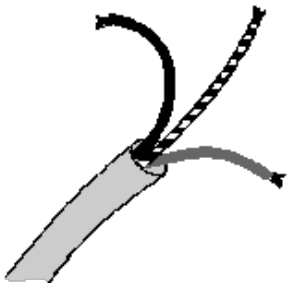
Q1. The properties of transition metals make them useful elements.

(a) Why is copper used for electrical wiring?



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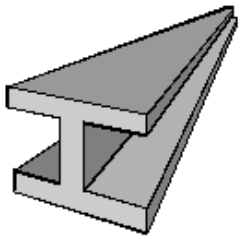
(1)

(b) Why is iron used for girders in buildings?



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(1)

(c) Why are transition metal compounds added to glazes for pottery?

.....

.....

(1)

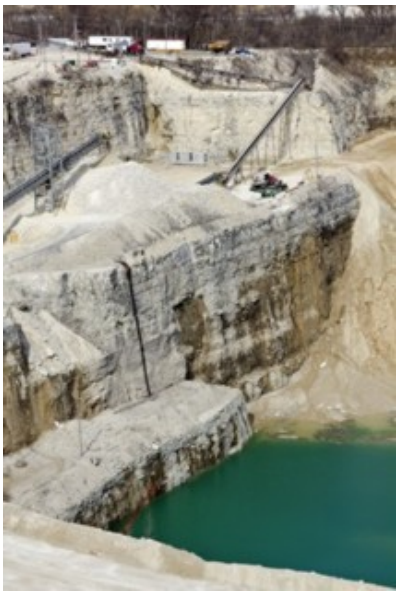
(Total 3 marks)

Q2. Limestone is used for statues and buildings.

Limestone contains calcium carbonate ($CaCO_3$).

(a) **Figure 1** shows a limestone quarry.

Figure 1



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(i) Suggest **one** problem quarrying limestone will cause for people living nearby.

.....

.....

(1)

(ii) Suggest **one** benefit of quarrying limestone for people living nearby.

.....

.....

(1)

(iii) Why are limestone statues and buildings damaged by rain?

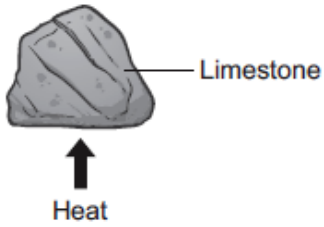
.....

.....

(1)

(b) A student investigated what happens when limestone is heated, as shown in **Figure 2**.

Figure 2



This is the method the student used:

- measure the mass of limestone before heating
- measure the mass of solid product after heating
- repeat the experiment two more times.

The student's results are shown in the table below.

	Experiment 1	**Experiment 2**	**Experiment 3**
Mass of limestone before heating in g	5.0	5.0	5.0
Mass of solid product after heating in g	3.6	3.4	3.8
Mass lost in g	1.4	1.6	

(i) Calculate the mass lost in experiment **3**.

.....

.....

Mass lost = ... g

(1)

(ii) Calculate the mean mass lost in the three experiments.

.....

.....

Mean mass lost = ... g

(1)

(iii) Suggest **one** reason why the mass lost was **not** the same for the three experiments.

.....

.....

(1)

(c) The word equation for the reaction when calcium carbonate is heated is:

calcium carbonate ⟶ calcium oxide + carbon dioxide

(i) Complete the sentence.

The reaction when calcium carbonate is heated is called

thermal ..... .

(1)

(ii) Heating 5.0 g of calcium carbonate produces 2.8 g of calcium oxide.

Calculate the mass of carbon dioxide produced.

.....

.....

Mass of carbon dioxide = ... g

(1)

(iii) Describe how to test a gas to show that it is carbon dioxide.

Test .....

.....

Result .....

.....

(2)

(Total 10 marks)

Q3. Metals are extracted from their ores.

Many copper ores contain only 2% of copper compounds.

(a) Copper is now extracted from ores containing a low percentage of copper compounds.

Suggest **two** reasons why.

.....

