

# Scientific Investigation Practice

**Directions:** Questions 6 through 9 are based on the information below.

Impact craters are formed when meteorites strike the surface of a planet. A researcher investigated some factors that might influence the formation of impact craters by either dropping marbles into a tray of sand or launching them from a slingshot into the sand. The results are shown in the table below.

| Test Number | Mass of Marble (g) | Method of Crater Formation | Marble Speed (cm/s) | Crater Diameter (cm) |
|-------------|--------------------|----------------------------|---------------------|----------------------|
| 1           | 3                  | Drop from 2 m              | 626                 | 5.0                  |
| 2           | 6                  | Drop from 2 m              | 626                 | 7.0                  |
| 3           | 6                  | Drop from 10 cm            | 140                 | 1.8                  |
| 4           | 6                  | Drop from 2 m              | 626                 | 6.5                  |
| 5           | 6                  | Launch from 36 cm          | 3,000               | 11.0                 |

**6** Tests 1 and 2 were designed to test the effects of which of the following factors?

- A The mass of the marble
- B The speed of the marble
- C The crater diameter
- D The method of crater formation

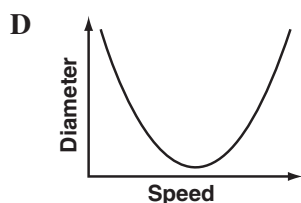
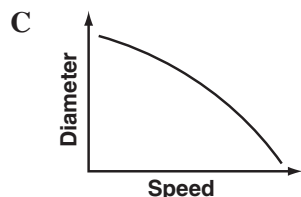
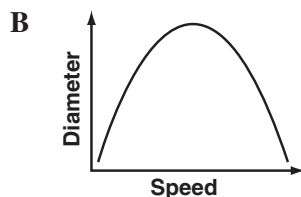
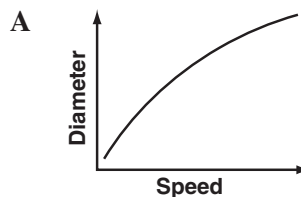
**7** Which of the following statements best explains why the speed of the marble in test 5 is so much greater than the speed of the marbles in tests 3 and 4?

- A It was dropped from the greatest height.
- B It was launched rather than dropped.
- C It produced the largest crater.
- D It was made of a different material.

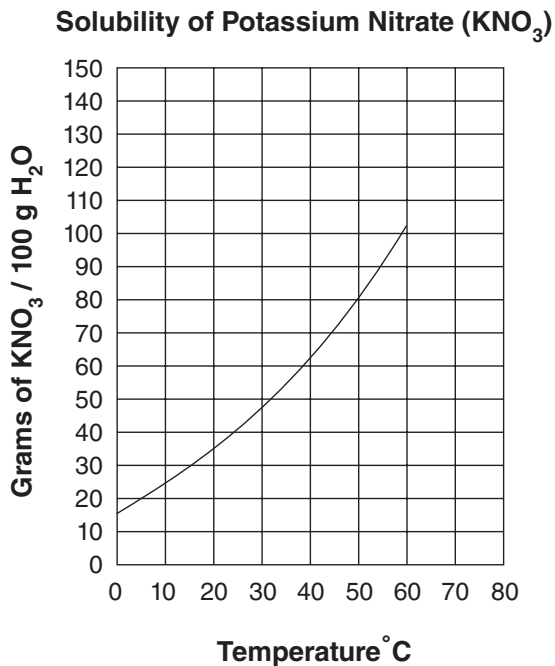
**8** The observed difference in the crater diameters in tests 3 and 4 is most likely due to which of the following factors?

- A The mass of the marbles
- B The researcher's measuring technique
- C Whether the marble was dropped or launched
- D The height from which the marbles were dropped

**9** Consider the results for tests 3, 4, and 5. Which of the following graphs best illustrates the relationship between marble speed and crater diameter?



**Directions:** The graph below shows the number of grams (g) of potassium nitrate (KNO<sub>3</sub>) dissolved in 100 grams of water (H<sub>2</sub>O) at different Celsius temperatures (°C). Use this information to answer questions 10 through 13.



**10** Approximately how many grams of KNO<sub>3</sub> can be dissolved in 100 grams of H<sub>2</sub>O at 35°C?

- A 65
- B 60
- C 55
- D 50

**11** Which of the following is the lowest temperature at which 70 grams of KNO<sub>3</sub> can be dissolved in 100 grams of H<sub>2</sub>O?

- A 55°C
- B 45°C
- C 35°C
- D 25°C

**12** Which of the following is the best prediction of the mass of KNO<sub>3</sub> that could be dissolved in 100 grams of H<sub>2</sub>O at 70°C?

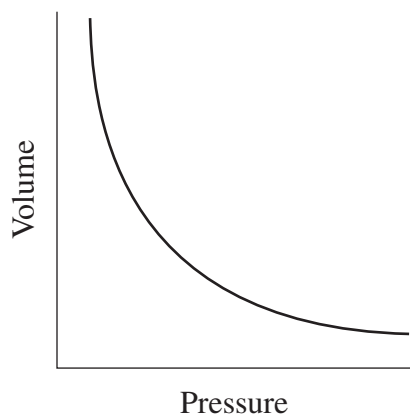
- A 105 g
- B 115 g
- C 135 g
- D 155 g

**13** Approximately 80 grams of KNO<sub>3</sub> is dissolved in 100 grams of H<sub>2</sub>O at 50°C. If this solution is cooled to 10°C, approximately how much KNO<sub>3</sub> will come out of the solution?

