B6 Photosynthesis

B6.1 Photosynthesis

What do plants need to grow?

1 Flower, leaf, stem and roots

2 Leaf

3 Water and mineral nutrients

4 Transporting substances through the plant

5 Carbon dioxide

6 Plants make their own food whereas animals must eat food to grow.

7 a To anchor the plant, absorb water and absorb mineral nutrients

b No chloroplasts (because there is no photosynthesis underground) and long extensions for a large surface area to absorb more water and mineral nutrients

c

Equation	image size = actual size × magnification
Values	image size = ? actual size = 0.5 mm magnification = ×600
Enter values	image size = 0.5 × 600
Result	image size = 300
Y(units)	image size = 300 mm

8 Through transfer by waves

9 Plants absorb water through their roots from the soil and not through the leaves.

10 Flower

How do plants make their own food?

11 Water and carbon dioxide

12 Glucose and oxygen

13 Chloroplast

14 Green

15 Products

16 Green

17 Root hair cells have no chloroplasts and have long extensions. Palisade cells have lots of chloroplasts and no long extensions.

18 Three from: Nucleus, vacuole, ribosomes, mitochondria, cell membrane, cell wall

19 Mitochondria

20 To make their own food

21 Photosynthesis

22 Oxygen

23 For example:
- a … they react water and carbon dioxide to make glucose and oxygen.
- b … only when there is enough light and chlorophyll present.
- c … they can make their own food.

24
- a How does the amount of chlorophyll in a leaf affect the rate of photosynthesis?
- b Amount of chlorophyll
- c Rate of photosynthesis
- d Two from: Amount of light, volume of water, amount of carbon dioxide, type of plant, size of leaf
- e The *x*-axis label has no unit.
- f As the amount of chlorophyll increases, the rate of photosynthesis also increases.

25 Oxygen

How did our understanding of photosynthesis change over time?

26 Soil

27 Willow tree

28 The soil only lost about 1 kg in 5 years, which does not explain the 75 kg gain in mass of the tree.

29 New evidence may be discovered.

30 Water and mineral nutrients

31 Flower, stem, leaf, roots

32 It would not be able to photosynthesise and so would not grow/would die.

33 Plants gain mass by making glucose through photosynthesis. They use water and carbon dioxide to photosynthesise.

34 The mass of soil would have decreased as much as the mass of the tree would have increased.

35 Chloroplasts

36 New evidence was discovered that particles cannot be destroyed.

37 New evidence was discovered, such as information from microscope images.

38 We can see what energy does through experimental evidence, which gives us an idea of a model for what energy is.

39 We could make a room dark and see that light does not come from our eyes.

How do we test for starch?

40 To build cell walls, to release energy through respiration, to be stored as starch

41 To provide structure to the cell

42
- a Photosynthesis
- b Converted from glucose
- c Photosynthesis
- d Starch will be converted back to glucose.

43 To transport substances through the plant

44

Equation	image size = actual size × magnification
Values	image size = ? actual size = 0.008 mm magnification = ×300
Enter values	image size = 0.008 × 300
Result	image size = 2.4
Y(units)	image size = 2.4 mm

45 It has many chloroplasts (for photosynthesis).

46 **a** Starch

b Iodine

c Brown iodine turns black

d That photosynthesis happened in the leaf

47 **a** Oxygen

b Water and carbon dioxide

48 Carbon dioxide

49 **a** The mass of dried soil did not change much while the mass of the willow tree increased quite a lot.

b Two from: Not enough sunlight, not enough carbon dioxide, temperature, nutrient deficiencies, disease

c Variable amounts of water can be present in fresh mass and this can affect the results.

d 2.3 + 2.4 + 2.2 = 6.9
mean = 6.9 ÷ 3 = 2.3 kg

e 76.7 + 76.9 + 77.0 = 230.6
mean = 230.6 ÷ 3 = 76.9 kg

f Tree 1: 76.7 − 2.3 = 74.4 kg
Tree 2: 76.9 − 2.4 = 74.5 kg
Tree 3: 77.0 – 2.2 = 74.8 kg
Tree 3 gained the most mass.

g 77 − 76.7 = 0.3 kg

50 It is involved in reproduction.

51 **a** Two from: To build cell walls, to release energy through respiration, to store in the form of starch

b For growth and repair of cells

c Ribosomes

52 Water + carbon dioxide ⟶ oxygen + glucose

53 To make glucose for growth, energy and to build mass

54 **a** From carbon dioxide and water (and minerals), as the plant used these (together with energy from the light) to make its own food to build mass

b 5 g (The soil would not change much in mass, as any water that was added would be taken up by the plant. The mass may in fact reduce very slightly, as mineral nutrients are taken up by the plant.)

c 650 ÷ 100 = 6.5 times

B6.2 Leaf structure

What is the internal structure of a leaf?

55 A waxy cuticle
B upper epidermis
C palisade mesophyll
D chloroplast
E spongy mesophyll
F air space
G lower epidermis
H guard cell
I stoma

56 Diffusion

57 To allow gases to diffuse through easily

58 To open and close the stomata

59 Thin, large surface area, lots of chloroplasts

60 It has air spaces.

61 Chlorophyll

62 Lower epidermis

63 Carbon dioxide enters the leaf through the stomata. Leaves need carbon dioxide for photosynthesis. A leaf with more stomata can allow more carbon dioxide to enter.

64 **a** How does the width of a leaf affect the rate of photosynthesis?
b Width of the leaf
c Rate of photosynthesis
d Two from: Type of leaf, amount of light, concentration of carbon dioxide, amount of water, temperature
e As width of a leaf increases, the rate of photosynthesis decreases.
f If the leaf is wide, gases need to diffuse over a larger distance, so there is a large diffusion pathway. This makes photosynthesis less efficient and so the rate of photosynthesis decreases as width of the leaf increases.

65 To allow oxygen to leave and carbon dioxide to enter the leaf

66 Water + carbon dioxide → glucose + oxygen

67 It may be used in respiration, stored as starch or used to build cell walls.

68 It is given out by the plant.

69 To anchor the plant and to absorb water and mineral nutrients from the soil

70 To allow as much light as possible to pass through

71 To absorb as much light for photosynthesis as possible

72 a Oak
b It has the highest number of chloroplasts, which is where photosynthesis takes place.
c Starch
d That part of the leaf may not have had enough light and so it did not photosynthesise.

73 To prevent water loss

74 Chloroplasts

75 By waves

How can we observe stomata in leaves?

76 Tiny openings on the surface of plant leaves that allow gases such as carbon dioxide and oxygen to enter and leave

77 They help in the process of photosynthesis by allowing carbon dioxide to enter and oxygen to leave.

78 To carry out photosynthesis

79 Plant cells have a cell wall, vacuole and chloroplasts while animal cells do not.

80 To allow photosynthesis to take place

81 Two from, for example: Leaves, roots, stems, flowers

82 Connects the other organs together and helps to transport key substances throughout the plant

83 Through their roots

84 The process by which plants use carbon dioxide and water to produce glucose and oxygen

85 Carbon dioxide and water

86 In chloroplasts in the leaves

87 To make cell walls, for energy through respiration or to be stored as starch

88 To anchor the plant in the soil and absorb water and minerals from the soil

89 The cuticle is a waxy layer on the surface of a leaf that helps reduce water loss.

90 Released into the atmosphere through the stomata

B7 Respiration

B7.1 Aerobic respiration

What is respiration?

1 Glucose + oxygen → carbon dioxide + water

2 It is not a chemical/product/substance

3 Carbon dioxide and water

4 To release energy from food

5 Cell membrane

6 To provide the oxygen needed for aerobic respiration

7 Respiratory system

8 Kidney

9 Move, respire, sense, grow, reproduce, excrete, nutrition

10 Diffusion

11 a The breaking down of large insoluble molecules into small soluble ones
b Biological catalysts that speed up reactions
c To provide energy from respiration
d Mouth, pancreas, small intestine
e Iodine turns from brown/orange to blue/black
f At the start, the enzyme has not had time to digest the starch. After 30 minutes, the starch has all been digested and is now glucose.
g Many folds/villi give it a large surface area. A good blood supply helps to absorb as many nutrients as possible.

Where does respiration happen?

12 They have swapped carbon dioxide and oxygen. They have put energy as a product when it is not a product.

Glucose + oxygen → carbon dioxide + water

13 Mitochondria

14 Diffusion

15 Cell membrane, cytoplasm

16 Releases more energy, can continue indefinitely

17 They are incorrect. We also need our lungs to remove carbon dioxide.

18 a Nucleus (chloroplasts)
b Cytoplasm

c

Equation	image size = actual size × magnification
Values	image size = ? actual size = 0.000 001 m magnification = ×20 000
Enter values	image size = 0.000 001 × 20 000
Result	image size = 0.02
Y(units)	image size = 0.02 m

19 a To carry oxygen around the body

b No nucleus, biconcave shape

c Specialised

d Less oxygen means less aerobic respiration, so less energy is released by their cells.

20 Glucose + oxygen ⟶ carbon dioxide + water

21 To allow respiration to occur

22 Diffusion

23 To release energy for the cell to use

24 From digesting carbohydrates

25 Circulatory system

26

Equation	image size = actual size × magnification
Values	image size = ? actual size = 0.0007 mm magnification = ×3000
Enter values	image size = 0.0007 × 3000
Result	image size = 2.1
Y(units)	image size = 2.1 mm

B7.2 Anaerobic respiration

What happens if the oxygen runs out?

27 Glucose ⟶ lactic acid

28 Sometimes there is not enough oxygen for aerobic respiration to occur.

29 The lactic acid causes a burning feeling.

30 To release energy so they can survive

31 Releases more energy, can go on all the time in presence of oxygen

32 a Anaerobic, because there is not enough oxygen

b The lactic acid builds up and burns.

c

Equation	speed = distance ÷ time
Values	speed = ? distance = 188.5 m time = 6.5 s
Enter values	speed = 188.5 ÷ 6.5
Result	speed = 29
Y(units)	speed = 29 m/s

d Aerobic, because there is now enough oxygen

33 For example:
- a … they need to survive when there is not enough oxygen.
- b … they can only do it for a short time.
- c … when we can keep exercising even when our cells cannot get enough oxygen.

34 a A substance that has a pH below 7
- b Lactic acid has been made, which lowers the pH of the blood.
- c Anaerobic, because it is the type that makes lactic acid
- d

Equation	speed = distance ÷ time
Values	speed = ? distance = 200 m time = 24.6 s
Enter values	speed = 200 ÷ 24.6
Result	speed = 8.13
Y(units)	speed = 8.13 m/s

How is anaerobic respiration different in fungi?

