Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

3445U30-1

S18-3445U30-1

APPLIED SCIENCE (Double Award)
UNIT 3: Food, Materials and Processes

FOUNDATION TIER

TUESDAY, 15 MAY 2018 – AFTERNOON

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**10**	
2.	**13**	
3.	**6**	
4.	**15**	
5.	**12**	
6.	**14**	
7.	**5**	
Total	**75**	

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ADDITIONAL MATERIALS

A calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
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.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
Question **5***(a)*(i) is a quality of extended response (QER) question where your writing skills will be assessed.
The Periodic Table is printed on the back cover of the examination paper.

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Answer **all** *questions in the spaces provided.*

1. There are different types of material in use today. Their uses are determined by their properties.

(a) (i) Complete the table below by selecting the word from the box to identify the type of material from its description.

Each word may be used once, more than once or not at all. [3]

polymer	ceramic	composite	alloy	metal

Description	Type of material
hard, brittle, high resistance	.....
hard, high melting point, good conductor	.....
mixture of two or more elements	.....

(ii) The properties of materials depend on their structure.
Describe the structure of polymers. [2]

.....

.....

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(b) Metals are very useful materials in a variety of industries. One use is for making wings of modern aircraft.

Some properties of the metals that could be used are given in the table below.

Metal	Density (kg/m^3)	Stiffness (GPa)	Tensile strength ($\times 10^7$ Pa)
titanium	4500	110	55
aluminium	2700	69	10
vanadium	5700	138	63
steel	7800	210	40

Use the information from the table above to answer the following questions.

(i) State which metal could be used to make the wings as flexible as possible. [1]

.....

(ii) I State which metal could be used to make the wings as light as possible. [1]

.....

II Give **one** reason for your answer. [1]

.....

(iii) I State which metal could be used so the wings can withstand large forces. [1]

.....

II Give **one** reason for your answer. [1]

.....

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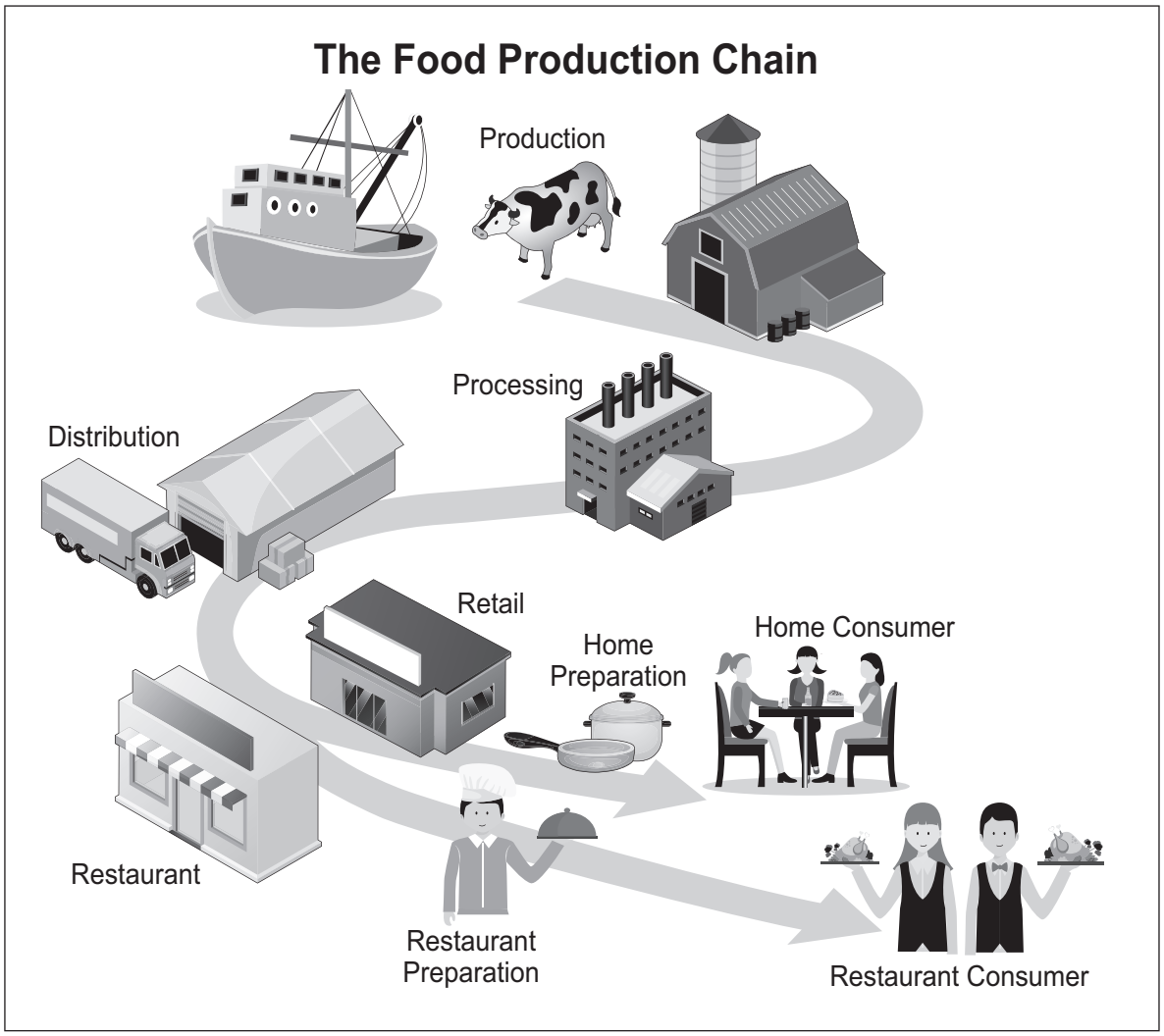
2. The food industry uses fruits, vegetables, grains and raw meat and processes these into the food products that are sold in supermarkets. Food production often involves cleaning and cooking raw foods, as well as the addition of additives and other ingredients.