- A 25 g
- B 35 g
- C 45 g
- D 55 g

| Question Number | Correct Answer |
|-----------------|----------------|
| 1               | C              |
| 2               | A              |
| 3               | A              |
| 4               | D              |
| 5               | B              |
| 6               | A              |
| 7               | B              |
| 8               | D              |
| 9               | A              |
| 10              | C              |
| 11              | B              |
| 12              | C              |
| 13              | D              |
| 14              | D              |
| 15              | A              |
| 16              | A              |
| 17              | C              |
| 18              | D              |
| 19              | A              |
| 20              | B              |
| 21              | A              |
| 22              | D              |
| 23              | C              |
| 24              | A              |
| 25              | C              |

**Mod 5 – Question 2** - The graph shows the relationship between volume and pressure.



How are the variables related?

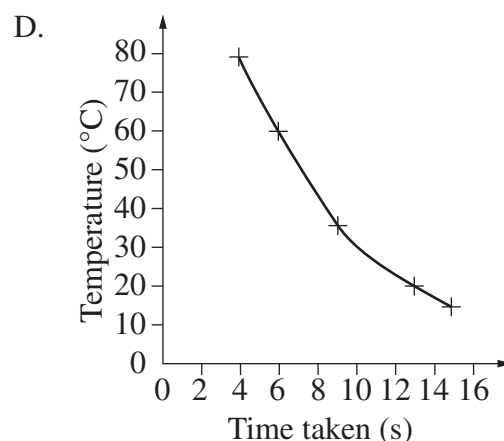
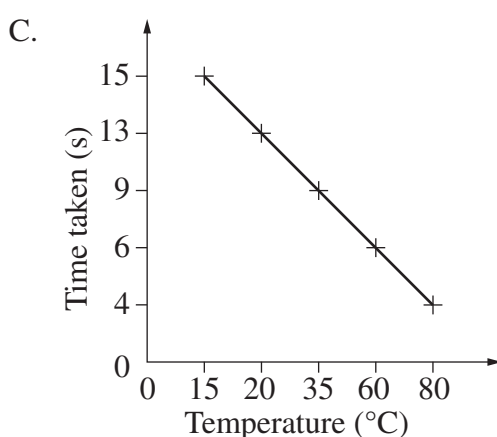
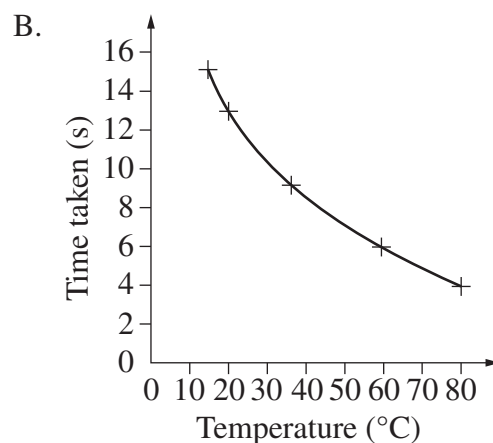
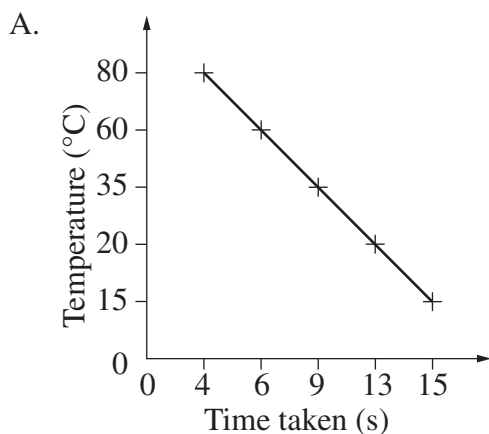
- A. As pressure is increased, volume decreases at a decreasing rate.
- B. As pressure is increased, volume decreases at an increasing rate.
- C. As volume is decreased, pressure increases at a decreasing rate.
- D. As volume is decreased, pressure increases at a constant rate.

**Mod 5 – Question 3**

An experiment was performed to investigate the effect of temperature on the time it takes for a tablet to dissolve. Five glasses of water of varying temperature were prepared. An effervescent tablet was then dropped into each of the glasses. The table below shows the temperature of each glass of water and the time taken for each of the tablets to dissolve.

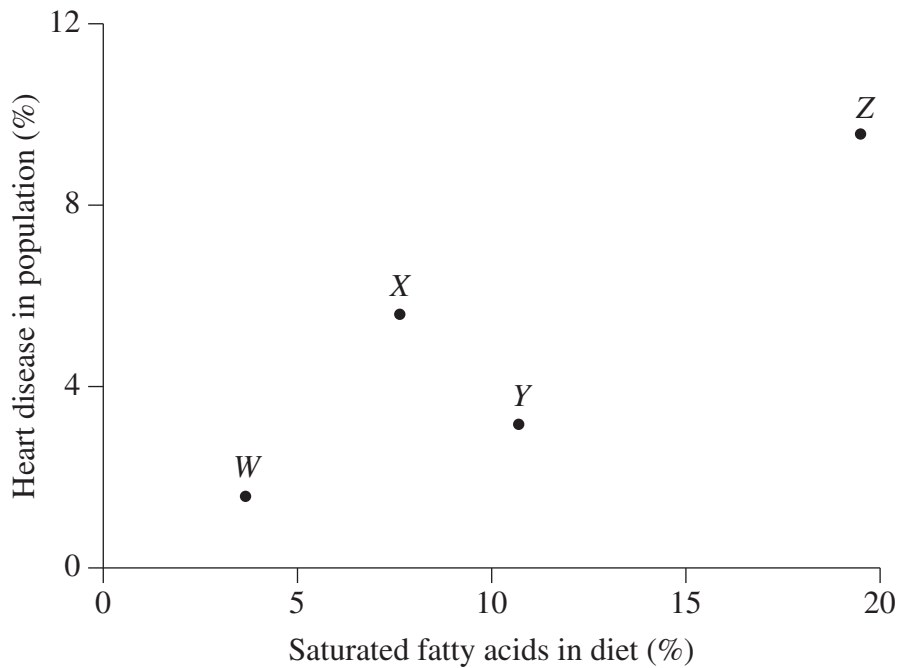
| <i>Temperature of water (°C)</i> | <i>Time taken to dissolve (seconds)</i> |
|----------------------------------|---|
| 15                               | 15                                      |
| 20                               | 13                                      |
| 35                               | 9                                       |
| 60                               | 6                                       |
| 80                               | 4                                       |

