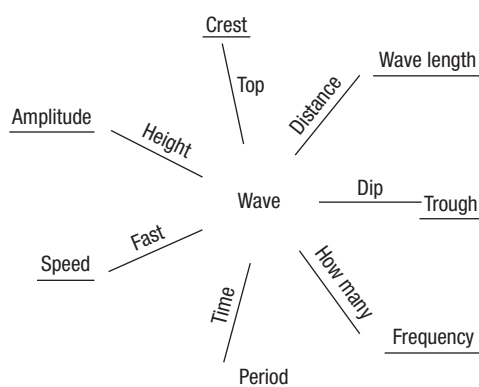


**ANSWERS**

## Unit 9 Communicating with energy

### Activity 9.2 Spider map

A suggested answer:



### Activity 9.6 Sound waves

- 1 The tapping is louder through the benchtop than through the air.
- 2 The tapping energy is transferred better by the solid because a solid has closely packed particles that transfer energy quickly and easily.
- 3/4 A gas has particles that are widely spaced so energy is not as easily or quickly transferred. A solid or liquid has more closely packed particles where energy is easily and quickly transferred.

## What have you learnt? 9.1

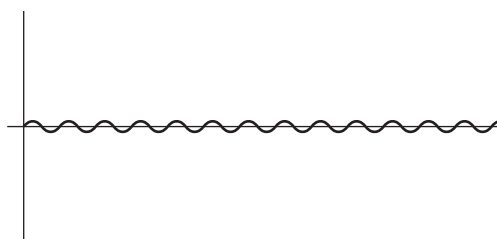
### Understand

- 1 A wave is a disturbance that transfers energy through a material.
- 2 Amplitude; crest; frequency; period; speed; trough; wavelength
- 3 EMR is a form of energy that shows wave-like behaviour as it travels through space.
- 4 Radio; TV; microwave; red light; green light; blue light; UV radiation; X-ray
- 5 EMR shows a continuous spectrum from low frequency /low energy through to high frequency/high energy

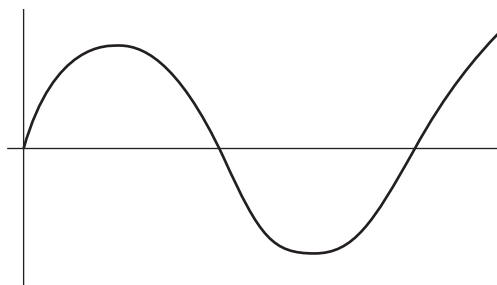
- 6 As energy increases, wavelength decreases. The highest energy has the shortest wavelength.
- 7 300 000 000 metres per second (or  $3.0 \times 10^8$  m/s)
- 8 Student responses could include microwave oven, mobile phone, digital TV, remote controllers, electric lights, or sunglasses.

## Apply

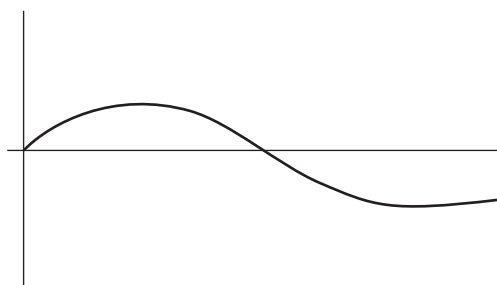
9 a



b



c



- 10 a Sound takes longer to arrive because it travels more slowly than light.
- b The flash of light arrives almost immediately. Sound travels at a speed of one kilometre every 3 seconds (distance (d) = speed  $\times$  time)
- $$d = 340 \text{ m/s} \times 7 \text{ s}$$
- $$d = 2380 \text{ m}$$
- $$d = 2.4 \text{ km away}$$
- c The speed of light 'c' is one million times faster than the speed of sound.

