost / less harmful / environmentally friendly

- crude oil / fossil fuel is running out / non-renewable
  allow biodiesel is renewable / sustainable
- demand for fuels / energy is increasing
  ignore demand for biodiesel is increasing
- new legislation / protocols

1

(c) (i) uses crops / land that could be used for food

*allow destroys habitats **or** reduces biodiversity*

ignore cost

1

(ii) increases the cost of food / land

ignore cost of machinery / process

ignore cheaper to produce biodiesel

1

[7]

31 (a) carbon dioxide <u>decreased (by plants / trees)</u>

allow plants / trees absorbed carbon dioxide

1

oxygen <u>increased</u> (by plants / trees)

allow plants / trees released oxygen

if neither of these marks awarded

allow plants / trees

*photosynthesise for **1** mark*

1

because coal 'locks up' / traps / stores carbon dioxide / carbon

allow trees 'locked up' carbon dioxide / carbon

1

(b) carbon / C

hydrogen / H

sulfur / S

*all 3 correct **2** marks*

*1 or 2 correct **1** mark*

allow H_2

ignore oxygen

2

(c) (i) 2 2

balancing must be correct

*do **not** accept changed formulae*

1

(ii) increases atmospheric pollution

carbon dioxide / CO_2 released

1

from the (thermal) decomposition of calcium carbonate **or**

*accept causes global warming **or** CO_2 is a greenhouse gas*

description of this decomposition **or** equation

ignore sulfur dioxide and effects in this part

1

decreases atmospheric pollution

sulfur dioxide / SO_2 is removed

accept less acid rain produced

1

by reaction with calcium oxide **or** calcium carbonate

*accept neutralisation **or** forms calcium sulfate*

1

[10]

32 (a) 6

1

oxygen

1

(b) (i) heating the hydrocarbon to a high temperature

1

the presence of a catalyst

1

(ii) all bonds correct

four C—H bonds**and**

one C=C bond

1

(iii) water

accept hydrogen oxide/steam

allow H_2O

1

(c) (i) carbon dioxide

allow CO_2

1

(ii) by filtering/decanting/centrifuging (to remove yeast)

ignore sieving

1

(fractional) distillation (to separate ethanol from water)

accept a description of (fractional) distillation

1

[9]

33 (a) (i) (1)

5

3

(6)

4

2

all numbers in the correct order gains both marks

*any two numbers in the correct position gains **1** mark*

2

(ii) Water

ignore formula if correct name given

accept hydrogen oxide

allow H_2O

1

carbon dioxide

allow CO_2

*accept carbon monoxide / CO **or** carbon / C*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a **basic** description of at least one advantage **or** one disadvantage caused by using plastic shopping bags made from poly(ethene)

Level 2 (3-4 marks)
There is a **clear** description of both an advantage **and** a disadvantage, caused by using plastic shopping bags made from poly(ethene).

Level 3 (5-6 marks)
There is a **detailed** description of both advantages **and** disadvantages caused by using plastic shopping bags made from poly(ethene)

examples of the chemistry/social points made in the response:
ignore cost unqualified

Advantages:

- Simple properties eg strong / low density / water resistant
- Bags can be reused (for shopping) **or** another specified use eg bin liners
- Money charged for bags can go to good causes **or** encourage reuse
- Poly(ethene) bags can be recycled eg made into milk bottle crates
- Poly(ethene) bags can be burned to provide heat for buildings/generation of electricity
- New bags are now made that can biodegrade

Disadvantages:

- (Older) bags can take many years to biodegrade
- There is a shortage of landfill space
- Bags are made from (crude) oil which is a non-renewable resource/running out
- Large amounts of energy/fuel are used for the production of poly(ethene)
- Production of poly(ethene) releases carbon dioxide/causes global warming
- Specified issue caused by litter eg visual pollution or effect on wildlife
- Burning bags release carbon dioxide / causes global warming

6

[10]

