1

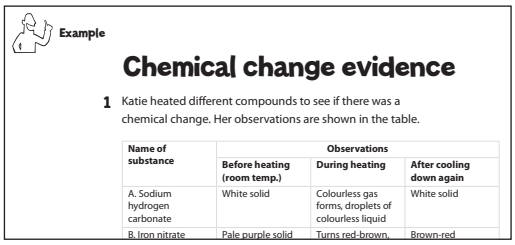
mastery science

MASTERY
PRACTICE BOOK

Learn to apply knowledge and get higher grades in science.

Contents

How to use the book



Example

Chemical change evidence

1 Katie heated different compounds to see if there was a chemical change. Her observations are shown in the table.

Name of substance	Observations		
	Before heating (room temp.)	During heating	After cooling down again
A. Sodium hydrogen carbonate	White solid	Colourless gas forms, droplets of colourless liquid	White solid
B. Iron nitrate	Pale purple solid	Turns red-brown,	Brown-red

Applying what you know is not easy. Keep trying, and learn from your mistakes. With practice you will master the concepts and be confident with whatever examiners ask.

The ***Example*** pages have 3 steps:

Detect — Work out what you need to do to answer the question.

Recall — Bring to mind what you already know about the concept. Showing it visually helps the thinking process.

Solve — Go from what you know to the answer, step-by-step.

Why is this evidence?

Do answer the questions in speech bubbles. This will help you follow the example and remember the main points.

Your turn

The ***Your Turn*** pages have three practice questions. The first is very similar to the example. Look back and copy the steps. The other two questions might look different but they are testing the same thinking process.

1	/3	2	/3	3	/3

Use the scoring box to check how you're doing. Award yourself 3 points if you did Detect, Recall and Solve well. Subtract 1 point for each step you didn't do well. +1 if you answered without a hint.

Hints & Answers

If you're stuck, go to the ***Hints*** pages at the back. The hint is a clue or question to get you moving. Use the ***Answers*** pages to check if you were correct. If you weren't, look back at the example and figure out what you did wrong.

Watch out !

The ***Watch Out*** pages are to help you avoid common mistakes and clear up confusions in your knowledge.

Mixed up problems

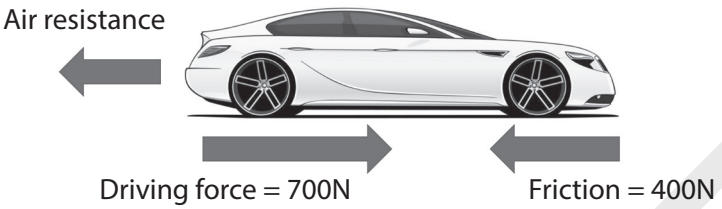
Now you're ready for the challenge at the end of the chapter: ***Mixed up problems.*** This is like an exam where different types of questions are jumbled up. Don't panic, just follow the 3 steps: Detect, Recall and Solve. If you get stuck, look back at the example or try a hint.

Good luck!

Example

1.1 Find missing force

1 A car travels at constant speed. The diagram shows the forces on the car.



Calculate the force of air resistance.

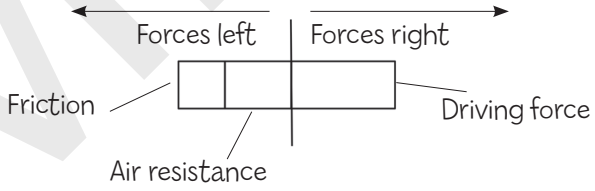
Detect

I know all the forces on the car except one. I have to calculate the missing force.

Recall

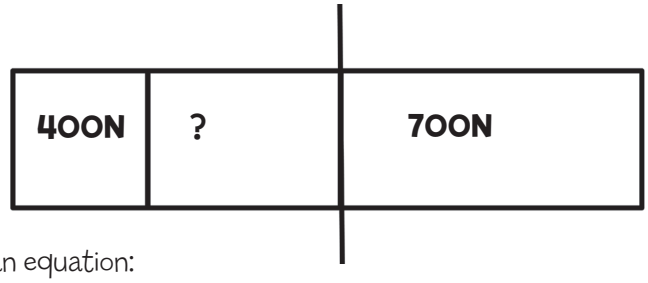
Constant speed (or at rest) means the forces are balanced. So,
Sum of forces in one direction = Sum of force in opposite direction.

Why is this equation true?