## Analyse

11 Student responses will vary.

## Synthesise

12 Student responses will vary.

13 Student responses will vary.

# What have you learnt? 9.2

## Understand

- 1 Radiation is a form of EMR and does not require a medium to be transferred. Convection requires a fluid (gas or liquid) for heat energy to be transferred. Conduction requires particles to transfer heat energy. Solids conduct heat energy very well.
- 2 A lid is placed on a saucepan to prevent evaporation and loss of heat. The metal lid will conduct heat energy and radiate energy above the contents of the saucepan.
- 3 Student responses could include the following.
  - a Why do you feel a cool breeze at your back if you are standing facing an open fire?
  - b Why would you use an oven mitt to take a metal tray from a hot oven?
  - c Why would you apply sunscreen on a cloudy summer day?

## Apply

- 4 Convection shapes the flame when gravity causes cool air to replace the rising warm air.
- 5 ISS is in weightlessness, so both the air and the candle are falling. Hot air cannot rise. Radiation heats the air.

## Analyse

- 6 Both transfer heat energy. Conduction: good in solids; the material doesn't move; heat energy travels along a solid. Convection: hot air rises; the material moves; good heat transfer in liquids and gases.
- 7 Student responses will vary.

## Synthesise

- 8 Student responses will vary.
- 9
  - a Radiation from the Sun can heat a satellite to several hundred degrees. The shaded side can be  $-100^{\circ}\text{C}$ . As the satellite moves from shade to Sun, the satellite expands and contracts. Satellites are usually spinning to reduce the heating and cooling problems. Gold foil conducts the heat energy quickly to even out the hot and cold spots.
- 10 Student responses will vary.

## Activity 9.12 Communication systems

Semaphore	This was a flag system of communication often used between ships. The French system used in 1792 could send a message over 140 km in two minutes with a series
Pony Express	This was a mail delivery system used in the US in 1860. It used a series of riders and horses to transfer a mail pouch. Each station was 16 km apart. Each rider travelled about 120 km per day. The system existed for only 18 months.
Cobb and Co.	Established in Melbourne in 1853. It was a stage coach transport system that delivered passengers, luggage and mail across Australia and New Zealand.
Telegram	A message was sent by an electric telegraph. Commenced about 1832 in the US and continued in Australia until 2011. Other countries still use telegrams. A continuous electric connection was required.
Morse code	Invented in 1836. Consisted of a series of on/off signals. It is still used in radio, widely known and used in emergency situations (for example, SOS).

## What have you learnt? 9.3

### Understand

- 1 Communication is to convey a message from a sender to a recipient who is able to understand the message.
- 2 Student responses could include talking, writing, singing, music, dance and painting.
- 3 Encode; transfer; decode

### Apply

- 4 Energy is required to transfer the message; for instance, a telephone uses electrical energy and yelling uses sound energy in the air.
- 5 Student responses could include 'More troops now!'

### Synthesise

- 6 Student responses will vary.
- 7 Student responses will vary.

## Activity 9.13 Modern communication technologies

- Fastest to slowest assumes a certain distance. The fastest technology to the teacher in the next room could be a Post-it note. The teacher is unlikely to answer a mobile phone or use Facebook in class.  
If the receiver were connected and at a distance, one possible order might be:
  - Twitter (depending on network overload)
  - mobile phone (depending on network overload)
  - satellite phone
  - email (depending on network overload)
  - SMS (depending on network overload)
  - fax
  - Post-it note.
- Most technologies require a send and receive unit. Several technologies allow viewing on a variety of services. Twitter, Facebook, SMS, and email can all be sent and received by a smartphone or Internet-connected computer, netbook or iPad.
- Assumptions made with several technologies are how quickly the message is transferred. Network congestion can delay SMS and email by many hours.
- A problems encountered could include the message being lost or corrupted through computer error. Many errors occur when a connection is broken during transmission, if wi-fi is out of range, or the battery becomes flat. Other errors are failure to send the message or a message sent to the wrong address.

	The next room	The next suburb	The next city	The next state	Another country
Telephone (fixed line)	No	Yes	Yes	Yes	No – expensive
Twitter	Yes	Yes	Yes	Yes	Yes
Facebook	Yes	Yes	Yes	Yes	Yes
Mobile phone	Yes	Yes	Yes	Yes	No – expensive
Fax	No	Yes	Yes	Yes	Yes
Email	Yes	Yes	Yes	Yes	Yes
SMS	Yes	Yes	Yes	Yes	Yes
Satellite phone	No	No	Yes	Yes	Yes
Post-it note	Yes	No	No	No	No

## Activity 9.14 Whispers

### Discussion

- The two messages are unlikely to be the same.
- Words can be misheard or misunderstood.

