

Dear Colleague

We've made major changes to our Science Homework books for Years 9, 10 and 11 over the last 2 years, so we hope you'll take the opportunity to look at these sample pages, and perhaps use some of the exercises or experiments with your classes this year.

Each book, now called a *Workbook*, contains written theory activities and write-on practicals in the printed book, plus interactive computer activities on the CD and a password-protected Quiz file for teachers. The Quizzes parallel the computer activities, allowing you to set specific activities for homework and then test the material covered with a Quiz the next day. The student CD also contains password-protected Answers to the theory exercises, and Answers to the practicals, an electronic version of the printed workbook, a Technician's guide for the practicals, and the Workbook Map showing exactly how all the material fits together and including student learning objectives for all topics.

In addition to the resources listed above, the CD for the *New Directions in Science Workbook* (for Year 11 NCEA Science) also includes: the NCEA exam papers for Level 1 Science for 2005–2007 plus fully-worked answers to all questions and judgement statements; a printable booklet of Key Facts for Year 11 Science; electronic flash cards and audio files of the key facts suitable for uploading onto MP3 players, mini photo frames or cell phones; and a full-colour pdf file of the 326 page *New Directions in Science* text book.

This printed sample booklet shows you pages from the student books for *Science 9 Workbook*, *Science 10 Workbook* and the *New Directions in Science Workbook*. The accompanying CD contains the complete Maps for all three books, selected Revision activities and Quizzes, and the Answer files for all three books. These allow you to try out some of the theory activities in class and mark them according to the marking schedules in the book.

Topic division between *Science 9* and *Science 10* was made by surveying a number of schools from throughout New Zealand to see which topics were done in which year. There is general agreement about many topics, but disagreement on others. Selected portions of *Science 9* are included on the *Science 10* CD, and vice versa, to meet the needs of those schools whose topic division does not perfectly match the printed books.

### **Raising student achievement**

We believe that to succeed in NCEA Science, students need a thorough knowledge of the basic facts and vocabulary for each topic, and they need to be able to write quality sentences and paragraphs to demonstrate their understanding of each topic.

It is a perennial complaint of teachers that their students won't learn their work. Most students have no particular objection to learning; it's just that they don't know how to learn. The computer activities on the CD are specifically intended to solve this problem. The wide variety of activities maintains student interest, while the repetition within the tasks means that students learn the key facts easily. When combined with the in-class Quizzes, you should find that your students master the basics with little difficulty.

Writing answers that link ideas is a skill that takes time to develop. We need to give students in Year 9 and 10 the opportunity to answer questions with sentences and paragraphs so that by Year 11 they are capable of writing Merit and Excellence responses when required. About half the theory activities in *Science 9* and *Science 10* include Merit or Excellence style questions. Even the less able students should be encouraged to write something for these questions so that they learn that *E* questions can still win them an *A* or *M*. In NCEA Mathematics, students aiming for Achievement are taught to skip the *E* questions,

but in NCEA Science, students who do not attempt the more difficult questions cannot gain sufficient A grades to Achieve the standard.

The theory activities in *New Directions in Science Workbook* are similar in style to examination questions, however each activity focuses on a discrete section of work (often that covered in a single lesson), whereas exam questions usually include ideas taught over a month or two within the one question. Thus the theory activities are suitable for formative work within a topic, whereas the examination questions are better saved for revision once the topic has been completed.

Practical work is essential if students are to understand, and not just memorise, the principles taught. Each *Workbook* contains a set of core practicals, suitable for all classes. The write-on format means that at the end of each topic students have clear records of their work to study for the test.

Students and teachers do better when they have a clear understanding what it is they are meant to achieve. We have written Student Learning Objectives for each topic in the *Workbooks*, and we encourage teachers in charge of each year level to go through these objectives, making whatever changes are required to fit your school scheme, and then distribute them to both staff and students. The list of objectives also makes it simple for teachers to see exactly what is covered in each unit, so that you can decide whether each book will meet your needs.

If you like what you see in this package, we hope that you will order sample books from Pearson Education.

Anne, Terry, Wendy and Janet

# 1.09 Bouncing balls

Chantelle and Maggie wanted to know what kind of ball would bounce the highest. Maggie dropped the balls, and measured their bounce height, while Chantelle wrote down the results. The picture on the right shows Chantelle's notepad.

