SAMPLE TEXTBOOK ANSWERS

Chapter 2 Investigating

The following are sample answers only. Other answers to the same questions may also be correct.

Science inquiry

Activity 2.1 Hypothesising

1 *Bacillus anthracis* causes anthrax.

Answer: This is a good hypothesis, because it is a statement containing a single idea that can be tested and it links two variables.

2 Can anthrax be passed from sheep to cattle?

Answer: This is not a hypothesis, because it is a question.

3 If a sheep is injected with *Bacillus anthracis* it will get anthrax.

Answer: This is not a hypothesis. It is a prediction arising from the hypothesis that *Bacillus anthracis* causes anthrax.

4 To look for *Bacillus anthracis* in the blood of animals with anthrax.

Answer: This is not a hypothesis because it is not written as a statement. It is written as an aim and it does not link two variables.

5 Why does *Bacillus anthracis* cause anthrax?

Answer: This is not a hypothesis, because it is a question.

6 If a cow is injected with *Bacillus anthracis* and is then kept out of the weather, it will not get anthrax.

Answer: This is not a good hypothesis for two reasons. First, it is a prediction. Second, it states two variables that could affect development of anthrax: injection with the bacillus, and weather.

7 Injecting blood from a sheep suffering from anthrax into a healthy sheep will transmit the disease.

Answer: This is a good hypothesis, because it is a statement containing a single idea that can be tested and it links two variables. It is also valid to say that it is a prediction based on the hypothesis that *Bacillus anthracis* causes anthrax.

8 Any animal suffering from anthrax will have *Bacillus anthracis* in its blood and will pass the infection on to other animals.

Answer: This is not a good hypothesis, even though it is a statement that can be tested. This is because it contains two ideas (that is, two variables): first, the bacterium in the blood, and second, passing the infection to other animals.

Activity 2.2 Controlled experiments

1 Suggest the hypothesis that Redi was testing.

Answer: Students may suggest many possible hypotheses, such as either of the following.

- That air coming in contact with meat causes maggots
- That flies coming in contact with meat results in maggots

2 List the variables that Redi controlled in his experiments.

Answer: Meat was placed in all flasks. All flasks were set up at the same time. It is also implied that all flasks were left for the same amount of time. We may also assume that all the flasks were left in the same place, so all were at the same temperature.

3 What other variables do you think Redi should have controlled?

Answer:

- The quantity and type of meat used
- That only one type of fly came into contact with the meat
- The volume of the flasks used
- That all flasks were made of the same material
- The environmental temperature
- That all flasks were left in the same location (to provide consistent exposure to light/dark)

4 What conclusion could Redi draw from his experiment?

Answer: Students may draw either of the following conclusions.

Maggots are caused by flies that come in contact with the meat. Air does not cause maggots in meat.

Maggots in meat do not develop by spontaneous generation; they develop from contact between meat and flies.

5 Make a list of further questions to be answered that arise as a result of Redi's experiments.

Answer: Further questions may include the following:

- How do flies cause maggots in meat?
- Do flies cause maggots in foods other than meat?
- Do all types of flies cause maggots?
- Is the development of maggots from flies affected by environmental conditions such as temperature or light?

6 What was Pasteur's independent (experimental) variable?

Answer: Exclusion of micro-organisms, which was achieved by sterilising by boiling and filtering to remove bacteria

7 What was Pasteur's dependent variable?

Answer: Growth of micro-organisms

8 List the variables that Pasteur would have controlled so he could make a valid conclusion from his experiment.

Answer:

- Type and amount of nutrient broth
- How the bacteria were filtered from the air
- Type and size of the flasks
- Temperature

- All flasks set up at the same time
- All flasks left for the same amount of time

Activity 2.3 Testing a hypothesis

1 Suggest one prediction that can be made from this hypothesis.

Answer: If the hypothesis is true then (any of the following):

- increase in environmental temperature causes a decrease in the level of hormone X in the blood
- if environmental temperature stays the same the level of hormone X will be constant
- environmental temperature determines the level of hormone X in the blood.