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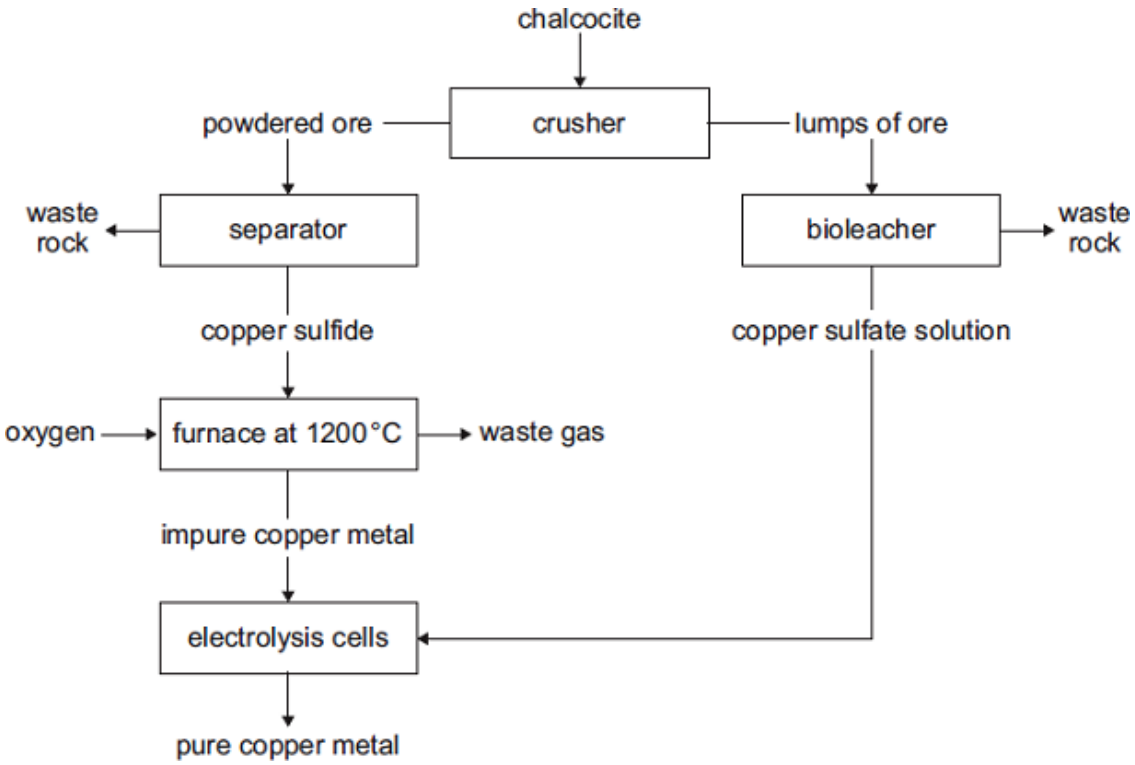
.....

.....

(2)

(b) Chalcocite, an ore of copper, contains copper sulfide.

The flow diagram shows how copper metal is extracted from chalcocite.



(i) Suggest **one** reason why it is difficult to dispose of the waste rock.

.....

.....

(1)

(ii) The reaction in the furnace could cause environmental pollution.
Explain how.

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.....

.....

(2)

(iii) The extraction of pure copper is expensive.
Give **one** reason why.

.....

.....

(1)

(iv) Pure copper is produced by electrolysis of copper sulfate solution.

Which electrode do the copper ions move towards?
Give a reason for your answer.

.....

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.....

(2)

(v) Large areas of land are contaminated with copper compounds.
Phytomining can be used to remove these copper compounds from the land.

What is used in phytomining to remove copper compounds from the land?

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(1)
(Total 9 marks)

Q4. This question is about oil reserves.

(a) Diesel is separated from crude oil by fractional distillation.

Describe the steps involved in the fractional distillation of crude oil.

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(3)

(b) Diesel is a mixture of lots of different *alkanes*.

What are *alkanes*?

.....

.....