Dropping tennis ball	
Bounce height	
49 cm	42 cm 43 cm 58 cm
Table tennis ball	
62 cm	58 54 59
Plastic ball	
17 cm	23 20 22
Tennis ball again	
37 cm	45 cm
Plastic ball again	
20 cm	19 cm
Table tennis ball again	
53 cm	61 cm
All from 1 m	

- 1 What was the **independent variable** in the girls' experiment? **A**  
\_\_\_\_\_
- 2 What was the **dependent variable**? **A**  
\_\_\_\_\_
- 3 What factor did Chantelle record as being **controlled**? **A**  
\_\_\_\_\_
- 4 Write down two other factors that the girls would also have needed to control to make their experiment fair. **A**  
\_\_\_\_\_  
\_\_\_\_\_

- 5 Put the results from Chantelle's notepad into this table. **A**

Type of ball	Tennis ball	Table tennis ball	Plastic ball
<b>Bounce height</b>			
<b>Average bounce height</b>			

- 7 Write a conclusion for the experiment. **A**  
\_\_\_\_\_  
\_\_\_\_\_

- 8 What did the girls do to make sure their conclusion is correct? **A**  
\_\_\_\_\_  
\_\_\_\_\_



### 3.01 State the state

- 1 Decide whether the following household substances are solid, liquid or gas. **A**
- |                             |   |
|-----------------------------|---|
| a Milk _____                | g The fuel in a cigarette lighter _____ |
| b Toast _____               | h The bubbles in Coca Cola _____        |
| c Wool _____                | i Rice Bubbles _____                    |
| d Beer _____                | j Ice-cream _____                       |
| e The smell of a rose _____ | k Smoke _____                           |
| f Honey _____               | l Peanut butter _____                   |

Be prepared to justify your answers in class.

- 2 Jessica says that table sugar is a solid because it is crunchy. Amanda says it is a liquid because it pours. Who is correct? Why?



**M** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

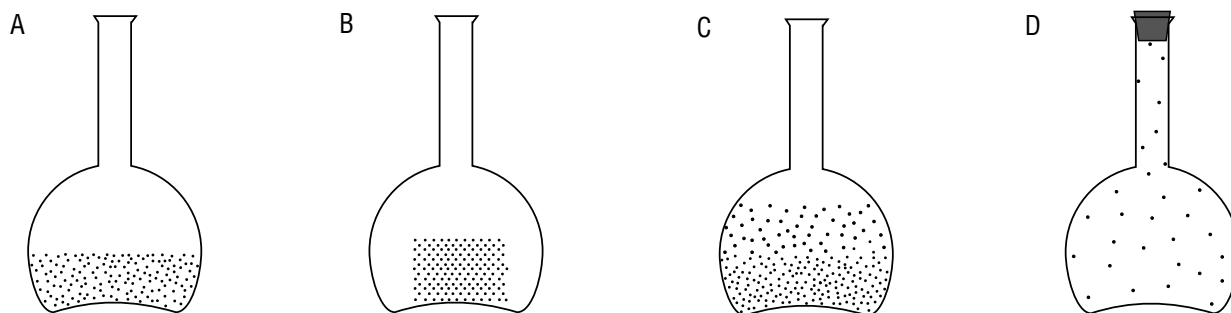
### 3.02 How do we know?

Match each statement about the particles in solids, liquids and gases with the experiment that shows the statement is true. The first one has been done for you. **M**

1	The particles in most liquids move closer together when that liquid changes into a solid.	b	Liquids and solids cannot be compressed easily.	a
2	Particles are much further apart in gases than they are in liquids.		Most liquids shrink when they set solid.	b
3	The particles in gases move very quickly.		Gases are easily compressed.	c
4	The particles in gases are far apart.		A drop of dye in a beaker of water spreads out until all the liquid is coloured.	d
5	Particles in liquids and solids are close together.		A plastic bottle filled with water vapour collapses when the vapour condenses into a liquid.	e
6	The particles in solids are in fixed positions.		A puff of perfume is soon smelt everywhere in the room.	f
7	Particles in liquids are in constant motion.		Solids keep their shape and appearance.	g