2 Why were six men and six women used for the experiment instead of just one of each sex?

Answer: Several subjects were used in case one subject was unusual or abnormal in some way. When results are averaged the effects of individual differences on the result should be reduced.

3 What was the experimental procedure?

Answer: Placing the subjects in a room at 10°C for 12 hours and then testing the level of hormone X in the blood

4 What was the control procedure?

Answer: Placing the subjects in a room at 22°C for 12 hours and then testing the level of hormone X in the blood

5 What was the independent variable?

Answer: The temperature of the room

6 What was the dependent variable?

The level of hormone X in the subjects' blood

7 What variables were controlled (according to the description of the experiment)?

Answer:

- Equal numbers of males and females
- All subjects of the same age
- All given an identical diet
- All in rooms 1 and 2 together
- All in the rooms for the same period of time

8 Can you think of any other variables that should have been controlled? If so, explain why.

Answer:

- State of health of the subjects: If a subject were suffering from a medical condition, it could affect his or her hormone levels.
- Body mass index of subjects: Being severely under or overweight could affect a subject's hormone levels.
- Physical fitness of subjects: Fitness could affect a subject's hormone levels.
- Amount of water drunk by subjects during the experiment: Level of hydration of the body could affect a subject's hormone levels.
- Amount of clothing worn by subjects.

9 Do you think the experiment would have been a fair test?

Answer: Answers will vary.

Students may argue that the experiment was a fair test because all subjects were exposed to the same conditions for the same length of time.

However, they may also argue that the experiment was not a fair test because of the uncontrolled variables listed in response to Question 8.

10 What results would have supported the hypothesis?

Answer: If all/most subjects showed an increase in the level of hormone X in the blood after exposure to the cold room the hypothesis would be supported.

11 What results would have disproved the hypothesis?

Answer: If all/most subjects showed no change or a decrease in the level of hormone X in the blood after exposure to the cold room the hypothesis would be disproved.

Activity 2.4 Tabulation of data

1 What were the independent and dependent variables in the students' experiment?

Answer:

Independent variable: Temperature (°C) of the emulsion

Dependent variable: Time (hours and minutes) for the protein and oil to be completely digested

2 Draw up a table to show the data they collected (refer to page 21 for the rules for drawing up a table of scientific data).

Answer:

Table 1 Time taken for digestion of oils and proteins at varying temperatures

Temperature of flask (°C)	Proteins	Oils
27	6 hours 40 minutes	7 hours 35 minutes
29	6 hours 5 minutes	7 hours 20 minutes
32	4 hours 35 minutes	5 hours 15 minutes
34	5 hours 20 minutes	6 hours 45 minutes
36	3 hours 10 minutes	4 hours 50 minutes
38	9 hours 25 minutes	12 hours 50 minutes

Activity 2.5 Graphing

1 Which is the dependent variable and which is the independent variable?

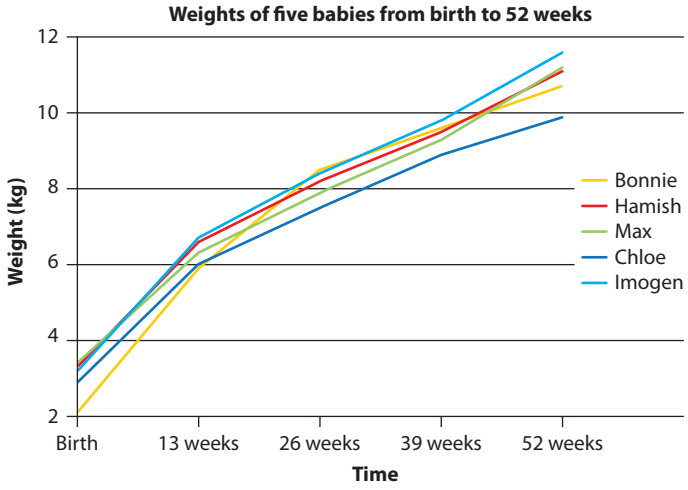
Answer:

Independent variable: Time

Dependent variable: Weights of babies (kg)

2 Plot the data as a graph in the most appropriate manner.

Answer: Students will most likely present the data as a clustered line graph, as shown below.



