1 This question is about substances that are found in different types of water.

(a) River water contains dissolved substances.

River water has to be purified before it can be drunk.

The water purification process has three stages.

These are

- filtration
- sedimentatio
- chlo ination.

Pollutants such as fertilisers are still in the water after this purification.

Explain why.

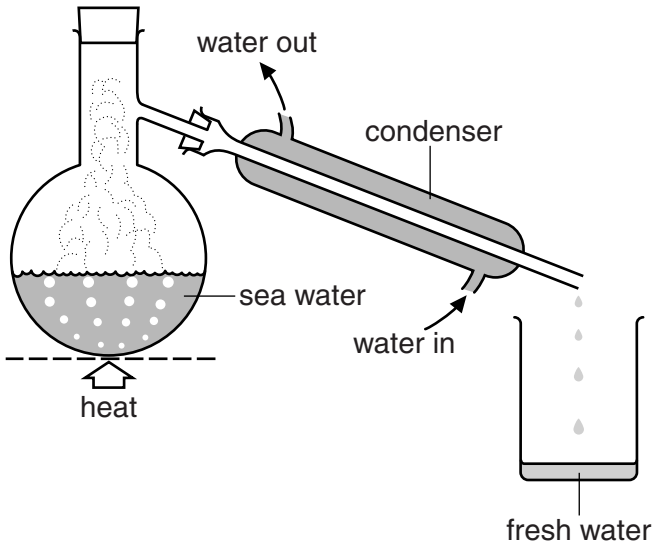
.....

..... **[1]**

(b) Sea water can be made into drinking water.

One way this can be done is by **distillation**.

Look at the diagram. It shows the apparatus used to distil water in the laboratory.



Explain the **disadvantages** of using distillation to make **large amounts** of drinking water.

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..... **[2]**

(c) Pete analyses two samples.

Look at Pete's results.

Sample	Addition of sodium hydroxide solution	Addition of barium chloride solution
A	blue solid made	white solid made
B	brown solid made	no reaction

Pete thinks that sample **A** is copper sulfate.

He thinks that sample **B** is iron(III) sulfate.

Is Pete right about **each** sample?

Explain your answer.

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..... **[4]**

2 Space probes have been sent to Mars to analyse the soil.

One compound analysed has the formula $Ca(ClO_4)_2$.

(a) Calculate the molar mass of $Ca(ClO_4)_2$.

The relative atomic mass, A_r, of O = 16, of Cl = 35.5 and of Ca = 40.

molar mass ..... g/mol [1]

(b) A compound with the formula K_2FeO_4 has also been discovered on Mars.

A sample of K_2FeO_4 is analysed.

The 1.00 g sample contains 0.39 g of potassium and 0.28 g of iron.

Calculate the percentage by mass of oxygen in this sample of K_2FeO_4.

percentage by mass = ... % [2]

(c) Another compound found on Mars has the molecular formula C_4H_{10}.

What is the empirical formula for this compound?

..... [1]

(d) Another compound found on Mars contains iron and oxygen.

The compound contains 70% by mass of iron and 30% by mass of oxygen.

Calculate the empirical formula of this compound.

The relative atomic mass, A_r, of O = 16 and of Fe = 56.

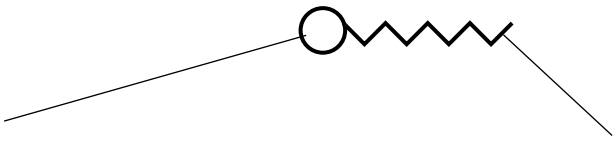
empirical formula is ..... [3]

3 This question is about emulsifiers and cooking.

(a) Mayonnaise is a mixture of an emulsifier, an oil and water.

The emulsifier helps to stop the oil and water from separating.

Look at the structure of an emulsifier molecule.



..... tail

..... head

(i) Label the two parts of the emulsifier molecule. **[1]**

(ii) Explain how an emulsifier helps to stop oil and water from separating.

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..... **[2]**

(b) Egg yolk is a runny liquid.

The egg yolk becomes a solid when it is cooked.

Explain why.

Use ideas about the type of molecules in egg yolk.

.....

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.....

..... **[2]**

[Total: 5]

4 An oil paint contains oil, a solvent, a binder and a phosphorescent pigment.

(a) A phosphorescent pigment will glow in the dark.

Explain why.

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..... **[2]**

(b) A layer of oil paint is left to dry and harden.

The solvent evaporates.

What happens to the oil?

.....

..... **[1]**

[Total: 3]

5 Fractional distillation separates crude oil into useful fractions.

The fractions have different boiling temperatures.

Look at the table.

It shows some information about fractions obtained from crude oil.

Fraction	Boiling temperature in °C
bitumen	above 350
LPG	less than 40
fuel oil	300 – 350
heating oil	250 – 300
petrol	40 – 200
paraffin	200 – 250

(a) Use ideas about intermolecular forces to explain how fractional distillation separates crude oil into fractions and list the fractions in the position, from top to bottom, that they 'exit' the fractionating column.