Solve

Put the values from the question into the balanced forces diagram:

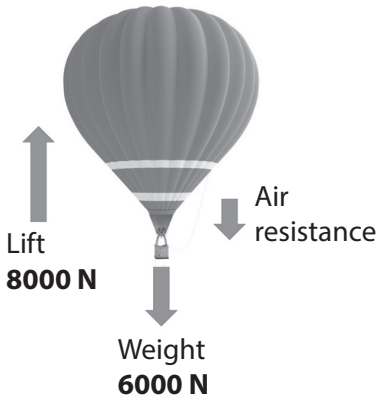


How did I work this out?

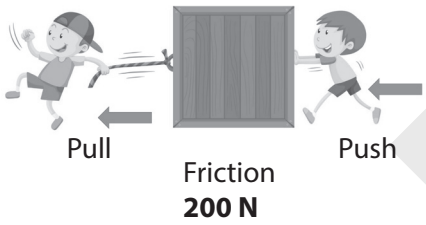
We can write this as an equation:

400N + air resistance = 700 N
So, air resistance = 700 - 400
= 300 N

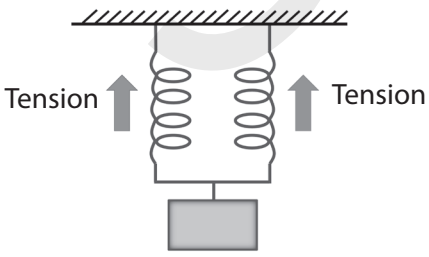
2 The hot air balloon is climbing at a steady speed. Calculate the air resistance.



3 Two boys pull and push a box with the same force. The box moves at a steady speed. Calculate the push and pull force.



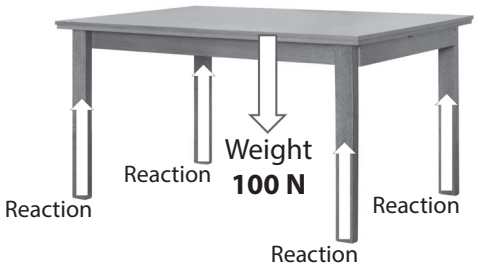
4 The weight is supported by the tension in two identical springs. What is the tension in each spring?



1	/3	2	/3	3	/3	no hints: +1 Total	/10

1.6 Mixed up problems

1 The weight of the table is supported by the upward reaction from the floor on each leg. What is the reaction on each leg?



2 The table shows the masses and volumes of different objects. Which object has the highest density?

Object	Mass (g)	Volume (cm^3)
A	11	24
B	11	12
C	55	4
D	55	11

3 Alison pours honey, water, alcohol and oil into a test tube. The liquids settles into four layers, one on top of another. The table shows the densities of the liquids. What is the correct order of the liquid layers, from top to bottom?

Liquid	Density (g/cm^3)
Alcohol	0.8
Honey	1.4
Oil	0.9
Water	1.0

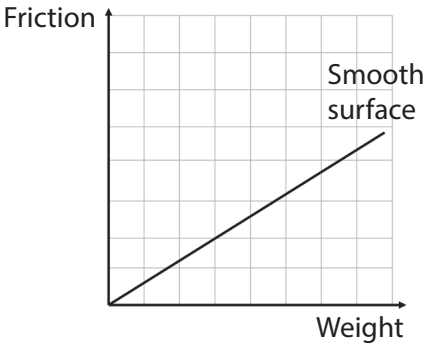
A Honey, water, oil, alcohol

B Alcohol, honey, oil, water

C Honey, oil, alcohol, water

D Alcohol, oil, water, honey.

1	/3	2	/3	3	/3	no hints: +1 Total	/10



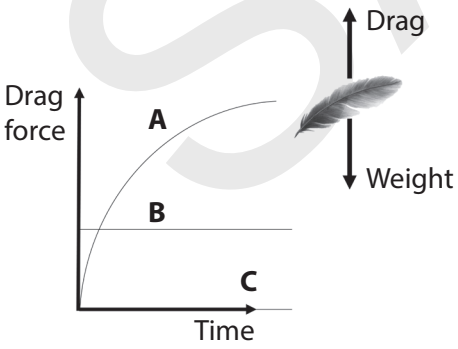
4 The more an object weighs, the bigger the force of friction stopping it move. The graph shows this relationship for a smooth surface.
How would the line look for a rough surface?
Show this by sketching another line on the same axes.

5 A student investigated the friction on her trainer. She wrote:
"I pulled harder and harder until I overcame friction."
Estimate the force of friction from the table.
Explain your answer.

A 2.5 N **B** 3 N **C** 2.5 - 3 N

Pull (N)	1	1.5	2	2.5	3
Shoe moves?	No	No	No	No	Yes

6 When a feather is dropped, the forces on it are its weight and drag.
Which graph shows how the drag force on the feather changes:
i) On Earth
ii) On the Moon. Give a reason for your answers.