Which graph correctly represents the data from the experiment?



#### Mod 5 – Question 4

The scatter plot shows the relationship between heart disease and the percentage of saturated fatty acids in the diets of the populations of some different countries.



What hypothesis would a comparison of the data from ONLY country X and country Y support?

- A. That heart disease is more common in country Y than in country X
- B. That people in country X have a high intake of saturated fatty acids
- C. That having more saturated fatty acids in the diet increases the risk of heart disease
- D. That having more saturated fatty acids in the diet decreases the risk of heart disease

#### Mod 5 – Question 7

A student wanted to test the idea that the performance of students in Mathematics examinations would be worse if they did not eat breakfast.

Which of the following would be the best control group for this experiment?

- A. A group that ate breakfast and attempted the same examination as the test group
- B. A group that ate breakfast and attempted similar questions to those of the test group
- C. A group that did not eat breakfast and attempted the same examination as the test group
- D. A group that did not eat breakfast and attempted similar questions to those of the test group

### Mod 5 – Question 9

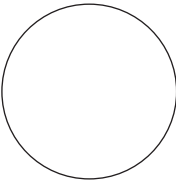
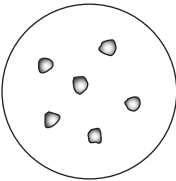
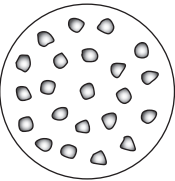
A student wanted to investigate the water content of a variety of foods. The student weighed out exactly 5 g of a variety of food samples including apple, raw beef, celery and tomato. The foods were then placed in an incubating oven for 4 days, removed and then reweighed.

What would be the dependent variable in this investigation?

- A. The types of food samples used
- B. The temperature of the incubating oven
- C. The amount of mass lost after 4 days in the incubating oven
- D. The amount of mass of each sample prior to being placed in the incubating oven

### Mod 5 – Question 13

An experiment was conducted to compare the effectiveness of two water treatments for purifying pond water. Three samples of pond water, *A*, *B* and *C*, were collected. Each sample was used to inoculate an agar plate. The plates were incubated at 25°C. The number of visible bacterial colonies on each plate was counted three days later.

| <i>Sample</i>                               | <i>A</i>   | <i>B</i>  | <i>C</i>  |
|---|--|---|---|
| <i>Treatment</i>                            | 5 grams of pool chlorine per litre of water  | Boiling for one minute  | No treatment  |
| <i>Number of visible bacterial colonies</i> | 0<br> | 6<br> | 22<br> |

Which row of the table correctly identifies an independent variable, a dependent variable, a controlled variable and the purpose of Sample *C* in this experiment?

|    | <i>Independent variable</i> | <i>Dependent variable</i>    | <i>Controlled variable</i>   | <i>Purpose of Sample C</i>   |
|----|-----------------------------|------------------------------|------------------------------|--|
| A. | Quality of pond water       | Temperature                  | Number of bacterial colonies | To control the independent and dependent variables                     |
| B. | Quality of pond water       | Number of bacterial colonies | Treatment                    | To ensure that the results reflect the effects of the water treatments |
| C. | Treatment                   | Pond water                   | Temperature                  | To control the independent and dependent variables                     |
| D. | Treatment                   | Number of bacterial colonies | Temperature                  | To ensure that the results reflect the effects of the water treatments |

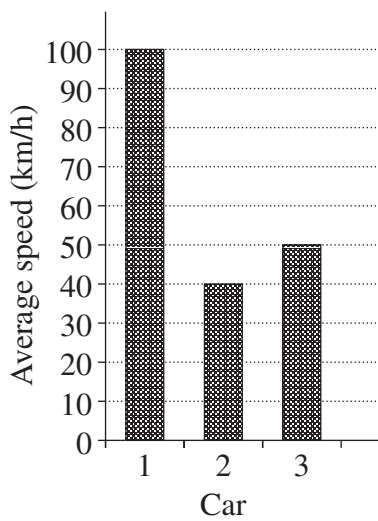
**Mod 5 – Question 15**

A student measured the time taken for three cars to travel particular distances. The student then calculated the average speed of each car, and put the information in the table below.

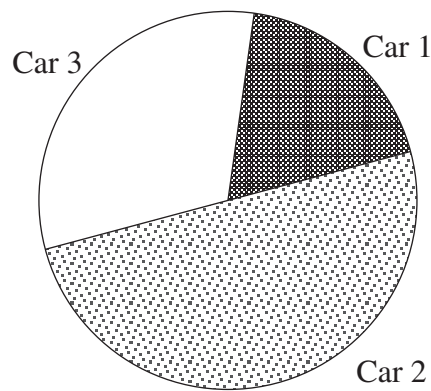
| <i>Car</i> | <i>Distance (km)</i> | <i>Time (hours)</i> | <i>Average speed (km/h)</i> |
|------------|----------------------|---------------------|-----------------------------|
| Car 1      | 100                  | 1                   | 100                         |
| Car 2      | 80                   | 2                   | 40                          |
| Car 3      | 150                  | 3                   | 50                          |

Which of the following graphs best shows the average speed of each car?