The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

(b) The LPG fraction contains propane gas, C_3H_8.

Write a **balanced symbol** equation for the **incomplete** combustion of propane in oxygen, O_2.

Only carbon monoxide, CO, and water are made.

..... **[2]**

[Total: 8]

6 Hydrogen peroxide has the molecular formula H_2O_2.

Hydrogen peroxide can be manufactured by reacting barium peroxide, BaO_2, with sulfuric acid, H_2SO_4.

$$BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$$

Barium sulfate, $BaSO_4$, is a waste product.

Look at the table of relative formula masses, M_r.

formula	relative formula mass, M_r
BaO_2	169
H_2SO_4	98
$BaSO_4$	233
H_2O_2	34

(a) Show that the **atom economy** for the reaction is 12.7%.

.....

.....

..... **[1]**

(b) A factory makes 18 tonnes of hydrogen peroxide.

Phil predicts the factory should make 20 tonnes of hydrogen peroxide.

Calculate the **percentage yield** of hydrogen peroxide.

.....

.....

.....

percentage yield = ... % **[2]**

(c) The manufacture of hydrogen peroxide from barium peroxide is **not sustainable**.

Explain why.

.....

..... **[1]**

[Total: 4]

7 Ethanoic acid, $C_2H_4O_2$, can be made by several different processes.

Three of these are process **R**, process **S** and process **T**.

(a) In process **R**, methanol reacts with carbon monoxide.

$$CH_4O + CO \rightarrow C_2H_4O_2$$

Process **R** has 100% atom economy.

Explain how you can tell this from the symbol equation.

.....

.....

..... **[1]**

(b) In process **S**, sodium ethanoate, $NaC_2H_3O_2$, reacts with sulfuric acid.

$$2NaC_2H_3O_2 + H_2SO_4 \rightarrow Na_2SO_4 + 2C_2H_4O_2$$

Look at the table of relative formula masses, M_r.

Substance	**Relative formula masses,** M_r
$NaC_2H_3O_2$	82
H_2SO_4	98
Na_2SO_4	142
$C_2H_4O_2$	60

(i) A mass of 8.2 g of sodium ethanoate reacts with excess sulfuric acid.

What mass of ethanoic acid, $C_2H_4O_2$, can be made?

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.....

mass of ethanoic acid = ... g **[2]**

(ii) Calculate the **atom economy** for process **S**.

Sodium sulfate, Na_2SO_4, is a waste product.

.....

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.....

atom economy = ... % **[2]**

(c) In process **T**, hydrocarbons are oxidised to make ethanoic acid.

Mike predicts that 5.2 tonnes of ethanoic acid should be made.

The factory actually makes 2.4 tonnes of ethanoic acid.

(i) Calculate the percentage yield of ethanoic acid.

Write your answer to **two** significant figures.

.....

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.....

percentage yield = ... % **[2]**

(ii) Describe one disadvantage of having a percentage yield of this value.

.....

..... **[1]**

[Total: 8]

8 This question is about fuels.

(a) Crude oil is a fossil fuel.

Crude oil is being used up faster than it is being made.

Write about the problems this will cause in the future.

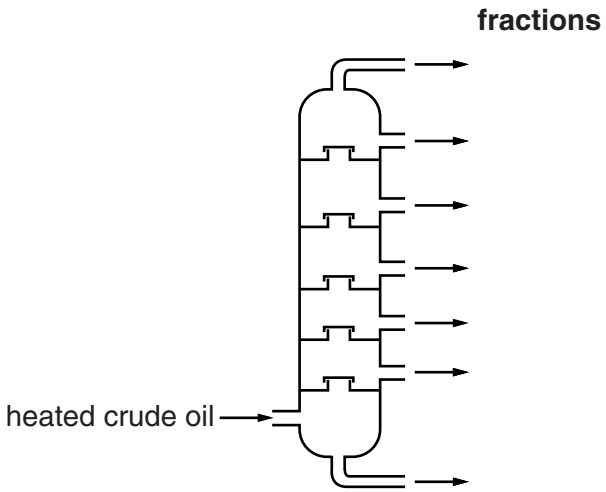
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..... **[2]**

(b) Crude oil is separated into many fractions by fractional distillation.

The diagram shows a fractionating column.



Look at the table. It shows the boiling point range for some of the fractions.

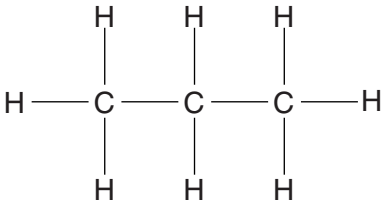
Fraction	Boiling point range in °C
bitumen	above 350
heating oil	240 to 350
paraffin	120 to 240
petrol	20 to 70
LPG	–160 to 20

Write down the name of the fraction which 'exits' from the **bottom** of the fractionating column.