One purpose of food production processes is to create products with longer shelf-lives than raw food ingredients.



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The food industry must take precautions to prevent consumers becoming ill from food poisoning.

(a) Complete the table below which shows some of the methods of controlling bacteria in the food industry. [3]

Method	Effect on bacteria
refrigeration	slows down bacterial growth
freezing	.....
.....	kills bacteria
.....	dries bacteria to prevent growth

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(b) Sometimes food becomes contaminated with bacteria, causing food poisoning.

(i) State **one** symptom of food poisoning. [1]

.....

(ii) Name **one** type of bacteria that causes food poisoning. [1]

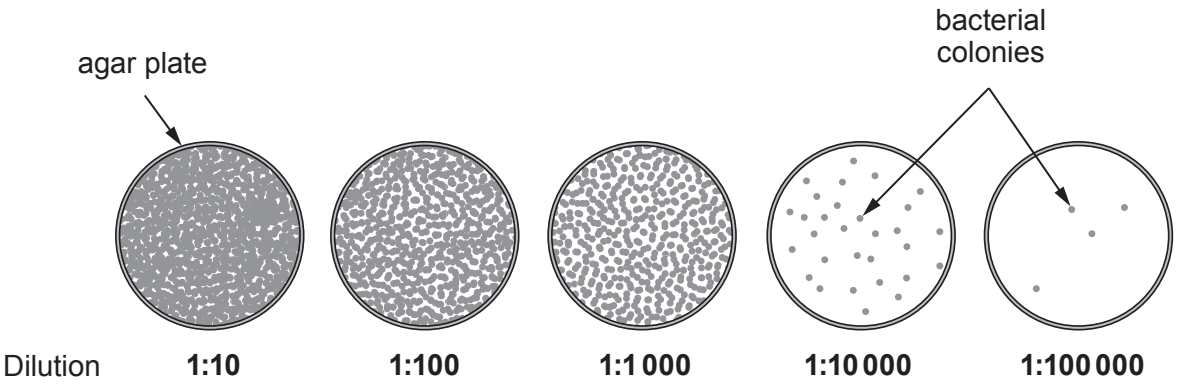
.....

(iii) State the harmful substances produced by bacteria as they grow. [1]

.....

