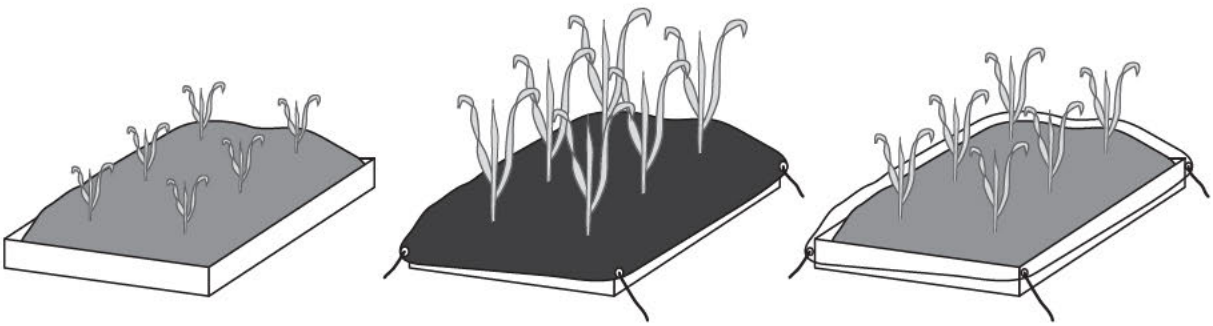
**1** A farmer often puts sheets of plastic on top of the soil in which his plants are growing. He wants to find out if the type of plastic used affects the growth of his plants.

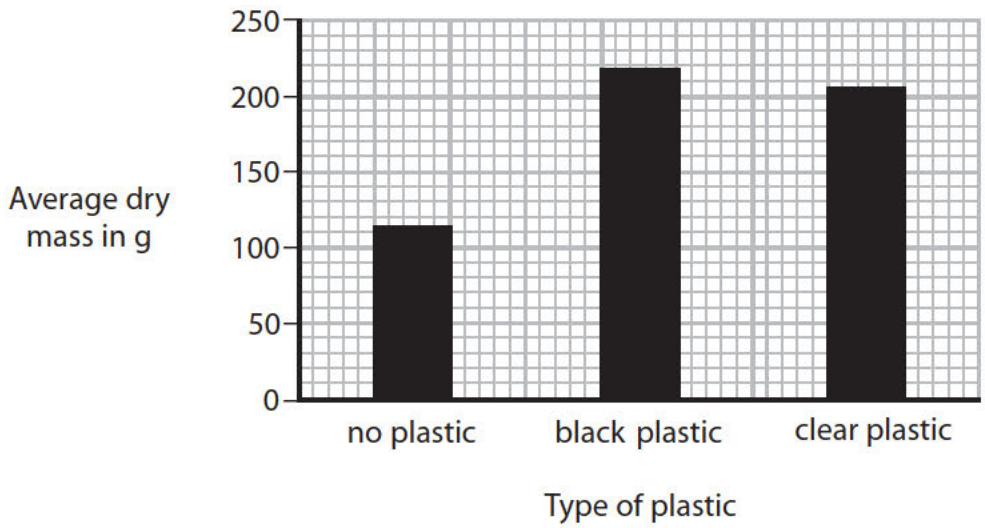
He grows plants in trays containing soil.

- ten trays have the soil uncovered
- ten trays have the soil covered by black plastic
- ten trays have the soil covered with clear plastic

The diagram shows some of the trays.



After three months the farmer measures the dry mass of the plants and calculates the average (mean) dry mass.




(a) (i) State the independent variable in this investigation.

**(1)**

(ii) Describe the steps the farmer takes to make sure his results are reliable.

**(2)**

.....

.....

(iii) To make a valid comparison of plant growth the farmer needs to control the abiotic (non-living) factors. He keeps the trays in the same light intensity.

Name three other abiotic factors the farmer should control.

**(3)**

1 .....

.....

2 .....

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3 .....

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(b) Suggest two reasons why the plants grow better when the soil is covered with black plastic.

**(4)**

1 .....

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2 .....

