Surname	Centre Number	Candidate Number
Other Names		0

GCSE

3440U10-1

S19-3440U10-1

APPLIED SCIENCE (Single Award)
UNIT 1: Science in the Modern World

FOUNDATION TIER

FRIDAY, 7 JUNE 2019 – AFTERNOON

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**8**	
3.	**10**	
4.	**8**	
5.	**11**	
6.	**8**	
7.	**6**	
8.	**12**	
9.	**7**	
Total	**75**	

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ADDITIONAL MATERIALS

In addition to this paper you will require, a calculator, pencil and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **7** is a quality of extended response (QER) question where your writing skills will be assessed.

You are reminded to show all your workings. Credit is given for correct workings even when the final answer given is incorrect.

A periodic table is printed on page 28.

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Answer **all** *questions.*

1. The National Grid supplies electricity throughout the country.

(a) State **two** advantages of the National Grid. [2]

1. .....

.....

2. .....

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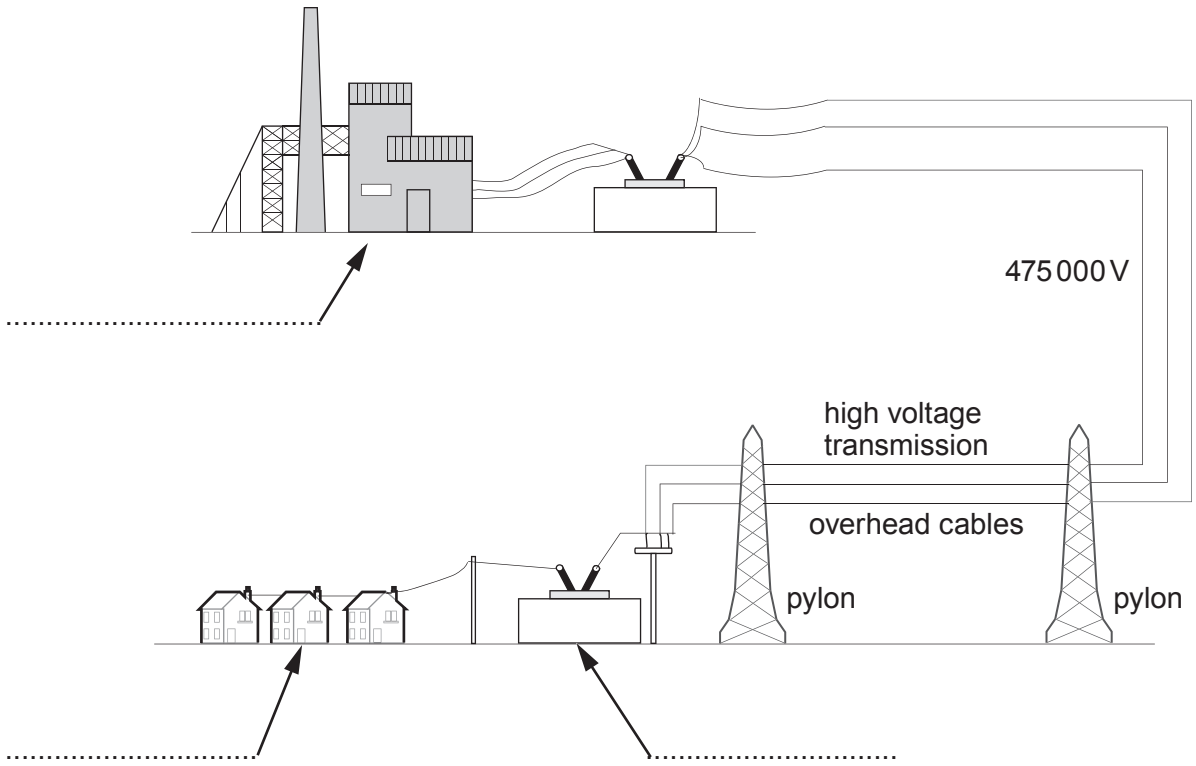
(b) The diagram below shows part of the National Grid.

(i) Label the diagram using **only** the words from the box. [2]

step-down transformer	power station	consumers	step-up transformer



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(ii) State the advantage of having an increased voltage in the overhead cables. [1]

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Turn over.

Examiner only

2. The Welsh Government is concerned about the environmental effect of electricity production. Currently only 20% of Wales' electricity is produced by renewable methods.

(a) (i) State what is meant by the term *renewable energy*. [1]

.....

.....

(ii) State **two** advantages (other than cost), of increasing the use of renewable energy. [2]

1. .....

2. .....

(b) The data below shows how electricity production in Wales from renewable sources has changed between 2012 – 2016.

Renewable energy source	Total units of electricity generated in Wales (GWh)				
	2012	***2013***	***2014***	***2015***	***2016***
Biomass	356	378	340	530	520
Wind	1400	1670	2290	3560	3800
Solar	87	120	235	537	783
Hydro-electricity	360	280	320	350	340

Use the data in the table to answer the following questions.