3 Identify the dependent and independent variables in these data.

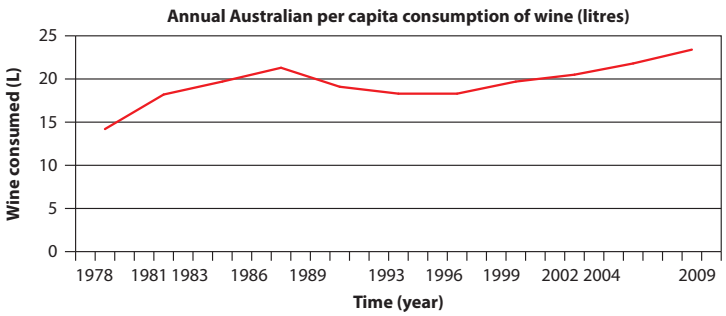
Answer:

Independent variable: Time – year

Dependent variable: Alcohol consumed – litres

4 Plot the data as a graph in the most appropriate manner.

Answer:



Review questions

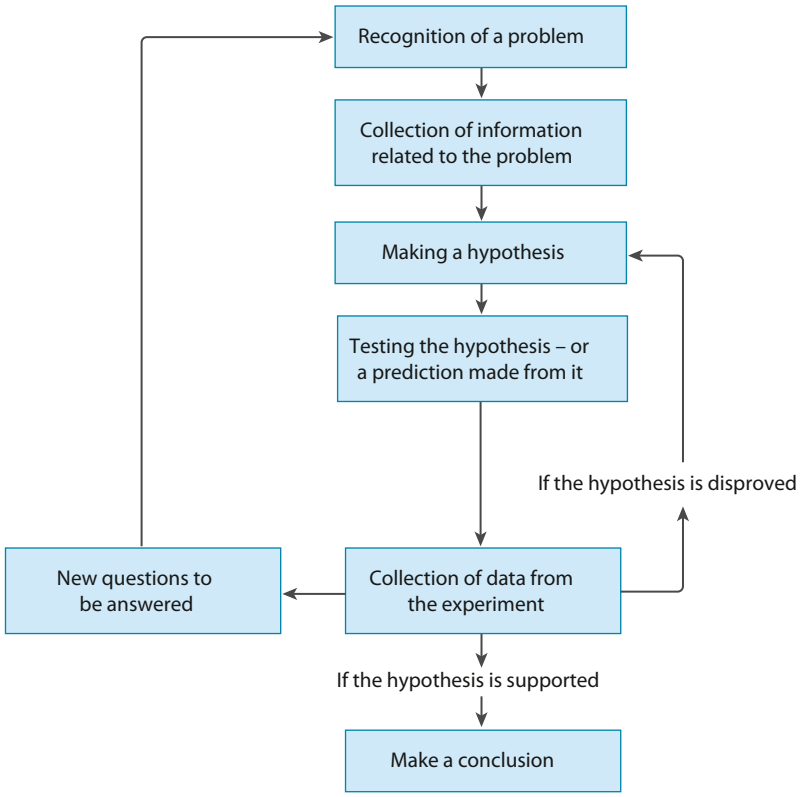
1 What is meant by a model in science?

Answer: A model is a simplified representation of an idea, usually a complex idea, which is often shown graphically or as a flow chart.

2 Describe a model for the scientific method that is followed by many scientists.

Answer: Once a scientist acknowledges a problem, information related to the problem is collected. From this information, a hypothesis is formed and a suitable experiment to test the hypothesis is devised. Data from the experiment is collected. The data will either appear to support or disprove the hypothesis.