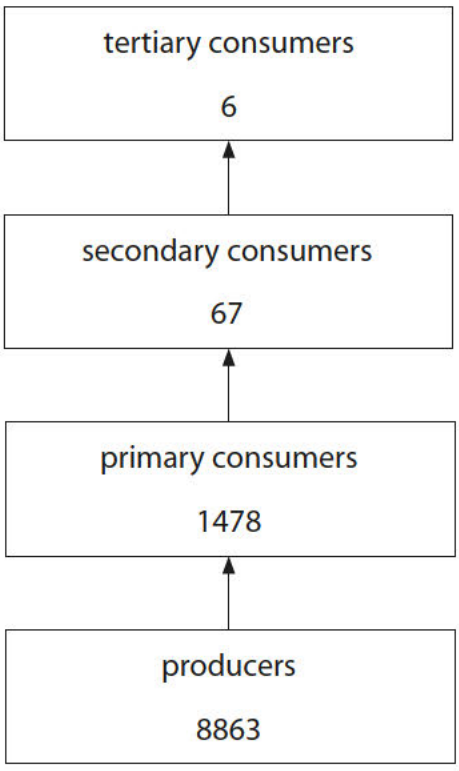
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**(Total for Question = 10 marks)**

**2** The diagram shows the energy transfer in a river ecosystem. The numbers on the diagram refer to the energy in the biomass at each trophic level in arbitrary units.




(a) The formula shows how to calculate energy transfer efficiency as a percentage.

$$\text{percentage energy transfer efficiency} = \frac{\text{total energy in biomass}}{\text{total energy available}} \times 100$$

(i) The total energy available to the producers from sunlight is 1 700 000 in arbitrary units.

Use this information, and the formula, to calculate the percentage energy transfer efficiency from sunlight to plants.

Show your working.

**(2)**

Answer ..... %

(ii) Suggest why the percentage energy transfer efficiency from sunlight to plants is low.

**(1)**

.....

.....

.....

(b) The table shows the calculated energy transfer efficiencies between the different trophic levels in the river ecosystem.

| Trophic levels | Percentage energy transfer efficiency |
|---|---|
| plants to primary consumers | 16.7 |
| primary consumers to secondary consumers | 4.5 |
| secondary consumers to tertiary consumers | 9.0 |

Suggest two reasons why the energy transfer from plants to primary consumers is not 100%.

**(2)**

1 .....

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.....

2 .....

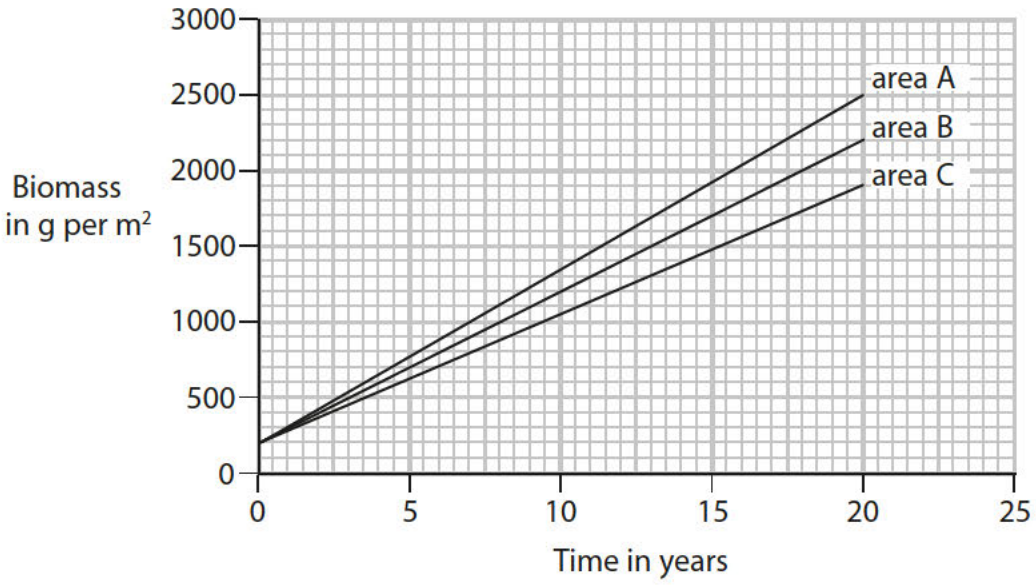
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**(Total for Question = 5 marks)**

**3** Scientists want to compare the growth of the same species of plant in three different areas.

The graph shows the biomass of the plants in each area in g per $m^2$ each year for a period of 20 years.