(i) Calculate the total number of electrical units (GWh) that were generated by renewable sources in 2016. [1]

Number of units = ... GWh

Examiner only

(ii) Use the equation:

$$\% \text{ contribution} = \frac{\text{solar electrical units generated (GWh)}}{\text{total renewable electrical units generated (GWh)}} \times 100$$

to calculate the % contribution made by solar energy to the total electricity generated in 2016 by renewable sources. [2]

% contribution = ...

(iii) It is suggested that the electricity generated using solar energy has increased the most between 2012 and 2016.
Use the data in the table to explain whether you agree with this suggestion. [2]

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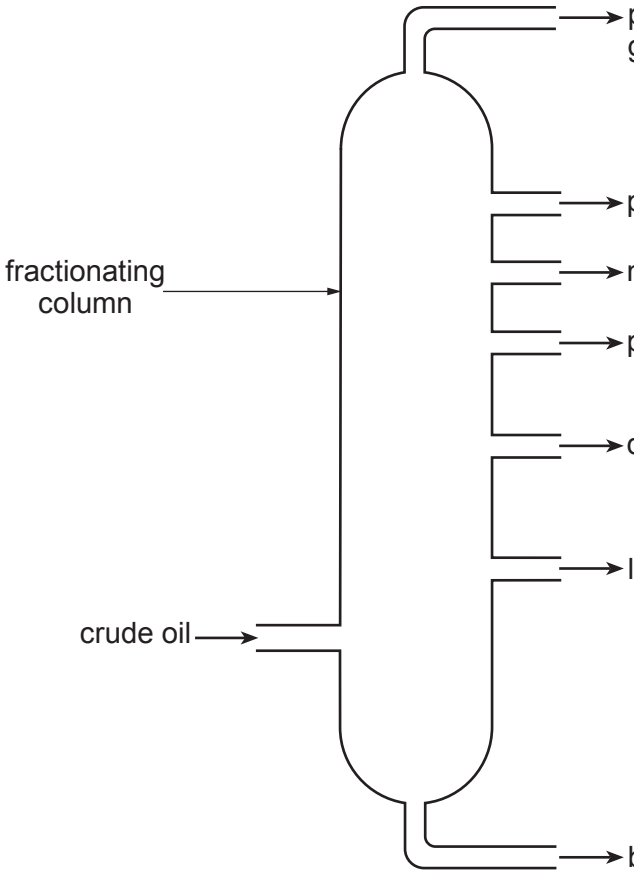
3. Valero owns an oil refinery in Pembroke. It imports crude oil which is a mixture of compounds called hydrocarbons. Crude oil is separated into fractions in a fractionating column such as the one shown below.



Fraction	Boiling point range (°C)	Number of carbon atoms in chains
petroleum gases	–160 to 25	1 to 4
petrol	40 to 100	5 to 12
naphtha	100 to 150	7 to 14
paraffin	150 to 250	11 to 15
diesel oil	250 to 350	15 to 19
lubricating oil	350 to 400	20 to 30
bitumen	over 400	over 30

(a) Use the information in the diagram to answer parts (i) to (v).

(i) Name the fraction which contains compounds with a boiling point of –125 °C. [1]

.....

(ii) Name the fraction which contains the compound with the formula C_5H_{12}. [1]

.....

(iii) State the number of carbon atoms in the hydrocarbon chain found in both paraffin and diesel oil fractions. [1]

.....

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(iv) State the physical property that allows hydrocarbons to be separated in a fractionating column. [1]

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(v) State why all fractions, apart from the petroleum gases, leave the column as liquids. [1]

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(b) Suggest why British oil refineries are located on the coast, away from built-up areas. [2]

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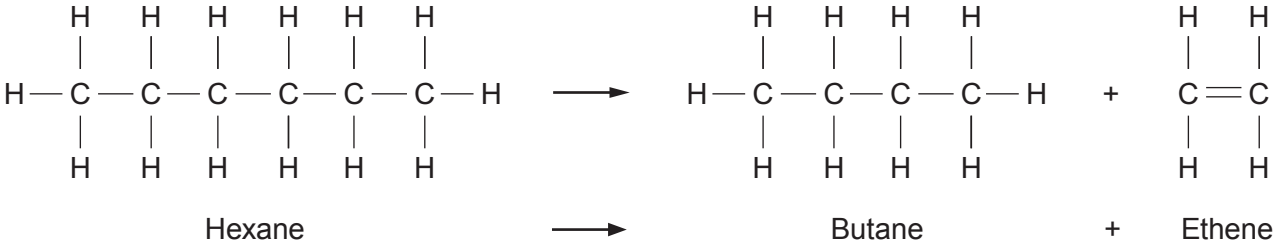
(c) Fractions that are produced by the fractional distillation of crude oil can go through a process called cracking. Cracking is a chemical reaction in which longer hydrocarbons are broken into shorter hydrocarbons.