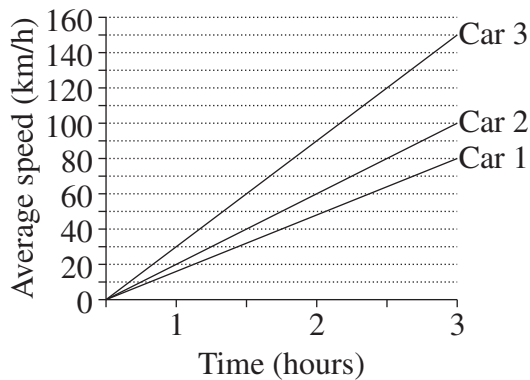
A. **Average speed of cars**



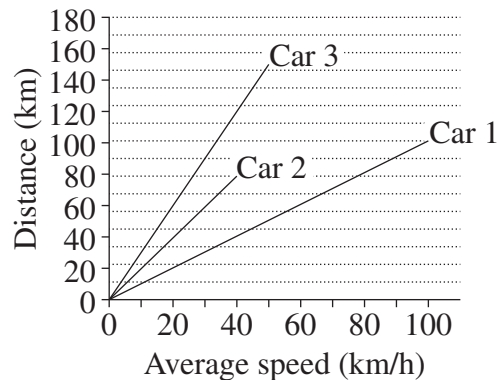
B. **Average speed of cars**



C. **Average speed of cars**

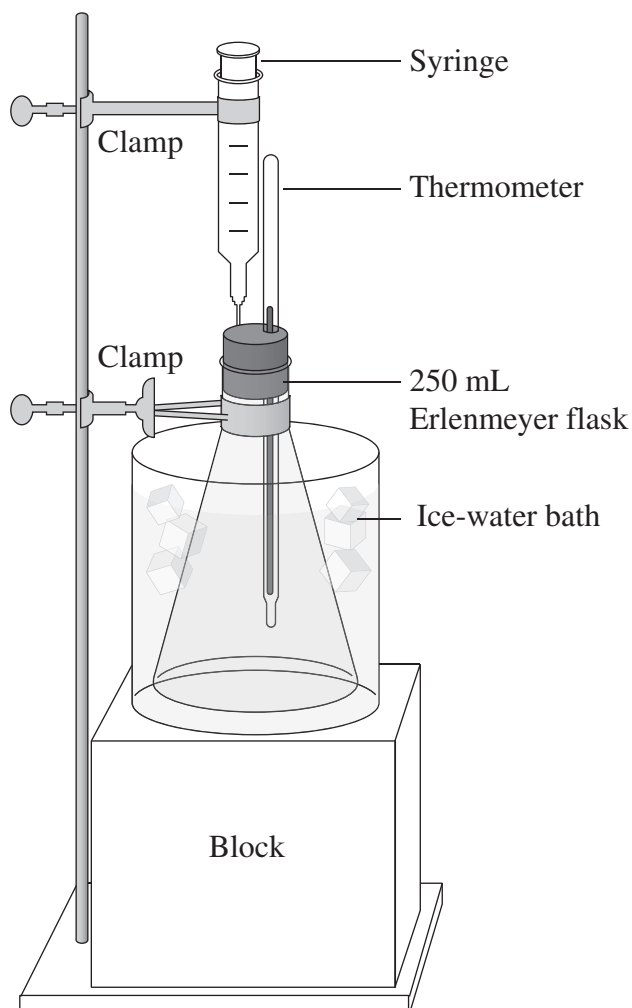


D. **Average speed of cars**



### Mod 5 – Question 17 (8 marks)

A student set up the following apparatus to measure the effect of temperature on volume of gas.



- (a) Outline the independent variable, dependent variable, and one controlled variable in this investigation.

3

- (b) Identify TWO ways that random errors could occur in this investigation.

2

### Mod 6 – Question 2

Students conducted an investigation to measure the amount of hydrogen gas produced at different temperatures. They set up 4 flasks. Each flask was heated to a different temperature.

The students performed their calculations and recorded them in the table shown.

| Flask | Temp (°C) | Volume gas produced (mL) | Time (s) | Reaction Rate (mL/s) |
|-------|-----------|--------------------------|----------|----------------------|
| 1     | 10        | 8                        | 180      | 0.056                |
| 2     | 20        | 17                       | 180      | 0.083                |
| 3     | 30        | 22                       | 180      | 0.12                 |
| 4     | 40        | 27                       | 180      | 0.16                 |

For which flask was the reaction rate calculated correctly?