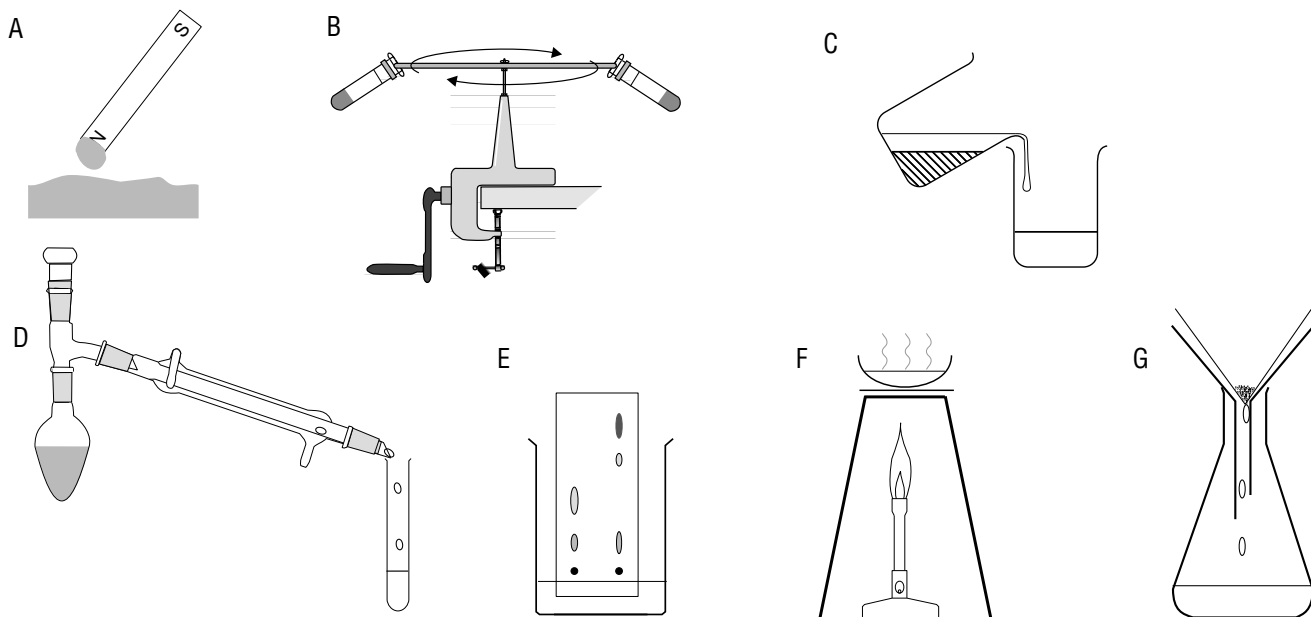


## 3.07 Four flasks



- 1 Write the letter of the flask above that contains: **A**
  - a a pure solid \_\_\_\_\_
  - b a pure liquid \_\_\_\_\_
  - c a pure gas \_\_\_\_\_
  - d two different liquids \_\_\_\_\_
  
- 2 For the diagram you chose in **a** above:
  - a state two characteristics of the particles in solids that are shown in this drawing. **A** \_\_\_\_\_  
 \_\_\_\_\_
  - b state one characteristic of the particles in solids that is **not** shown by this drawing. **A** \_\_\_\_\_  
 \_\_\_\_\_
  
- 3
  - a State two characteristics of the particles in gases shown by the diagram you chose for **1 c** above. **A** \_\_\_\_\_  
 \_\_\_\_\_
  - b State one characteristic of particles in gases that is **not** shown by this drawing. **A** \_\_\_\_\_  
 \_\_\_\_\_
  
- 4 For the diagram showing two different liquids:
  - a How do you know that they are liquids rather than gases or solids? **M** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
  - b What is different about the two liquids? How can you tell? **M** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## 4.06 Separation techniques



- 1 Write the letter of the separation technique above that: **A**
- shows a liquid condensing on a cold surface. \_\_\_\_\_
  - quickly moves heavy material to the bottom of a test tube \_\_\_\_\_
  - separates substances by the speed at which they move. \_\_\_\_\_
  - traps a solid in paper while allowing a liquid to pass through. \_\_\_\_\_
  - leaves crystals behind in the dish. \_\_\_\_\_
  - holds particles of iron on a magnet. \_\_\_\_\_
  - pours a low density substance off the top of a mixture. \_\_\_\_\_
- 2 Write the term from this list beside its definition. **Distillation   Evaporation   Filtration**  
**Decanting   Crystallisation   Chromatography   Centrifuging**
- \_\_\_\_\_ A low-density substance is poured off the top of a mixture.
  - \_\_\_\_\_ Liquid turns to gas below its boiling point.
  - \_\_\_\_\_ Liquid passes through something that traps particles of a solid.
  - \_\_\_\_\_ A liquid boils and then condenses on a cold surface.
  - \_\_\_\_\_ Tubes of a mixture are spun very fast and form layers.
  - \_\_\_\_\_ A mixture dissolved in a solvent separates as it moves through filter paper.
  - \_\_\_\_\_ Pure crystals form as a liquid evaporates from a solution. **A**