- 3 Each person passed on what they thought they had heard, but a small error may have been introduced at each step.
- 4 Analogue signals become distorted each time they are sent and received. Each person in this activity was a receiver and sender.

## Activity sheet – From old to new

This activity can be as simple as an image search and placing images onto PowerPoint (or Prezi) to fade slides. An additional research task would be to compile a table of functions for each generation of phone. Morph software allows one shape to be merged into the next shape.

## Activity 9.19 NBN coverage

- 2 As the NBN rolls out, features are still being developed. Communities are chosen as case studies, such as rural, city, urban. Locations included suburbs with failing infrastructure in need of urgent replacement, such as the older suburbs of Melbourne and Sydney, where the copper exchange was replaced with digital optic fibre.

## What have you learnt? 9.4

### Understand

- 1 Optic fibre travels further and faster with a cleaner signal than copper wire.
- 2 Digital signals are precisely a '1' or a '0'. Analogue signals can take a range of values – 0, 0.1, 0.3, 0.4, 0.7, 0.9, 1.0 – which translate to 'fuzzy' pictures or static sounds.
- 3 A cellular network is a series of towers that send and receive radio (wireless) signals from mobile phones. The towers are connected to the NBN by optic fibres. Each tower forms a 'cell', which is surrounded by other cells. Together they combine to provide continuous coverage for mobile devices so the signal is not lost.
- 4 Some suggested answers could include:
  - current infrastructure works well (enough)
  - cost of new equipment
  - lack of technicians to install and operate new network
  - geography may be difficult to install an effective low-cost network.

### Apply

- 5 Student responses will vary.

### Evaluate

6 Student responses could include digital telephone that gives coverage for a low cost over large areas.

## Synthesise

7 Student responses will vary.

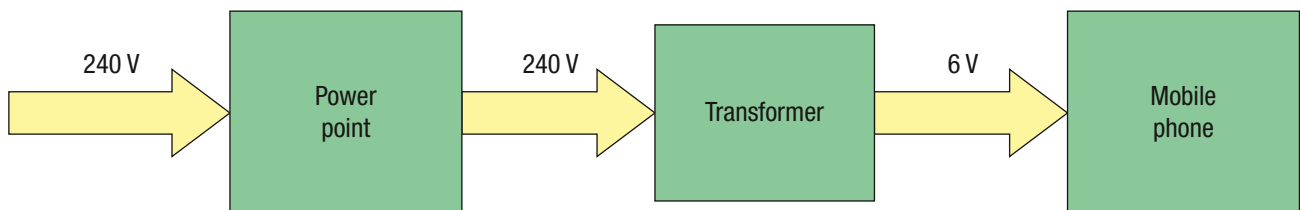
## What have you learnt? 9.5

### Understand

- 1 As the electrons travel around the circuit they 'give away' (transfer) their energy until they return to the battery with zero potential. A rock begins at the top of the hill with large potential energy and loses energy as it goes lower and lower. When the rock reaches the lowest point there is no more energy to be gained, until the rock is lifted to another place to begin falling again.
- 2
  - a Student responses could include: How is the energy of a battery measured?
  - b Student responses could include: What is changed to make a light bulb bright or a resistor get hot?
  - c Student responses could include: What is the ratio of voltage to current called?
- 3 Extra energy is added into an electronic circuit by adding a battery.
- 4 Energy is lost from a circuit by a circuit element converting electricity into light, heat, sound or motion.

### Apply

5



6 Parallel: side by side; add current; same voltage

Series: in line; same current; add voltage

Both: use globes, resistors, wires

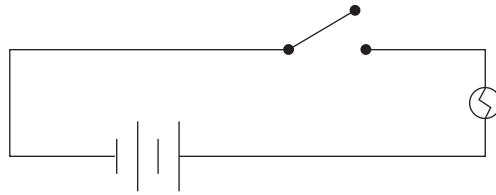
## Synthesise

7 Student responses could include:

	P	M	I
Solar	Slow No cost	Needs sunshine	Fragile
Power point	Fast Low cost		Might forget to take out
Car	Fast Low cost	Needs sunshine	Might be stolen

8 Student responses will vary.

9



10 Student responses will vary.

## Evaluate

11 Student responses will vary.

## Activity 9.20 Finding your blind spot

### Results

- 1 The blind spot is an area on the retina where there are no receptor cells. The circle on the card falls directly on this area and so cannot be detected.
- 2 We do not see a hole in everything since usually images fall over a greater area that includes our blind spot. Our brain fills in the area where there are no receptor cells so we see a complete image.