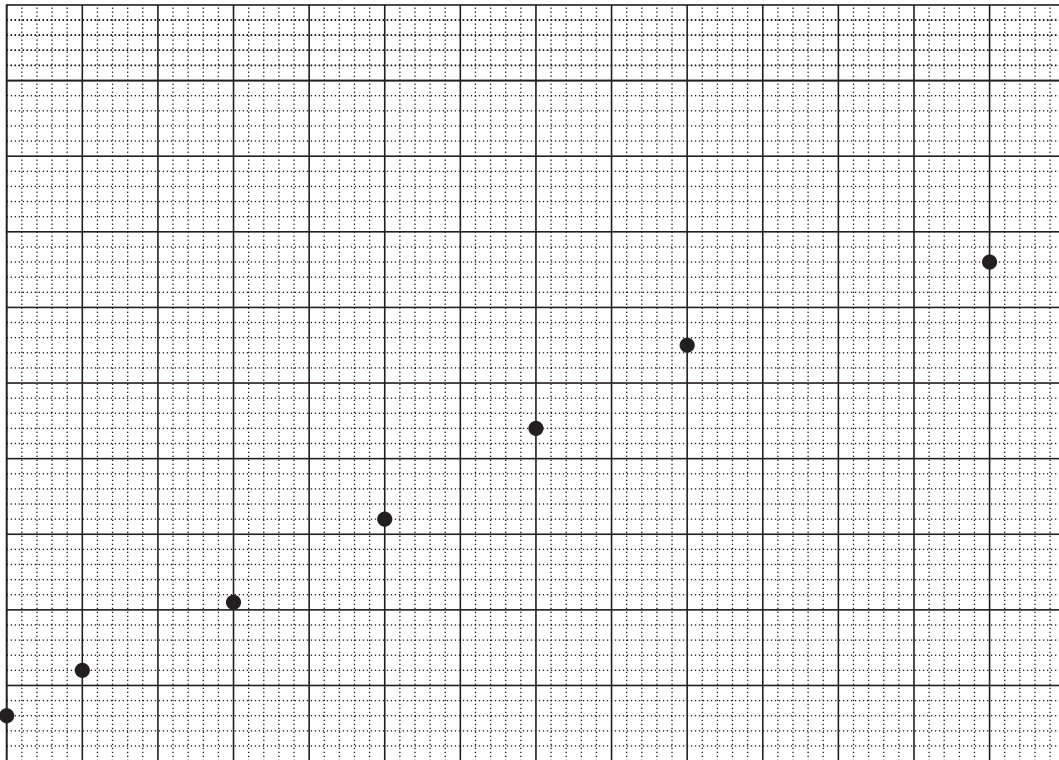
- A. Flask 1
- B. Flask 2
- C. Flask 3
- D. Flask 4

**Mod 5 – Question 18** (6 marks)

Some rats were being fed to determine the rate at which they put on ‘weight’. The table shows the average masses of male and female rats from birth to 26 months of age when they are fully grown.

| <i>Age (months)</i> | <i>Average mass of female rats (grams)</i> | <i>Average mass of male rats (grams)</i> |
|---------------------|--|--|
| birth               | 65   | 54                                       |
| 2                   | 123  | 100                                      |
| 6                   | 211  | 164                                      |
| 10                  | 320  | 400                                      |
| 14                  | 440  | 485                                      |
| 18                  | 550  | 630                                      |
| 26                  | 665  | 865                                      |

The change in the mass of female rats with age was graphed as shown.



- (a) Label the axes and indicate the scales. 2
- (b) On the same grid, construct a graph to show the change in the mass of male rats with age. 2
- (c) Outline how to predict the average mass of male rats at 28 months. Include the predicted value in your answer. 2

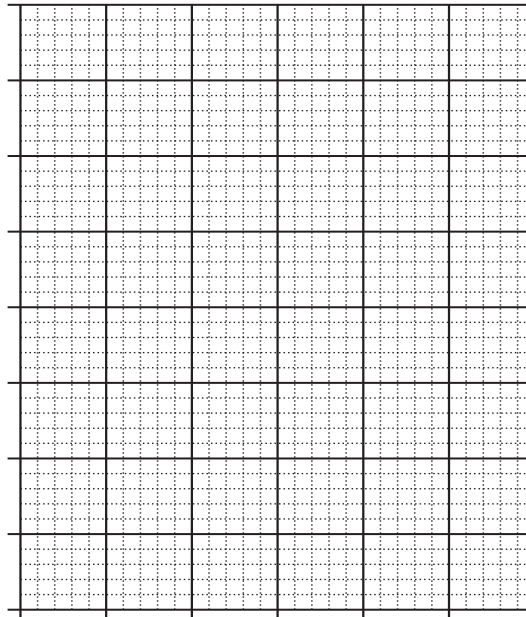


**Mod 6 – Question 7** (7 marks)

A student investigated the average rate of a chemical reaction over a period of time. She measured the amount of solid product produced over a 4-minute period, and tabulated her data as shown.

| Time (s) | Mass of product produced (g) |
|----------|------------------------------|
| 0        | 0                            |
| 30       | 1.4                          |
| 60       | 2.1                          |
| 90       | 2.8                          |
| 120      | 3.1                          |
| 150      | 3.5                          |
| 180      | 3.6                          |
| 210      | 3.6                          |
| 240      | 3.6                          |

(a) Graph the results of the student’s investigation on the grid provided.



3

Question 7 (continued)

(b) Use the graph and the formula given to find the average reaction rate between 40 and 100 seconds. Note that for this investigation, reaction rate is measured in  $\text{g s}^{-1}$ .

2

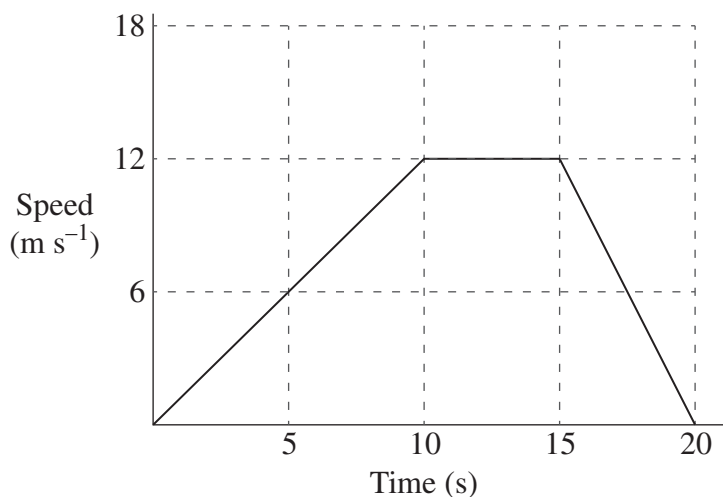
$$\text{average reaction rate} = \frac{\text{change in mass}}{\text{change in time}}$$

(c) At what point is the reaction complete? Justify your answer.