When hexane is cracked it produces butane and ethene.



(i) State **two** similarities between the **structure** of hexane and butane molecules. [2]

1. .....

2. .....

(ii) State **one** difference between the type of bonds in butane and ethene. [1]

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4. Soft water readily forms a lather with soap. It is more difficult to form a lather with hard water. Hard water contains dissolved calcium or magnesium compounds. The hardness can be either temporary or permanent.

(a) (i) Describe a method to find the amount of hardness in water using soap solution. [3]

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(ii) Four different samples of water (**M**, **N**, **P**, **Q**) were tested.

The results are shown below.

- Scum was formed with samples **M**, **P** and **Q**.
- Sample **P** contained the most scum.
- Lather was formed with sample **N**.
- When sample **M** was boiled no scum was formed.
- When sample **P** was boiled scum was still formed.

Use the results and your knowledge to tick (✓) the **three** correct statements below. [3]

All the samples contained hard water.	☐
Sample **M** contained soft water after boiling.	☐
Sample **N** contained soft water.	☐
Sample **Q** was not as hard as sample **P**.	☐
Sample **P** contained temporary hard water.	☐
Sample **M** contained permanent hard water.	☐

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(b) State **two** health benefits of drinking hard water. [2]

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5. Heat can be transferred in different ways.

(a) Complete the following sentences. [4]

(i) Heat transfers through a solid by .....

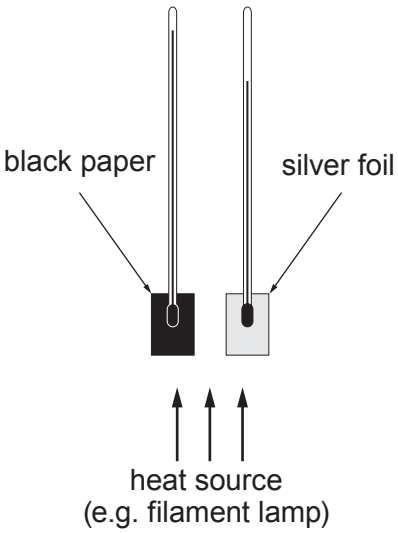
(ii) Heat transfers through a liquid by .....

(iii) Heat transfers through space by .....

(iv) Heat transfers occur when there is a ..... difference.

(b) A group of students investigated how the temperature change of a material varied with the surface colour.

Two identical thermometers were heated. The bulb of one thermometer was wrapped in silver foil and the other was wrapped in black paper.



Results from the thermometer wrapped in black paper are shown in the table below.

Results for the thermometer wrapped in silver foil are shown in the graph.

Time (minutes)	Temperature recorded for the black paper (°C)
0	16
2	20
4	24
6	28
8	32
10	36
12	41
14	45

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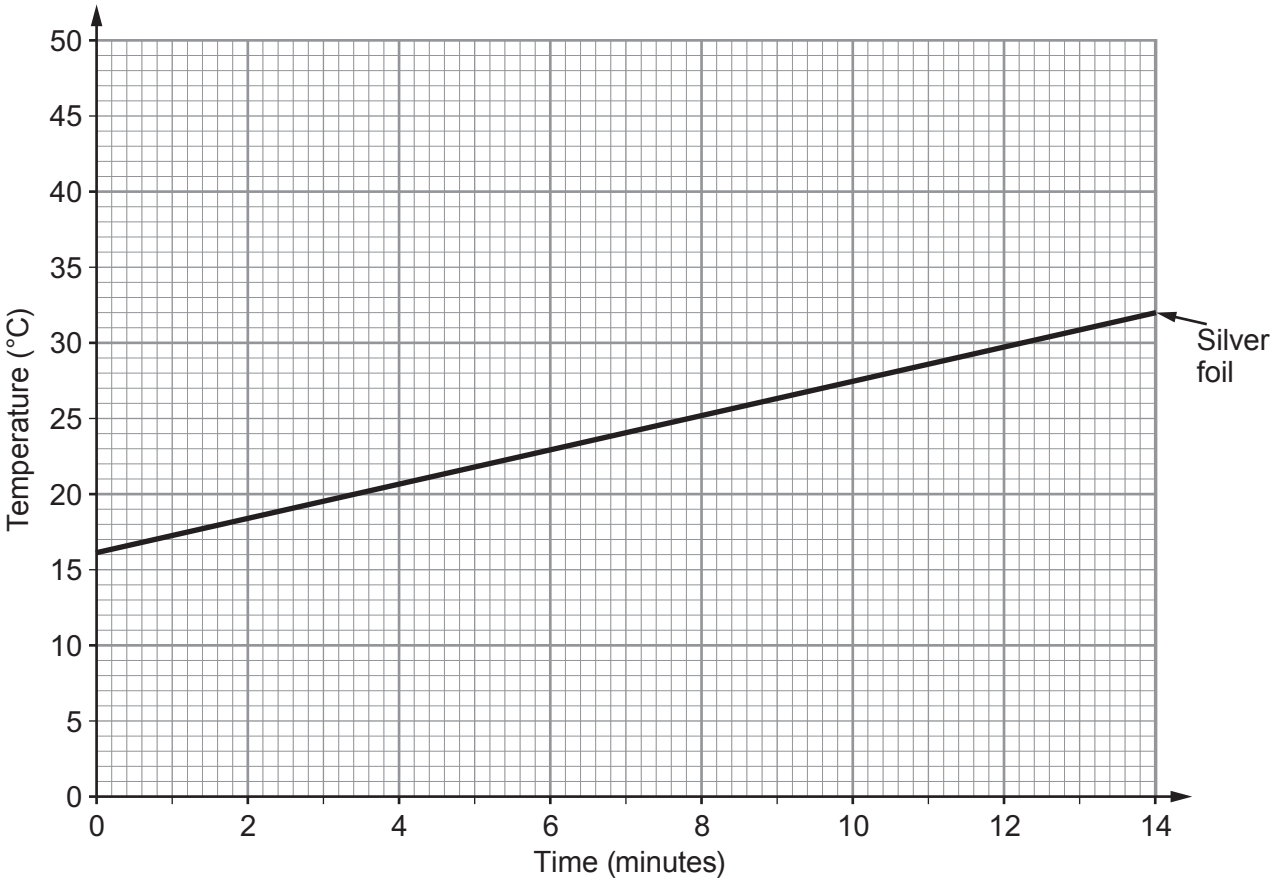
(i) Plot the data for black paper on the grid below and draw a suitable line. [3]