(c) Whenever an outbreak of food poisoning occurs, environmental health officers test samples of food for the presence of bacteria.

(i) To be able to count the number of bacterial colonies a series of dilutions is carried out as shown in the diagram below.



The 1:10 000 dilution was used to calculate the number of bacteria present.

I Explain why using a dilution of 1:10 will not provide valid results. [2]

.....

.....

.....

II Give **one** reason why the 1:100 000 dilution was also not used to calculate the number of bacteria present. [1]

.....

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(ii) In an investigation, six agar plates were prepared by adding 1 cm^3 of solution from a 1:10 000 dilution. The agar plates were incubated for 72 hours. The results are shown below.

Plate number	1	2	3	4	5	6
Number of colonies	35	35	25	15	30	25

I State which plate has produced an anomalous result. [1]

.....

II Use the equation:

number of bacteria/cm^3 = mean number of colonies × 10 000

to calculate the number of bacteria/cm^3 in the original sample. [3]

Number of bacteria/cm^3 = ...

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3. Forensic scientists analyse substances found at crime scenes. They routinely identify powder samples.

Students are using the same techniques to analyse an unknown powder.

(a) The students dissolve the unknown powder in water and add sodium hydroxide solution (NaOH) to test for metal cations. They then add excess NaOH solution to see if the precipitate dissolves or not.

The table shows results for a selection of cations.

Cation	Colour of precipitate when a little NaOH solution is added	Precipitate dissolves when excess NaOH solution is added (✓ or ×)
Ca^{2+}	white	×
Zn^{2+}	white	✓
Pb^{2+}	white	✓
Mg^{2+}	white	×
Cu^{2+}	blue	×
Fe^{2+}	green	×

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They noticed that a white precipitate was produced which did not dissolve in excess NaOH solution.

(i) State the symbols for the **two** metal cations that could be present. [1]

.....

(ii) The table below shows the flame tests for a selection of metal cations.

Metal cation	Flame colour
Ca^{2+}	brick-red
Zn^{2+}	greyish-white
Pb^{2+}	greyish-white
Mg^{2+}	no colour
Cu^{2+}	blue-green
Fe^{2+}	gold

Describe how a flame test could be used to confirm which cation is present. [2]

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(b) They use another sample of the powder and perform the following tests to identify the anions that may be present.

Anion	Test	Observation
bromide (Br^-)	add aqueous silver nitrate	cream precipitate
carbonate (CO_3^{2-})	add hydrochloric acid	bubbles of gas
chloride (Cl^-)	add aqueous silver nitrate	white precipitate
iodide (I^-)	add aqueous silver nitrate	yellow precipitate
sulfate (SO_4^{2-})	add aqueous barium chloride	white precipitate

The observations from the students' tests are:

- bubbles of gas are given off when hydrochloric acid is added
- a white precipitate forms when aqueous silver nitrate is added

Use the information above to determine the **two** anions present in the powder. [2]

.....

(c) Name **one** compound that could be present in the powder. [1]

.....

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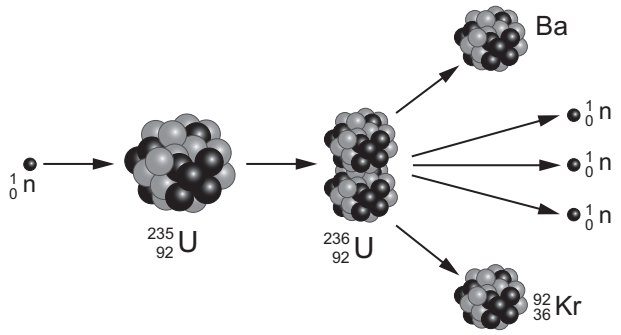
4. During their operation nuclear reactors produce large quantities of electrical energy without creating greenhouse gases.

(a) One type of reaction involving uranium-235 is shown in the diagram below.



(i) Use the information in the diagram to complete the balanced symbol equation for part of this reaction. [3]

$$^{236}_{92}U \rightarrow \text{.....}\ \text{.....}\ Ba + {}^{92}_{36}Kr + \text{.....}\ {}^{1}_{0}n$$

(ii) Underline the correct word(s) in the brackets in the paragraph below. [4]

The absorption of slow neutrons can cause a (**fusion / fission / chemical**) reaction in uranium nuclei.