2

**Mod 6 – Question 9** (5 marks)

A student conducted an experiment to investigate the change in the speed of a car over time. The speed of the car at various times was measured and graphed.



(a) Describe, in words, the change in the speed of the car for t

(i) the first 10 secs

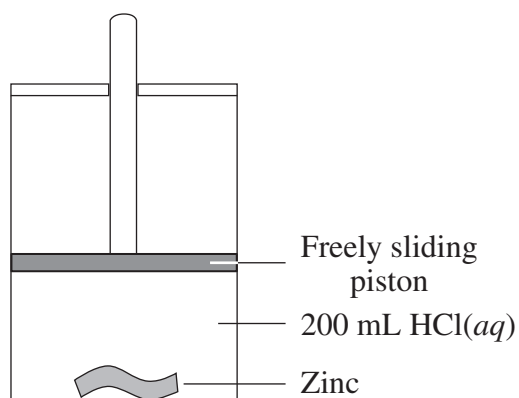
(ii) from 10 secs to 15 secs

(iii) the final 5 secs

3

**Mod 6 – Question 10** (5 marks)

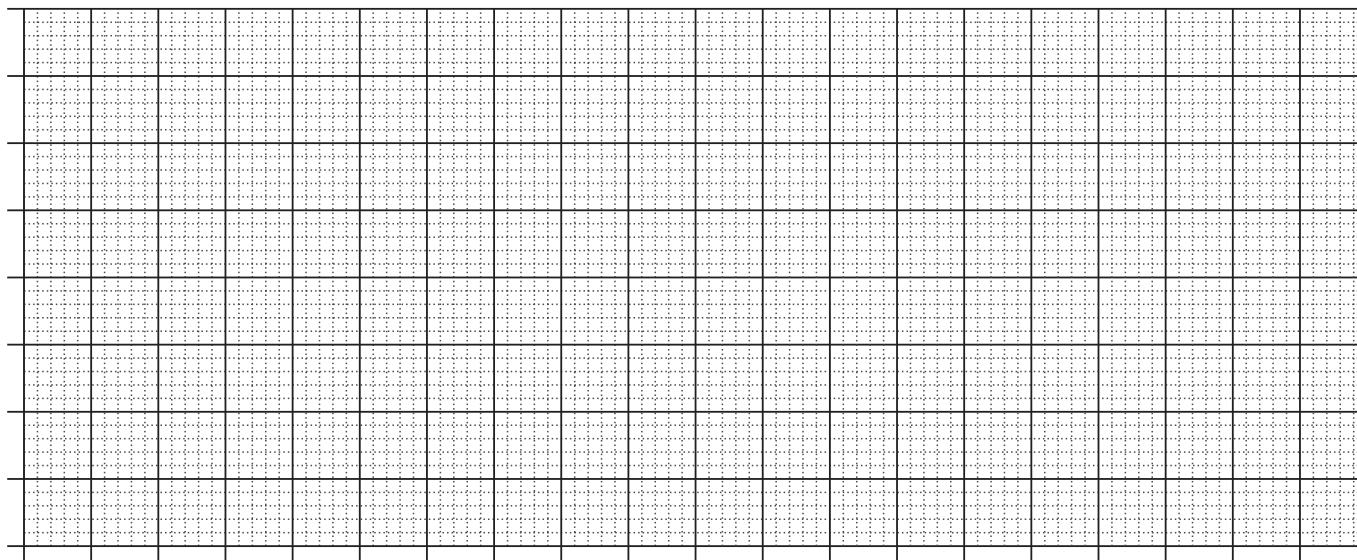
A student carried out a first-hand investigation to identify the relationship between the mass of a metal used in a reaction and the volume of gas produced. The first-hand investigation was carried out at 25°C and 100 kPa. In each trial, 200 mL of hydrochloric acid was added to some zinc, and the volume of gas produced was recorded. The diagram shows the equipment used, and the table contains the student's results.



| <i>Mass of zinc (g)</i> | <i>Volume of gas collected (mL)</i> |
|-------------------------|-------------------------------------|
| 0.12                    | 45                                  |
| 0.33                    | 125                                 |
| 0.56                    | 115                                 |
| 0.83                    | 315                                 |
| 0.96                    | 365                                 |
| 1.22                    | 380                                 |
| 1.64                    | 380                                 |
| 1.93                    | 380                                 |

(a) Draw an appropriate graph to represent these results.

**3**



(b) Predict the volume of gas that would be produced in this experiment if 3.00 g of zinc is used. Justify your answer.