## Activity 9.21 Stereoscopic vision

- 4 Students will see that the image moves depending on which eye they are looking out of. This is because the image we see with the right eye is different from the image we see with the left eye because of the distance between our eyes (about 3 cm). When we look at something with two eyes, our brain usually puts both images together so we only see one image.

## Activity sheet – What is the use of 3D?

This activity needs space, so could be carried out outside. Each group of three will need a tennis or stress ball.

- 4 Students should find that their catching ability improved over time as the brain made adjustments for using one eye only.
- 5 Condition 1 was included as a control – to show how effective it is to judge distance using both eyes.
- 6 Stereoscopic vision would give animals survival advantages so they could judge distances to trees and cliffs, and also judge how far predators or prey were from them.
- 7 Suggested answers include drive a car (although people with one eye are still able to obtain a conditional car licence in all Australian states); play tennis, basketball, or cricket.

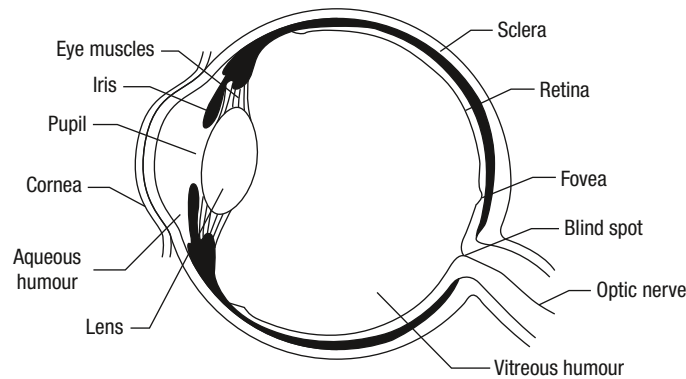


# What have you learnt? 9.6

## Understand

- 1 Our eyes receive light rays, which have bounced off objects in the environment. Different wavelengths are either absorbed or reflected by objects and so we see objects as coloured.

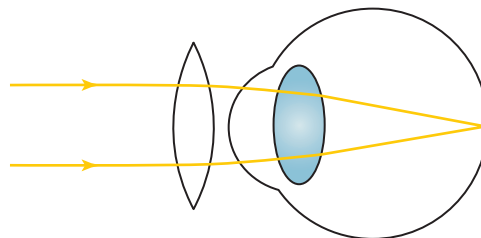
2



- 3 Light rays need to be refracted in order for us to see clearly because the light rays need to be focused on the fovea on the retina where receptor cells are tightly packed.
- 4 Light energy is transformed into electrical energy at the receptor cells in the retina. This electrical energy is transferred along the optic nerve to the brain.
- 5 We can trick our eyes with visual illusions because our brains have evolved to interpret external information in a particular way. If we feed the brain information that does not conform to what it is evolved to interpret then it has trouble in interpreting it.

## Apply

6



- 7 Compare: both transfer electrical energy; both require an input of energy. Contrast: the human eye is made of cells whereas an electrical circuit is not.