## 6.05 Photosynthesis

- 1 Write these words next to their definitions: **glucose** **chlorophyll** **iodine solution**  
**starch** **photosynthesis** **producers** **respiration** **methyated spirits** **A**
- a \_\_\_\_\_ Living things that make their own food.
- b \_\_\_\_\_ The process of building up food molecules using light energy.
- c \_\_\_\_\_ Brown liquid used to detect starch.
- d \_\_\_\_\_ Green substance found in leaves.
- e \_\_\_\_\_ Small food molecule.
- f \_\_\_\_\_ Flammable liquid used to remove chlorophyll from leaves.
- g \_\_\_\_\_ The process of releasing energy from food molecules.
- h \_\_\_\_\_ Large food molecule made by joining many glucose molecules.
- 2 Write the colour of: **A**
- a the chemical used to test for starch. \_\_\_\_\_
- b a leaf after the chlorophyll has been removed. \_\_\_\_\_
- c starch after iodine has been added. \_\_\_\_\_
- d a leaf containing lots of chlorophyll. \_\_\_\_\_
- 3 After Hamish's class had been testing leaves for starch, his teacher put up some statements to complete about the experiment. Hamish wrote the end to each statement, but now needs your help to complete writing in the teacher's part. **M**
- a We need to remove \_\_\_\_\_  
so that we can see the colour change once iodine is added.
- b First we \_\_\_\_\_  
to soften it and break open the cell walls.
- c We had to make sure that \_\_\_\_\_  
because meths is flammable.
- d We saw \_\_\_\_\_  
because meths has a lower boiling point than water.
- e We add \_\_\_\_\_  
because it changes colour when starch is present.
- f If the leaf turns \_\_\_\_\_ it shows that \_\_\_\_\_  
which means that photosynthesis has occurred.
- g If there is \_\_\_\_\_ because \_\_\_\_\_  
then the leaf will turn brown.

## 7.08 Differences

- 1 Circle the term that does not belong in each of these groups, then give a reason for your answer. **M**
- a fertilisation germination pollination transpiration \_\_\_\_\_  
 \_\_\_\_\_
- b apple lettuce orange tomato \_\_\_\_\_  
 \_\_\_\_\_
- c cotyledon ovule plumule testa \_\_\_\_\_  
 \_\_\_\_\_
- d filament ovary stigma style \_\_\_\_\_  
 \_\_\_\_\_
- e bright colours feathery stigma nectar scent \_\_\_\_\_  
 \_\_\_\_\_
- 2 The pairs of words below can be confused. For each pair state what they have in common, and how they are different. **E**
- a **pollination** and **dispersal** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- b **filament** and **style** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- c **sepal** and **testa** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- d **self-pollination** and **cross-pollination** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- e **transpiration** and **osmosis** \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## 9.10 Living together; working apart

When different species of animals live in the same place, each one needs to find its own, unique way of living and feeding in order to survive. Biologists say that each one has its own niche.

Stilts, dotterels, godwits and oyster-catchers are all wading birds common in estuaries and mudflats throughout New Zealand. In one estuary the following observations were made.

- Stilts and dotterels use their large eyes to see and capture their prey. Each bird hunts on its own, so as not to disturb its prey which live in the water or on the surface of the mud.
- Stilts have very long legs and beaks and feed by plunging their beaks through water to catch crabs, shrimps and aquatic insects.
- Dotterels have short legs and beaks and feed in very shallow water or mud, eating insect larvae, flies and worms.
- Godwits and oyster-catchers have short legs but long beaks which they use to dig deep into the mud to pull out animals hiding several centimetres under the surface. They feel their prey with special sense organs on the tip of their beaks, rather than seeing them. Both these species are able to feed at night and in large groups.
- Oyster-catchers eat mostly shellfish which they prise open or pierce with strong beaks.
- Godwits eat mostly worms and crabs.

1 Complete this table using the information above. **M**

	Beak length	Sense used to find prey	Location of prey	Preferred prey
Stilt				
Dotterel				
Oyster-catcher				
Godwit				

2 List two **physical adaptations** of a stilt that help it to find its prey. **M** \_\_\_\_\_

\_\_\_\_\_

3 List two **behavioural adaptations** of a godwit. **M** \_\_\_\_\_

\_\_\_\_\_

4 Suggest why stilts need to spread out to find their food, whereas oyster-catchers are able to feed in large groups. **E**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



# 10.07 Generating electricity

1 Rearrange these cards to make a sentence explaining how a generator works. **A**

between   there is   whenever   is generated   relative movement   a magnet   Electricity   and a wire.