(a) The table shows the increase in biomass in each area in g per $m^2$ per year for the 20-year period for areas A and B.

| Area | Increase in biomass in g per $m^2$ per year |
|---|---|
| A | 115 |
| B | 100 |
| C | ? |

Calculate the increase in biomass in g per $m^2$ per year for area C

Show your working.

**(2)**

Increase in biomass = ..... g per $m^2$ per year

(b) After 20 years, the plants in area A had a greater biomass than those in area B.

(i) Explain how abiotic (non-living) factors could cause this difference.

**(4)**

(ii) Explain how biotic (living) factors could cause this difference.

**(2)**

(c) The scientists wanted to find out how efficient plants in area A were at converting light energy and using it to make biomass.

The scientists knew the following information:

- the increase in biomass for the plant growth in area A is 115 g per $m^2$ per year
- one gram of the plants in area A contains 22 kJ of energy
- the amount of light energy available in area A is 3 200 000 kJ per $m^2$ per year

The formula for calculating the percentage energy transfer efficiency is

$$\% \text{ energy transfer efficiency} = \frac{\text{total energy in biomass}}{\text{energy avaliable}} \times 100$$

Use this information to calculate the percentage energy transfer efficiency of the plants in area A.

Show your working.

**(2)**

Energy transfer efficiency = ..... %

**(Total for Question = 10 marks)**

**4** Read the passage below. Use the information in the passage and your own knowledge to answer the questions that follow.

## Red and Grey Squirrels



(Photographer: Matti Parkkonen)

Red squirrels live in pine tree habitats in the United Kingdom (UK) where their main predators are birds of prey such as the goshawk. The squirrels mainly eat pine cone seeds. This food is plentiful in the autumn and helps the squirrels increase their body mass. Having a larger body mass helps red squirrels to survive the cold winter conditions. It also means that breeding females are in good condition to produce young in the spring.

Red squirrels were common in the UK until a different species, the grey squirrel, was introduced from America in 1876. The two species struggled to exist in the same woodland habitat and it is the red squirrel population that is decreasing. There are estimated to be only 140 000 red squirrels left in the UK, and 2.5 million grey squirrels. The spread of the grey squirrel has been rapid, and in some areas native red squirrels are no longer seen.

The grey squirrel outcompetes the red squirrel and there is some evidence that it is also more resistant to disease. The increase in the number of grey squirrels in the UK is having a harmful effect on other native communities where the plants and animals are poorly adapted to withstand their presence. The grey squirrels are causing significant harm to woodland habitats, and recent scientific studies have reported that they are having a serious effect on the number of native woodland birds.

The Forestry Commission is an organisation in the UK trying to develop a long-term conservation strategy to save the red squirrel from extinction. It is hoped that this work will help to restore the UK's native biodiversity.

(a) Name a secondary consumer in a food chain containing red squirrels.

**(1)**

.....

(b) Suggest how a larger body mass helps squirrels survive the cold winter (lines 4 and 5).

**(2)**

.....

.....

.....

.....

(c) Suggest two reasons why it is an advantage for red squirrels to produce young in the spring (line 6).

**(2)**

1 .....

.....

2 .....

.....

(d) (i) What is meant by the term **habitat** (line 9)?

**(1)**

.....

.....

(ii) What is meant by the term **population** (line 9)?

**(1)**

.....

.....

(e) Use the data in the passage to calculate the percentage of all the squirrels in the UK that are red. Show your working.

**(2)**

percentage ..... %

(f) Give two possible reasons why grey squirrels are increasing in number compared to red squirrels.

**(2)**

1 .....

.....

2 .....

.....

(g) Grey squirrels have a greater effect on the number of woodland birds than red squirrels (lines 17 to 19).

Suggest how scientists could collect data to support this hypothesis.

**(3)**

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(h) Suggest two methods the Forestry Commission might use to save the red squirrel from extinction (line 21).

**(2)**

1 .....