## Synthesise

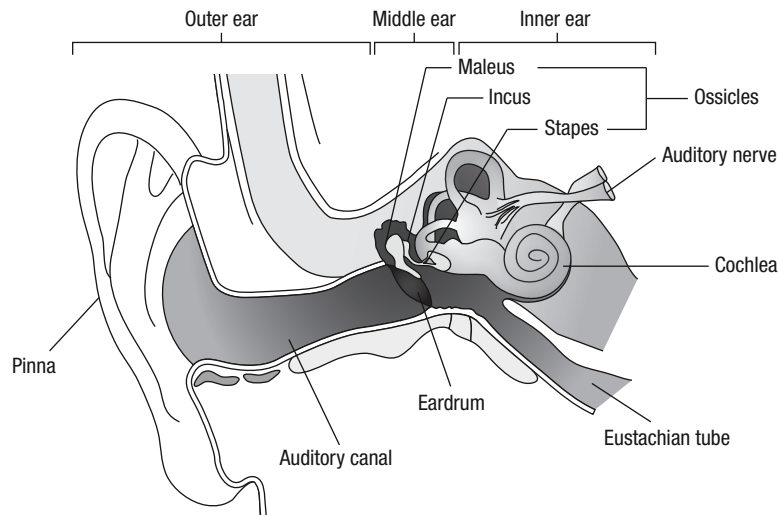
- 8 Student responses will vary.

# What have you learnt? 9.7

## Understand

1 The sound source vibrates, causing compression waves in the air. These waves move to our ears.

2



3 Exposure to loud continuous noise.

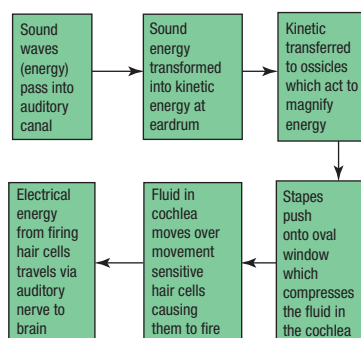
## Apply

4 If the malleus no longer functions, energy cannot be passed through to the cochlear. This would render you deaf in that ear.

5 Compare: both transform energy into electrical energy for interpretation by the brain, and both allow us to detect our outside environment (they are senses). Contrast: eye is sensitive to light energy whereas the ear is sensitive to sound energy. The ear can magnify the vibrations (through the ossicles) whereas the eye cannot magnify light rays. The ear converts sound energy to kinetic energy; there is no kinetic energy in the eye.

## Synthesise

6



7 Student responses will vary.

## Student research: Workplace regulations

- 1 Students may suggest mining, agriculture, construction, manufacturing, transportation, military, music industry, including orchestras.
- 2 Noise becomes a problem if it exceeds (on average) 85 dB.
- 3 An eight hour period
- 4 Workers need to use hearing protection (ear plugs or ear muffs) to protect their ears.

## 9.22 Hearing loss in teens

This is an important activity as a major problem in coming decades will be deafness caused by loud music through earbuds and headphones.

- 2 Teenagers risk deafness by listening to loud music through headphones or at pubs and clubs.
- 3 Tinnitus is ringing in the ears. About 70% of 18–24 year olds suffer from it.
- 4 Do not turn your MP3 player up more than half way.
- 5 71% of Australians use headphones to listen to music; of these 60% have it turned up too high, so:  
 $71 \times 60/100 = 42.6\%$  of Australians have their headphones turned up too high.
- 6 No, once ears are damaged, it is permanent. Intervention means a hearing aid.

## Unit review

### Understand

- 1 Labels should correspond to Figure 9.2 in the student book (page 205).
- 2 A microwave oven heats food by increasing the vibration of the water particles (or molecules). We detect the increased vibration as an increase in temperature.
- 3 Your nose gets the direct sunlight and the reflected sunlight from the coated sunglasses. Sunglasses reflect the harmful UV light, some of which is incident on the wearer's nostrils.
- 4 If the battery were 'flat', the voltage graph with time would be a constant zero (horizontal or a flat line). The chemicals in the battery have been discharged, so that the particles no longer transfer energy inside the battery cell.
- 5 A short circuit occurs when the electric charges do not follow the planned circuit. An interruption in the circuit allows the charges to follow a different path, taking the shortest way back to the battery (the path of least resistance). Short circuits are prevented by placing insulation around the circuit, also by removing any gaps into the circuit from outside, which could allow human contact (or contact by a screwdriver).
- 6 The switch on the hairdryer disconnects the active wire from the heater and the motor. The electricity remains available inside the hairdryer. If the hairdryer were to be immersed in water, the electricity would 'jump across' the switch and the entire unit would become 'live'. If a person were touching the hairdryer, or went to pull it out of the sink, they would be at risk of an electric shock, or electrocution. Any hairdryer in a bathroom should be switched off at the wall, or have the plug removed from the wall socket.