On the basis of this, the experiment can be repeated to make sure the result is reliable. Further experiments may be devised and a conclusion can then be drawn. This may lead to new questions that need to be answered.



The scientific method

3 a What is a hypothesis?

Answer: A hypothesis is a tentative statement that is made to explain certain observations.

b What are the characteristics of a good hypothesis?

Answer: It is usually a positive statement, it can be tested, it is as short as possible and it links two variables.

4 Explain the difference between a hypothesis and a scientific theory.

Answer: A scientific theory is formed when a hypothesis has been tested many times and no evidence against the hypothesis has been found. The hypothesis is the beginning of the process of developing a scientific theory. When the hypothesis has so much supporting evidence that it is generally accepted, it becomes a theory.

5 a Explain the difference between the experimental group and the control group in an experiment.

Answer: An experimental group is the group that is being exposed to the experimental treatment. The control group is identical to the experimental group in every way but is not exposed to the experimental treatment.

b What is the purpose of the control group?

Answer: The control group gives a 'base line' reading. This group shows what is 'normal' and what happens in the experimental set-up without the effect of the experimental treatment. Thus its results are used as a comparison. Without the control group the investigator would not be able to say that the result was due to changes in the independent variable.

c What is a fair test?

Answer: A fair test is an experiment where only one variable is different between the control and experimental groups. At the end of the experiment any difference between the two groups must be the result of that one variable.

6 a Explain the difference between the independent and dependent variables in an experiment.

Answer: The independent variable is the variable the experimenter is testing and is deliberately manipulating to see its effect on the results.

The dependent variable is the measurement/observation that changes as a result of changes in the independent variable.

b What are controlled variables in an experiment?

Answer: These are the variables that are kept the same between the control group and the experimental group so as not to affect the results.

7 Why is repetition important in experiments?

Answer: Repetition is used to decrease the impact of errors and natural variation on the results. It also allows more evidence to be collected to give weight to the conclusion made.

Results are considered to be reliable if they are consistent over many trials.

8 a What are the two types of experimental error?

Answer:

Random errors: Unpredictable errors caused by lack of precision in measuring

Systematic errors: Caused by experimental design

b How can the effects of each type be minimised?

Answer:

Minimising random errors: Take several measurements and find the average.

Minimising systematic errors: Critically evaluate experimental design and change the design if necessary.

9 List some of the ethical principles that must be satisfied in any research project.

Answer:

- Voluntary participation
- Informed consent
- No risk of harm to subjects or investigators
- Confidentiality
- Anonymity

10 What is a placebo? Why are placebos used in research?

Answer: A placebo is an inactive substance that looks, feels, tastes and smells like the real medication. They are used in drug testing so that members of the control group think that they are receiving the drug.

Use of a placebo is a way of controlling variables so that both experimental group and control group are treated in the same way except for the drug that is being tested.

Apply your knowledge

1 Table 7.4 on page 93 shows the blood flow through body organs at rest and during exercise. Using the appropriate format, plot a graph showing blood flow through the various body parts at rest and during moderate exercise.

Answer: Plot a column graph to show the data in the table. Place a column for resting and for exercising alongside one another for each of the organs.

2 American Dr William Bean studied the growth of his fingernails for 35 years. He filed a horizontal line on his thumbnail just above the cuticle (the strip of skin at the base of the nail). By recording how long it took the mark to reach the tip of the thumbnail he was able to calculate the growth rate. He was eventually able to conclude:

> A 35-year observation of the growth of my nails indicates the slowing of growth with increasing age. The average daily growth of the left thumbnail, for instance, has varied from 0.123 mm a day during the first part of the study when I was 32 years of age to 0.095 mm a day at the age of 67.
>
> Source: Bean, W. 'Nail growth: thirty-five years of observation'. Quoted in *The Guardian*, 24 February 2004.

a Suggest a hypothesis that Dr Bean was testing.

Answer: Rate of nail growth changes as a person ages

b Which was the independent variable and which was the dependent variable in this investigation?