The neutrons are slowed down by (**a moderator / control rods / concrete shielding**).

The emission of (**protons / neutrons / electrons**) in this reaction can cause a chain reaction.

An uncontrolled chain reaction is prevented by using (**a moderator / control rods / concrete shielding**).

(iii) Complete the table below about the two uranium isotopes. [2]

Uranium isotope	Number of protons	Number of neutrons
uranium-235	.....	143
uranium-236	.....	.....

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(b) Information about two natural isotopes of uranium is given below.

Isotope	Symbol	Type of decay	Half-life (years)
uranium-235	$^{235}_{92}U$	alpha	700 million
uranium-238	$^{238}_{92}U$	alpha	4.5 billion

(i) Put ticks (✓) in the **two** boxes that correctly give the meaning of the half-life of a radioactive substance. [2]

Half the time for the radioactivity to halve ☐

The time taken for an atom to split in half ☐

The time taken for the number of undecayed nuclei to halve ☐

The time taken for the activity to halve ☐

The time taken for half of the alpha particles to decay ☐

(ii) The isotopes of uranium in the table have been in existence since the Earth was formed. One estimate of the Earth's age is 4.5 billion years.
Calculate the fraction of uranium-238 that remains on Earth today. [2]

Fraction = ...

(iii) When the Earth was formed, it contained equal amounts of uranium-235 and uranium-238. It is suggested that more uranium-235 remains today than uranium-238.
Explain whether or not you agree with this suggestion. [2]

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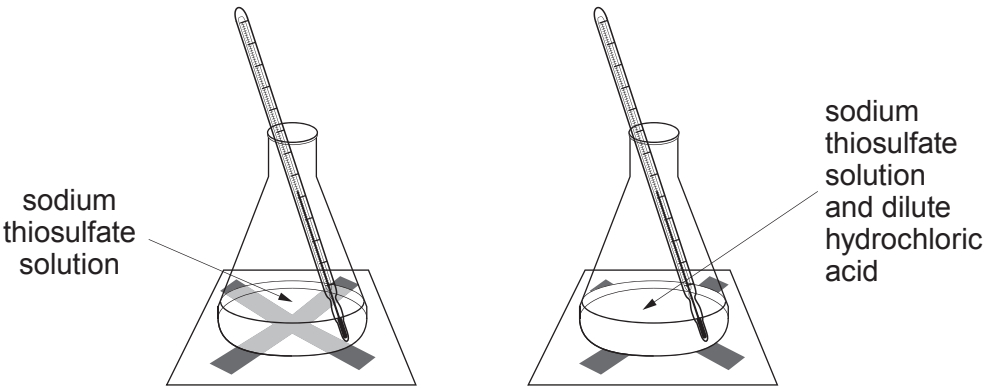
5. The chemical industry is developing new processes to manufacture chemicals more efficiently.

(a) (i) When sodium thiosulfate reacts with hydrochloric acid the solution becomes cloudy.



Describe a method used to investigate how temperature affects the rate of the reaction between hydrochloric acid and sodium thiosulfate solution. Include details of apparatus and volumes of chemicals used in your answer. [6 QER]

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(ii) State the **two** variables that need to be controlled in this experiment. [2]

1 .....

2 .....

(iii) State **one** reason why these variables need to be controlled. [1]

.....

.....

(b) In a different experiment hydrochloric acid was poured into a flask containing different volumes of sodium thiosulfate solution and water. The time taken to react was measured. The results are shown in the table below.

Volume of acid (cm^3)	Volume of sodium thiosulfate (cm^3)	Volume of water (cm^3)	Time for cross to disappear from view (s)
60	55	5	44
60	50	10	51
60	45	15	57
60	40	20	83
60	35	25	106

(i) State what conclusion can be made from the results. [1]

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.....