- 7 Cornea, aqueous humour, pupil, lens, vitreous humour, retina, optic nerve. Light energy is transformed into electrical energy by the cells in the retina.
- 8 Both the eyes and the ears enable us to receive encoded messages (either in writing or as speech) from the outside world.
- 9 Auditory canal, eardrum, malleus, incus, stapes, oval window, cochlea, hair cells, auditory nerve
- 10 The eardrum transforms sound energy into kinetic energy.
- 11 The hair cells in the cochlea can be damaged by continuous loud sounds.

## Apply

- 12 The air cannon requires air to make the shock wave. There is too little air in space for this to work.
- 13 To handle a hot object, only make contact with the sides or bottom. Insulated gloves or tongs would be necessary to prevent or slow the transfer of heat energy. If it were a hot liquid, care would be needed to move slowly to prevent splashing and spilling. Once moving, to slowly change speed to a stop. The container will stop; the liquid inside will keep moving.
- 14 Cold running water for 20 minutes will remove as much heat energy as possible. Using ice introduces the danger of freezing the burnt skin. Ice can be colder than  $0^{\circ}\text{C}$  so the transfer of surface heat energy may be quick, but the deeper heat energy remains under the skin to cause third-degree burns.
- 15 A microwave oven uses microwave radiation to heat food. The waves are very small, but do not heat the area inside the oven evenly. A rotating table is placed in the centre of the oven to assist even distribution of radiation. If the plate of food (with little moisture) is placed off-centre, the heat energy will be generated in a larger part of the food. If placed exactly in the centre, some parts will be hot, while others remain cold. The art of microwave cooking is to slowly and evenly heat the food and let heat energy conduct through the entire plate. 'Standing time' is always good.
- 16 Microwave radiation increases the vibration of water particles or water molecules. If there is only a small amount of moisture, very little microwave energy is transformed to heat energy. By adding some water to food, and covering with plastic film, the food can be reheated by the hot water, which will then evaporate.
- 17 Hypothermia is when a human body suffers from being very cold. A foil blanket is wrapped around the body so any heat produced is reflected back to the body.

## Analyse

- 18 Heat energy comes from the heating element on the stovetop. The metal handle became hot by conduction through the bottom and sides of the metal pot. As you touch the handle, the vibrating particles in the handle come into contact with the particles of your skin. The skin particles begin vibrating more quickly. The faster the vibration, the higher the temperature felt. The heat energy continues to transfer into the skin, and deep under the skin. Burns are caused when the cells are damaged and the self-healing processes begin. Fluid or blisters form to move the affected cells away and protect the underlying skin layers from infection when the skin is broken. Cool or cold running water (a conducting fluid) reduces the immediate pain, and conducts the damaging heat energy away.

- 19** IR cameras detect a different part of the electromagnetic spectrum. Hot objects and cool objects appear differently in this part of the spectrum. Colours can be allocated so a visual image of the scene can be interpreted quickly. White or blue for cold, yellow and red for warm/hot. If a bushwalker or skier appears in such an image, their face and hands will contrast red/yellow against the blue/white surroundings. In a bushfire, smoke obscures the seat of the blaze. By observing where the hot spots are, the fire retardant can be applied more effectively.
- 20** Noise-cancelling headphones have a microphone, amplifier and battery that combine to detect the incoming sound waves(s) and 'flip' to make an inverse wave, which will add to cancel the sound wave. Sound proofing is usually made of a material that has very small and deep holes. The sound wave goes into the hole and it absorbed, rather than reflected around the room to create unwanted echoes.
- 21** To cool off in summer, use evaporation. Spray water on your skin and allow it to evaporate. When water changes state from liquid to gas, energy is absorbed. Use conduction, jump into water at a pool or the beach. Heat energy is conducted away from your skin. Use convection: let air rise over your body; warmer air rises so a natural chimney effect will cool your body. Other methods can use combinations of convection and evaporation. Evaporative air conditioners push damp air from vents in the ceiling, which is cooler than the room air, so it falls and cools the room.
- 22–27** Student responses will vary.