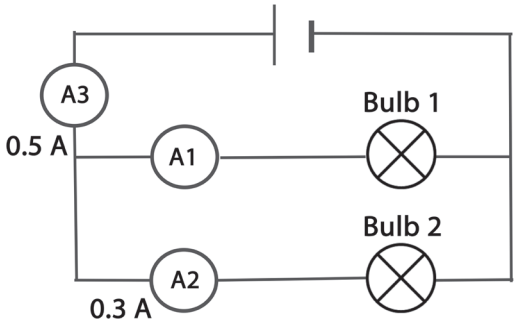


Example

2.2 Ammeter readings

1 **i)** What current flows through bulb 1?

ii) If bulb 1 breaks, what happens to the readings on each ammeter? Explain your answers.

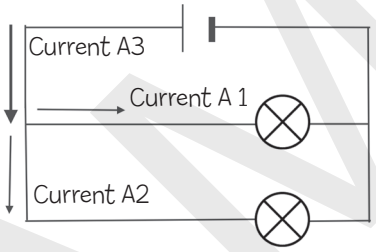


Detect

I need to work out what happens when a loop splits or joins another.

Recall

Why is this true?



1. Current can only flow in a complete loop.
2. The current is the same all around a loop.
3. Current changes when a loop splits off or joins another loop. Some current goes each way at a split and then it meets up again at a join.
4. The current in loop 3 = the sum of the currents going though the loops 1 and 2:

current in A3 = current in A1 + current in A2

Solve

i) We know current in A3 = 0.5 A and current in A2 = 0.3 A
So 0.5 A = current in A1 + 0.3

Changing the subject of the formula to A1:
current in A1 = 0.5 A - 0.3 A = 0.2 A.

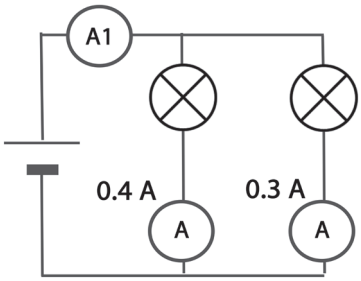
ii) If bulb 1 breaks, there is an incomplete loop through A1. So ammeter A1 reads zero.

The loop through bulb 2 is not affected. So ammeter A2 still reads 0.3 A To work out the effect on the ammeter, we use: A3 = A1 + A2

Why is A1= 0?

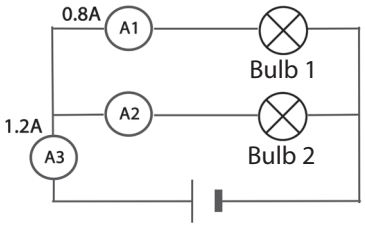
We know A1 = 0, so:
A3 = 0 + 0.3 = 0.3 A. So ammeter A3 reads only 0.3 A.

2



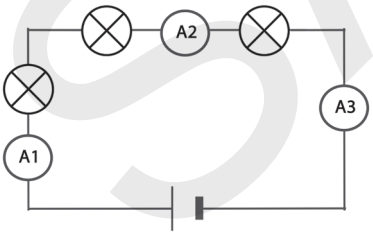
What is the reading on ammeter A1?
Explain your answer.

3



i) What is the reading on ammeter A2?
ii) How would the reading on ammeter A2 change if another bulb was added between A2 and bulb 2?

4



How do the readings on the ammeters compare?
The bulbs are identical.

A A1 = A2 = A3
B A1 > A2 > A3
C A1 = A3, and bigger than A2

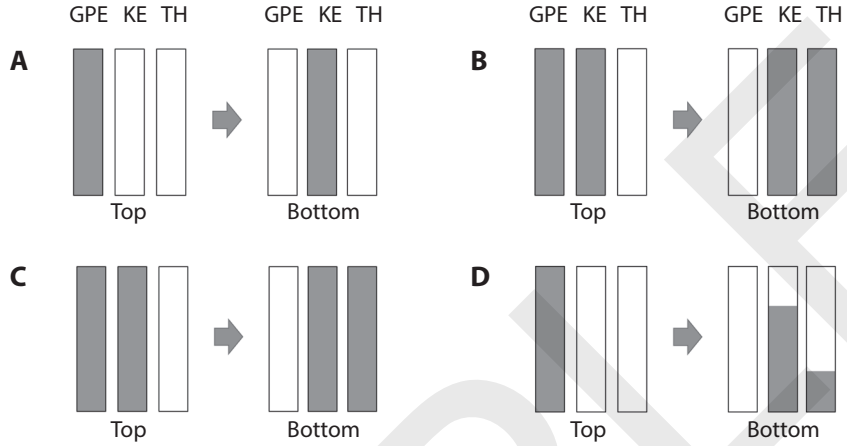
Example

3.1 Identify energy change

1 A car sits at the top of a hill. The driver releases the brakes and the car rolls down. As it picks up speed, it also heats up.