(ii) Calculate the difference in **temperature increase** between the silver foil and black paper at 14 minutes. [2]

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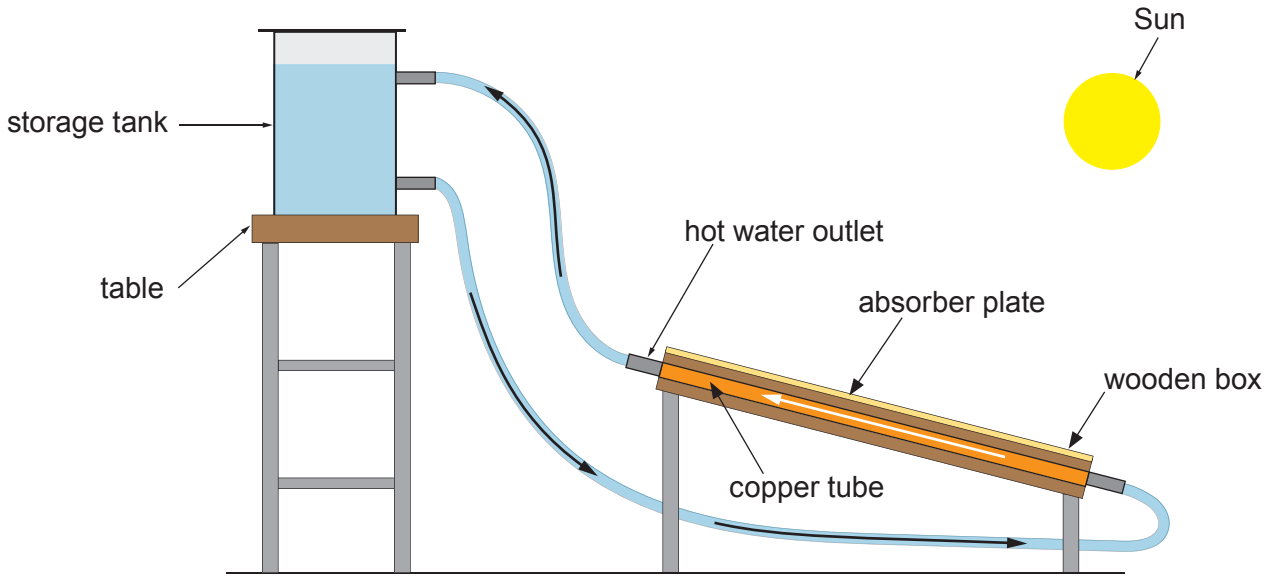
(c) The students used the data collected during the investigation in *(b)* and decided that the best colour for an absorber plate in the model solar water heater shown below is black.



Explain why black is the better colour to use as the absorber plate. [2]

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6. Riversimple is a Welsh car manufacturer of hydrogen-powered fuel cell electric vehicles. It is based in Llandrindod Wells.

Their working prototype car is called the Rasa. The Rasa fuel cell generates electricity by combining hydrogen with oxygen to form water.