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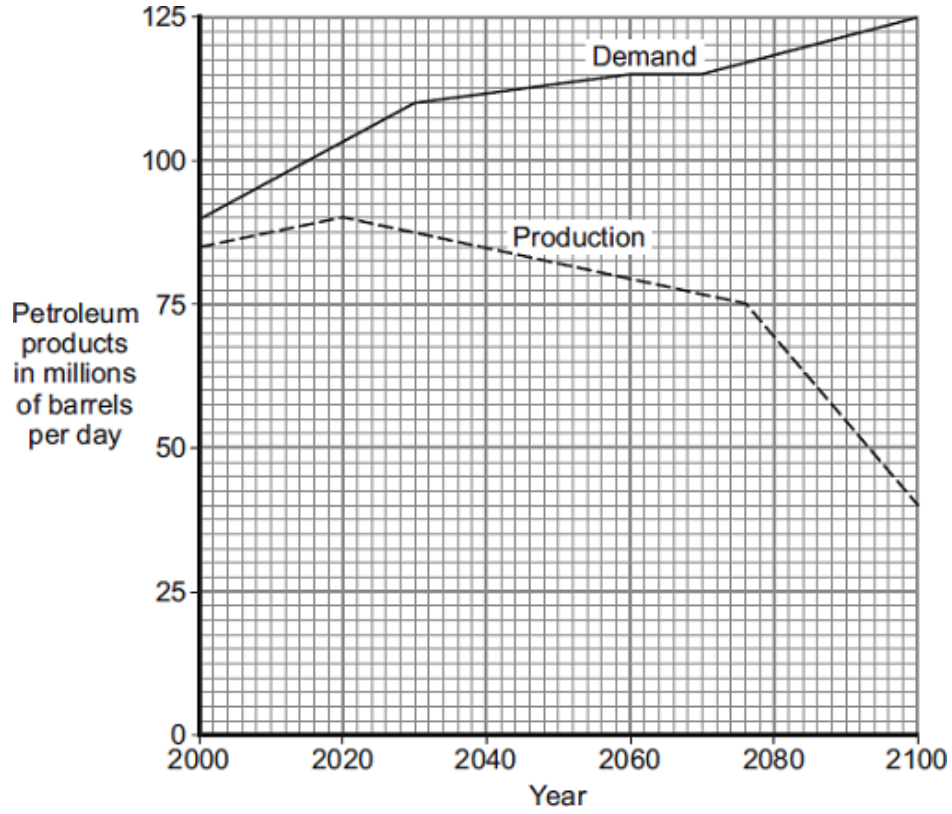
.....

.....

(2)

(c) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Petroleum products, such as petrol, are produced from crude oil.
The graph shows the possible future production of petroleum products from crude oil and the expected demand for petroleum products.



Canada's oil sands hold about 20% of the world's known crude oil reserves.

The oil sands contain between 10 to 15% of crude oil. This crude oil is mainly bitumen.

In Canada the oil sands are found in the ground underneath a very large area of forest. The trees are removed. Then large diggers and trucks remove 30 metres depth of soil and rock to reach the oil sands. The oil sands are quarried. Boiling water is mixed with the quarried oil sands to separate the bitumen from the sand. Methane (natural gas) is burned to heat the water.

The mixture can be separated because bitumen floats on water and the sand sinks to the bottom of the water. The bitumen is cracked and the products are separated by fractional distillation.

Use the information given and your knowledge and understanding to suggest the advantages and disadvantages of extracting petroleum products from oil sands.

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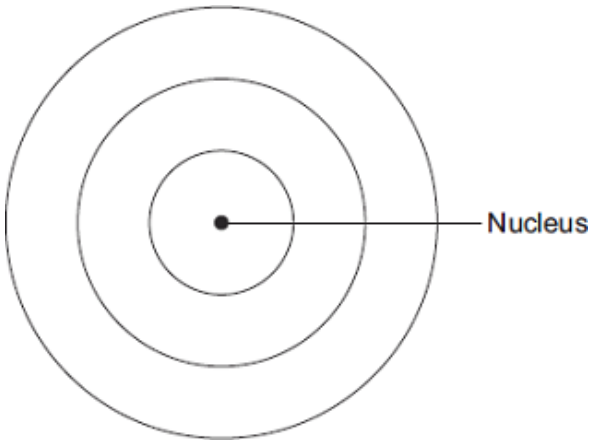
(6)
(Total 11 marks)

Q5. Aluminium has many uses.

(a) An aluminium atom has 13 electrons.

(i) Draw the electronic structure of an aluminium atom.



(1)

(ii) Name the **two** sub-atomic particles in the nucleus of an aluminium atom.

..... and .....

(1)

(iii) Why is there no overall electrical charge on an aluminium atom?

.....

.....

(1)

(b) Rail tracks are made from steel.

Molten iron is used to weld rail tracks.

The reaction of aluminium with iron oxide is used to produce molten iron.

(i) Balance the chemical equation for the reaction.

$$\text{.....Al} + Fe_2O_3 \longrightarrow \text{.....Fe} + Al_2O_3$$

(1)

(ii) Why does aluminium react with iron oxide?

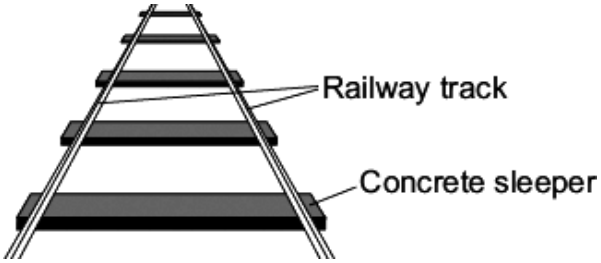
.....