(ii) Explain the results in terms of particles. [2]

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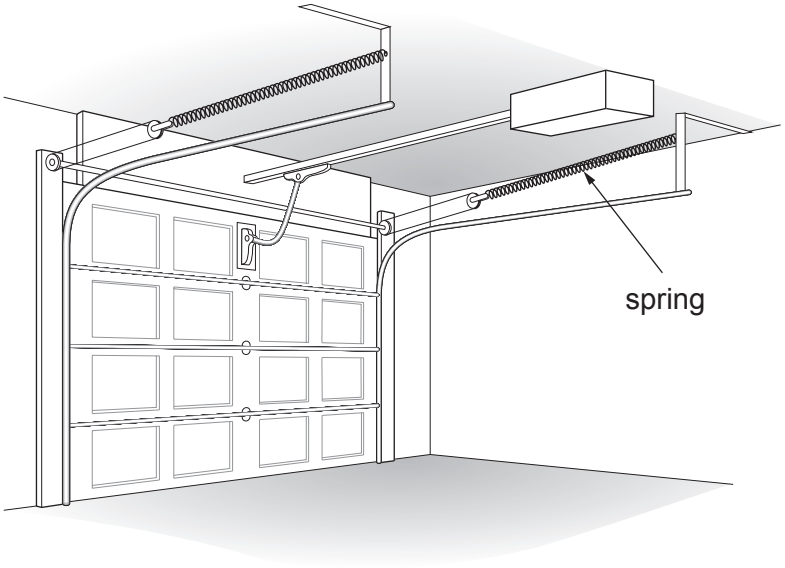
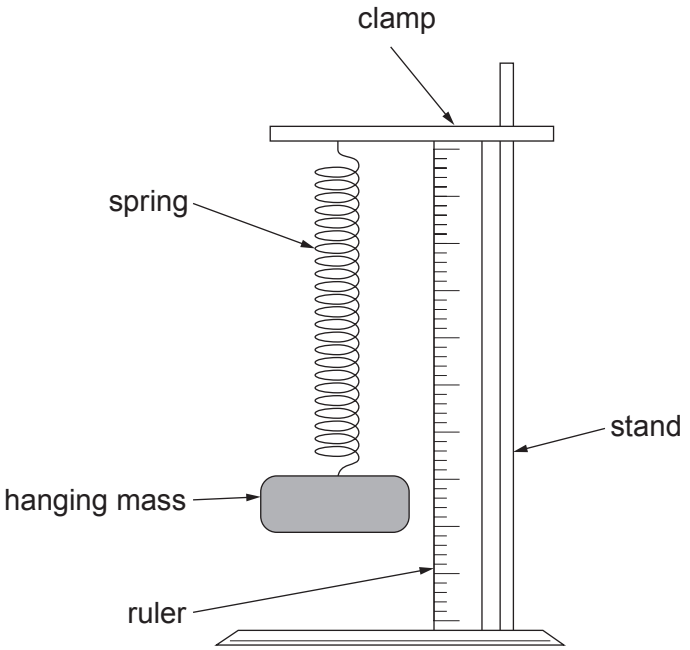
6. Springs can be used in garage doors. When the door shuts the springs are stretched and put under tension. When the door opens the spring returns to its original length making it easier to raise.