35 Glucose → carbon dioxide + ethanol

36 To allow respiration to occur

37 Glucose

38 Ethanol

39 Carbon dioxide

40 Aerobic, because it releases more energy and can happen for longer

41 a True for all
- b True for aerobic respiration
- c True for anaerobic respiration in animals and true for anaerobic respiration in fungi
- d False for all
- e True for all
- f True for anaerobic respiration in animals
- g True for anaerobic respiration in fungi
- h True for aerobic respiration and true for anaerobic respiration in fungi
- i True for aerobic respiration

42 a To allow respiration to occur
- b They are unable to release enough energy from respiration.
- c Their energy is limited by the mitochondria not working properly, not a lack of oxygen.
- d Nucleus

43 For example:
- a … they need to be able to survive when there is not enough oxygen.
- b … they release less energy than in aerobic respiration.
- c … we can use them in brewing and baking.

44 a Fungi/yeast
- b Glucose is a reactant in anaerobic respiration.
- c To prevent the yeast using aerobic respiration, which does not produce ethanol

45 a Respiratory system

b Mouth → trachea → bronchi → bronchioles → alveoli → bloodstream

c Large surface area, good blood supply, moist, membrane is one cell thick

d Diffusion

e Carbon dioxide

f No nucleus to allow for more oxygen to be carried, biconcave shape helps them fit through small blood vessels

g Their lungs are damaged so they find it harder to get enough oxygen into their bloodstream.

46 a Pairs of muscles that oppose each other's action, so when one contracts, the other relaxes

b To reduce friction/stop the bones rubbing together

c Tendons

d … The intercostal muscles contract, moving the rib cage up and out. The volume of the lungs expands. The pressure in the lungs drops and air moves into the lungs.

e There is not enough oxygen so the muscles are respiring anaerobically. This makes lactic acid, which causes the burning sensation.

f The student's chemical energy store is reducing and the kinetic energy store is increasing.

47 a The breathing rate increases slowly at first, then rapidly.
It reaches a maximum at 16 minutes and then begins to decrease.

b Any answer after 4 minutes and up to and including 6 minutes, because the breathing rate begins to increase

c Minute 16, because the breathing rate drops afterwards

d They need more energy, so their rate of respiration increases. They breathe faster so that more oxygen can get to their muscles and maintain aerobic respiration.

e Lactic acid caused the burning feeling due to there not being enough oxygen and anaerobic respiration occurring.

B8 Ecosystems

B8.1 Food chains

What are food chains?

1 Which organisms eat each another

2 An organism that can make its own food

3 They eat other organisms

4 Direction nutrients and energy move

5 Dandelion → snail → frog → bird

6 a Plant plankton → animal plankton → herring → cod

b Producer – plant plankton, consumers – animal plankton, herring, cod

c The Sun

d It reduces the amount of energy the producer gets, so reduces the food for the rest of the food chain.

7 No, because it cannot photosynthesise/it is not a plant

8 a Producers

b Photosynthesis

c Carbon dioxide + water → glucose + oxygen

d Chlorophyll

e Chloroplasts

f

Equation	image size = actual size × magnification
Values	image size = 6.4 mm actual size = ? magnification = ×800
Enter values	6.4 = actual size × 800
Result	actual size = 6.4 ÷ 800 = 0.008
Y(units)	actual size = 0.008 mm

What is bioaccumulation?

9 A chemical builds up as it passes up the food chain until it reaches toxic levels.

10 An organism that can make its own food

11 An organism that eats other organisms

12 Direction of movement of nutrients and energy

13 The Sun

14 Yes, because producers make their own food

15 a Oak tree

b Squirrel, wolf

c Oak tree → squirrel → wolf

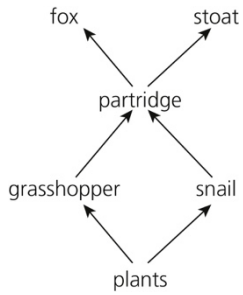
16 a Phytoplankton
b Three
c They are much larger/they need more energy than one shrimp can provide
d The shrimp are lower in the food chain and only feed on phytoplankton, which have the chemical only at low levels. However, the heron is eating sticklebacks, which have eaten many shrimp. This has caused the chemical to build up to toxic levels.

17 a The leaves are eaten by insects and the robin eats the insects. The chemical passes into the robin.
b As the robin eats many insects, the small amount of chemical in each one stays inside it and builds up.
c It takes time for the robin to eat enough insects that have eaten the sprayed plants.
d The robins will not have a dangerous level of chemical inside them so their numbers will increase.

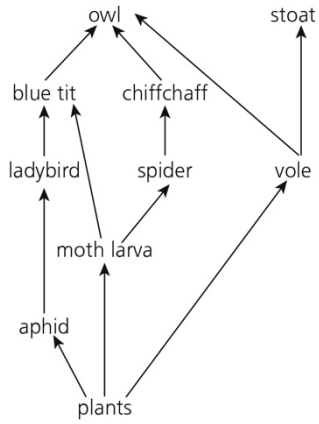
B8.2 Food webs and interdependence

What is interdependence?

18



19



20 a Oak tree
b Five
c Shrew and squirrel
d If there are fewer squirrels, the foxes might eat more shrews. This might reduce the food available for owls so they might starve.
e Increasing the number of oak trees might increase the populations of squirrels and caterpillars by providing more food. This might increase the population of shrews, which would provide more food for owls.
f The tree makes many acorns. The squirrels collect acorns and bury them to eat later. They forget where some are buried, and those acorns germinate into new oak trees.
g So the new plants do not compete for space, light and nutrients

How do predators and prey demonstrate interdependence?

21 Predator

22 An animal that eats only plants

23 Plants and animals

24 There is less food for them to eat.

25 There are fewer predators to hunt them.

26 No, prey can also be carnivores and omnivores.

27 For example:
- a … if the number of one changes, the other is affected.
- b … a predator might eat more than one type of prey.
- c … we can help conserve a population of predators by maintaining the population of prey.

28 a Cod, ringed seal, harbour seal, killer whale, polar bear

b Two from:
Plankton → cod → harbour seal → killer whale
Plankton → cod → ringed seal → polar bear
Plankton → cod → harbour seal → polar bear
Plankton → cod → ringed seal → killer whale

c Ringed seal, polar bear, harbour seal, killer whale

d Ringed seal, polar bear, harbour seal, killer whale

e Decreasing harbour seals reduces the food for polar bears and killer whales. Therefore they may eat more ringed seals, reducing their numbers.

f When the ringed seal population increases, there will be more food for the polar bears so their number increases. If the number of polar bears increases, they will hunt more ringed seals. This may reduce the available food later on and the polar bears might starve and reduce in numbers.

How can we estimate the population of a species?

29 Because counting each individual species would take too long

30 A population

31 The correct order is:
- Count the number of a species in a grid square.
- Repeat for more than one sample grid.
- Calculate a mean.
- Multiply by the total area of the land being studied.
- Obtain an estimate of population.

32 They are wrong, because sampling only gives an estimate. The exact number will be different.

33 For example:
- a … it would take too long to count each individual.
- b … it only provides us with an estimate, not the actual number.
- c … ecologists can monitor the effects that changes in the environment have on a particular species.

34 a 3 × 12 = 36 sheep

b 11 × 12 = 132 sheep

c (3 + 11) ÷ 2 = 7
7 × 12 = 84 sheep

d 84 sheep is better because it is not too big or too small like the others.

What is an adaptation?

35 Thick fur, extra body fat, thick legs, small ears

36 So it can hunt prey

37 To prevent heat loss

38 To store fat for respiration and to make water

39 Long eyelashes

40 Spines

41 To prevent water loss

42 No, because a camel is not a predator

43 For example:

a … it allows them to survive in their habitats.

b … they may not be able to adapt if their habitats change quickly.

c … we need to conserve their habitats so they can survive.

44 a To listen out for predators, to keep cool

b Predator, carnivore

c Grass → grasshopper → fennec fox

d Increasing grass provides more food for grasshoppers, which might increase in number. This provides more food for foxes so they might increase in number too.

e The Arctic fox lives in a cold environment so it has small ears to prevent heat loss. The fennec fox lives in hot conditions so its ears are much bigger than those of the Arctic fox; this allows it to lose heat from them and stay cool.

f To insulate the fox, to camouflage it

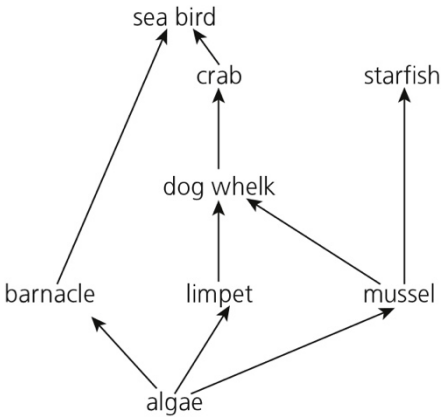
45 The cactus has a thick, waxy cuticle to prevent water loss and a swollen stem that can store water. It also has spines instead of leaves, which reduce water loss.

46 a Ova, pollen

b Seed

c The seeds have adaptations that allow them to be blown away from the parent cactus. When the seeds land, they can germinate away from the parent.

47 a



b Sea bird, starfish, dog whelk, crab

c Increasing the number of mussels might provide more food for dog whelks.

d Increasing the number of crabs might provide more food for sea birds, so they eat fewer barnacles.

e **i** It might increase their numbers because there will be fewer starfish to eat them.

ii If the number of mussels increases, it means more food for dog whelks so their numbers might increase.

iii More dog whelks might lead to an increase in the number of crabs, as they will have more food.

iv More crabs might lead to an increase in the population of the sea birds, as they will have more food.

f **i** It might reduce the population of dog whelks as more will be eaten.

ii There might be fewer of the original type of crab as they have fewer dog whelks to eat.

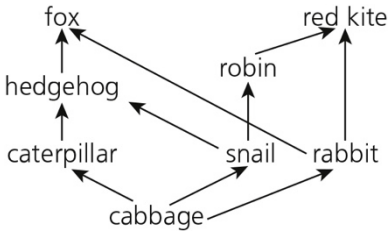
iii The number of sea birds might be reduced, as the new type of crab is not food for them, and the number of the original type of crab might decrease.

iv As the sea birds have fewer crabs to eat, they might eat more barnacles, reducing the size of the barnacle population.

g The algae could absorb small amounts of mercury. This could pass up the food chain, bioaccumulating until it reaches the sea birds.

h The sea birds eat many crabs and barnacles, which have eaten many algae (and dog whelks in the case of the crabs), so the bioaccumulation of mercury occurs.