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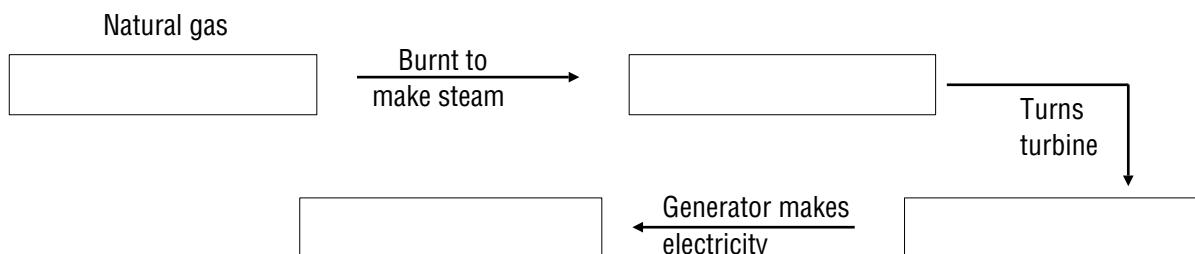


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2 The term ‘relative movement’ in the sentence above means:

either the \_\_\_\_\_ moves and the \_\_\_\_\_ stays still, or the \_\_\_\_\_ moves and the \_\_\_\_\_ stays still. **A**

3 Complete this passage to show the energy type at each state of electricity generation at a thermal power station. **A**



4 Draw a diagram similar to that in 3 above to show the energy changes that take place in a hydroelectric power station. **A**

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5 Which type(s) of power stations do these statements apply to — wind (W), thermal (T) geothermal (G) or hydroelectric (H)? **M**

- a Construction can often be very expensive and take many years. \_\_\_\_\_
- b The amount of electricity that can be produced each year depends on the weather. \_\_\_\_\_
- c These may sit, unused, for many months (possibly years) without being used. \_\_\_\_\_
- d These end up with warm water that must be cooled down before discharge. \_\_\_\_\_
- e These are often build in a line so that they can use the same water. \_\_\_\_\_
- f Over half New Zealand’s electricity is generated with this type of power station. \_\_\_\_\_
- g This kind is only possible in a few special places in the world. \_\_\_\_\_
- h These can be more energy efficient when the waste heat is used by a nearby factory. \_\_\_\_\_

# 11.08 Using mirrors

1 Rearrange these phrases to make five sentences about mirrors. **M**

<b>a</b> A convex mirror can be used	can project a real image	because the image is the same size as the object.
<b>b</b> A plane mirror is used	by dentists	because it gives a wide angle view.
<b>c</b> A concave mirror is used	as security mirror in a shop	because it makes it harder to judge distance.
<b>d</b> A concave mirror	can be misleading in a car	when held far away from the object.
<b>e</b> A convex mirror	when trying on clothes	because it gives an enlarged view when close to the object.

**a** A convex mirror can be used \_\_\_\_\_

\_\_\_\_\_

**b** A plane mirror is used \_\_\_\_\_

\_\_\_\_\_

**c** A concave mirror is used \_\_\_\_\_

\_\_\_\_\_

**d** A concave mirror \_\_\_\_\_

\_\_\_\_\_

**e** A convex mirror \_\_\_\_\_

\_\_\_\_\_

2 Study the images in the mirrors pictured below. Describe each image, and then state the shape of the mirror that formed it. **M**



**a** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Mirror is \_\_\_\_\_



**b** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Mirror is \_\_\_\_\_



**c** \_\_\_\_\_

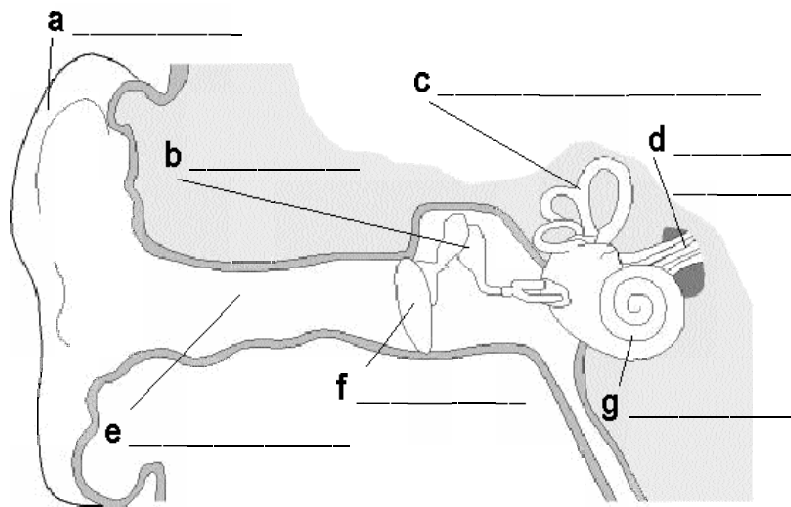
\_\_\_\_\_

\_\_\_\_\_

Mirror is \_\_\_\_\_



# 11.18 Hearing



**Hearing sound**  
 We hear sounds when vibrating air particles are collected by the **pinna** (the external part of the ear), and travel down the **ear canal** to hit the **ear drum**, causing it to vibrate. Tiny **ear bones** (also called ossicles) amplify each vibration and pass them on to a spiral-shaped organ called the **cochlea**. Inside the cochlea are thousands of hair cells, each one responding to a different frequency of sound. When triggered, these cells send an electrical signal, via the **auditory nerve**, to the brain.  
 Also part of the ear are three, fluid-filled **semicircular canals**, each one at right angles to the others. They are not involved with hearing, but instead make up our system of balance.