The electricity powers a small, lightweight 4 kW motor in each wheel, giving the car four-wheel-drive.

Each of the car's electric motors works as a generator when the brakes are applied and recovers 70% of kinetic energy during heavy braking as electricity.

Adapted from https://www.riversimple.com/

(a) Use the information above to:

(i) Name **one** element. [1]

.....

(ii) Name **one** compound. [1]

.....

(b) Complete the balanced symbol equation for the reaction in the fuel cell. [3]

$\square H_2$ + ... $\longrightarrow$ $\square$ .....

(c) Calculate the **total** power developed at the wheels. [1]

Total power = ... kW

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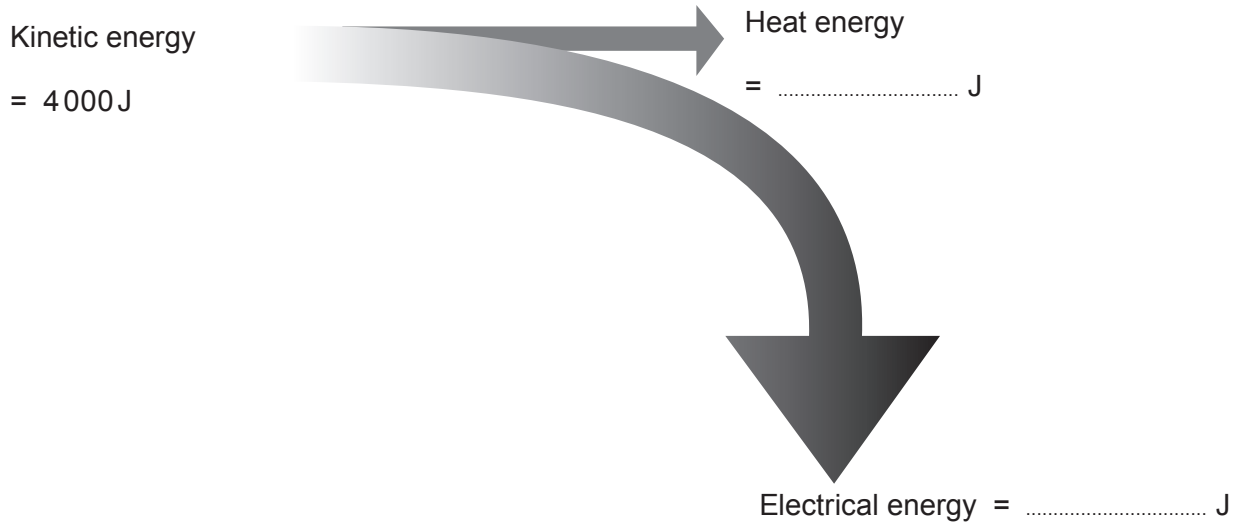
(d) Complete the Sankey diagram below (not drawn to scale) that shows the energy changes during heavy braking. [2]

Space for working



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7. Describe how you would prepare a sample of zinc sulfate from zinc oxide. Include details of the apparatus and quantities used, and the safety precautions you would take. [6 QER]

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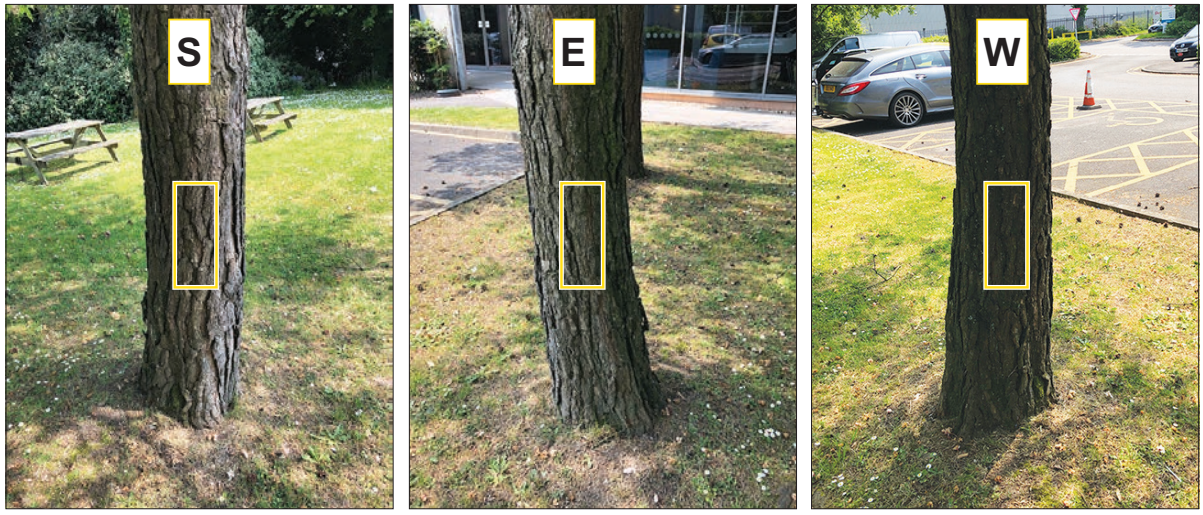
8. Some plants are more sensitive to air pollution than others. The risk of damage to these plants can be evaluated by surveying a site using living indicators.