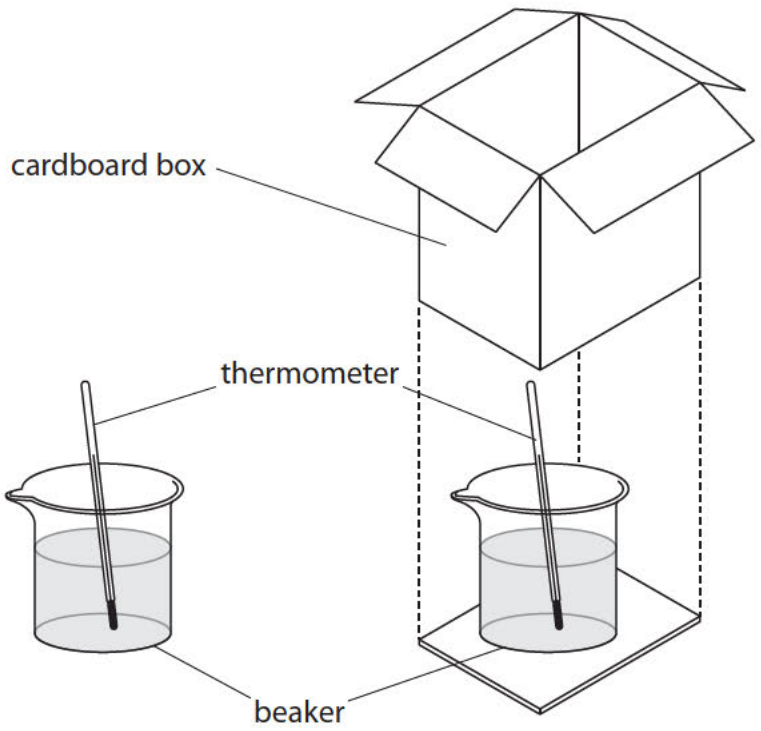
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2 .....

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**(Total for Question = 16 marks)**

**5** A student was told that farming animals outdoors was less efficient than keeping them indoors (factory farming). The student investigated this idea, using beakers of hot water to represent the animals, with the apparatus shown below. The cardboard box was used to represent keeping animals indoors.




The beakers were filled with the same volume of hot water and the temperature in each beaker was measured at intervals of 10 minutes over a period of 30 minutes. The investigation was repeated five times. The results are shown in the table.

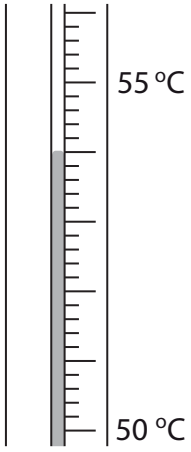
| Trial | Temperature in °C for each beaker | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Outside box | | | | Inside box | | | |
| | 0 min | 10 min | 20 min | 30 min | 0 min | 10 min | 20 min | 30 min |
| 1 | 70 | 55 | 49 | 44 | 70 | 59 | 51 | 46 |
| 2 | 68 | 56 | 49 | 43 | 68 | 57 | 52 | 45 |
| 3 | 62 | 50 | 45 | 20 | 62 | 50 | 45 | 41 |
| 4 | 70 | 56 | 45 | 38 | 70 | 54 | 48 | 40 |
| 5 | 67 | 55 | 48 | 43 | 67 | 60 | 53 | 48 |

(a) (i) How many times did the student measure the temperature of the water in the beakers outside the box during the investigation?

**(1)**

.....

(ii) The diagram shows one of the temperature readings during the investigation.




Use the diagram and the information in the table to complete the following sentence.

**(2)**

The reading on this thermometer is ..... °C, which suggests the reading was

taken from a beaker after ..... minutes kept ..... the box.

(b) (i) What was the independent variable (the variable that the student chose to change) in this investigation?

**(1)**

.....

(ii) What was the dependent variable (the variable measured by the student) in this investigation?

**(1)**

.....

(iii) Explain why the student kept the other variables constant.

**(2)**

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(c) The student tried to make his measurements accurate.

Give **one** way that he could have done this.

**(1)**

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(d) The results of this investigation suggest that meat production would be less efficient if farmers kept their animals outdoors rather than indoors.

Use the data and your knowledge to explain why.

**(3)**

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**(Total for Question = 11 marks)**