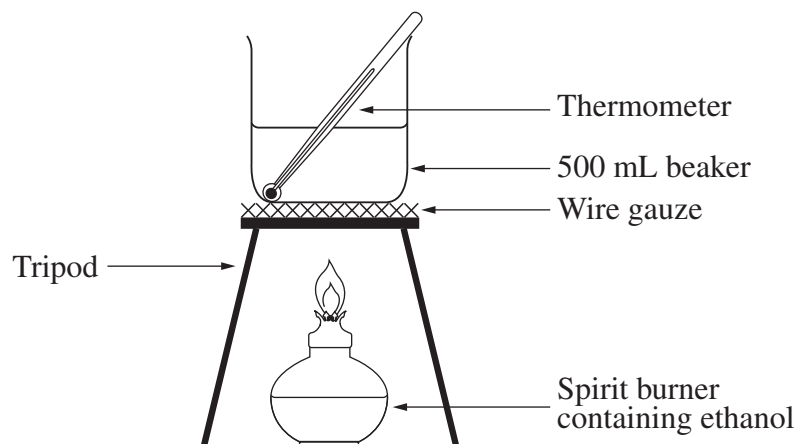
**2**

**Mod 6 – Question 11** (4 marks)

Students were asked to perform a first-hand investigation to determine the heat of combustion of alcohol.

The following extract is from the practical report of one student.

*Apparatus used:*



*Lab data:*

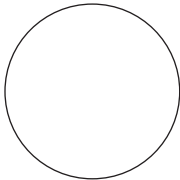
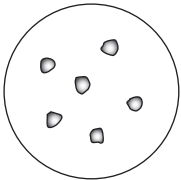
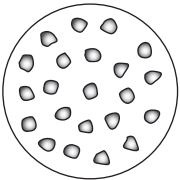
|                              |   |         |
|------------------------------|---|---------|
| Mass of water                | = | 250.0 g |
| Initial mass of burner       | = | 221.4 g |
| Final mass of burner         | = | 219.1 g |
| Initial temperature of water | = | 19.0°C  |
| Final temperature of water   | = | 59.0°C  |

- (a) After completing the calculations correctly, the student's answer did not agree with the value found in data books. Suggest ONE reason for this. **1**
- (b) Explain TWO adjustments that the student could make to the apparatus or experimental method to improve the accuracy of the results. **3**

## Module 7 Fact or Fallacy?

### Mod 7 – Question 2

An experiment was conducted to compare the effectiveness of two water treatments for purifying pond water. Three samples of pond water, *A*, *B* and *C*, were collected. Each sample was used to inoculate an agar plate. The plates were incubated at 25°C. The number of visible bacterial colonies on each plate was counted three days later.

| <i>Sample</i>                               | <i>A</i>   | <i>B</i>  | <i>C</i>  |
|---|--|---|---|
| <i>Treatment</i>                            | 5 grams of pool chlorine per litre of water  | Boiling for one minute  | No treatment  |
| <i>Number of visible bacterial colonies</i> | 0<br> | 6<br> | 22<br> |

What is the purpose of Sample *C*?

- A. To ensure that the experiment can be repeated at a later time
- B. To provide control of the independent and dependent variables
- C. To improve the accuracy of the count of visible bacterial colonies
- D. To ensure that the results reflect the effect of the water treatments

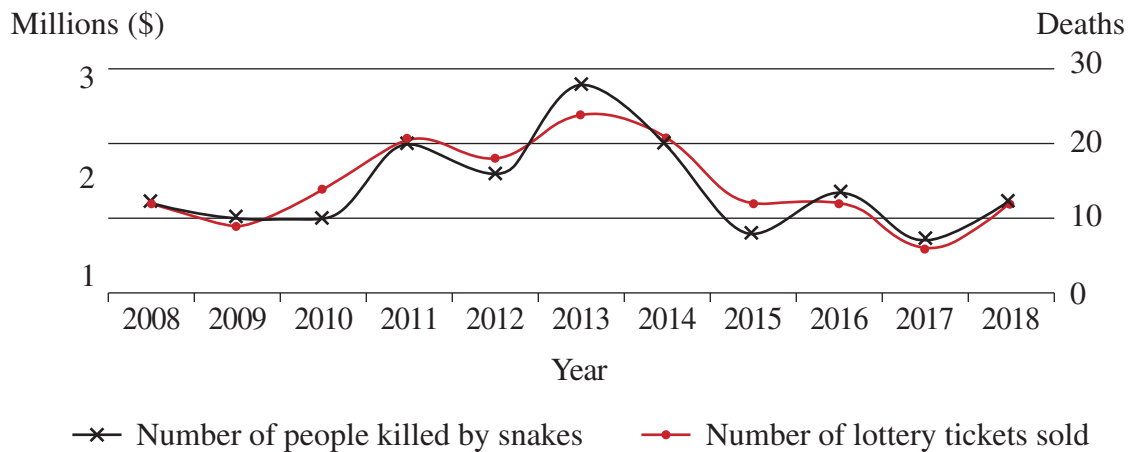
### Mod 7 – Question 3

Which of the following is NOT a feature of a double-blind trial?

- A. The researcher ensures that only female participants receive the control
- B. The participants are unaware of the specific treatment they each receive
- C. Some participants receive the treatment while others receive the control
- D. The researcher is unaware of the specific treatment each trial participant receives

### Mod 7 – Question 4

The following is a graph showing lottery ticket sales and number of people killed by snakes.