Which diagram shows the energy stores of the car **i)** At the top **ii)** At the bottom?

GPE = Gravitational potential
KE = Kinetic
TH= Thermal

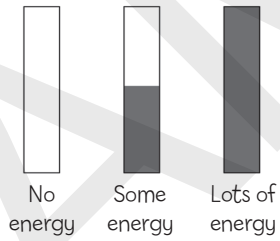


Detect

I need to work out the energy stores before and after the change.

Recall

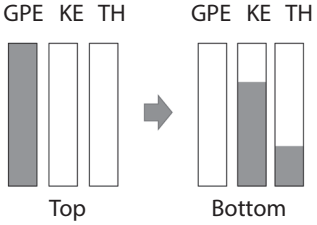
Which stores are filled at the beginning?



1. The height of the shaded bars compares how much energy is in each store.
2. Energy is never destroyed. During a change it is transferred from one store to another.
3. Raising an object fills its GPE store (car at the top).
4. Fuel has energy in the chemical store (petrol)
5. An object that starts moving fills its KE store (car rolling down)
6. An object that heats up fills its thermal store.

Solve

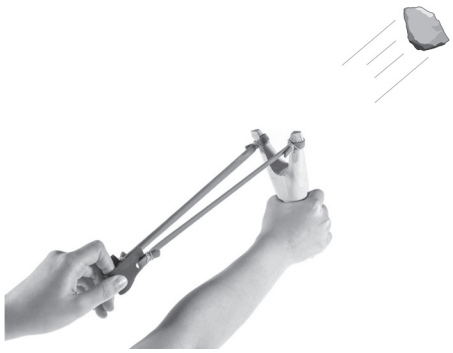
What else is wrong about B?



The car is not moving at the top, so it has no KE stored. As the car moves it heats up and so fills its thermal store.

B and C are wrong. They show the car having KE at the top.
A is wrong. It shows no energy in the thermal store.

So D must be correct. Some of the GPE moves to KE. The rest moves to the thermal store.



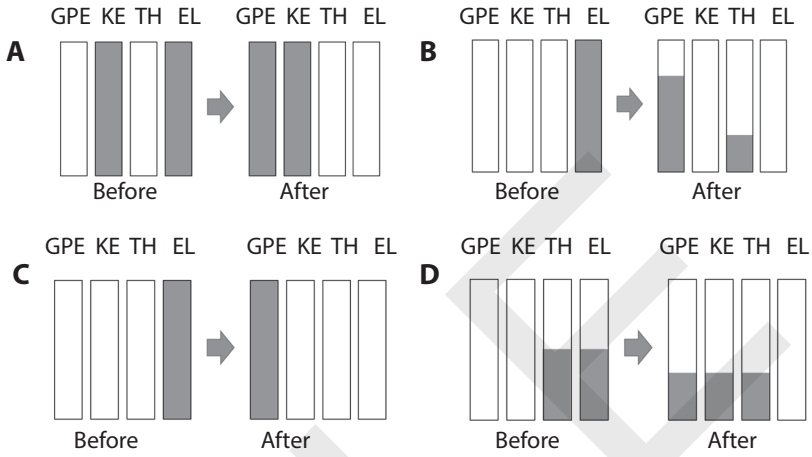
GPE = Gravitational potential

KE = Kinetic

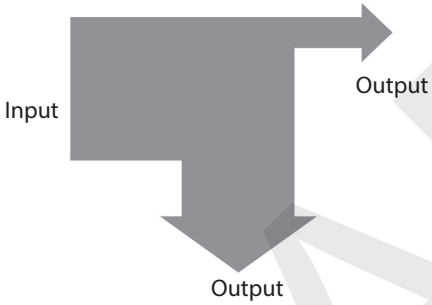
TH = Thermal

EL =Elastic

2 The catapult in the diagram launches stones into the air. When the string is stretched, it gets warm. Which diagram shows the energy changes?



3 The image shows a Sankey diagram. The size of the arrows represent the amount of energy. A light bulb transfers 100 J from its electrical store to light (75 J) and heat (25 J). Draw a Sankey diagram to show this energy change.