48 a



b Increasing the number of rabbits might provide more food for foxes so they eat fewer hedgehogs.

c **i** Hard shell

ii Protects them from predators

d This is wrong because robins also eat snails.

e So they can listen for predators

f Spines to protect them from predators

g i If there are fewer rabbits there is less food for foxes, so the population might decrease.

ii The foxes might eat more hedgehogs so it might reduce the population of hedgehogs.

h i The leaves

ii Respiration and growth

49 a i To be camouflaged in the desert

ii To be camouflaged in the jungle

b i Plants → locust → bearded dragon

ii Plants → locust → bearded dragon → dingo

iii Plants should be labelled 'producers' and locust, bearded dragon and dingo should be labelled 'consumers'.

c i So they are camouflaged to hunt

ii So they can eat bearded dragons/because they are carnivores

d i If there are fewer locusts, there is less food for bearded dragons. This might reduce the population of bearded dragons, which will provide less food for dingoes, so the dingo population might be reduced.

ii The plants are eaten by locusts and the insecticide is taken in too. The locusts then pass it on to bearded dragons when they are eaten. The dingoes eat many bearded dragons so the insecticide can build up in them.

iii It takes time for the insecticide to pass up the food chain and accumulate in the dingoes, as they have to eat many bearded dragons.

B8.3 Insect pollination and food security

Why are insects important to food security?

50 The ability to provide enough nutritious food for everyone

51 Bees

52 Pollen

53 Ovum

54 Fertilisation

55 Zygote

56 Bright-coloured flowers, nectar, scent

57 The pollen grows a tube down to the ovum in the ovary and fertilises it. As the embryo develops the ovary grows into a fruit.

58 No, bees try to drink the sweet nectar

How are insects being harmed and what can we do to help them?

59 Habitat destruction, use of pesticides

60 As the number of flowers increases, the number of bees increases.

61 If the pesticides are banned, fewer bees will die so the population will increase.

62 Plant more flowers, let grass grow longer, ban pesticides that harm bees

63 No, because only some pesticides kill bees

64 a How does the amount of pesticide used affect the size of the bee population?

b The amount of pesticide used

c The size of the population of bees

d So they can estimate the population of bees across the whole country/Some areas might have more bees than others

65 a Rose → bee → crab spider → robin

b Bee, crab spider

c Crab spider, robin

d The pesticide will reduce the population of bees, so there will be less food for crab spiders. As the crab spiders die, there will be less food for robins so they will starve.

66 a They make their own food by absorbing sunlight.

b Carbon dioxide + water → glucose + oxygen

c Chlorophyll

d Chloroplasts

e Nucleus, cytoplasm, cell membrane, mitochondria, ribosomes

f Provides strength and support for the plant cell

g Palisade (mesophyll)

h To allow oxygen to leave and carbon dioxide to enter/gas exchange

i To prevent water loss

j

Equation	image size = actual size × magnification
Values	image size = 6.7 mm actual size = ? magnification = ×1200
Enter values	6.7 = actual size × 1200
Result	actual size = 6.7 ÷ 1200 = 0.005 583
Y(units)	actual size = 0.0056 mm

67 The seeds are released and catch the wind. They float far from the parent plant and land on the ground where they can grow.

68 a 3.53 million

b 2.34 million

c 1.19 million

d (1.19 ÷ 3.53) × 100 = 33.71%

e Loss of habitat, use of pesticides

f No, because this is the number of colonies, each of which has many bees.

g We are protecting their habitats by planting more flowers and some pesticides have been banned.

B9 Inheritance

B9.1 DNA and chromosomes

What is a gene?

1 A Nucleus
B Chromosome
C DNA
D Gene

2 In the nuclei of our cells

3 The process by which genetic information is transmitted from one generation to another

4 Two from, for example: Height, eye colour, blood group, type of hair

5 A long chain of coiled DNA

6 They code for a protein.

7 They receive half of their DNA from their father and the other half from their mother.

8 Sperm

9 Ovum

10 The different siblings receive a different set of genes from each of their parents.

11 Fertilisation

12 Ovaries

13 Testes

14 For example: Lots of mitochondria, a tail to swim to the ovum

Where do humans' 46 chromosomes come from?

15 46

16 23 in each

17 a It has halved.
b So that when they join together at fertilisation, the zygote has the correct number of chromosomes

18 27

19 Because half have come from the mother and the other half have come from the father. This means the chromosome number is double that found in sperm/ovum cells.

20 a Nucleus
b More genes
c Chromosome 1 is much longer than chromosome 22, so it is made of more DNA and will likely have more genes on it.

21 a 38 chromosomes (allow any answer between 35 and 40)
b Potato
c 33 chromosomes (allow any answer between 32 and 34)
d No they are not correct, as shrimp are very small but have the highest number of chromosomes.

22 Two from, for example: Height, skin colour, eye colour, hair type

23 15

24 No they are not correct, as we inherit half of our chromosomes from our mother and the other half from our father.

25

Equation	image size = actual size × magnification
Values	image size = ? actual size = 0.002 mm magnification = ×400
Enter values	image size = 0.002 × 400
Result	image size = 0.8
Y(units)	image size = 0.8 mm

How did we discover the structure of DNA?

26 James Watson, Francis Crick, Maurice Wilkins and Rosalind Franklin

27 Double helix

28 Because of the new evidence of Photograph 51

29 For example: To see if it is accurate, if it makes sense or if there are any problems in the experiments

30 In a journal

31 It was not peer reviewed, so we cannot be sure if the results are accurate or correct.

32 a Nucleus
b Red blood cells
c Half
d Tail to swim to the ovum, lots of mitochondria, enzymes to get to the middle of the ovum
e

Equation	image size = actual size × magnification
Values	image size = 0.06 mm actual size = ? magnification = ×120
Enter values	0.06 = actual size × 120
Result	actual size = 0.06 ÷ 120
Y(units)	actual size = 0.0005 mm

33 It cannot code for proteins.

34 a For growth and repair
b In the small intestine
c Two from, for example: Meat, cheese, eggs, beans

35 Scientists write about their experiments and theories, other scientists check these, and the journal publishes the findings.

36 Gene, chromosome, nucleus, cell

37 78

38

Equation	image size = actual size × magnification
Values	image size = 0.007 mm actual size = ? magnification = ×500
Enter values	0.007 = actual size × 500
Result	actual size = 0.007 ÷ 500
Y(units)	actual size = 0.000 014 mm

39 Other scientists check their claim and if confirmed the journal publishes the results.

B9.2 Variation

What is variation?

40 The differences between organisms

41 a Genes
b Genes and environment
c Genes and environment
d Genes
e Environment

42 46

43 29

44 Cell, tissue, organ, organ system, organism

45 Ovum

46 Environment, because it was caused by exposure to sunlight

47 Environment, because it is caused by a lack of water

48 Genes, because the leaf shape is determined by the genes it inherits from the parent plants

49 Chickenpox is caused by an infection and is not passed on by genes.

50 Zygote

What are the two types of variation?

51 Both genes and environment

52 Genes

53 a Continuous
b Discontinuous
c Discontinuous
d Continuous
e Continuous
f Continuous
g Discontinuous
h Discontinuous
i Continuous

54 Bar chart

55 Diet can affect a person's height so even if someone has tall parents, they may not be tall because of their diet.

56 Proteins

57 Nucleus

58 Long chains of coiled DNA

59 They are not caused by your genes.

60 12

61 Fertilisation

62 Discontinuous variation

63 Variation

64 Continuous

65 When the sperm fertilises the ovum, the resulting zygote will have the correct number of chromosomes.

66 a Three from: Body size, length of body, hair colour, size of tail, size of ears, etc.
b There is variation in dogs because of which genes they inherit from their parents.
c From both its parents and its environment
d It may inherit fast running but its environment and diet can influence how fast it runs.

67 Foot size variation is caused by both genes and the environment because you can inherit larger or smaller feet but your diet can also affect foot size.

B9.3 Competition and natural selection

Why is competition necessary?

68 Food, mates, territory

69 Light, water, minerals, space

70 To survive, reproduce and pass on genes

71 A polar bear that is better at swimming will be more likely to survive as the ice melts, because it can swim to regions of ice better than bears that are not very good at swimming.

72 Territory

73 Mates

74 a It can absorb more sunlight and can therefore photosynthesise more.
b It can survive longer and so reproduce to make more offspring.

75 Water, minerals, space

76 a So that it had a larger surface area to reduce pressure, allowing it to walk easily on muddy surfaces
b They could walk more easily on less muddy surfaces and so they were more likely to survive.
c They were more likely to survive longer and reproduce.

77 a They are camouflaged against brown bark.
b So they can kill the squirrel/eat the flesh of the red squirrel easily
c Acorn → red squirrel → pine marten
d They do not have to compete with each other for food, mates or territory.
e The population of red squirrels would decrease as they contract the disease and die.
f Food (acorns)
g The population of red squirrels will decrease over time.
h Red squirrels will mate less.

78 a Strong teeth means horses can chew plants more easily than horses that do not have strong teeth.
b The thick fur means they can keep warmer in cold areas compared to horses with less thick fur.
c Tall horses can reach food that is higher up and so they may be able to find more to eat and survive for longer.

What is natural selection?

79 Charles Darwin

80 The best adapted to the environment

81 Plant C, because it has the longest roots

82 Mates, food, territory

83 a Yellow bearded dragons
b The population of yellow bearded dragons would decrease as they would not be well camouflaged.

84 Bigger squirrels were more likely to survive during the winter, and so they were more likely to reproduce and increased in number over time. The smaller grey squirrels were less likely to survive and so did not reproduce as much. Over time, the number of bigger grey squirrels increased while the number of smaller grey squirrels decreased.

85 a Phytoplankton → shrimp → cod → penguin
Phytoplankton → shrimp → penguin
Phytoplankton → shrimp → squid → penguin
b The Sun
c The population of penguins would decrease.
d The population of cod could increase (because there are fewer penguins to eat them).
e The penguins that survive will not have as many other penguins to compete with for food.
f Penguins with stronger wings can swim better and so are more likely to survive and reproduce.
g Mercury will be taken up by phytoplankton and will then pass up the food chain until it reaches penguins.
h Penguins are higher up in the food chain, and each animal in a food chain eats many of the organism below it. This means the mercury accumulates as it moves through from phytoplankton to shrimp to cod and to the penguin.

86 Continuous variation

87 False. Adult horses cannot grow their legs to survive. Those with longer legs will be more likely to survive than those with shorter legs.

B9.4 Biodiversity

How are organisms categorised into groups?