1 Use the information in the box to label the diagram of the ear. **A**

2 Write the part of the ear that matches the description. **A**

- a \_\_\_\_\_ contains hair cells that respond to sound.
- b \_\_\_\_\_ involved with balance, not hearing.
- c \_\_\_\_\_ amplify and transmit sound vibrations.
- d \_\_\_\_\_ transmit electrical signals to the brain.
- e \_\_\_\_\_ collects and funnels sound.
- f \_\_\_\_\_ vibrates when air particles strike it.

3 The **eustachian tube** connects the space behind the ear drum to the back of the throat, thus allowing the air on both sides of the ear drum to be at the same pressure.

a Find the eustachian tube on the diagram of the ear above, and label it. **A**

It is common for small children to get ear infections in which the eustachian tube fills up with fluid.

b Why is it hard to hear with an ear infection of this nature? **M**

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c What happens when small children are unable to hear properly because of frequent ear infections?

**A** \_\_\_\_\_

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## 12.09 A matter of air pressure

	Mercury	Venus	Earth	Mars	Earth's Moon
<b>Pressure</b>	None	90 atmospheres	1 atmosphere	0.01 atmospheres	None
<b>Sky</b>	Black. Stars visible both day and night.	Thick clouds all day and all night.	Blue with clouds and stars at night.	Pink, some clouds, stars at night.	Black. Stars visible both day and night.
<b>Temperature change</b>	Over 500 °C difference between day and night.	About 5 °C difference between day and night.	Possible 25 °C difference between day and night.	About 120 °C difference between day and night.	About 250 °C difference between day and night.
<b>Craters</b>	Very many, both ancient and young.	None ancient, a few young craters.	None ancient, a few young craters.	None ancient, a few young craters.	Very many, both ancient and young.
<b>Meteorites</b>	Surface hit by small, medium and large objects.	Surface only hit by the largest objects.	Surface hit by medium and large objects.	Surface hit by medium and large objects.	Surface hit by small, medium and large objects.

Use the information in the table above to answer these questions.

- 1 What do you know about a planet's or moon's atmosphere if stars can be seen during daytime? **A**  
\_\_\_\_\_
- 2 What does the presence of clouds over the surface of a planet tell you? **A**  
\_\_\_\_\_
- 3 What is the relationship between the day-time and night-time temperature difference and the atmospheric pressure? **M**  
\_\_\_\_\_
- 4 Astronomers believe that all the bodies in our solar system have collided with the about same number and range of meteoroids or asteroids, and that if there are few craters visible today, things must have happened to remove them or stop them from forming.
  - a What is the relationship between the size of rock that hits a planet or moon and the atmospheric pressure on that planet or moon? **M**  
\_\_\_\_\_
  - b Suggest a reason for the relationship you found in a. **M**  
\_\_\_\_\_  
\_\_\_\_\_
  - c What is the relationship between the **age** of craters on a planet's surface and its atmosphere? **A**  
\_\_\_\_\_
  - d Explain how ancient craters could disappear on those planets where they are no longer visible. **E**  
\_\_\_\_\_  
\_\_\_\_\_



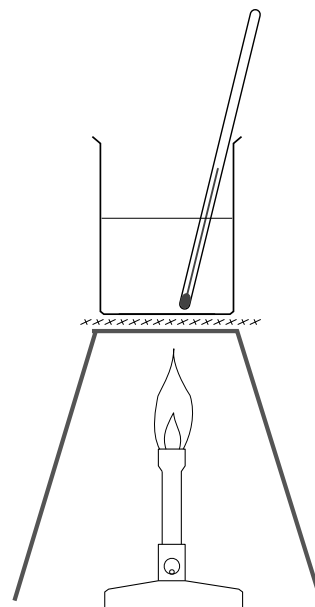
## 1E 1 Flame colour

### Aim

To find out which colour Bunsen flame will heat water faster – yellow or blue.