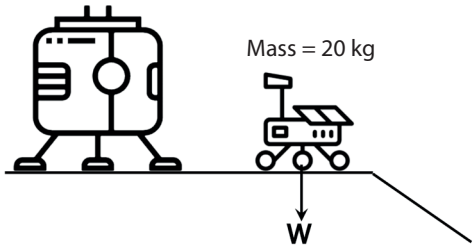
4 Jan cooks dinner in a gas oven. Which answer describes the energy changes taking place? Explain your choice.

	Stores that decrease	**Stores that increase**
A	Electrical	Thermal - food and pot
B	Electrical	Thermal - food and air
C	Chemical	Thermal - food and pot
D	Chemical	Thermal - food, pot, air

Example

4.5 Calculate weight

1 A Mars robot travels along a thin metal ramp. It can break if the force on it exceeds 150 N.



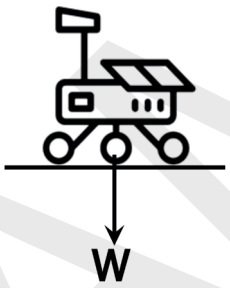
The robot's mass is 20 kg. On Mars its weight, shown by W, is 72 N.
Could the robot use the ramp on Earth without breaking the ramp?
g on Earth = 10 N/kg.

Detect

I need to calculate the robot's weight on Earth.

Recall

Why is the robot's weight different on Earth?



1. The force of gravity (weight) pulls downwards on the robot.
2. The robot pushes downwards on the ramp with the same force as its weight.
3. The maximum force the ramp can take is 150 N.
4. The formula for calculating the weight of the robot is:

W = m x g

W is weight, m is mass and g is gravitational field strength.

Solve

Why is the weight of 72 N not used?

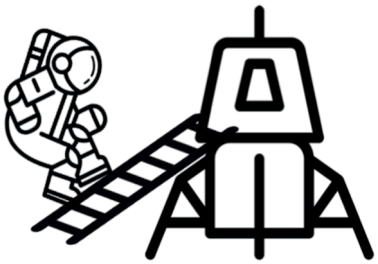
We need to find out whether the robot's weight on Earth is greater than 150 N.
The values to put into the weight formula are:

m = 20 kg (mass is the same everywhere)
g = 10 N/kg (Earth)

So W = m x g becomes
W = 20 kg **x** 10 N/kg = 200 N,

As this force is more than 150 N, the ramp might break. So the robot cannot use the ramp on Earth.

2 The ladder of a spacecraft breaks if the weight on it exceeds 500 N. On Mercury, an astronaut can use it safely. She weighs 360 N and her mass is 100 kg.
Can she use the ladder on Earth? Show your calculation.
g on Earth = 10 N/kg.



3 A table designed for the Moon can support a weight of 4 N. Can it support a 2.5 kg laptop on Mars? Explain your answer.
g on Mars = 4 N/kg.

4 On Earth, a dance mat needs a force of 250 N pressing down on it to work.
Would the weight of a 60 kg person work the mat on Venus?
g on Venus = 9 N/kg.

Example

5.1 Chemical change evidence

1 Katie heated different substances to see if there was a chemical change. The table shows her observations.

Name of substance	Observations		
	Before heating (room temperature)	**During heating**	**After cooling**
i) Sodium hydrogen carbonate	White solid	Colourless gas and droplets of colourless liquid form	White solid
ii) Iron nitrate	Pale purple solid	Turns red-brown, brown gas forms	Brown-red solid
iii) Hydrogen peroxide	Colourless liquid	Bubbles form	Colourless liquid

For substances **i)**, **ii)** and **iii)**, explain whether there was a chemical change.

Detect

I need to think what the evidence is for a chemical change.

Recall

Why is this evidence?

In a chemical change, a new substance always forms.

The evidence for a new substance can be:

- ◯ Permanent colour change
- ◯ Fizzing or sign of a new gas
- ◯ Heat or light produced
- ◯ A precipitate (solid) forms if I mix two solutions.

Solve

i) Heating sodium hydrogen carbonate

- ◯ Permanent colour change
- ✓ Fizzing or sign of a new gas
- ◯ Heat or light produced

→ **Chemical change**
The droplets are likely to be water. A colourless gas and water droplets are both evidence for new substances.

ii) Heating iron nitrate

- ✓ Permanent colour change
- ✓ Fizzing or sign of a new gas
- ◯ Heat or light produced

→ **Chemical change**
A permanent colour change and brown gas are both evidence for new substances.

iii) Heating hydrogen peroxide solution

- ◯ Permanent colour change
- ? Fizzing or sign of a new gas
- ◯ Heat or light produced

→ **Not sure**
The bubbles could be a new gas, or due to boiling. There is no other evidence.

Why is the answer 'not sure'?