88 Carl Linnaeus

89 Vertebrates have a backbone and invertebrates do not.

90 Animals, plants, fungi, prokaryotes, protoctists

91 Any suitable example, e.g. frogs

92 So scientists can study and understand organisms better and can communicate about them more easily

93 They are wrong because snakes have a backbone and so are vertebrates.

94 a Animals, invertebrates

b Sperm

c No, because having a backbone is controlled by genes and offspring of a crab cannot inherit a backbone

d Yes, because claws are also controlled by genes and so the offspring of a crab will inherit claws

What is biodiversity?

95 The rainforest

96 To keep up the food supply, to avoid affecting food webs, some species are useful for medicines, for moral reasons

97 Organisms that have similar characteristics and can reproduce to produce fertile offspring

98 The poodle and the Great Dane can reproduce to produce fertile offspring, so they belong to the same species.

99 They should look in the rainforest as it has many different species and so the chance of finding plants with new medicinal uses is high.

100 This decreases biodiversity because one of the species in the area (tigers) will no longer be there.

101 a Birds

b Plants → apple snails → snail kites

c The population of apple snails will decrease as they die due to the disease.

102 The different colours allow the snails to camouflage so they cannot be seen as easily in their environment.

103 a Photosynthesis

b Stomata

c Lots of chloroplasts for more photosynthesis

d Diffusion

e Pollen and ova

f The ovary turns into a fruit.

g For example: Attached to animal fur, eaten and excreted out by animals

h Yes, they belong to the same species because they can produce fertile offspring.

i Discontinuous variation

j

Equation	image size = actual size × magnification
Values	image size = 0.04 mm actual size = ? magnification = ×500
Enter values	0.04 = actual size × 500
Result	actual size = 0.04 ÷ 500
Y(units)	actual size = 0.000 08 mm

How do organisms become extinct?

104 When no more of a species exists

105 For example: New predators, competition with better adapted species, loss of habitats

106 The species does not have space to live, grow and reproduce safely so its numbers will reduce over time.

107 A Critically endangered
B No concern
C Extinct
D Critically endangered
E No concern

108 For example: Competition with better adapted species

109 They probably belong to two different species.

110 It will decrease.

111 Endangered

112 **a** Pollen
b Ovum
c Fertilisation
d Water, minerals
e Carbon dioxide + water → glucose + oxygen
f Extinct

How do we maintain biodiversity?

113 **a** Decrease
b Increase
c Decrease
d Decrease

114 **a** The range of different species in an area
b The oryx is kept safe and as breeding is successful, their numbers will increase, which means the species will survive.
c Oryx with larger feet are more likely to survive, reproduce and pass on their genes. Over time, their numbers will increase compared to oryx with smaller feet.

115 It is very cold this far north of Scotland, which keeps the seeds in the seed bank safe.

116 **a** Plants → beavers → foxes
b As beavers live partially in water, having waterproof fur means they are more likely to stay warm and survive.

117 This is so the animals can breed together.

118 Measure the area of the field. Randomly place the quadrat on the field and count the number of plants in the quadrat. Repeat at least 10 times and calculate a mean number of plants per square metre. Multiply the mean by the area of the field to estimate the population size of the plants.

119 Organisms that have similar characteristics and can reproduce to produce fertile offspring

120 **a** Phytoplankton → zooplankton → small fish → tuna → shark

b Toxins can accumulate as they move up a food chain. As tuna is higher up than small fish in the food chain, it has more toxins in its body.

c The population of small fish will increase as fewer will be eaten by tuna. This means that the population of zooplankton will decrease as there are more small fish to eat them.

121 **a** Photosynthesis

b They contain chlorophyll.

c Spongy mesophyll layer

d Space, minerals, water, light

e Lower, because it only has one species of plant growing whereas a forest will have many species of plants and animals growing and living there.

122 Large surface area, moist membranes, good blood supply, membranes are one cell thick

123 They reduce in number and could become extinct.

124 Plant cells, animal cells, fungi

125 Fertilisation

126 Chromosome

C6 The Periodic Table

C6.1 Properties of metals and non-metals

1 Two from: Malleable, good electrical conductors, good thermal conductors, high melting and boiling points

2 Two from: Brittle, poor electrical conductors, poor thermal conductors, low melting and boiling points

3 118 (92 naturally occurring)

4 Metal, because metals are good thermal conductors

5 Metal, because metal oxides are basic and react with acids to give a neutral solution

6 118 (92 naturally occurring)

7 A substance made of only one type of atom

8 The temperature at which a substance melts

9 a Bases
b Salt and water
c Green
d 7
e Less than 7
f More than 7
g A substance with a pH between 6 and 7 or between 0 and 1 is still an acid.

10 There are strong forces of attraction between the particles, so they cannot move over each other.

11 They do not allow electricity to pass through them.

12 a Malleable
b Plastic is a non-metal, and non-metals are brittle.
c They are stronger than pure metals.

13 Temperature change, light or flame produced, change of colour, effervescence, precipitation of a solid

14 Non-metal + oxygen → non-metal oxide

15 a i Oxidation
ii Zinc + oxygen ⟶ zinc oxide
iii $2Zn(s) + O_2(g) \longrightarrow 2ZnO(s)$
iv It is a metal oxide and metal oxides are basic.
v Add universal indicator and see if it turns blue or purple, or react it with an acid to see if it forms a neutral solution.

b i A neutral solution forms/A neutralisation reaction happens.
ii Zinc chloride and water
iii Zinc oxide + hydrochloric acid ⟶ zinc chloride + water
iv $ZnO(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2O(l)$
v Neutralisation
vi New substances are formed.
vii Exothermic

16 a Metal is a good conductor for the electricity to flow through. Plastic is a good insulator and will prevent you getting an electric shock.
b It is (more) expensive (than copper).
c Two from: Malleable, good thermal conductor, high melting/boiling point

17 For example:
a … they are good thermal conductors.
b … non-metals are not.
c … they are good thermal insulators.
d … would not be suitable for the whole saucepan.

18 It is a poor thermal conductor/It is a good thermal insulator.

19 a Sulfur + oxygen → sulfur dioxide
b i Sulfur and oxygen
ii Sulfur dioxide
iii Sulfur dioxide
iv Sulfur and oxygen
c Red/orange/yellow
d There are two atoms of the element (oxygen).
e Do it in a fume cupboard; do not breathe the gas
f $S(s) + O_2(g) \rightarrow SO_2(g)$
g It is balanced.
h A colour change happens, a gas is formed
i Protons – 16, neutrons – 16, electrons – 16
j Brittle, poor thermal conductor, poor electrical conductor, low melting and boiling points

20 Most metals have high melting points.

21 Metal is a good thermal conductor and would not prevent heat loss from the house.

22 Steel is strong.

23 *Student answers will vary, but should contain reference to suitable properties of metals and why these properties are relevant. Ignore reference to metals being 'heavy'. An example is included below.*

Submarines are best constructed from metals because metals are strong, so the submarine can withstand the forces of the water. Metals are also malleable, not brittle, so the submarine will not shatter. Metals can corrode, but they can be coated with paint or oil to prevent that from happening.

C6.2 Groups, periods, metals and non-metals

Who was Mendeleev and what did he do?

24 By atomic weight

25 By properties and atomic weight

26 He left gaps for undiscovered elements.

27 For undiscovered elements

28 The elements that went in the gaps were discovered.

29 The elements were discovered.

30 A regular pattern

31 a Iodine
b To keep the elements with their groups (of elements with similar properties)
c Tellurium has a lower atomic (proton) number.
d Tellurium: protons – 52; neutrons – 76; electrons – 52
Iodine: protons – 53; neutrons – 74; electrons – 53
e Chadwick

32 a 1
b Alkali metals
c 4
d Malleable, strong, hard, high melting and boiling point, good thermal and electrical conductor
e Potassium is highly reactive. (It is also actually quite soft and has a fairly low melting point.)
f One
g They all have one electron in their outer shell.
h i Potassium + water → potassium hydroxide + hydrogen
ii Evaporate off the water.
iii The potassium hydroxide is dissolved in the water and will pass through the filter.

What is the trend in reactivity down Group 1?

33 Pattern

34 For example:
a … they have similar properties.
b … potassium is more reactive than sodium.
c … they have the same number of electrons in their outer shell.
d … sodium is bigger than lithium, so it loses its outermost electrons more easily.
e *Student answers will vary. Accept any scientifically correct response.*
f *Student answers will vary. Accept any scientifically correct response.*

35 They lose one electron.

36 Increases down the group

37 Outer electrons get further away from the nucleus, which means it is easier to lose them.

38 a Extremely reactive, because the outer electron is very far away from the nucleus, so it is very easy for caesium to lose that electron
b Metal
c Either malleable, strong, hard, good conductor, high melting and boiling points; or soft, highly reactive, relatively low melting and boiling point, as per other alkali metals
d Caesium is in Group 1.

39 a Four from: oxidation, reduction, neutralisation, displacement, combustion

b A reaction where a more reactive element takes the place of a less reactive element in a compound

c i Neutralisation

ii Displacement

iii Reduction (of CuO), displacement, oxidation (of C)

iv Thermal decomposition

v Oxidation/combustion

vi Neutralisation

What is the reactivity of the Group 0 elements?

40 Increases down the group

41 For example:

a … they have similar properties and the same number of electrons in their outer shell.

b *Student answers will vary. Accept any scientifically correct response.*

c *Student answers will vary. Accept any scientifically correct response.*

d … chlorine is bigger and so it is harder for it to gain electrons than it is for fluorine to do so.

e … more reactive than bromine.

f *Student answers will vary. Accept any scientifically correct response.*

42 They gain one electron.

43 Decreases down the group

44 Atoms get larger, which means it is harder for them to attract and gain one electron.

45 a Unreactive, because it is hard to gain that electron

b Astatine forms

c Astatine and potassium chloride

d Potassium astatide + chlorine → astatine + potassium chloride

e Chlorine, astatine

f Potassium chloride, potassium astatide

g Solid

h Soft, brittle, weak, low melting and boiling point, poor thermal and electrical conductor

46 Increases down the group

47 a Liquid

b 4

c Vibrate around a fixed position

48 a i Chlorine + lithium bromide ⟶ lithium chloride + bromine

ii Will not occur

iii Fluorine + strontium bromide ⟶ strontium fluoride + bromine

iv Will not occur

v Will not occur

vi Will not occur

vii Calcium bromide + chlorine ⟶ calcium chloride + bromine

viii Will not occur

ix Copper chloride + fluorine → copper fluoride + chlorine

x Zinc iodide + bromine → zinc bromide + iodine

b i $Cl_2 + 2LiBr \rightarrow 2LiCl + Br_2$

ii Will not occur

iii $F_2 + SrBr_2 \rightarrow SrF_2 + Br_2$

iv Will not occur

v Will not occur

vi Will not occur

vii $CaBr_2 + Cl_2 \rightarrow CaCl_2 + Br_2$

viii Will not occur

ix $CuCl_2 + F_2 \rightarrow CuF_2 + Cl_2$

x $ZnI_2 + Br_2 \rightarrow ZnBr_2 + I_2$

c Displacement

d i Fluorine + sodium chloride → chlorine + sodium fluoride

ii $F_2(g) + 2NaCl(aq) \rightarrow Cl_2(g) + 2NaF(aq)$

iii Fluorine and chlorine are both toxic gases.

iv Do it in a fume cupboard.