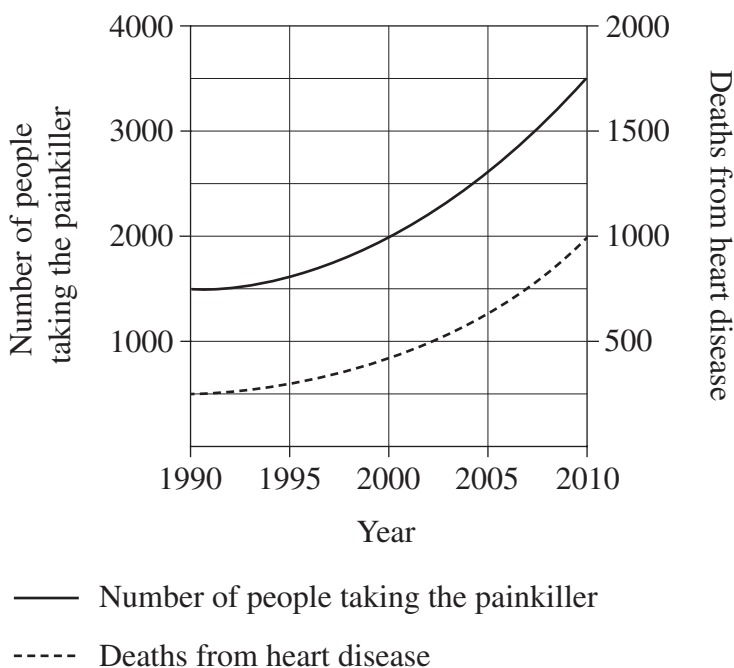


Which of the following best describes the relationship present in the graph?

- A. Causation – the more money you win in the lottery, the more likely you are to be killed by a snake
- B. Correlation – the more money you win in the lottery, the more likely you are to be killed by a snake
- C. Causation – the more lottery tickets you buy, the more people killed that year by snakes
- D. Correlation – the number of lottery tickets sold and the number of deaths from snakes follow the same trend

### Mod 7 – Question 5

The graph shows information related to the consumption of a particular painkiller and death from heart disease in a city.

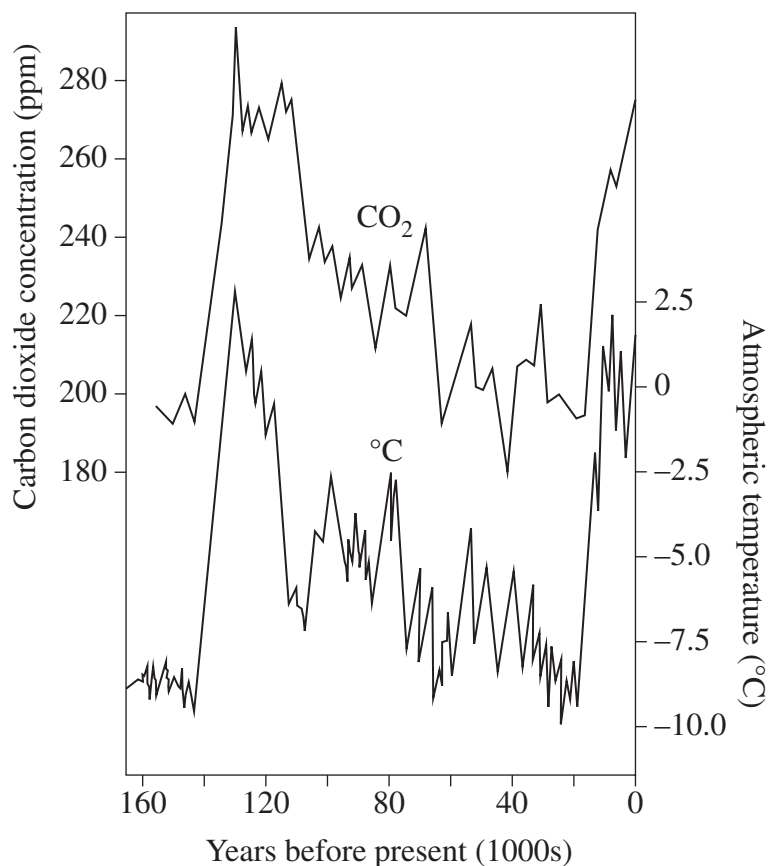


Which deduction **CANNOT** be made from this graph?

- A. There is a correlation between taking the painkiller and deaths from heart disease.
- B. The number of deaths from heart disease in the city quadrupled from 1990 to 2010.
- C. The number of people in the city taking the painkiller more than doubled in the 20 years.
- D. The increase in deaths from heart disease was caused by the consumption of the painkiller.

### Mod 7 – Question 6

The diagram shows some changes in Earth's atmosphere.



Which of the following is supported by the information in the graph?

- A. The temperature on Earth, 160 thousand years ago, ranged from 8°C to 10°C.
- B. The amount of carbon dioxide in Earth's atmosphere decreased between 80 and 40 years ago.
- C. For most of the last 160 thousand years the amount of carbon dioxide in the atmosphere has been decreasing.
- D. There is no relationship between the amount of carbon dioxide in the atmosphere and the temperature of the atmosphere.

### Mod 7 – Question 10 (9 marks)

An investigation was carried out to disprove the hypothesis that a single model can be used to express the relationship between voltage and the current flowing through any resistor.

The resistors used for the investigation were an incandescent light globe and a wire-wound resistor encased in a ceramic block. The resistive component of both of these devices consisted of a thin, coiled wire.

The measurements taken for each resistor are tabulated below.

| <i>Incandescent light</i> |             | <i>Wire-wound resistor</i> |             |
|---------------------------|-------------|----------------------------|-------------|
| Current (A)               | Voltage (V) | Current (A)                | Voltage (V) |
| 0.0                       | 0.0         | 0.0                        | 0.0         |
| 0.5                       | 0.2         | 0.5                        | 5.0         |
| 1.0                       | 1.0         | 1.0                        | 10.0        |
| 1.5                       | 2.4         | 1.5                        | 15.0        |
| 2.0                       | 4.5         | 2.0                        | 20.0        |
| 2.5                       | 7.2         | 2.5                        | 25.0        |

Question 10 (continued)

Analyse the investigation to determine whether it disproves the hypothesis. In your answer, refer to graphical evidence and features of validity, reliability and accuracy to strengthen your conclusion.