2 Alys mixed different solutions together. The table shows her observations.

	Solution 1	Solution 2	After mixing
i)	Silver nitrate (colourless)	Sodium chloride (colourless)	White precipitate forms
ii)	Copper sulfate (blue)	Dilute sulfuric acid (colourless)	The solution stays blue
iii)	Sodium hydrogen carbonate (colourless)	Hydrochloric acid (colourless)	Fizzing, leaving a colourless solution

For each experiment **i)**, **ii)** and **iii)**, explain whether there was a chemical change.

3 Jason added different substances to water. The table shows his observations.

Experiment	Substance	Before adding water	After adding to water
i)	Sodium metal	Silvery-grey metal	Fizzes, catches fire, solid disappears leaving a colourless solution
ii)	Sodium iodide	White solid	Solid disappears leaving a colourless solution
iii)	Iodine	Silvery-grey solid	A pale orange solution forms. Some solid remains

For each experiment **i)**, **ii)** and **iii)**, explain whether there was a chemical change.

4 Tomas mixed red and blue food colour in a glass of water. The water went purple.
Tomas concluded there was a chemical change because it went a different colour.
Do you think he was correct? Explain your answer.

Example

6.3 Explain state changes

1 Naimah noticed that on a cold day her breath formed droplets of water on the inside of the car window. Explain this observation using the particle model.

Detect

I need to think how forming water droplets links to the properties of particles.

Recall

1. There is water vapour in the air. This is water in the gas state.
2. Forming water droplets is condensation, a change of state from gas to liquid.

Freezing ← Condensing

	Solid	Liquid	Gas
Forces	Strong	Weaker	None. The particles move freely
Energy	Little	More. The energy partly overcomes the forces of attraction (but not enough to move freely)	Lots. The particles have enough energy to completely overcome the forces of attraction
Spacing	Very close together. Particles cannot change position	Close together. The particles move around each other	Far apart. The particles move in all directions

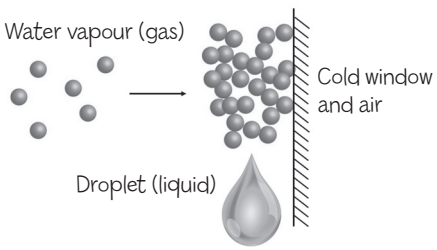
Melting → Evaporating, or boiling

3. A liquid evaporates at all temperatures. But it only boils at the boiling point.

What happens to water vapour as it hits the window?

Solve

What happens to particles when a gas cools?



The air contains water vapour, which is invisible. As the particles of water hit the cold window, they transfer some of their energy to it. With less energy, the particles can no longer overcome the forces of attraction pulling them together. They get closer together. In other words, water changes from a gas into the liquid state.
This is why there are droplets of water on the inside of the car window.

2 Megan found water droplets on her bedroom mirror on a winter morning. The condensation disappeared after she turned on the heater.
Explain what happened to the water droplets, using the particle model.

3 Samora noticed that the ice cubes in his drink get smaller and smaller.
Explain this observation using the particle model.

Experiment 1 **Experiment 2**

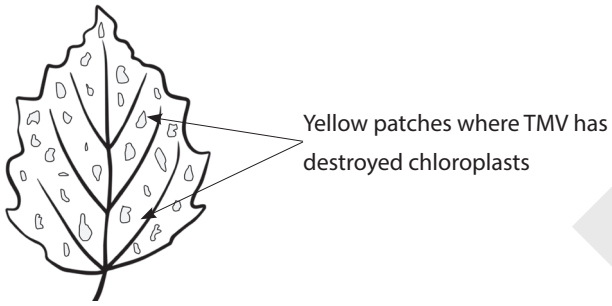
4 Josie did two experiments:
Experiment 1 Heating 200 g of ice until it melted.
Experiment 2 Heating 200 g of water up to 100 °C.
In each case, she measured the mass afterwards.
In which experiment did the mass change?
Explain why, using the particle model.

1	/3	2	/3	3	/3	no hints: +1 Total	/10

Example

7.1 Functions of cell parts

1 The diagram shows a leaf infected with the tobacco mosaic virus (TMV).



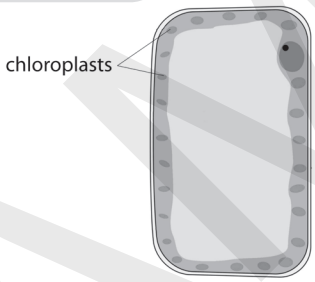
Explain how destroying chloroplasts will affect the growth of the plant.

Detect

I need to think about the function of chloroplasts.

How is this cell part useful to the organism?