34 (a) C_2H_4

1

a correct other product **and** balanced eg C_4H_{10}

1

(b) bubbling / fizzing / frothing / effervescence

*ignore gas given off **or** solution goes cloudy*

1

(c) any **five** from the following bullet points:

allow converse for ethanol from crude oil

To gain full marks there should be both advantageous and disadvantageous issues and their importance

Advantageous issues using sugar cane:

ignore costs – unless specified

ignore safety

ignore simple/low technology process

ignore labour intensive as an advantage

linked importance

- sugar cane/plants absorb carbon dioxide / photosynthesise

  *so is carbon neutral **or** reduce global warming*

- sugar cane / plants are renewable / sustainable

  *and so save resources / oil **or** crude oil is non-renewable*

- low energy process

  *and so it saves fuel **or** / making ethanol from crude oil needs fuel for fractional distillation / cracking*

Disadvantageous issues using sugar cane:

ignore fermentation releases carbon dioxide; destruction of habitats/land to build production plants; types of pollution; waste products

- large areas of land are needed

  which leads to destruction of habitats / forest

- land could be used for food crops

  *may cause food shortages **or** increases the price of food **or** increasing world population*

- slow process

  so limits supply / production of ethanol

- ethanol is impure **or** contains 50% ethanol

  so needs further separation or ethanol from crude oil is 100% pure

- batch process

  so uses more labour

- the crop yield / supply of ethanol is unreliable

  *because growth is seasonal / weather dependent **or** possibility of crop failure*

a justified conclusion

***compensation mark,** if no other mark awarded allow one mark for*

two or more issues

5

[9]

35

(a) (i) hydrocarbons

accept alkanes

1

(ii) distillation

1

(b) (i) vaporising

1

(ii) cracking

1

(c) B

1

(d) (i) new plastic products are made from the used plastic bags

1

(ii) not biodegradable

accept does not decompose

allow does not rot

1

(iii) advantage – energy is released

1

disadvantage – carbon dioxide is produced

1

[9]

36

(a) (i) a reasonable attempt at a smooth curve

allow a curve which is close to but does not necessarily touch all points

1

(ii) any **two** from:

allow thicker / thinner / runny for viscous

- biodiesel is more viscous than petroleum diesel at all / lower temperatures
- biodiesel – as the temperature increases the viscosity decreases or vice versa
- petroleum diesel – the viscosity does not change

if no other mark awarded

*allow **1** mark for any correct conclusion based on time or rate of flow*

2

(iii) does not flow as easily (through pipes / engine)

allow could form a solid / block pipes / engine at low temperatures

or

needs a high temperature to flow

allow more difficult to vaporise / ignite

ignore burning

ignore references to viscosity

1

(b) (i) global dimming

allow correct description

1

(ii) 56 (%)

1

(iii) (increases) acid rain

1

because there is more nitrogen oxide(s)

ignore sulfur dioxide

if no other mark awarded

*allow **1** mark for nitrogen oxide(s) given*

1

(iv) *answer yes or no does not gain credit because the marks are for an explanation*

ignore references to petroleum diesel

allow carbon for carbon dioxide

no

because carbon dioxide (26%) is released / produced

1

this will not all be absorbed by photosynthesis / growing plants for biodiesel

accept growing plants / farming uses machinery / fossil fuels releases carbon dioxide

OR

yes

because although carbon dioxide (26%) is released / produced (1)

this was absorbed by photosynthesis / growing plants (for biodiesel) (1)

allow this will be absorbed by photosynthesis / growing plants for biodiesel

1

[10]

37 (a) *allow answers referring specifically to the naphtha fraction*

crude oil is evaporated/vaporised (by heating)

1

the vapours are condensed (by cooling)