Lichens are one type of living indicator. Some species of lichen can be used to monitor the levels of nitrogen pollutants in the air (nitrogen air quality index).

Method one: How to record indicator lichens on trunks

A 50 × 10 cm area is analysed on each of the three sides facing south (S), east (E) and west (W) on each trunk between 1.0 and 1.5 m above ground level as shown in **Diagram 1**. The presence of nitrogen-sensitive or nitrogen-tolerant lichen species is recorded.

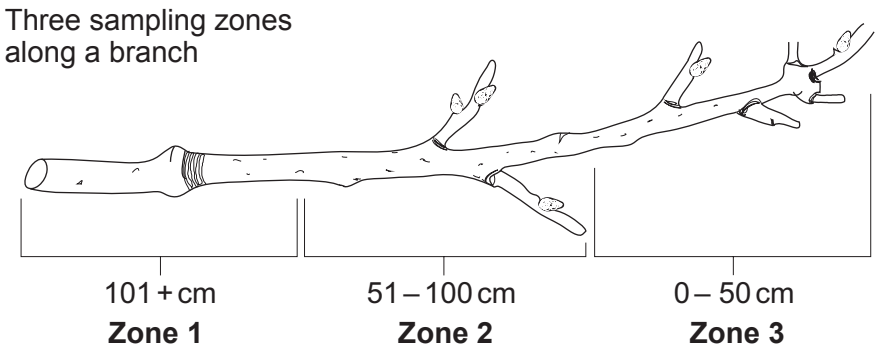
Diagram 1



Method two: How to record indicator lichens on branches

Locate the zones along the selected branch as shown in **Diagram 2**. The presence of nitrogen-sensitive or nitrogen-tolerant lichen species is recorded.

Diagram 2



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(a) (i) State the dependent variable in the survey. [1]

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(ii) State **two** variables that are controlled when surveying tree trunks in **Method one**. [2]

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(b) Results from a survey of four trees, **A**, **B**, **C** and **D** in Aberdare park are shown in the tables below. **P**, **R**, **S** and **T** are four branches from tree **A**.

1 = lichen present
0 = lichen not present

Tree trunk	**A**			**B**			**C**			**D**				
Direction	W	S	E	W	S	E	W	S	E	W	S	E	Total	Mean score per trunk
Nitrogen-sensitive lichen present	1	0	1	1	1	1	0	0	1	0	1	1	8	2
Nitrogen-tolerant lichen present	0	0	0	1	0	0	1	0	1	1	0	0	4	1

Branches	**P**			**R**			**S**			**T**				
Zone	1	2	3	1	2	3	1	2	3	1	2	3	Total	Mean score per branch
Nitrogen-sensitive lichen present	1	0	1	1	1	1	1	1	1	0	1	1	.....	.....
Nitrogen-tolerant lichen present	0	1	0	0	0	0	0	0	0	0	0	1	.....	.....

(i) **Complete** the table for branches. [3]