### Method

- 1 Use a **measuring cylinder** to measure 50 mL of cold water into a clean, dry 100 mL beaker.
- 2 Place the beaker on a tripod and gauze.
- 3 Use a thermometer to measure the temperature of the water. (Keep the thermometer in the beaker.) Record the temperature on the table below.
- 4 Light a Bunsen burner and open the air-hole to produce a blue flame. Place the burner under the beaker and heat for 2 minutes.
- 5 Hold the thermometer so that the bulb is above the bottom of the beaker but still in the water. Record the temperature of the water after 2 minutes of heating.
- 6 Turn off the Bunsen and allow the equipment to cool. Empty the water out of the beaker and dry the beaker.
- 7 Repeat the experiment with the air-hole of the Bunsen burner closed so that there is a yellow flame.



### Results

Temperature readings	Blue flame	Yellow flame
Starting temperature		
Temperature after 2 minutes heating		
Temperature change		

### Conclusion

- 8 The \_\_\_\_\_ flame was hotter because the temperature rise was \_\_\_\_\_.

### Thinking about it

- 9 Underline the parts of the method that were kept the same for both flames.
- 10 Would the experiment have been fair if a different Bunsen burner was used for the second part of the experiment? Explain your answer.

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## 3B Density

### 3B 1 Determining density

The density of an object is calculated by dividing its mass by its volume.

- Your teacher will give you an object small enough to fit inside a measuring cylinder.

Weigh the object accurately with a laboratory balance. Mass of object = \_\_\_\_\_ g.

- Half-fill the measuring cylinder with water and measure the volume of the water accurately.

Volume of water used = \_\_\_\_\_ mL

- Gently place the object into the measuring cylinder (still containing the water). Do not drop it in, or the measuring cylinder may break. Measure the total volume of the water plus object.

Volume of the water + object = \_\_\_\_\_ mL

- Calculate the volume of the object by subtracting your volume for **2** from your volume for **3**.

Volume of object = \_\_\_\_\_ mL

- Calculate the density of the object:

$$\begin{aligned} \text{Density} &= \frac{\text{mass}}{\text{volume}} \\ &= \text{_____} \\ &= \end{aligned}$$

#### Thinking about it

- Which has the greater density: a substance whose particles are far apart, or the same substance when its particles are closer together? \_\_\_\_\_
- What will happen if you drop an object of low density into a liquid of greater density? \_\_\_\_\_

### 3B 2 Using density to identify plastics

The densities of some common plastics are shown on the table on the right.

Number	Code	Name of plastic	Density
1	PET	Polyethylene terephthalate	1.29–1.4
2	HDPE	High density polyethylene	0.95–0.97
5	PP	Polypropylene	0.90–0.91

- Water has a density of 1.00. Which of the plastics on the table will float in water?  
\_\_\_\_\_

- Your teacher will give you a 50:50 mixture of meths and water, which has a density of 0.92. Which of the plastics on the table will float in this mixture? \_\_\_\_\_

## 6C 3 Photosynthesis 3: Oxygen

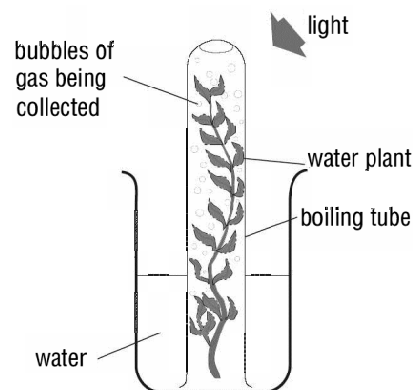
Use a water plant for this experiment.

- 1 Set up the apparatus as shown.
- 2 Leave the beaker in a sunny place for a day or so and observe from time to time and record your observations.

Observations \_\_\_\_\_

- 3 Test the gas collected with a glowing splint.

The gas collected \_\_\_\_\_ a glowing splint, indicating that the gas is \_\_\_\_\_.



### Thinking about it

- 4 What two things do plants make during photosynthesis? \_\_\_\_\_
- 5 What is the purpose (job) of photosynthesis? \_\_\_\_\_
- 6 Oxygen is a very reactive gas that combines with most other elements. Why is there so much oxygen in our air?  
\_\_\_\_\_

## 6D Plants and water

### 6D 1 Osmosis

Osmosis is the movement of water through a semi-permeable membrane from a place of high water concentration to a place of low water concentration. When there is salt or sugar in the water then the water concentration is lower than pure water.

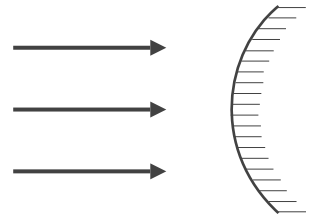
This experiment could be done as a homework exercise.

- 1 Make 3 potato chips (apples or carrots could be used if you do not have potatoes) each about  $0.5\text{ cm} \times 0.5\text{ cm} \times 3\text{ cm}$ .
- 2 Leave the first chip in the air. Put the second chip in 100 mL (half a cup) of tap water. Put the third chip in 100 mL of water containing 1 teaspoon of salt.
- 3 Leave the chips for 15 minutes and then take them out of the liquid and compare the two chips in liquids to the control chip left in the air. Use words such as soft, hard, bendy, rigid, more or less.