49 Very unreactive

50 Very unreactive

51 They have full outer shells, so do not need to lose or gain electrons.

52 **a** A gas is formed, which escapes.

b Chemical reactions form new substances, but physical changes do not.

c A gas is formed, which is a new substance.

d You do not know what the products will be and they could be hazardous. The reaction could be explosive or produce a lot of heat or flames.

e i pH 3–5

ii Acids

f i 100.005 g

ii The mass of the powder and the liquid together adds up to 100.005 g. (5 mg is 0.005 g.)

iii The mass of all the reactants is equal to the mass of all the products.

g Bubble the gas formed through lime water. If the lime water turns cloudy, the gas is carbon dioxide. Collect the gas in a boiling tube. Hold a lit splint near the mouth of the tube. If there is a squeaky pop, the gas is hydrogen. Hold a glowing splint near the mouth of the boiling tube. If it relights, the gas is oxygen.

C7 Materials

C7.1 Metal reactivity

1 Three from: High melting and boiling point, hard, strong, malleable, good thermal and electrical conductor

2 Gas is formed, change of colour, change of temperature, light or flame produced, precipitation of a solid

3
- a Magnesium + hydrochloric acid → magnesium chloride + hydrogen
- b Zinc + sulfuric acid → zinc sulfate + hydrogen
- c Hydrochloric acid + potassium → potassium chloride + hydrogen
- d Aluminium + nitric acid → aluminium nitrate + hydrogen
- e Nitric acid + nickel → nickel nitrate + hydrogen
- f Sulfuric acid + lead → lead sulfate + hydrogen
- g Hydrochloric acid + magnesium → magnesium chloride + hydrogen
- h Nitric acid + iron → iron nitrate + hydrogen
- i Titanium + sulfuric acid → titanium sulfate + hydrogen
- j Sulfuric acid + cobalt → cobalt sulfate + hydrogen

4 A list of metals in order of their reactivity

5 By reacting them with a substance and seeing how vigorous the reaction is or which substances are displaced

6 A substance with a pH less than 7

7 A substance with a pH of 7

8 A substance with a pH greater than 7, or a substance that neutralises an acid

9 A soluble base

10
- a Magnesium, because it reacted and the copper did not
- b Magnesium + oxygen → magnesium oxide
- c $2Mg + O_2 \rightarrow 2MgO$
- d Reactants – Mg + O_2, products – MgO
- e A gas from the air (oxygen) is added. The mass of the oxygen can only be recorded once it has bonded with the magnesium.
- f Magnesium has gained oxygen.
- g High melting and boiling point, hard, strong, malleable, good thermal and electrical conductor
- h Soft, brittle, poor thermal and electrical conductor, low melting and boiling points
- i Magnesium oxide is a compound and compounds have different properties from their constituent elements.

11 Mendeleev's Periodic Table would have gaps.
Mendeleev's Periodic Table was organised by atomic weight, whereas today it is organised by atomic number.

12
- a Magnesium; zinc; copper
- b The acid might affect the results, which would mean it is not a fair test.
- c Volume of acid, concentration of acid, temperature of reactants, mass of metal

d Magnesium + hydrochloric acid → magnesium chloride + hydrogen
Zinc + hydrochloric acid → zinc chloride + hydrogen

e Temperature increased, bubbles showing a gas is formed

f A new substance (the gas) is formed.

g Exothermic, because the temperature increased

13 a Potassium – more, gold – less

b Sodium – more, platinum – less

c Magnesium – more, lead – less

d Iron – less, aluminium – more

e Gold – less, lead – more

f Silver – less, calcium – more

g Lead – less, zinc – more

h Zinc – more, iron – less

i Copper – more, silver – less

j Potassium – more, sodium – less

14 a i Yes
ii No
iii No
iv No
v Yes
vi No
vii No
viii Yes
ix No

b i Magnesium oxide + calcium → calcium oxide + magnesium
ii Will not occur
iii Will not occur
iv Will not occur
v Zinc + copper chloride → zinc chloride + copper
vi Will not occur
vii Will not occur
viii Carbon + lead iodide → carbon iodide + lead
ix Will not occur

15 a Sodium + calcium chloride → calcium + sodium chloride

b The more reactive metal has taken the place of the less reactive metal in a compound.

c Elements – sodium, calcium
Compounds – calcium chloride, sodium chloride

d If sodium was less reactive than calcium, the reaction would not happen.

e We cannot know if the student is correct, because we can only compare the reactivity of the metals in this way.

16 a C, D, B, A

b Hydrogen

c For example:

Metal	Observation
A	No change
B	Slight fizzing
C	Violent fizzing
D	Fizzing

d Type of metal

17 a Not concentrated

b Calcium, magnesium, zinc, iron, copper, silver
(This is the correct order, though you cannot tell just from the table which of copper and silver is more reactive.)

c How they react

d Type of metal

e How does the type of metal affect its reaction with water and with acid?

f Use a displacement reaction and see which metal displaces which.

g Very violent

h It would be dangerous.

C7.2 Metal extraction with carbon

18 Removal of oxygen from a compound

19 Oxygen has been removed from the magnesium.

20 A rock containing metal (A rock containing enough metal to make it worthwhile/profitable to extract this metal)

21 Lithium is more reactive than carbon and therefore carbon cannot displace lithium from its compounds.

22 a Potassium, because it is the most reactive

b Potassium is very reactive and it could be unsafe.

23 a Gold, zinc, lead, iron, copper

b Carbon is more reactive than these metals, so it can displace them from their compounds.

24 a Units in the table instead of in the headers, copper's symbol is given as Co not Cu, iron's symbol is given as I not Fe

b 17.5 °C

c Calcium, magnesium, iron, copper – the bigger the temperature rise, the more reactive the metal.

d Three from: volume of acid, concentration of acid, mass of metal, starting temperature, type of acid

e Thermometer

f Between 8.1 and 15.0 °C

g Is aluminium more or less reactive than carbon?

h It decreases.

i Bar chart
j Type of metal is categoric/discrete data
k Iron, copper
l 25.4 °C (Test 2)
m It is a random error because it is a single wrong value.

25 Copper is less reactive than lithium so cannot displace it from its compounds.

26 a Which metals are the most reactive?
b Type of metal
c Speed at which a volume of gas is produced
d Concentration of acid, mass of metal, temperature of acid, volume of acid, type of acid
e Gas syringe or upturned measuring cylinder and stopwatch
f *Student answers will vary but should include the following:*

- *Measure a given volume of acid using an appropriately named piece of measuring apparatus, e.g. 5 cm^3 with a measuring cylinder.*
- *Add the acid to an appropriate reaction vessel, e.g. a boiling tube.*
- *Measure a given quantity of named metals. (Do not accept 'amount'.)*
- *A sensible method for measuring the rate of gas produced, e.g. timing until a set volume is produced, measuring the volume of gas produced in a given time, using a balance to find the mass decrease in a given time or the time taken to reach a stated mass decrease. Equipment stated should relate to the method chosen, e.g. using a delivery tube and trough or gas syringe for gas collection methods, or using a conical flask as reaction vessel for mass decrease methods.*

g

Metal	Time taken to produce [volume] of gas OR Volume of gas produced in [time] *(depending on method chosen)*

27 a $Fe_3O_4 + 2C \rightarrow 2CO_2 + 3Fe$
b Carbon
c Removal of oxygen from a compound
d Iron
e Iron ore is heated with carbon in a blast furnace. The iron ore is reduced using carbon. The carbon displaces the iron from the ore, producing iron and carbon dioxide.

28 a i Made of only one type of element or compound
ii No, as long as the impurities are few, because there will be enough water for the reaction to take place and the impurities are unlikely to affect the results.
b i Fizzing, the sodium floating on the water
ii Sodium + water → sodium hydroxide + hydrogen
iii $2Na + 2H_2O \rightarrow 2NaOH + H_2$
iv 7
v Green
vi Any value greater than 7
vii Blue or purple
viii A gas is formed, which escapes.

ix Exothermic, because energy has been released
x Sodium is more reactive than carbon, so carbon cannot displace it from its compounds.

c i Lithium is less reactive, so the reaction will not be as vigorous/fast.
ii Lithium is higher up the group, so the outer electron is closer to the nucleus. This means it is harder for lithium to lose that electron.
iii Alkali metals

d i A bigger mass will cause a bigger reaction, so the two reactions could not be compared.
ii A balance
iii A very slight/slow reaction
iv Three from: Malleable, strong, hard, high melting and boiling point, good thermal and electrical conductor

C7.3 Ceramics, polymers and composites

29 Three from: Brittle, good thermal insulators, good electrical insulators, strong when compressed, high melting and boiling point

30 Two from: Bricks, crockery, porcelain sinks

31 High melting and boiling point/Good thermal insulator

32 a i Lithium oxide
ii Aluminium oxide
iii Potassium oxide
iv Sodium oxide
v Magnesium oxide
vi Iron oxide
vii Calcium oxide

b Iron oxide
c Iron is less reactive than carbon so can be displaced from its compounds using carbon.
d Oxidation is the addition of oxygen to an element to form a compound. The removal of oxygen is reduction.
e There are three iron atoms for every four oxygen atoms.
f Seven

33 a Potassium oxide and zinc
b Potassium
c Zinc
d New substances are formed.
e You do not need to react a substance with carbon to reduce it. Reduction is just the loss of oxygen.

34 Ceramics are good thermal insulators.

35 Ceramics are good for making mugs as they are thermal insulators but not very good for travel cups as they are brittle and could break.

36 a It is strong when compressed.
b Porcelain is very heavy and planes and other vehicles need to be as light as possible.

37 a Metals
b Ceramics are good electrical insulators.

38 A long-chain molecule made of repeating units

39 A single repeating unit in a polymer

40 They can be moulded into shapes, they are insulators, they are unreactive.

41 For example: Poor electrical conductors, poor thermal conductors, brittle, unreactive, solids at room temperature

42 a One that has bonds between the layers

b It would burn.