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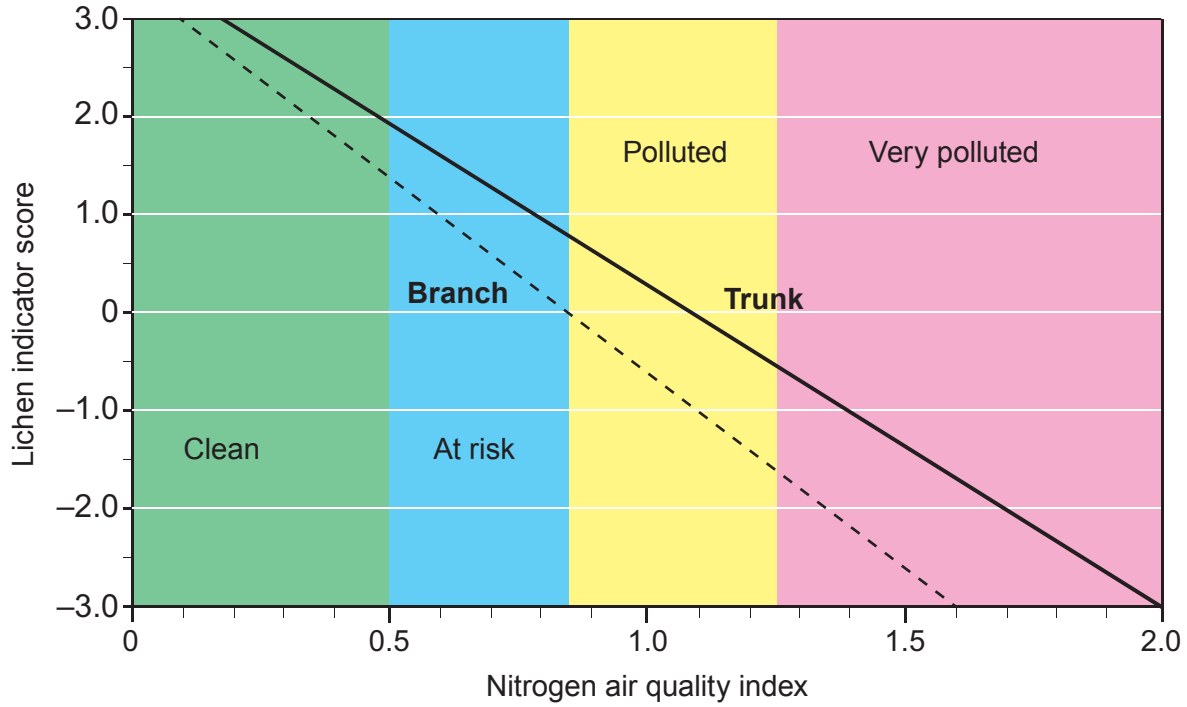
(ii) The lichen indicator score allows the air quality to be determined.
The lichen indicator score is calculated using the equation:

Lichen indicator score = Nitrogen-sensitive lichen mean score – Nitrogen-tolerant lichen mean score

The graph below shows how the lichen indicator score can be used to determine the nitrogen air quality index.



The **conclusion** from the branch data is that the nitrogen air quality is **clean**.

Determine whether the **tree trunk** data agrees with this conclusion.
Show your working. [4]

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(c) (i) In the 18th century Carl Linnaeus developed the system of giving all living organisms a two-word scientific name.
State how this system helps scientists in different countries who are studying these organisms. [1]

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(ii) The scientific classification of three species of lichen is shown below.

Kingdom:	Fungi	Fungi	Fungi
Phylum:	Ascomycota	Ascomycota	Ascomycota
Class:	Lecanoromycetes	Lecanoromycetes	Lecanoromycetes
Order:	Lecanorales	Candelariales	Lecanorales
Family:	Ramalinaceae	Candelariaceae	Ramalinaceae
Genus:	*Ramalina*	*Candelaria*	*Frutidella*
Species:	*farinacea*	*concolor*	*caesioatra*

Ramalina farinacea is sensitive to nitrogen pollutants. *Candelaria concolor* is a nitrogen-tolerant lichen.

Use the information in the table to suggest why *Frutidella caesioatra* is likely to be sensitive to nitrogen pollutants. [1]

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9. The table gives information about 4 planets in the Solar System.

Planet	Orbital speed (km/h)	Time to orbit the Sun (years)	Diameter of planet (km)	Circumference of the planet's orbit (AU)
Earth	10.7×10^4	1	12 800	6.28
Mars	8.1×10^4	2	6 784	9.43
Jupiter	4.7×10^4	12	143 360	32.68
Saturn	3.5×10^4	30	120 320	59.71

The circumference of the planets' orbits is given in astronomical units (AU).

1 AU = 150 000 000 km

(a) Use your knowledge and data from the table to answer the following questions.

(i) Estimate the circumference of the asteroid belt. [1]

Circumference = ... AU

(ii) State **two** reasons why Saturn takes longer than Mars to orbit the Sun. [2]

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(iii) The radius of the Sun is 695 700 km. Calculate how many times Earth would fit along this radius. [1]

Number of times = ...

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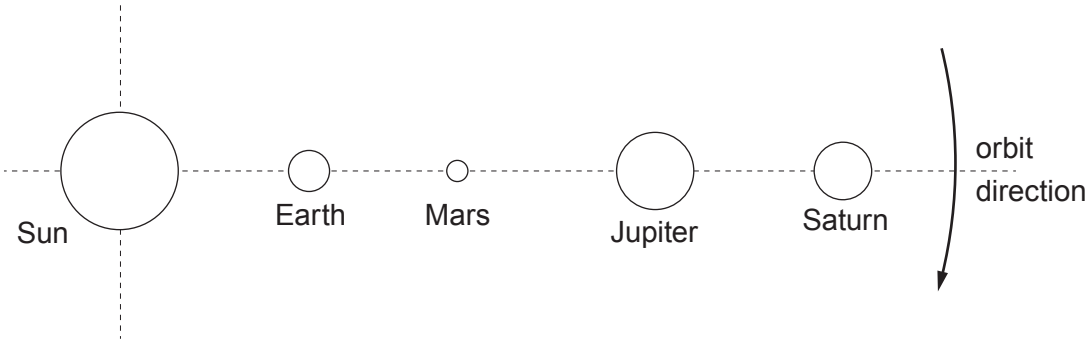
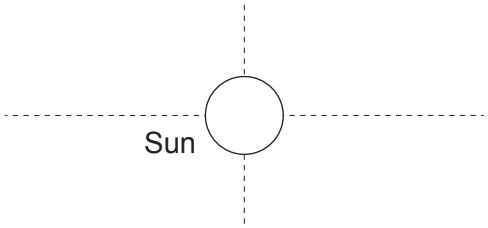
(b) The diagram below (not to scale) shows one alignment of the 4 planets with respect to the Sun.