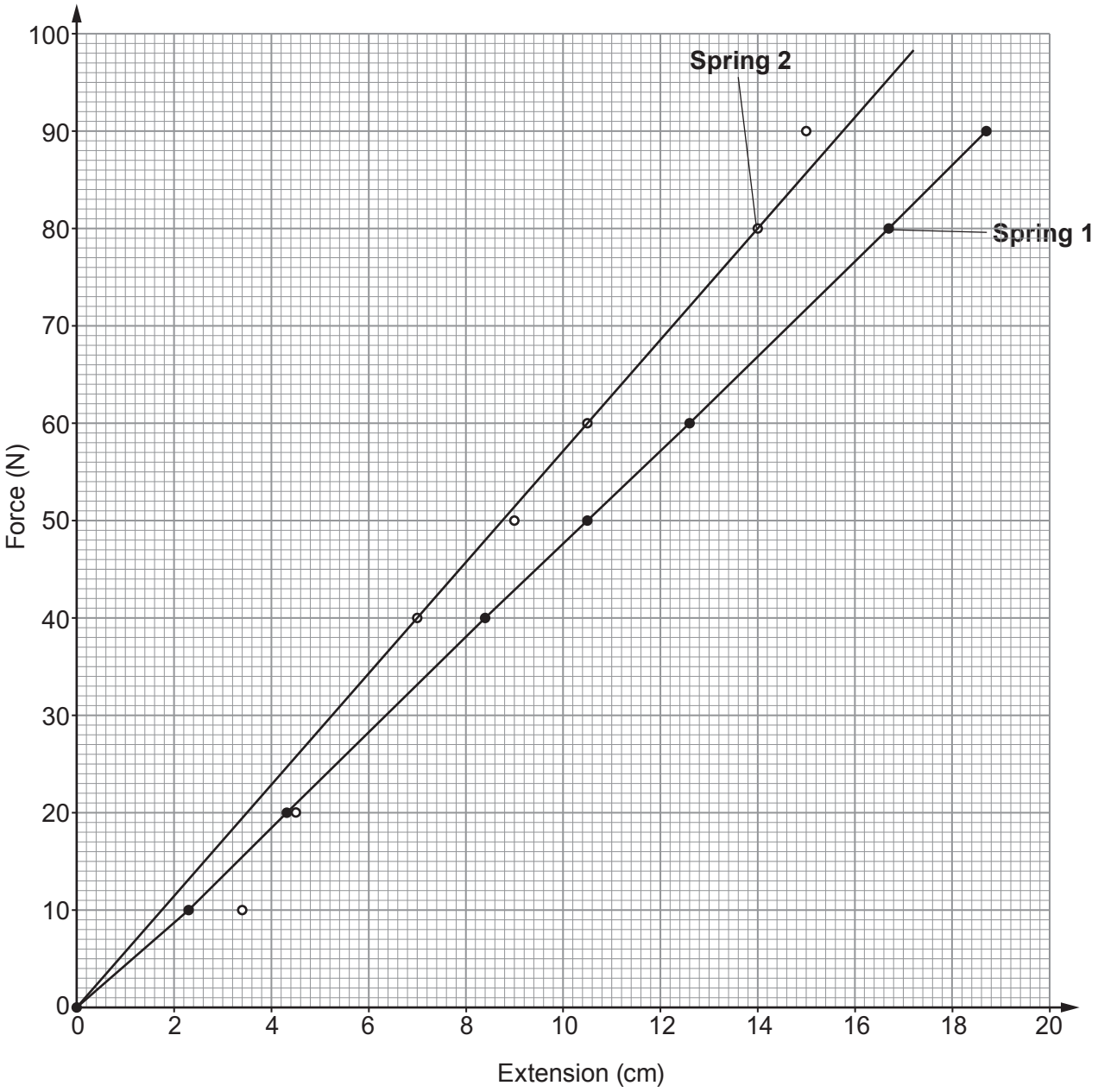


It is important that the spring is designed so that it does not become permanently stretched during the process. Springs become permanently stretched once they pass their **elastic limit**. This is the point where extension is no longer proportional to the stretching force.

Students test three springs using the apparatus shown below.



(a) Their results for two springs used in the doors are shown in the graph below.



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(i) Compare the behaviour of the springs as the force increases from 10 N to 40 N. [2]

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.....

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(ii) Use the graph and the equation:

$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$

to calculate the value of the spring constant for **Spring 1**. [3]

spring constant = ... N/cm

(iii) Use the graph to state **one** reason why the students can have more confidence in the results for **Spring 1** than for **Spring 2**. [1]