43 a One that does not have bonds between the layers

b It would melt.

44 Pure gold – good thermal conductor, very expensive
Polymer with no bonds – would melt, poor thermal conductor
Ceramic – poor thermal conductor
Steel – heavy, good thermal conductor

45 How does the type of polymer affect how the polymer behaves when heated?

46 a If it was too hot, the pykrete would melt.

b Concrete is very dense and the ship would sink.

c Reinforced concrete would not be a suitable material to make a ship from because it is too dense and would sink.

d It would melt.

47 It is cheap and lightweight.

48 a The concrete can support a lot of weight, and the steel rebar prevents it from crumbling in twisting conditions.

b i A mixture of two or more elements, at least one of which is a metal.

ii Snaps easily

iii Low-carbon steel

c The flexibility provided by the rebar would be gone and the concrete could crumble.

49 a They are too fragile and are not held together.

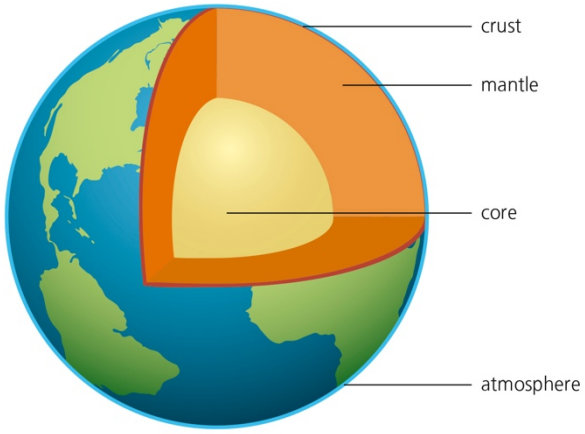
b It is lighter and easier to repair when damaged.

c Brittle, poor thermal conductor, poor electrical conductor

C8 The Earth and its atmosphere

C8.1 Composition and structure of the Earth

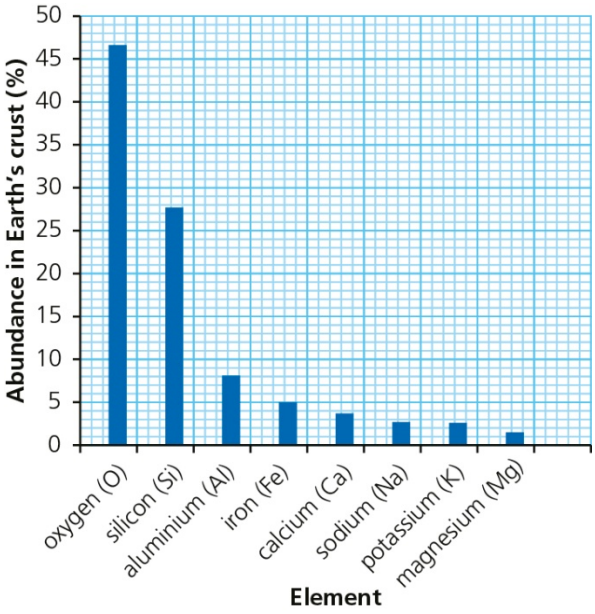
1



2 The crust

3 The crust and the atmosphere

4 **a**



b Oxygen and silicon

c 97.9%

d The rest of the elements make up the remaining 2.1%.

e For example, copper in wires, gold or silver in jewellery

f A substance made from two or more different types of elements chemically joined together

g i SiO_2
ii Two oxygen atoms to each one silicon atom
iii It cannot dissolve in water.
iv Liquid
v Sand is not pure silicon dioxide, it is a mixture of silicon dioxide and other substances.

h i Two aluminium atoms for every three oxygen atoms
ii Aluminium + oxygen → aluminium oxide; an oxidation reaction
iii Aluminium oxide + calcium → calcium oxide + aluminium; a displacement reaction

i Sodium is more reactive than carbon.

j Iron

5 For example:

a … they are less dense than the mantle.
b … they move around on the mantle/the mantle bursts through making volcanoes.
c … when the plates move there are earthquakes and formation of mountains.

C8.2 The rock cycle

What are metamorphic rocks?

6 Hot molten rock from under the ground cools and solidifies.

7 Other rocks are changed by heat and pressure under the ground over millions of years.

8 Igneous

9 It was formed under the ground where the magma cooled slowly, making large crystals.

10 Slate is impermeable and water cannot pass through it, so the water runs off the roof and the roof does not leak.

11 Granite is impermeable, which means water cannot pass through it, so rain does not drain down through the rocks.

12 a Neutralisation reaction
b Copper oxide + hydrochloric acid → copper chloride + water
c Acid is corrosive; use goggles while handling and heating
d pH 7
e Filtration
f Evaporate the solution slowly for large crystals.

What are sedimentary rocks?

13 Small particles of rocks are deposited at the bottom of rivers, lakes and oceans and are compressed together over time.

14 Soft and crumbly, porous, contain fossils

15 For example:

a … dead creatures can be trapped in the sediment layers.
b … they are not found in igneous rocks.
c … they can be used to age the fossils/they can be used to identify sedimentary rocks.

16 a 0.44 g
b Sedimentary, because metamorphic and sedimentary rocks are usually impermeable
c Porous/permeable

17 a Sedimentary
b Thermal decomposition
c Metamorphic
d Calcium carbonate ($CaCO_3$)

What is the rock cycle?

18 They would be melted and turned into molten rock.

19 a Igneous
b The crystals in the rock are large.

20 Weathering

21 Metamorphic

22

Type of rock	How is the rock type formed?	What properties/features do these rocks have?
Igneous	Molten rock from underground cools and solidifies.	Contain crystals Impermeable
Sedimentary	Small particles of rocks are deposited at the bottom of lakes and oceans and are then compressed together.	Porous Soft and crumbly Contain fossils
Metamorphic	Other rock types are changed by heat and pressure under the ground over millions of years.	Squashed, banded or layered Impermeable

23 Temperature change, light or flame produced, change of colour, effervescence, precipitation of a solid

24 Solid (s), liquid (l), gas (g), aqueous solution (aq)

25 The mass of all reactants is equal to the mass of all products.

26 Solutions with pH less than 7

27 Soluble bases with pH greater than 7

28 A chemical that changes colour depending on the pH of the solution

29 A process that releases energy into the surroundings

30 A process that takes in energy from the surroundings

31 a Methane + oxygen → carbon dioxide + water
b $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
c Combustion reaction
d Exothermic, because heat is released into the surroundings

C8.3 Composition of the atmosphere

32 a Argon (Ar)
b Group 0
c Zero, they all have a complete outer shell
d They are inert.
e It does not react with anything.

33 Nitrogen

34 N_2

35 a Element, because it only contains one type of atom (nitrogen)
b True, because it is just two nitrogen atoms chemically joined together

36 a Glucose + oxygen → carbon dioxide + water
b Glucose, oxygen
c Carbon dioxide, water
d To release energy from glucose

37 a Carbon dioxide + water → glucose + oxygen
b Carbon dioxide, water
c Glucose, oxygen
d To trap energy from the Sun in glucose

38 These reactions are the opposite of each other.

39 0.04%

40 The rate of respiration and photosynthesis was broadly the same, so carbon dioxide going into the atmosphere (from respiration) was matched by that leaving the atmosphere (in photosynthesis).

41 a Hexane + oxygen → carbon dioxide + water
b $C_6H_{14} + 9½O_2 \rightarrow 6CO_2 + 7H_2O$ **or** $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$
c Exothermic reaction
d Long-chain molecules made of smaller, repeating units

42 A more reactive element displaces a less reactive element from its compound.

43 Alkali metals

44 One

45 Halogens

46 Seven

47 The number of electron shells

48 Materials made from two or more different types of material

49 For example, reinforced concrete, fibreglass

50 Solid materials made by firing a starting material in a kiln

51 Two from: Strong, brittle, electrical insulators

C8.4 The carbon cycle

What is the greenhouse effect?

52 Greenhouse gases stop the heat from the Earth escaping into space and increase the Earth's average temperature.

53 Carbon dioxide, methane

54 Nitrogen, oxygen, argon

55 Energy from the Sun passes through the glass and makes the inside of the car warmer. The heat given off by the inside of the car is trapped by the glass windows of the car.

56 The particles move quickly and randomly in every direction until bumping into each other or their container

57 Can flow and can be compressed

58 Weak forces of attraction between the particles

59 The temperature when a substance changes from a liquid to a gas

60 It stays the same.

61 Gas particles colliding with the surface of a container

62 Temperature, size of the container, number of gas particles

63 They move faster.

What is the carbon cycle?

64 Carbon dioxide (CO_2)

65 Photosynthesis

66 Respiration

67 a Photosynthesis: carbon dioxide + water ⟶ glucose + oxygen
Aerobic respiration: glucose + oxygen ⟶ carbon dioxide + water

b They have all the same substances, but they are opposites. The products of one reaction are the reactants of the other.

68 Dead animals and plants are crushed under rocks over millions of years and turn into fossil fuels.

69 Both are changed by heat and pressure underground over millions of years.

70 Methane + oxygen ⟶ carbon dioxide + water

71 Greenhouse gases trap some of the Earth's heat, stopping it from escaping the Earth.

72 Carbon dioxide, methane

73 a Deforestation

b Increased combustion of fossil fuels and trees

c Carbon dioxide levels in the atmosphere have increased.

74 C

75 a Six
b Six
c Six
d Protons and neutrons
e 2,4

76 Air is a mixture of nitrogen, oxygen, argon and small amounts of other substances.

77 (Fractional) distillation

78 Fuel, heat, oxygen

79 a Water
b 13.5 g

80 a Water
b Carbon dioxide
c Weak acid, because non-metal oxides are acidic

What is global warming and climate change?

81 An increase in the average global temperature caused by increasing amounts of greenhouse gases in the atmosphere

82 Greenhouse gases (methane and carbon dioxide)

83 A change in weather patterns

84 Global warming

85 Three from: Droughts, storms, floods, high winds, snowstorms, heatwaves

86 Climate change changes weather patterns. In some places in the world there can be floods due to extreme storms, while in other places there may be a lack of rain causing a drought.

87 a Land–ocean temperature fluctuates more than CO_2 levels.
b Approximately 290 ppm
c Approximately 415 ppm
d Approximately 24 years (1987–2011)
e The trend is that land–ocean temperature is increasing, and the rate of increase is increasing.
f The greenhouse effect, because CO_2 is a greenhouse gas/
Global warming

88 Methane, carbon dioxide

89 For example: Deforestation, the combustion of fossil fuels

90 For example:
a … a small amount of carbon dioxide is normal/a small amount of carbon dioxide from respiration is normal.
b … human activities such as deforestation and burning fossil fuels are increasing the greenhouse effect.
c … it is important that a small greenhouse effect is maintained to keep the Earth warm.