(i) Use information in the table to find the number of years it will take for the alignment to occur next. [1]

Number of years = ...

(ii) Complete the diagram below to show the position of the planets with respect to the Sun, 12 years after the alignment above. [2]



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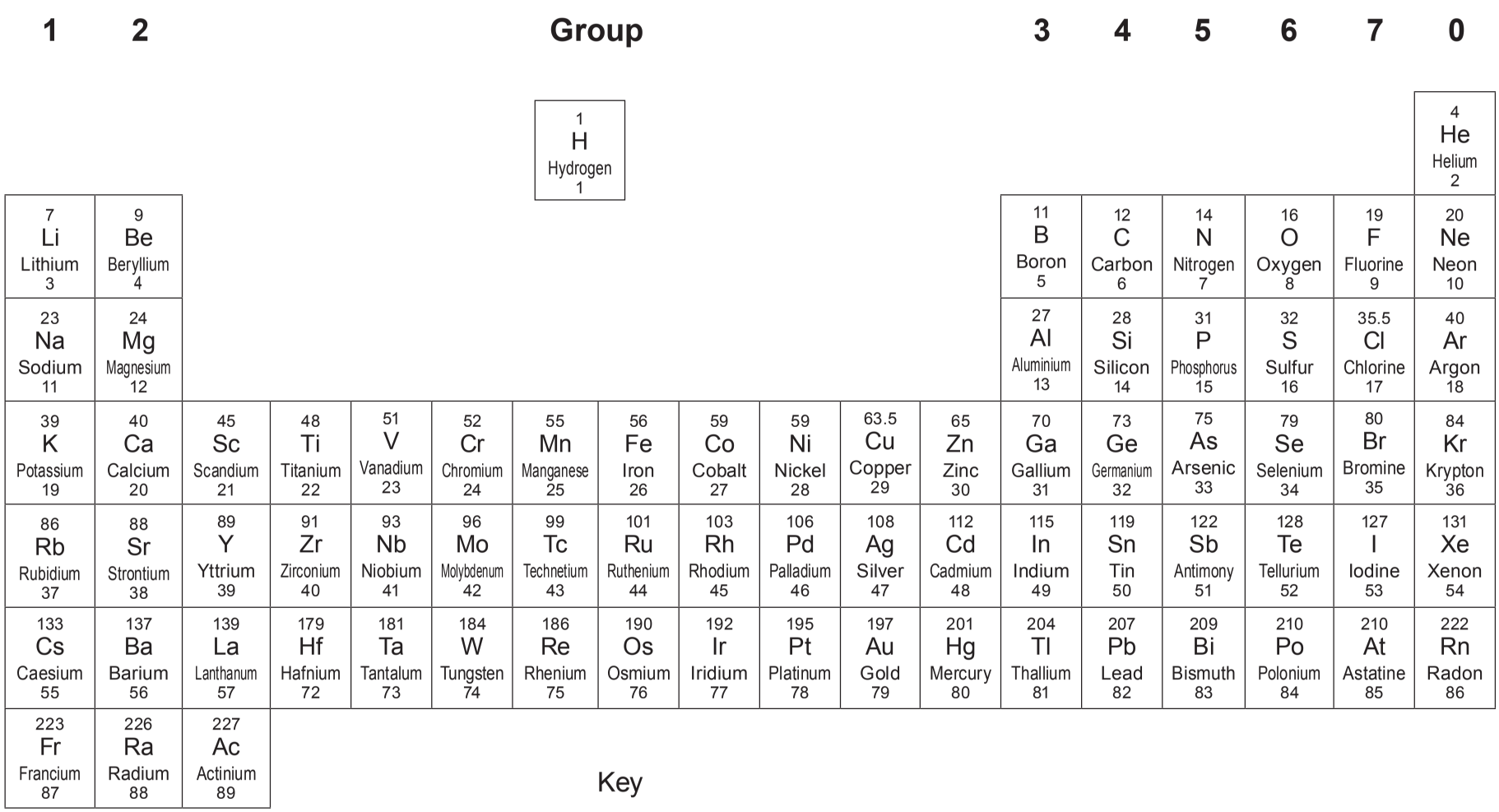
THE PERIODIC TABLE



Key