Recall



1. Chloroplasts are green structures inside plant cells.
2. Their function is to carry out photosynthesis.
3. Photosynthesis is a process plants use to make food for themselves.
4. Growth is a life process. Organisms need food to grow.

Solve

How does this cell part affect growth?

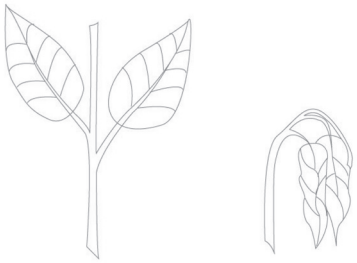
IF TMV destroys some of the chloroplasts,
THEN there will be fewer chloroplasts.

IF chloroplasts carry out photosynthesis
THEN fewer chloroplasts means less photosynthesis,

SO the plant will produce less food.
SO the plant will grow less.

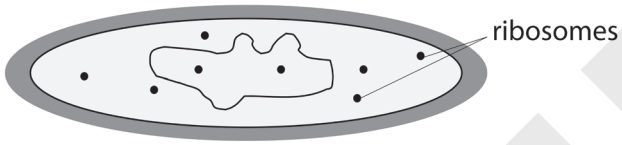
OVERALL destroying chloroplasts will reduce the growth of the plant.

2



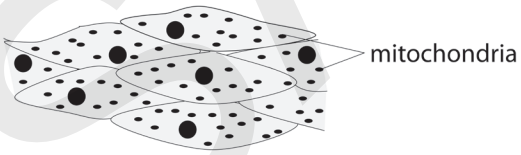
The diagram shows a plant wilting. This happens when plants cannot absorb enough water through their roots. Water moves out of the cell vacuole and the vacuole disappears. Explain why this causes the plant to wilt.

3



Antibiotics are drugs that kill bacteria. Some antibiotics stop ribosomes from working. Explain how this will kill a bacteria cell.

4



The diagram shows a group of muscle cells. Muscle cells have many more mitochondria than a typical animal cell. Explain why.

1	/3	2	/3	3	/3	no hints: +1 Total	/10

Example

8.5 Explain competition

1 When the seedpods of the lupin plant dry out, its seeds are sent flying out. They will eventually grow into offspring. Explain how this mechanism helps the parent and offspring plants to grow successfully.

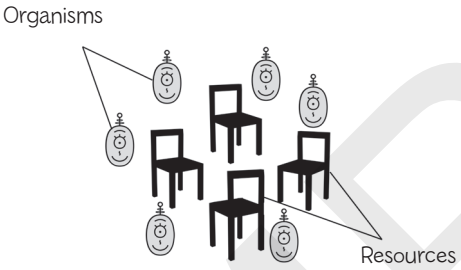
Detect

I need to think why there needs to be distance between parent and offspring plants.

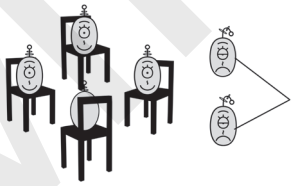
Recall

What is competition?

1. Plants and animals compete for the resources they need to grow - light, water, food, space and minerals.
2. Organisms that live in the same area have to share resources. There are not enough resources for all of them, so they compete - like musical chairs.



Like the players who get the chairs, the organisms best at competition get enough resources to survive and grow.



Just as players without a chair are out, organisms that do not get enough resources die.

Increasing access to resources is like adding more chairs, and means more organisms can thrive.

Solve

The lupin plants need resources like light, minerals and water to grow and survive so they can reproduce.

Why is there less competition?

If the parent and the offspring live in the same area, they will compete for the resources there. Spreading the seeds far away from the parent plant means that the offspring have access to more resources. This reduces the competition. So the lupin plants will grow more, and more of them will survive.

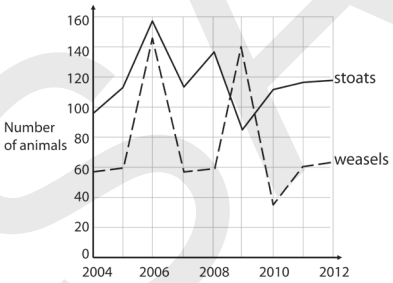
2

The image shows a farmer spraying a herbicide onto his field of soy plants. This kills any weeds.
Explain why removing weeds increases the growth of the soy plants.

3

Cheetahs are predators of animals such as deer. In a population of cheetahs, some are faster than others.
Explain why the faster cheetahs have a higher chance of survival.

4



Stoats and weasels are wild animals that both eat rabbits. The graph shows how the numbers of animals living in the same area have changed between 2004 and 2012.
Suggest why the numbers of weasels changed between 2008 and 2010.