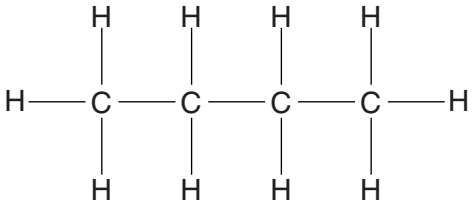
..... **[1]**

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(c) LPG contains propane and butane.



propane



butane

(i) Write down the **molecular formula** of **butane**.

answer ..... **[1]**

(ii) Look at the displayed formulas of propane and butane.

Propane and butane are **hydrocarbons**.

They are also **alkanes**.

Explain why they are both hydrocarbons and alkanes.

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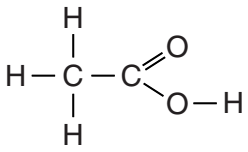
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..... **[3]**

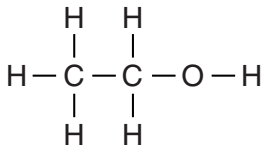
[Total: 7]

9 This question is about carbon compounds.

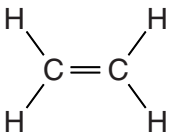
Look at the displayed formulas of some compounds.



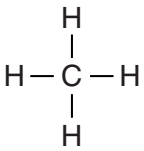
ethanoic acid



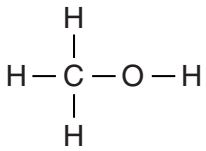
ethanol



ethene



methane



methanol

(a) Methane is an **alkane**.

Explain how you can tell from the displayed formula.

..... **[1]**

(b) Write down the name of a compound that is an **unsaturated** hydrocarbon.

Choose from the compounds shown.

..... **[1]**

(c) Write down the **molecular formula** of ethanoic acid.

..... **[1]**

(d) Ethene reacts with bromine, Br_2, to form dibromoethane, $C_2H_4Br_2$.

Write a **balanced symbol** equation for this reaction.

..... **[1]**

[Total: 4]

10 This question is about oil and the products from oil.

(a) Crude oil is transported over long distances by sea and through pipelines.

The UK gets some of its crude oil from politically unstable countries.

Suggest one argument for, and one argument against, getting oil from such countries.

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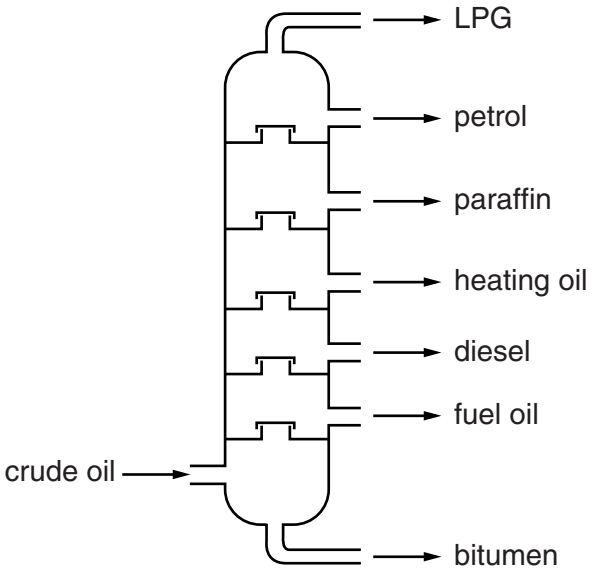
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..... **[2]**

(b) Crude oil is separated into many fractions by fractional distillation.

Look at the diagram.

It shows a fractionating column.



LPG has a lower boiling point than petrol.

Explain why.

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.....

..... **[2]**

(c) Look at the table.

It shows the percentage of each fraction in crude oil.

It also shows the percentage of each fraction needed for everyday use.

fraction	% in crude oil	% needed
LPG	4	4
petrol	5	22
heating oil	9	5
diesel	19	23
paraffin	13	8
fuel oil and bitumen	50	38

The table shows that fractional distillation cannot supply all the petrol that is needed.

Explain how an oil refinery uses **cracking** to make sure that enough petrol is made.

Use information from the table.

.....

.....

..... **[2]**

(d) Look at the table.

It gives information about some fuels.

fuel	energy released by one gram of fuel in kJ	products of burning	availability
ethene	44.3	carbon dioxide and water	limited
hydrogen	143.0	water	limited
LPG	55.6	carbon dioxide and water	available
petrol	48.3	carbon dioxide, water and other gases	widely available

Petrol can be used to power a car.

Recommend one of these fuels as an alternative fuel to petrol.

fuel .....

Explain your answer using information from the table.

.....

.....

.....

..... **[2]**

(e) Ethene, C_2H_4, reacts with oxygen, O_2.

Carbon dioxide and water are made.

Write the **balanced symbol** equation for this reaction.

..... **[2]**

[Total: 10]