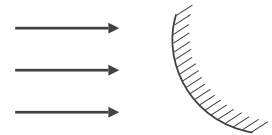
Compared to the chip left in the air, the chip in fresh water was \_\_\_\_\_

Compared to the chip left in the air, the chip in salty water was \_\_\_\_\_

- 5 Place a convex mirror straight in front of the light rays and observe the change in direction of the paths. Complete the diagram on the right to show the ray paths entering and leaving the mirror.



- 6 Tilt the convex mirror so that it is at an angle to the ray paths. Complete the diagram on the right to show the ray paths entering and leaving the mirror.



- 7 A convex mirror is a \_\_\_\_\_ mirror.

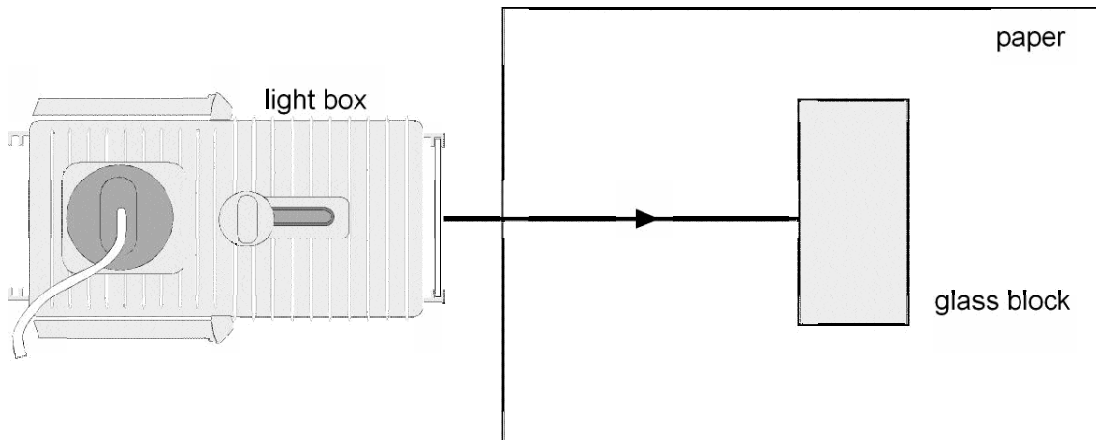
**Thinking about it**

- 8 Each light \_\_\_\_\_ that hits the mirror obeys the law of \_\_\_\_\_ that the angle of incidence \_\_\_\_\_ the angle of reflection. However, because the mirror \_\_\_\_\_, each of the light rays hit the mirror at a \_\_\_\_\_ angle and so is reflected at a different \_\_\_\_\_. This results in the light rays being \_\_\_\_\_ or \_\_\_\_\_.

## 11C Refraction

### 11C 1 Light through a glass block

- 1 Set up a light ray box and a glass block on a white sheet of paper as shown in below. Use a single, narrow slit.



## 12A Exploring the planets

### 12A 1 A model solar system

- Your teacher will provide you with a wide range of spherical objects ranging in diameter from 25 cm down to 0.5 cm.
- Use a pair of dividers to measure the diameter of each object.

Object	Diameter	Object	Diameter

Object	Diameter (km)	Relative diameter
Mercury	4 880	0.9
Venus	12 100	2.1
Earth	12 756	2.2
Mars	6 787	1.2
Jupiter	142 984	25.0
Saturn	120 660	21.0
Uranus	51 120	8.9
Neptune	49 530	8.7
Pluto	2 300	0.4
Moon	3 476	0.6
Io	3 630	0.6
Callisto	4 840	0.8
Europa	3 130	0.5
Ganymede	5 280	0.9
Titan	5 140	0.9
Triton	2 700	0.5

- Using a 25 cm basketball to represent Jupiter, choose the most appropriate object to represent each of the planets or moons on the table.

Real object	Represented by	Real object	Represented by	Real object	Represented by
Mercury		Uranus		Europa	
Venus		Neptune		Ganymede	
Earth		Pluto		Titan	
Mars		Moon		Triton	
Jupiter		Io			
Saturn		Callisto			

- Join sheets of paper together to make a 4 m long strip. Measure out the distances in the table below, place your 'planets' in the appropriate positions with their 'moons' beside them, and label each one.

Planet	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Distance	3.9 cm	7.2 cm	10 cm	15.2 cm	52 cm	95 cm	192 cm	300 cm	394 cm