91 For example:
- a … humans have been burning lots of fossil fuels and chopping down forests.
- b … humans have also invented technologies that can help reverse global warming.
- c … we must act quickly to reverse the effects.

92 For example: Burn less fossil fuel by using renewable energy resources instead, plant more trees

93
- a 11.6 °C
- b 13 °C
- c 1.4 °C
- d Same day of the year, same weather stations
- e Global warming is an increase in the average temperature across the whole planet. Local temperatures will still vary. Climate change can cause extreme changes (hot and cold) all over the Earth, but the overall average increases.

94
- a Calcium carbonate → calcium oxide + carbon dioxide
- b $CaCO_3 \rightarrow CaO + CO_2$
- c Thermal decomposition
- d Sedimentary
- e Composite
- f Carbon dioxide is made during the production of calcium oxide for cement.

95 Mantle

96 Igneous

97 Small particles (sediments) are transported to lakes/oceans and deposited. They are then compressed together under the layers above over time.

98 Metamorphic rocks have squashed bands/layers and are impermeable.

C8.5 Recycling

99 Resources that can be replaced or will not run out

100 Resources that there is a fixed amount of in the Earth's crust and/or atmosphere, which will eventually run out

101
- a Renewable
- b Finite
- c Renewable
- d Renewable
- e Finite
- f Finite
- g Renewable
- h Finite
- i Finite
- j Finite

102 A rock containing metal compounds/(A rock containing enough metal to make it worthwhile/profitable to extract this metal)

103 **a** Iron, carbon dioxide

b Iron oxide + carbon ⟶ iron + carbon dioxide

c Displacement reaction

d Carbon dioxide is made, which contributes to global warming.

e Iron is a finite resource, less energy is used, cheaper, less mining required (which causes environmental issues), less CO_2 produced

104 Three from: Malleable, high melting and boiling points, hard, electrical conductor, thermal conductor

105 Two from, for example: Zinc, tin, lead, copper

106 Two from: Gold, silver, platinum, copper

107 Three from: Soft, low melting and boiling points, brittle, electrical and thermal insulator

108 Reused is best, then recycle, and then thrown away is the worst option

109 **a** They are made from multiple different types of material.

b Natural rubber

c Synthetic polymers (from crude oil) and steel

d Long-chain molecules made of smaller, repeating units

110 This is not recycling; this is reuse of an item. They should say, 'It is great how you reuse that bottle every day.'

111 Crust, atmosphere

112 Nitrogen, oxygen, argon

113 Less energy is required to recycle than to produce new materials. Most of this energy comes from fossil fuels, and burning them releases carbon dioxide, so recycling helps reduce the amount of carbon dioxide added to the atmosphere.

114 For example:

a … plastic is a non-renewable material.

b … if they are reused then it is better than throwing them away.

c … we should search for renewable materials to make bags from.

P7 Electricity in circuits

P7.1 Conductors and insulators

What is an electrical conductor?

1 a The 'fuel level' of the battery is decreasing.
(Energy from the chemical energy store of the battery is being transferred to the kinetic energy store of the motor.)
b The motor is moving (faster).
c The wires allow energy to be transferred between the battery and the motor by moving charges.
d Transfer by electric current

2 a No
b The elastic band is an insulator so cannot conduct an electrical current.
c Any metallic object

3 Any three suitable examples, such as: Wood, plastic, air, glass

4 a Yes
b A paperclip is made of metal so can conduct electricity.
c Any insulating material

5 Metals

6 The metal part of the wire can conduct electricity, but the plastic part cannot. Overall, the wire can conduct, but the plastic part keeps us safe.

7 a The chemical energy store of the battery
b Transfer by electric current
c The oscillations that make up the wave are perpendicular to the direction of the energy transfer (or direction of the wave).
d The bulb is emitting light.
e White objects reflect all colours of light. If only red light is shone on them, they reflect just red so appear red.
f Blue objects reflect only blue light and absorb all other colours. If only red light is shone on them, they absorb blue and reflect nothing so appear black.

8 Glass is not opaque since it lets light through. Glass is transparent.

How do circuits transfer energy?

9 Electrons

10 The 50p coin is made of metal and so has delocalised electrons, which can move and conduct electricity. The £5 note is made of paper (or polymer in the case of the newest bank notes) and has no delocalised electrons, so it cannot conduct electricity.

11 The wood has no delocalised electrons, but the metal in the wires does.

12 Electrons that are not in a fixed position so can move through the material

13 A material with no charges (delocalised electrons) that are free to move, so it does not conduct electricity

14 A material that has charges (delocalised electrons) that are free to move, so it can conduct electricity

15 a The chemical energy store of the battery

b Transfer by electric current

c The oscillations of particles are parallel to the direction of the energy transfer (or direction of the wave).

d The speaker is emitting sound.

e The oscillations get larger.

f 25 J

g The sound travels faster since the particles in the wall are closer together.

16 Aluminium is not an electrical insulator. It is an electrical conductor since it has delocalised electrons within it, which are free to move and conduct electricity.

How do we keep track of the moving charges?

17 By their charge; we can measure the amount of charge that has passed by

18 Coulombs (C)

19 Transfer energy from one place to another

20 The electrons are already within all the conducting elements of the circuit (wires, batteries, components); the battery just makes them move.

21 In an electrical insulator, the charges are not able to move.

22 Delocalised electrons

23 The string is an electrical insulator so will not conduct electricity.

24 a The chemical energy store of the battery

b The gravitational energy store of the helicopter and the kinetic energy store of the helicopter

c

Equation	$E = P \times t$
Values	E = ? P = 120 W t = 1 minute × 60 = 60 s
Enter values	$E = 120 \times 60$
Result	$E = 7200$
Y(units)	E = 7200 J

d

Equation	$s = d \div t$
Values	s = ? d = 78.75 m t = 12.5 s
Enter values	$s = 78.75 \div 12.5$
Result	$s = 6.3$
Y(units)	s = 6.3 m/s

25 In plastic, the electrons are not delocalised – they are stuck to their atoms – so they are not free to move around and transfer energy.

P7.2 Circuits, current, potential difference and resistance

How do we make circuits work?

26 A power supply

27 Two or more cells connected together

28 The bulb is not lit since there is no power supply. To make it light, add a battery or mains power.

29 A complete circuit

30 A power supply, all the components to be properly connected (both terminals of a battery/cell), switches to be closed, no gaps or breaks

31 The bulb is not lit since there is not a complete loop. The cell is not properly connected as the negative terminal is not connected to a wire. To make this bulb light, connect the loose wire to the negative terminal of the cell.

32 Electrical cell/battery, mains power

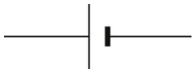
33 The motor is not turning as both wires are connected to the same terminal of the cell. To make it work, connect one of the wires from the motor to the positive terminal of the cell.

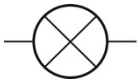
34 Paper is an insulator, so will not conduct electricity. If there is an insulator in the circuit, the bulb will not light.

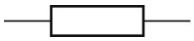
How do we draw circuits?

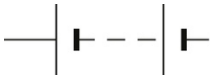
35 They are the simplest way to draw a circuit.

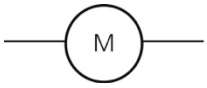
36

a 

b 

c 

d 

e 

f 

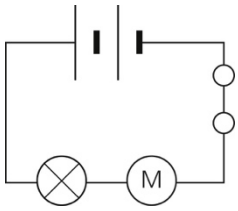
g

37 As straight lines

38 A battery contains multiple cells so the symbol for a battery is multiple cells drawn one after another.

39 The cells need to be connected so that the positive terminal of one attaches to the negative terminal of the next.

40

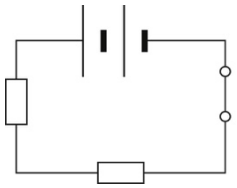


41 The bulb is not connected.

42 There is no power source.

43 a The chemical energy store of the battery
b Transfer by electric current
c A longitudinal wave
d They are oscillating more frequently back and forth
e In space there are no particles – it is a vacuum – so sound cannot travel.

44

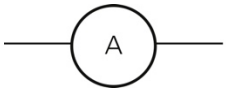


How do we measure current?

45 How fast the charges move through the wire (rate of flow of charge)

46 Higher

47 a Ammeter
b



c Amps (A)

48 a Resistor
b Closed switch
c Lamp/bulb
d Battery
e Open switch
f Cell
g Motor

49 5 C/s = 5 A

50 8 C/s = 8 A

51 More charge passes a point every second – the charges are moving faster.

52 One coulomb of charge passing a point per second

53 The two wires have been connected to the same terminal of the cell.

54 0 A, because the circuit is not complete so no current can flow.

55 a 7 C
b 14 C
c 35 C

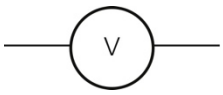
How do we describe the changes in energy around a circuit?

56 The power supply

57 Afterwards

58 Potential difference

59 a A voltmeter
b



c Volts (V)

60 9 J/C = 9 V

61 3 J/C = 3 V

62 More energy is given to the charges

63 1.5 J/C = 1.5 V

64 4.2 J/C = 4.2 V

65 More energy is lost by the charges

66 1 V = 1 J/C, so each coulomb gains or loses 1 J of energy

67 An ammeter connects inside the loop (in series), whereas a voltmeter connects around a component (in parallel).

68 3 C/s = 3 A

69 The two cells are connected the wrong way around.

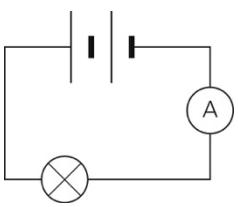
70 a 5 J
b 15 J
c 50 J

71 Current is not measured in volts, it is measured in amps (A).

72 Potential difference is the change in energy for one coulomb of charge, it is not a total amount of energy. Potential difference and energy have different units so cannot be the same thing.

How can we change the current?

73 a



b 4 A = 4 C/s, so 4 coulombs of charge pass by each second.
c The current will decrease (to 2 A).
d The current will increase (to 6 A).

74 4 J/C = 4 V

75 12 C/s = 12 A

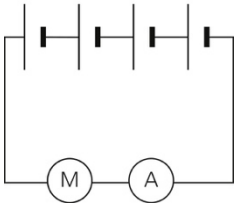
76 The rate of flow of charge

77 The amount of energy transferred to or from one coulomb of charge

78 a Amps (A)
b Volts (V)

79 As potential difference increases, current increases.

80 a



b 2 V = 2 J/C, so 2 joules of energy are given to each coulomb of charge.
c The current will increase/double (to 16 A).
d The current will decrease (to 6 A).