Answer:

Independent variable: Time

Dependent variable: Nail growth

c List some of the variables that should have been controlled in Dr Bean's study.

Answer:

- How often the finger nails were cut or broken
- Diet
- Use of hand creams
- Always measuring nail from the same place
- Measuring the thumbnail on same hand each time
- The time of day when the measurement was made

d Describe one source of random error in the investigation.

Answer: Many answers are acceptable. For example:

- Reading the instrument used for measuring
- When the measurement was taken
- Measuring from exactly the same place each time

e Measure the length of your thumbnail. Assume that your thumbnail grows at the same rate as that of the 32-year-old Dr Bean. How long did it take the tip of your thumbnail to grow from the cuticle to its present position?

Answer:

Calculation: Days (predicted for nail to have grown) = current length of thumbnail (mm) ÷ 0.123 mm

f Do you think your fingernails and toenails grow at the same rate? Propose a hypothesis and outline an investigation that you could do to test your hypothesis.

Answer: Students may answer yes or no – no correct answer.

Hypothesis: Toenails and fingernails grow at the same rate. Or, fingernails and toenails grow at different rates.

File a horizontal line on your thumbnail and toenail just above the cuticle (the strip of skin at the base of the nail). Record how long it takes the mark to reach the tip of the thumbnail/toenail and the distance from the cuticle to the tip. Compare the two growth rates. Repeat a number of times to make sure the results are reliable.

3 Suppose you wished to find out whether people could tell the difference between normal instant coffee and decaffeinated instant coffee.

a Propose a hypothesis and outline a blind experiment that you could do to test your hypothesis.

Answer: There are two possible hypotheses.

i People *are* able to tell the difference between normal instant coffee and decaffeinated instant coffee.

ii People *are not* able to tell the difference between normal instant coffee and decaffeinated instant coffee.

Experiment: Give a group of people unlabelled samples of normal coffee and decaffeinated coffee and ask them which is which.

b How could you make your experiment into a double blind experiment?

Answer: To make it into a double blind experiment, in addition to the subjects not knowing which sample was normal and which decaffeinated, the person handing them the samples would not know which was which either.

4 Some scientists were testing a new drug called *Presslo*. It was hoped that *Presslo* would reduce blood pressure in people whose blood pressure was too high. The scientists selected two groups of people, all of whom were quite healthy but had high blood pressure. All of the people were aged between 50 and 55 years. There were 100 people in each group and each group had equal numbers of males and females.

One group was given a *Presslo* tablet at 8 a.m. each day. The control group was given a sugar pill at 8 a.m. each day. The blood pressure of the people in both groups was measured and recorded at the same time each day.

a What was the independent variable in this experiment?

Answer: The type of tablet given to the subjects – *Presslo* or a sugar tablet

b What was the dependent variable in the experiment?

Answer: The blood pressure of the subjects

c List four variables that were controlled in the experiment.

Answer: Any four of the following.

- Age of the subjects – between 50 and 55 years
- All subjects had high blood pressure
- All subjects were otherwise healthy
- The tablet was given at the same time each day
- Blood pressure was measured and recorded at the same time each day
- Both groups included males and females (in equal numbers)

d List two variables that were not controlled in the experiment.

Answer: Any two of the following:

- Physical fitness of the subjects
- Body build or body mass index of the subjects
- Diet of the subjects
- Amount of exercise done by subjects during the experiment
- Daily activities of the subjects

e What was the purpose of the control group?

Answer: The control group was a necessary comparison. If the blood pressure of the subjects taking *Presslo* was lowered, one could not say that this was caused by the *Presslo* unless there was a control group not taking *Presslo* whose blood pressure did not change.

f Why did the scientists have so many people in each group?

Answer: A few subjects may have an atypical response to the drug. By using a large group of subjects, the scientists minimised the effect that the few subjects may have on the overall result of the experiment. This minimised the effect of chance variables that could not be controlled.

In essence, this means the more subjects, the more reliable the results of the experiment.