1

(fractions condense) / boil at different temperatures

allow fractions have different boiling points

1

(b) any **four** from:

answer yes or no does not gain credit

ignore references to volume of milk held / number of bottles used / biodegradability / habitats / pollution / mining / dust

each marking point must be a comparison

milk bag points

- uses (75%) less **crude oil** to make (than a plastic milk bottle)

  allow eg uses 75% less

  poly(ethene) which is made from crude oil

- uses less **energy** / fuel to make (than a plastic / glass milk bottle)

- produces less **carbon dioxide** to manufacture (than a plastic / glass milk bottle)

  allow produces less greenhouse gases / causes less global warming

  allow produces less CO_2 on burning

- produces less **waste** (than a plastic / glass milk bottle)

  allow takes up less landfill (space)

  allow an argued case for more waste eg milk bags are discarded / cannot be reused

- less fuel used for **transport** than glass milk bottles

- (produces waste because) milk bags are only used once whereas glass bottles can be **re-used**

  allow milk bags are discarded but glass bottles can be reused (24 / many times)

  allow glass bottles can be reused but milk bags can't

poly(ethene) points

- uses a limited **raw material** / crude oil whereas the raw materials for glass are almost unlimited

- **less** (5%) poly(ethene) is **recycled** (compared to glass (35%))

  allow (35%) glass is recycled or (5%) poly(ethene) (bottles) recycled BUT milk bags aren't / are discarded

  or

  recycled poly(ethene) is not used to make new bags whereas recycled glass is used to make new bottles

4

[7]

38

(a) (i) carbon

1

hydrogen

accept in either order

ignore number eg 2 carbons

4 hydrogens

1

(ii) (a carbon carbon) double (bond)

1

(b) poly(ethene)

1

(c) any **two** from:

ignore pollution / cost / global warming / harms environment / recycling

- made from crude oil
- non-renewable resources

  accept resources are running out
- litter

  accept go to landfill
- not biodegradable
- use energy to make
- when burned or biodegraded carbon dioxide is released
- encourage customers to reuse bags / use their own bags

  accept reduces carbon emissions / footprint

2

[6]

39

(a) crude oil / it is evaporated / vaporised

ignore heated

1

vapours / gases / fractions <u>cool and condense</u>

accept named fraction(s)

1

(different) vapours / gases / fractions (condense) at different temperatures

accept (different) vapours / gases / fractions have different boiling points

*max **2** marks for description of laboratory method **or** mention of cracking*

1

(b) (i) any **one** from:

- range of boiling points
- range of carbon atoms

1

(ii) greater the number (of carbon atoms) the higher the boiling point

*do **not** accept molecules / particles*

1

(c) (i) burning / combustion

allow oxidation / redox

1

(ii) any **two** from:

*reaction with hydrogen gains max of **1** mark only*

- cracking / (thermal) decomposition
- heat / vaporise
- catalyst / aluminium oxide

allow porous pot

ignore names of other catalysts

2

[8]

40

Reused

- saves raw materials / crude oil
    - *unable to reuse many times*
    - *bags easily split*
- saves energy / fuel / transport
- fewer bags needed / made
- reduces carbon / CO_2 emissions
- reduces use of landfill
- saves cost of a new bag
- no waste

1

Recycled

- saves raw materials / crude oil
    - *has to be collected / transported / washed / separated / melted*
- saves energy / use of fuel
- reduces carbon / CO_2 emissions
- reduces use of landfill
- can be used for new products

    ignore uses energy

1

Burned

- heat / energy released can be used (for heating / generating electricity)
    - *has to be collected / transported*
- reduces use of landfill
    - *wastes the resource / plastic*
    - *releases harmful gases / toxic gases / CO_2*

1

Dumped

- collected / transported with household waste
    - *wastes the resource*
    - *plastic uses landfill*
- (slowly) biodegrades **or** produces methane which can be used as a fuel
    - *produces methane which is a greenhouse gas / could cause explosions*
- (not biodegradable so) does not release CO_2 / green house gas into the air
    - *not biodegradable / take years to decompose*

ignore cost / litter / waste / global warming / habitats unless mentioned above

1

[4]