.....

(1)

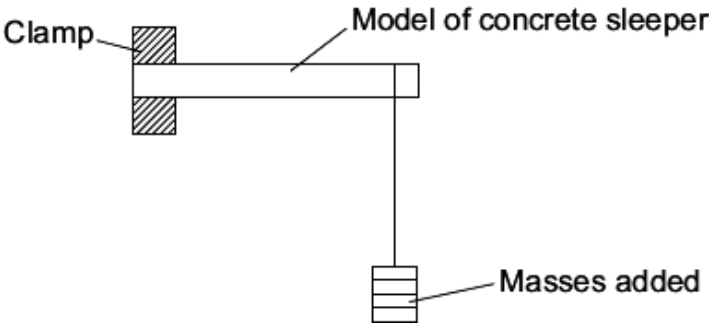
(Total 5 marks)

Q6. In the UK, railway sleepers were made from wood.
They are now often made from concrete.



A scientist was asked to find the best concrete mixture to use so that railway sleepers would not break easily.The scientist made:

- a mould to make small models of concrete sleepers
- concrete mixtures using crushed rock, sand, cement and water
- the equipment shown to add 0.1 kg masses until the model sleeper broke.



The scientist's results are shown in the table.

Concrete mixture in % by volume			**Total mass added to break the model sleeper in kg**				
Cement	**Sand**	**Crushed rock**	**Test 1**	**Test 2**	**Test 3**	**Test 4**	**Mean**
10	70	20	1.2	1.1	1.3	1.2	1.2
20	60	20	3.0	2.6	2.5	2.4	
30	50	20	3.5	3.3	3.3	3.3	3.3
40	40	20	3.9	3.8	4.0	3.3	3.9
50	30	20	4.2	4.5	4.2	4.3	4.3

(a) Calculate the mean total mass added to break the model sleeper that has 20 % cement by volume.

.....

.....

Mean = ... kg

(2)

(b) State **one** conclusion that the scientist could make from these results.

.....

.....

.....

(1)

(c) The scientist sent the results in a report to a company that makes full-size concrete railway sleepers.

(i) Suggest **two** other factors that the company should take into consideration before deciding which mixture to use to make a full-size concrete railway sleeper.

.....

.....

.....

.....

(2)

(ii) The scientist's report claimed that using concrete sleepers instead of wooden sleepers would have less environmental impact.
Do you agree with the scientist's claim?
Use your knowledge and understanding to justify your answer.
Remember to compare using concrete with using wood for the sleepers.

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(4)
(Total 9 marks)

Q7. There has been research into fuels for car engines.

Fuel	Content	Melting point in °C	Flashpoint in °C	Energy released in MJ per litre
Ethanol	C_2H_5OH	−114	+14	21.2
Diesel	hydrocarbons	About −24	+64	38.6
Petrol	hydrocarbons	About −57	−45	34.8
Rapeseed oil	fats	About +5	+130	32.8

The flashpoint is the lowest temperature a fuel vapour ignites in air.

(a) The melting point of ethanol is precise but the other melting points are approximate.

Suggest why.

.....

.....

.....

(2)

(b) Ethanol is produced by fermentation of sugar cane. Rapeseed oil is produced by pressing rapeseeds. Waste plant material from both processes is used to feed animals.

(i) Describe how the process of fermentation is done.

.....

.....

.....

.....

(2)

(ii) Carbon neutral fuels do **not** increase the amount of carbon dioxide in the atmosphere.

Suggest why using a biofuel, such as ethanol or rapeseed oil, is thought to be carbon neutral.

.....

.....

.....

.....

(2)

(c) When any fuel from the table is used in a car engine, the exhaust gases contain nitrogen oxides.

Explain why.

.....

.....

.....

.....

(2)

(d) Evaluate replacing petrol with ethanol as a fuel for cars.

To gain full marks you should give a justified conclusion.

Use the information from the table and your knowledge to answer this question.

.....