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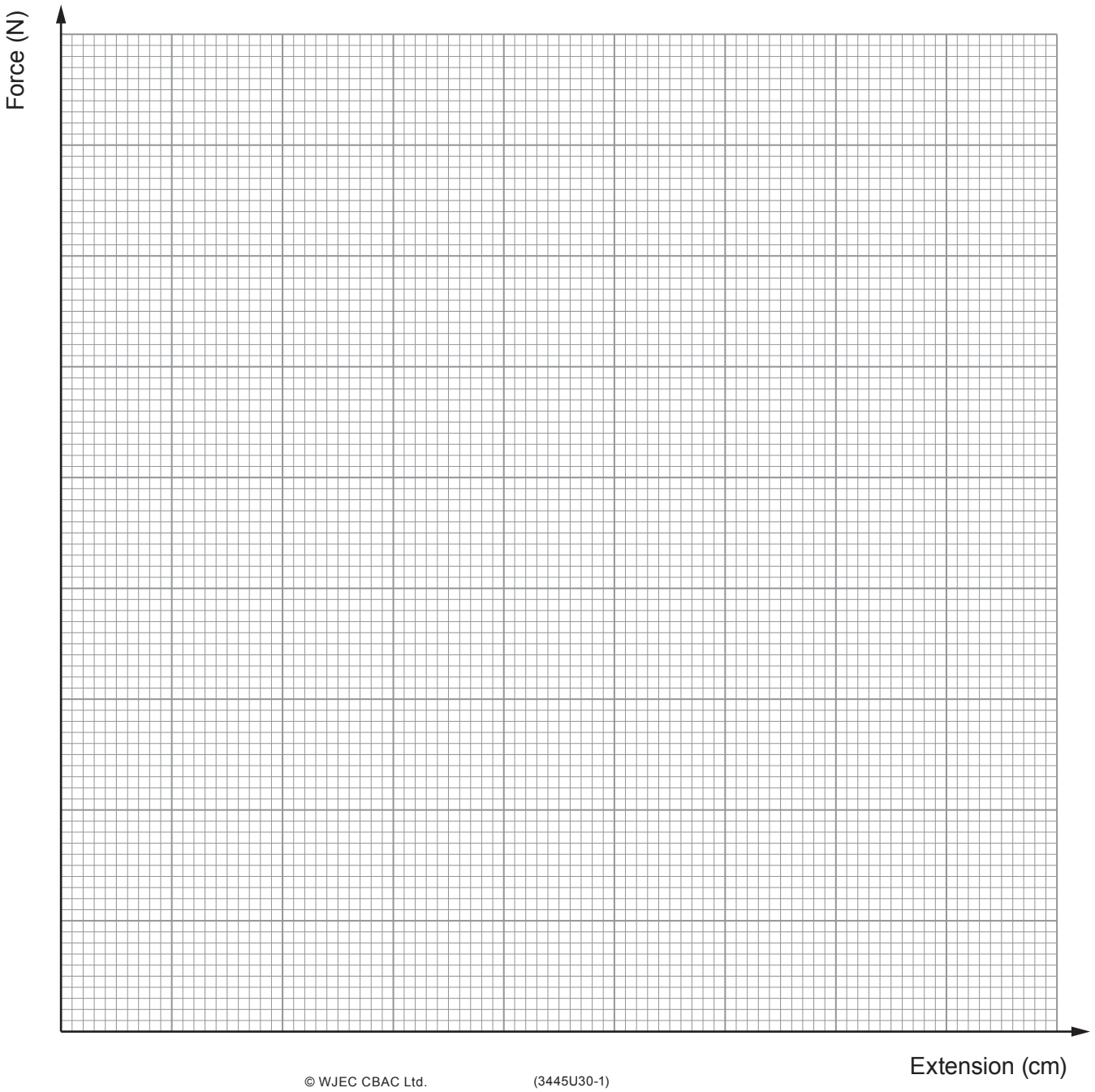
(b) The results for **Spring 3** are given in the table below.

Force (N)	Extension (cm)
0	0.0
10	2.4
20	4.8
40	9.6
50	12.0
60	16.0
80	28.0
90	36.0

(i) Plot the data on the grid below and draw a suitable line. [4]



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(ii) Springs become permanently stretched once they pass their **elastic limit**. This is the point where extension is no longer proportional to the stretching force.