41

(a) carbon / diesel / it reacts / burns in oxygen / air

1

limited supply (of oxygen / air)

accept incomplete combustion

$2C + O_2 \rightarrow 2CO$ ***or***

*$C + CO_2 \rightarrow 2CO$ gains **2** marks*

1

(b) any **four** from:

accept converse statements for fossil diesel.

ignore cost / ease of manufacture / usage issues

for biodiesel:

- less global dimming (because fewer carbon particles)
- less acid rain (because less sulfur dioxide)

  *if neither point awarded, fewer carbon particles and less sulfur dioxide = **1** mark*
- renewable resource / sustainable

  accept fossil fuel / diesel supplies are limited
- use waste vegetable oils / fats
- vegetables / plants absorbed carbon dioxide / carbon neutral

  accept fossil fuel / diesel releases locked up carbon / is not carbon neutral
- uses land which could be used to produce food
- third world countries can produce bio diesel
- biodegrades easily
- more NOx released

4

justified conclusion

1

[7]

42

(a) sulfur dioxide / SO_2

allow sulfur oxide

1

(b) global dimming

1

(c) oxygen / O_2

1

(d) (oil is a) limited resource / finite / non-renewable

*accept running out of oil **or** wood is sustainable*

*accept (burning oil) increases amount of carbon dioxide in the atmosphere / global warming **or** releases locked up carbon / global dimming / acid rain*

accept the oil (may become) too expensive

1

(e) carbon dioxide produced (from burning wood)

ignore global warming

1

carbon dioxide used by plants / trees **or** for photosynthesis

if no other mark awarded

*allow carbon emissions used by plants / trees **or** for photosynthesis for **1** mark*

1

[6]

43 (a) (i) distillation

1

(ii) condense (at different temperatures)

accept they / fractions / hydrocarbons have different boiling points

ignore melting point / size of molecule

1

(b) contains hydrocarbons

1

has a high boiling point

1

(c) C_5H_{12}

1

[5]

44 (a) (i) *if (fractional) distillation / hydrogenation mentioned as the method = max 1*

heat / high temperature / hot / vaporise

allow thermal decomposition

ignore evaporation

*do **not** accept 'burns'*

*do **not** accept temperature < 100*

1

catalyst **or** silica / alumina / porous pot

ignore other named catalyst

or steam

*allow heat (the vapour) to a very high temperature / >800°C for **2** marks*

1

(ii) C_2H_3Cl

ignore attempts to balance equation

1

(iii) single bonds between C – H, C – Cl **and** C – C

*do **not** accept symbols outside the bracket*

1

(b) (i) so that the amount of plasticiser / (sample of) PVC is the independent / only variable that affects the bending / flexibility of the samples

allow because different sizes would give different results

accept because size is a control variable

ignore references to reliability / precision etc

1

(ii) to improve the reliability (of the investigation)

accept to calculate a mean

*accept to check for anomalous results **or** to check the range of results*

ignore accuracy / precision etc

1

(iii) 23

*correct answer with or without working = **2** marks*

if answer is incorrect

allow $\frac{22 + 23 + 24}{3}$

***or** 21 for **1** mark*

2

(iv) (PVC) sample had been stretched / used / tested in first three tests

accept higher temperature

*allow worn **or** become weaker*

ignore (human) error

ignore more flexible / softer

ignore intermolecular forces

1

(c) does not bend (easily / much)

ignore non-biodegradable / low maintenance

or it is <u>not</u> flexible **or** it is rigid

ignore sturdy / stronger / harder

1

[10]

45 (a) complete diagram with 2 carbon atoms and 5 hydrogen atoms each C–C and each C–H linked by a single line (bond)

1

(b) (i) the greater the number of (carbon) atoms (in an alkane molecule) the greater its boiling point **or** vice versa

allow as the (carbon) chain gets longer the boiling point increases

ignore melting points

*do **not** accept reference to greater number of molecules*

1

(ii) *they = hydrocarbons from the graph*

it = $C_{30}H_{62}$

any **two** from:

- low boiling point / volatile

  accept they are gases or liquids
- low viscosity
- high flammability

  accept easier to burn / ignite
- small molecules

  accept short chains

  ignore number of carbon atoms
- burn completely

  ignore speed of burning

2

(c) (i) 16 (CO_2) + 18 (H_2O)

1

(ii) (carbon dioxide in the Earth's early) atmosphere

accept from volcanoes (millions of years ago)

***or** from <u>dead</u> plants / animals*

allow dead sea creatures

ignore shells

1

(iii) increase in burning / use of fossil fuels

1

locked up carbon (carbon dioxide) is released

allow carbon / carbon dioxide from millions of years ago is released

accept extra carbon dioxide is not 'absorbed' (by the carbon cycle)

1

[8]

46

any **four** from:

*to gain **4** marks both pros and cons should be given*

Arguments for biodiesel

max **three** from:

- sustainable / renewable
- (carbon neutral) absorbs CO_2 when growing / during photosynthesis
- burning biodiesel produces low amounts particulates / carbon monoxide

  allow burning biodiesel produces little / low amount of global dimming

  ignore sulfur dioxide
- can use waste vegetable oils / fats (from food industry) **or** can use waste plant material
- can be used to conserve crude oil (instead of / mixed with petroleum diesel)
- produced by a low energy / temperature process

  accept produced by a low tech process
- biodegrades (easily)

  ignore engine effects

Arguments against biodiesel

max **three** from:

- creates food shortages

  accept price of food increases
- deforestation to plant more crops leads to loss of habitat / biodiversity **or** deforestation leads to a reduction in absorption of CO_2

  allow burning trees increases CO_2

  allow deforestation increases global warming
- burning biodiesel produces high amounts of nitrogen oxides

  allow increases acid rain
- crops takes time to grow

  allow crops can fail
- vast areas of land needed to grow crops

4

conclusion supported by the argument presented, which must give added value to the points for and against given above

1

[5]

47

(a) elements

1

(b) (i) nucleus

1

(ii) six

1

(c) (i) CH_4

1

(ii) bond

1

(d) (i) oxygen

1

(ii) any **one** from:

- (water) does not pollute
  accept no harmful gas(es)
  allow less pollution
- (only) water is produced
- no carbon dioxide / monoxide (is produced)
  *accept no greenhouse gas(es) / effect **or** no global warming*

1

[7]

48

(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]

49

(a) acid rain → sulfur dioxide

1

global warming → carbon dioxide

1

global dimming → carbon particles

1

(b) (i) oxygen

1

(ii) carbon monoxide

1

(c) (i) decreasing

accept running out / none left

1

(ii) any **two** from:

it = coal

- world needs (more) energy
  accept population is increasing
  allow (greater) demand for coal / fuels / energy
- plentiful supply
  accept readily available
  allow coal will 'last longer'
- (many) countries have coal
- easy to find / extract
- oil / gas is running out
  accept need to use less oil / gas
  accept need to use it to replace oil / gas
- cheap **or** cheaper than oil

2

[8]

50 (a) it is a mixture (of hydrocarbons) **or** contains hydrocarbons with different boiling points

*accept to separate (crude) oil (into fractions) **or** obtain the naphtha (fraction)*

accept to get useful products

ignore removal of impurities

1

(b) (i) heat / vaporise

*mention of hydrogen = max **1***

accept thermal (decomposition) for heat

allow boil

do not allow temperatures below 100°C

ignore steam

1

catalyst

allow alumina / porous pot

ignore other catalysts

1

(ii) 4 × C – H **and** C = C

ignore brackets with or without an 'n' before them

do not allow poly(ethene)

1

(c) *ignore ideas about carbon dioxide formation / photosynthesis or cost / economics / environmentally friendly*

any **four** from:

*candidates are only awarded **1** mark if they use equivalent pairs of bulleted points*

must be at least **one** advantage and **one** disadvantage for all four marks

<u>crops</u>
advantages eg:

<u>crude oil</u>

disadvantages eg:

- renewable (resource) / sustainable
  - *non-renewable (resource) / finite / running out*
- low / less energy / fuel needed for process **or** lower temperature [ignore heat or quoted temperatures]
  - *high / more energy needed for process **or**/ higher temperature*
- can use waste plant / crop material
- carbon neutral
  - *not carbon neutral **or** releases locked up carbon*
- low safety risk (processes)
  - *high safety risk (process)*
- low technology
  - *high technology*
  - *risk of major oil spillage*
  - *can be used to make other products*

disadvantages eg:

advantages eg:

- batch process / process is slow
  - *continuous process / process is fast*
- many steps in the process
  - *few steps in the process*
- ethanol is impure / may contain water
  - *ethanol is pure*
- food shortages
  - *'conserves' food*
- need very large areas of (arable) land to grow crops **or** can only grow in certain areas / climates

- destruction of woodland / habitat
- slow growth of crops
- labour intensive
    - *can accept reverse arguments*

4

a conclusion
with a reasoned argument based on valid advantages **and** disadvantages

there must be at least one advantage and one disadvantage, however, a matched pair, although only awarded one mark would allow the conclusion mark to be awarded

1

[9]

51 (a) (i) straight line through the 'points' and extended to C_8H_{18}

*do **not** accept multiple lines*

1

(ii) 5500

range 5400 to 5600
accept ecf from their graph

1

(iii) it is a straight line graph

allow directly proportional
accept constant difference between (energy) values
accept C_5H_{12} close to values on the graph
***or** C_5H_{12} comes in middle of the graph*
ignore 'fits the pattern' unqualified
ignore 'line of best fit'
ignore 'positive correlation'

1

(iv) expected ranges for working are:

accept correct numerical answer as evidence of working

(5400 to 5600) – (2800 to 2900) = (2500 to 2800)

or

their value from (a)(ii) – a value from 2800 to 2900

or

(5400 to 5600) / their (a)(ii) divided by 2

or

a value from 2800 to 2900 - 2

1

no / not quite / almost / yes

this mark is only awarded on evidence from their correct working

1

(b) (i) incorrect / no **or** partially correct

ignore references to hydrogen

1

bio-ethanol produces least energy

mark independently

or

bio-ethanol produces 29 kJ

1

(ii) *ignore incorrect / correct*

any **two** from:

- hydrogen produces only H_2O
  accept hydrogen does not produce harmful gases / CO_2 / SO_2
- coal produces SO_2
  allow coal causes acid rain / respiratory problems
- coal produces smoke
  allow coal causes global dimming
- both renewable and non-renewable fuels produce CO_2
  accept bio-ethanol and natural gas / coal produce CO_2 / global warming
- (both) the non-renewable fuels produce CO_2
  accept coal and natural gas produce CO_2 / global warming
- (both) renewable fuels produce no smoke
  accept hydrogen and bio-ethanol do not produce smoke / global dimming
- (both) renewable fuels produce no SO_2
  accept hydrogen and bio-ethanol
  do not produce SO_2 / acid rain

2

[9]

52 (a) (i) polyethene / poly(ethene)
accept polythene / polyethylene

1

(ii) needs heat / energy / high temperature / fuel (for cracking)
ignore other processes

1

produces carbon dioxide / CO_2
*ignore use of CO_2 **or** 'produces carbon'*

1

(b) any **three** from:

- use water from local sources **or** water from close to home
- recycle bottles in the UK / close to home
  accept do not recycle in other countries / Asia
- (reduction in distance travelled) would reduce CO_2 emitted by transport
  accept use of transport with low / no carbon dioxide emissions
- use tap water
- use glass bottles / waxed cartons / metal bottles
  *do **not** accept 'do not use plastic bottles' without an alternative material*
- do not put in landfill **or** recycle more
- reuse / refill plastic bottles
- tax imported water / plastic bottles (to offset carbon cost)
- make more / all plastic bottles in UK
  answers must be about the reduction of carbon cost