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(4)
(Total 12 marks)

M1. (a) (good)conductor of electricity

conductor of electricity and heat (+/–) = 0
*accept can be drawn into wires **or** ductile*
ignore flexible

1

(b) strong

*accept tough **or** hard **or** high tensile strength*

1

(c) reference to colour

1

[3]

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

- destruction of habitats
- fewer plants / trees to absorb carbon dioxide
- dust / noise / air / visual *(pollution)*
  allow breathing problems
- more traffic

1

(ii) any **one** from:

- provides employment
- local business make more profit
- new transport links
  ignore future use of quarry

1

(iii) (rain water is) acidic

1

(b) (i) 1.2(g)

1

(ii) 1.4(g)

allow ecf from (b)(i)

1

(iii) any **one** from:

- temperature of the flame varied
  allow flame was too hot or not hot enough
- different purity of the limestone
- incorrect measurement of mass
- heated for different times

1

(c) (i) decomposition

1

(ii) 2.2(g)

1

(iii) limewater

test must be correct to gain second mark

1

turns cloudy

allow turns milky or white (precipitate)

1

[10]

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

- copper / ores are running out / harder to find
- there are no / very small amounts of high-grade copper ores left
- copper metal is in demand
- copper is expensive
- now economical to extract copper from low-grade ores

it = copper

allow new methods of extraction e.g. bioleaching and phytomining

*allow high-grade ores are running out for **2** marks*

2

(b) (i) large amounts / 98% of rock to dispose of as waste

accept contains toxic (metal) compounds / bioleacher

or

waste rock takes up a lot of space

1

(ii) (copper sulfide reacts with oxygen to) produce sulfur dioxide / SO_2

allow (sulfur reacts with oxygen to) produce sulfur dioxide / SO_2

1

that causes acid rain

*allow description of effects of acid rain **or** sulfur dioxide*

*if no other mark awarded allow CO_2 produced which causes global warming **or** CO_2 produced by burning fuel or heating the furnace for **1** mark*

1

(iii) any **one** from:

- large amounts of fuels / energy used (for the furnace and electrolysis)
  allow large amounts of electricity needed
  ignore high temperature / electrolysis unqualified
- (the extraction has) many steps / stages / processes
  allow (extraction) is a long process / takes a lot of time
- large amounts of ore / material have to be mined
  allow ores contain a low percentage of copper

1

(iv) (copper ions move towards) the negative electrode / *cathode*

1

because copper ions / Cu^{2+} are positively charged **or** are oppositely charged **or** copper ions need to gain electrons

*allow because metal ions are positive **or** opposites attract*

1

(v) (growing) plants

1

[9]

M4. (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]

M5. (a) (i) 2.8.3

any sensible symbol can be used to represent an electron

1

(ii) proton(s) **and** neutron(s)

both needed for the mark

1

(iii) number of protons is equal to number of electrons

allow positive and negative charges cancel out

allow same amount of protons and electrons

1

(b) (i) **2** Al + Fe_2O_3 → **2** Fe + Al_2O_3

equation must be balanced

1

(ii) aluminium is more reactive (than iron)

it = aluminium

accept converse

accept aluminium displaces iron

accept aluminium is higher in the reactivity series (than iron)

1

[5]

M6. (a) 2.5

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

if answer incorrect

2.6 / 2.625 / 2.62 / 2.63

***or** recognise 3.0 as anomalous gains **1** mark*

accept answer in table

ignore units

2

(b) as the percentage of cement increases the mass needed to break the sleeper increases

*allow 50% cement is the strongest **or** 30% sand is the strongest **or** the highest amount of cement is the strongest*

or

as the percentage of sand increases the mass needed to break the sleeper decreases

1

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

- availability of materials
- cost (of materials)
- time needed (for the concrete mixture) to set/harden
- compression strength (of the concrete)

  accept weight of the train
- testing full size (concrete railway sleepers)

  accept any test on full size sleepers

  accept 'how well it would last / weather'

2

(ii) any **four** from:

*maximum of **3** marks if no comparison made*

ignore yes or no

negative concrete:

allow converse statements for wood

- more fossil fuel / energy / heat (needed to produce cement / concrete)
- cement / concrete resources / limestone not renewable whereas wood is renewable
- quarrying limestone destroys landscapes / habitats whereas growing wood improves landscapes / habitats

  allow quarrying causes noise pollution / dust / etc.
- making cement / concrete releases carbon dioxide / greenhouse gases whereas growing wood absorbs carbon dioxide / greenhouse gases / is carbon neutral

  allow making cement / concrete

  causes global warming / climate

  change whereas growing wood

  reduces global warming / climate change

  ignore loss of trees / deforestation (and resultant effects such as an increase in CO_2)

positive concrete:

- (less resources are needed because) cement / concrete sleepers last longer **or** wood rots / needs replacing

  ignore strength / ease of breaking

  ignore weathering / effects of acid rain

4

[9]

M7. (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]