Example

9.1 Sexual vs asexual

1 Milo is a Labradoodle. His mother has curly brown fur. His father has straight black fur. Milo has curly black fur. Explain why Milo has these two characteristics.


Father: Labrador


Mother: Poodle


Milo: Labradoodle

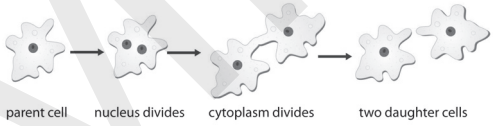
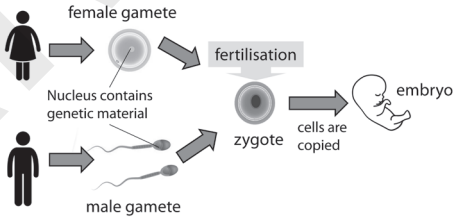
Detect

I need to work out why Milo looks a bit like each of his parents.

Recall

1. There are two different kinds of reproduction: sexual and asexual.
2. Most animals use sexual. Many plants use a mixture. Most single-cell organisms (like bacteria) use asexual.

Sexual/ asexual – what's the difference?

Type	Number of parents	What happens	Genetic material in the offspring
Asexual	1	The parent cell copies itself to produce offspring. 	Same as parent. So it gets all its parent's characteristics.
Sexual	2	 In plants, gametes are in pollen (male) and the ovule (female).	Mixture from both parents. So some characteristics will be the same as one parent's, and some the same as the other's.

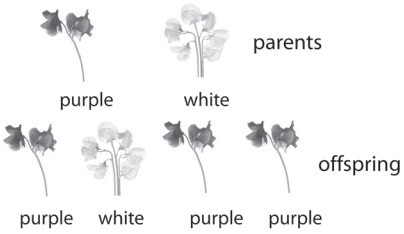
Solve

How does this explain what happened?

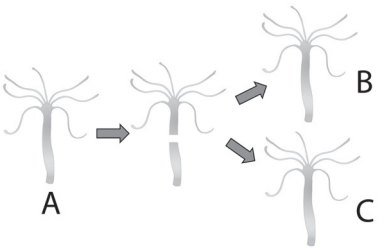
Milo was produced by sexual reproduction. During fertilisation, genetic material from his mother's egg was combined with genetic material from his father's sperm.

So, he has characteristics from both his mother and his father.

The characteristic Milo shares with his mother is curly fur. The characteristic Milo shares with his father is black fur.



2 A scientist bred two pea plants together. One had white flowers with and the other purple flowers. Some of the offspring had white flowers and some had purple flowers. Explain why the offspring had a mixture of colours.



3 The diagram shows how hydra reproduce.
i) Describe how the characteristics of hydra A, B and C compare
ii) Explain your answer to i) in terms of the different types of reproduction.

4 Liz and Tim want a baby. However, Liz cannot produce any eggs. Her friend Kerry donates an egg. It is fertilised in a dish with Tim's sperm. Then it is placed in Liz's uterus to grow.
Which two people will the baby share characteristics with? Explain your answer.

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"They are fantastic. My staff and I are blown away at the quality of these books."
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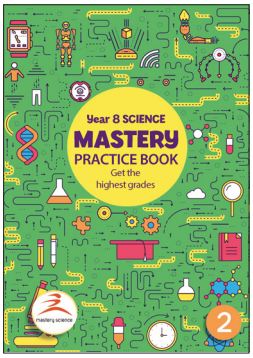

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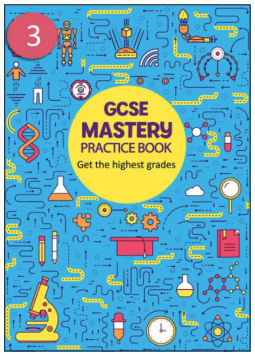
GCSE/year 9 Apply Practice Book



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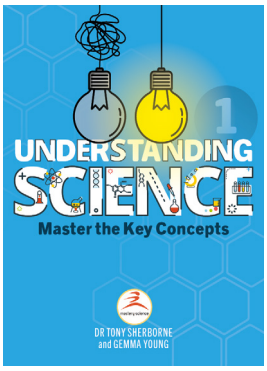

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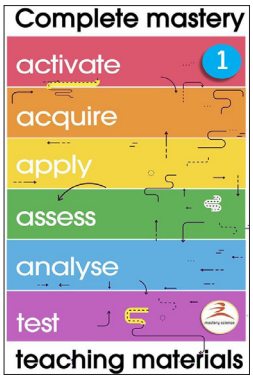

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