3

[6]

53 (a) (i) the greater the number (of carbon atoms), the higher its boiling point
*do **not** accept hydrocarbons for carbon atoms*
allow converse
allow melting point

1

(ii) accept answers in the range 344 to 350

1

(iii) 216

1

(b) (i) **EITHER**

shortage of petrol **or** demand for petrol is higher than supply

diesel is in excess **or** supply of diesel is higher than demand

1

OR

petrol low supply **and** diesel high supply (1)

petrol high demand **and** diesel low demand (1)

*petrol / diesel not specified = max **1***

1

(ii) any **one** from:

- use diesel to make petrol
  *accept crack diesel **or** description of cracking*
- make diesel cheap(er) (than petrol)
  or make petrol more expensive
  accept lobby the government to reduce the tax on diesel / increase tax on petrol
- mix ethanol with petrol
  ignore biodiesel

1

[6]

54 (a) (i) wood

1

(ii) 30 (kJ)

1

(iii) carbon / C

or hydrogen / H

or sulfur / S

or oxygen / O

1

(iv) 3 / three (g)

1

(b) (i) releases most energy

accept releases a lot of energy / burns rapidly

ignore references to cost

1

no harmful gases / no or less pollution formed / no global warming / no climate change / no greenhouse gas

accept produces water (only) /steam
*accept does **not** produce sulfur dioxide / carbon dioxide / carbon monoxide / particles / smoke*

1

(ii) any **one** from:

- expensive
- difficult to produce

  accept large volume needed
- not available in large quantities
- explosive / dangerous
- not a natural fuel / resource

  allow will run out / non-renewable
- made from fossil fuels
- difficult to store

1

[7]

55 (a) (i) C_2H_4

1

(ii) poly(ethene)

1

(b) (i) is not biodegradable

1

(ii) not enough landfill sites / space

*accept landfill sites are filling up **or** plastics remain for <u>years</u> **or** plastics not broken down*

ignore cost / waste of resources / not biodegradable / wildlife

1

(iii) less (crude) oil / fuels / energy used

accept (crude) oil is a non-renewable resource

1

[5]

56 (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]

57 (a) (i) made up of one sort of atom
accept it is in the periodic table
or
has its own symbol

1

(ii) nitrogen / N / N_2 **or** oxygen / O / O_2
*do **not** accept argon **or** helium*
*do **not** accept oxide*

1

(b) (i) compound

1

carbon

1

(ii) bond

1

[5]

58 (a) (i) monomers

1

(ii) crude oil

1

(b) any **three** from:

- metal may not corrode away / remains
- plastic remains / does not break down (decay) / not affected by microorganisms
  accept non-biodegradable
- should recycle / conserve resources / mend the kettle / burn (plastic) as a fuel
  accept it is a waste of materials / resources
- landfill sites are limited / filling up
- water pollution
  *ignore harms wildlife / habitats **or** problems caused by burning the kettle*

3

[5]

59 (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*

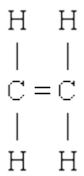
1

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) all 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]

60 (a) (i) hydrogen

must be name

1

(ii) a line of four or more ethene molecules joined to the original two with single bonds

*at least two other ethene molecules joined to the original two in a chain gains **1** mark*

2

(b) (i) any **two** from:

- non-biodegradable

  accept remains a long time
- landfill sites are filling up / limited

  accept land / space used up
- <u>waste of a resource</u> / could be recycled / reused

  ignore references to tablets / animals

2

(ii) any **one** from:

- (two) different polymers / plastics / materials
- need to be separated
- limited collection points / many need to be collected
- tablets may still be present

1

[6]