I. **Label** the elastic limit on your graph with a letter **E**. [1]

II. Use your graph to find the force required to reach the elastic limit. [1]

Force = ... N

(iii) During the opening and closing of the garage doors the spring will extend by 30 cm. Explain whether or not **Spring 3** is suitable for this purpose. [2]

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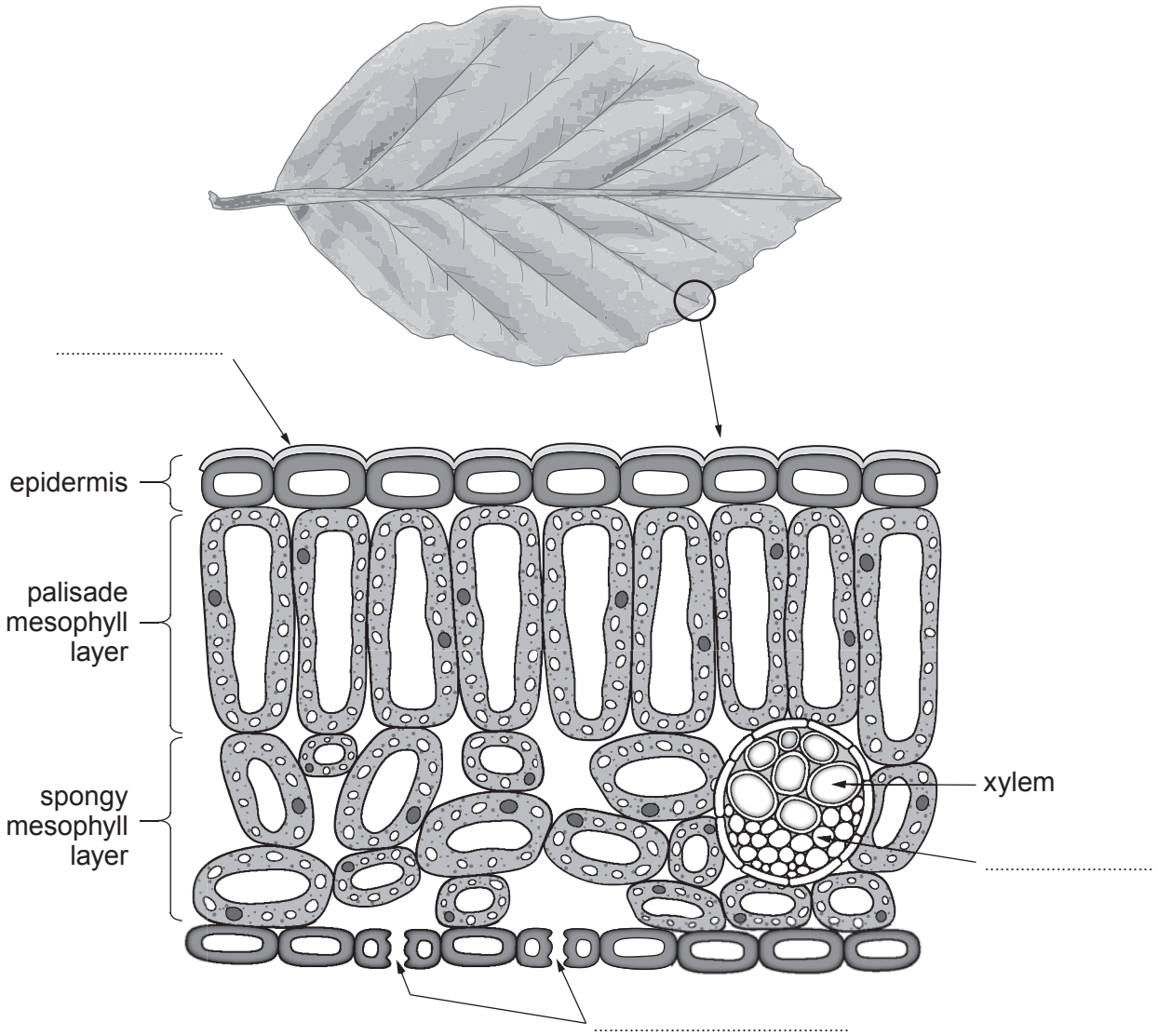
7. Students are learning about plants. They are interested in the structure and function of leaves.

(a) **Complete** the labelling of the parts of the leaf in the diagram below. [3]



(b) State the advantage of a transparent epidermis. [1]

.....

.....

(c) State the purpose of the spongy mesophyll layer containing air spaces. [1]

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THE PERIODIC TABLE