81 Any circuit drawn with a motor and a bulb but with multiple cells connected correctly.

What else can change the current in a circuit?

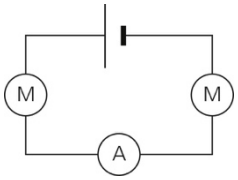
82 How electrons can be slowed down by the components of a circuit. The opposition to an electrical current.

83 As the resistance increases, the current decreases.

84 Ohms (Ω)

85 Decrease the potential difference or increase the resistance

86 a



b 8 A = 8 C/s, so 8 coulombs of charge pass a point per second
c There would be more resistance if we added a third motor, so the charges would move more slowly.
d The current would increase.

87 Increase the potential difference or decrease the resistance

88 a Any circuit drawn with either more bulbs or the addition of any other component.
b Any circuit drawn with two bulbs but fewer cells.

89 By adding the motor to the circuit, the resistance of the circuit will increase, so the current will be lower.

How can we tell the difference between a conductor and an insulator?

90 **a** The aluminium foil is a conductor and the plastic cling film is an insulator.

b A conductor has delocalised electrons inside that are free to move, and an insulator does not.

c The aluminium foil has a resistance of 0.003 Ω since it is a conductor and will have low resistance. The plastic cling film has a resistance of 3 000 000 Ω since it is an insulator so will have a very high resistance.

91 Because the current does not just depend upon resistance, it also depends on how big the potential difference is, and we do not know this when the resistor is made.

92 **a** Any circuit drawn with more cells/batteries

b Any circuit drawn with either of the bulbs removed but still with three cells

93 The current also depends upon how much resistance is in the circuit, and we do not know that if we just have a battery.

94 0.7 J/C = 0.7 V

95 **a** 3000 C/s = 3000 A

b 3000 ÷ 1000 = 3 kA

96 **a** When the 'on' switch is pressed, the circuit is completed so that the electrons can transfer energy from the battery to the motor. If the fan is not switched on, the circuit is not complete and so no current flows.

b

Equation	$E = P \times t$
Values	E = ? P = 100 W t = 2 × 60 = 120 s
Enter values	E = 100 × 120
Result	E = 12 000
Y(units)	E = 12 000 J

c

Equation	$E = P \times t$
Values	E = ? P = 250 W t = 2 × 60 = 120 s
Enter values	E = 250 × 120
Result	E = 30 000
Y(units)	E = 30 000 J

d It transfers more energy to the fan.

e The current will increase.

How do we calculate the current?

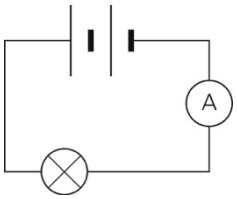
97 Current = potential difference ÷ resistance

98 **a** Volts (V)

b Amps (A)

c Ohms (Ω)

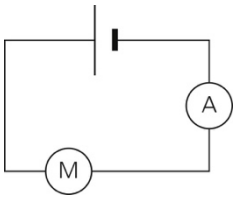
99 **a**



b

Equation	$I = V \div R$
Values	I = ? V = 10 V R = 2 Ω
Enter values	$I = 10 \div 2$
Result	$I = 5$
Y(units)	I = 5 A

100 **a**

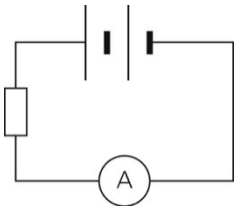


b

Equation	$I = V \div R$
Values	I = ? V = 4 V R = 8 Ω
Enter values	$I = 4 \div 8$
Result	$I = 0.5$
Y(units)	I = 0.5 A

101 0.3 A = 0.3 C/s, so 0.3 coulombs of charge pass a point per second

102 **a**



b

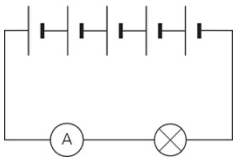
Equation	$I = V \div R$
Values	I = ? V = 800 V R = 2 kΩ = 2000 Ω
Enter values	$I = 800 \div 2000$
Result	$I = 0.4$
Y(units)	I = 0.4 A

c By having larger resistance (or more resistors) or by having a smaller potential difference

103 2 kA = 2000 A = 2000 C/s, so 2000 coulombs of charge pass a point per second

104 0.7 J/C = 0.7 V

105 **a**



b 10 V

c

Equation	$I = V \div R$
Values	I = ? V = 10 V R = 0.5 Ω
Enter values	$I = 10 \div 0.5$
Result	$I = 20$
Y(units)	I = 20 A

106 **a** 1500 C/s = 1500 A

b 1500 ÷ 1000 = 1.5 kA

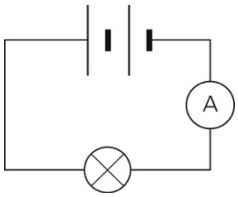
107 12 V = 12 J/C, so every coulomb of charge that passes through the battery gains 12 J of energy

What if we need to calculate resistance?

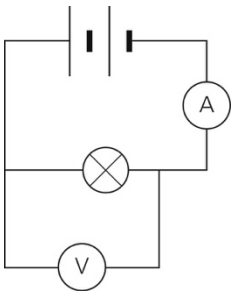
108

Equation	$I = V \div R$
Values	I = 4 A V = 20 V R = ?
Enter values	$4 = 20 \div R$
Result	$4 \times R = 20$ $R = 20 \div 4$
Y(units)	R = 5 Ω

109 **a**



b

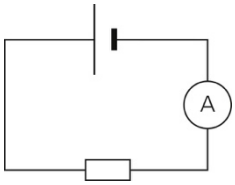


c

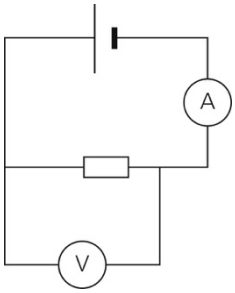
Equation	$I = V \div R$
Values	$I = 7$ A $V = ?$ $R = 3\ \Omega$
Enter values	$7 = V \div 3$
Result	$7 \times 3 = V$ $21 = V$
Y(units)	$V = 21$ V

d 21 V

110 a



b



c

Equation	$I = V \div R$
Values	$I = 0.2$ A $V = ?$ $R = 1.5\ \text{k}\Omega = 1500\ \Omega$
Enter values	$0.2 = V \div 1500$
Result	$0.2 \times 1500 = V$ $300 = V$
Y(units)	$V = 300$ V

d 300 V

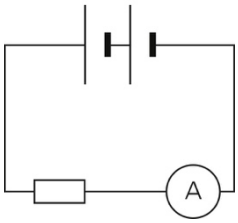
111

Equation	$I = V \div R$
Values	$I = 1.2$ A $V = 12$ V $R = ?$
Enter values	$1.2 = 12 \div R$
Result	$1.2 \times R = 12$ $R = 12 \div 1.2$
Y(units)	$R = 10\ \Omega$

112

Equation	$I = V \div R$
Values	I = ? V = 3 V R = 2 Ω
Enter values	$I = 3 \div 2$
Result	$I = 1.5$
Y(units)	I = 1.5 A

113 a



b Each of the cells has a potential difference of 1.5 V and they add together.

c

Equation	$I = V \div R$
Values	I = 0.2 A V = 3 V R = ?
Enter values	$0.2 = 3 \div R$
Result	$0.2 \times R = 3$ $R = 3 \div 0.2$
Y(units)	R = 15 Ω

114 a 225 C/s = 225 A

b 225 ÷ 1000 = 0.225 kA

115 1.5 V = 1.5 J/C, so every coulomb of charge that passes through the cell gains 1.5 J of energy.

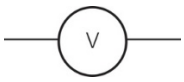
116

Equation	$I = V \div R$
Values	I = 1.5 A V = 12 kV = 12 000 V R = ?
Enter values	$1.5 = 12\,000 \div R$
Result	$1.5 \times R = 12\,000$ $R = 12\,000 \div 1.5$
Y(units)	R = 8000 Ω

117

Equation	$I = V \div R$
Values	I = ? V = 5 kV = 5000 V R = 10 kΩ = 10 000 Ω
Enter values	$I = 5000 \div 10\,000$
Result	$I = 0.5$
Y(units)	I = 0.5 A

118

a


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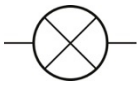

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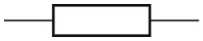

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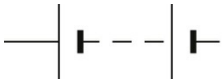
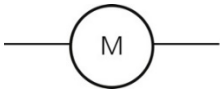


e


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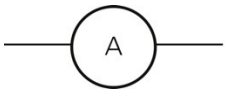


g


What if we need to rearrange other equations?

119

Equation	$E = P \times t$
Values	$E = 3600$ J $P = ?$ $t = 12$ s
Enter values	$3600 = P \times 12$
Result	$3600 \div 12 = P$
Y(units)	$P = 300$ W

120

Equation	$s = d \div t$
Values	$s = ?$ $d = 250$ m $t = 50$ s
Enter values	$s = 250 \div 50$
Result	$s = 5$
Y(units)	$s = 5$ m/s

121

Equation	$I = V \div R$
Values	$I = ?$ $V = 0.5$ V $R = 10\ \Omega$
Enter values	$I = 0.5 \div 10$
Result	$I = 0.05$
Y(units)	$I = 0.05$ A

122

Equation	$s = d \div t$
Values	$s = 12.4$ m/s $d = ?$ $t = 2.8$ s
Enter values	$12.4 = d \div 2.8$
Result	$12.4 \times 2.8 = d$
Y(units)	$d = 34.72$ m

123

Equation	$I = V \div R$
Values	$I = 2.5$ A $V = 15$ V $R = ?$
Enter values	$2.5 = 15 \div R$
Result	$2.5 \times R = 15$ $R = 15 \div 2.5$
Y(units)	$R = 6\ \Omega$

124

Equation	$F = k \times e$
Values	$F = 7$ N $k = 350$ N/m $e = ?$
Enter values	$7 = 350 \times e$
Result	$7 \div 350 = e$
Y(units)	$e = 0.02$ m

125

Equation	$M = F \times d$
Values	$M = 16$ Nm $F = ?$ $d = 20$ cm $= 0.2$ m
Enter values	$16 = F \times 0.2$
Result	$16 \div 0.2 = F$
Y(units)	$F = 80$ N

126

Equation	$P = F \div A$
Values	$P = 1600$ N/m^2 $F = ?$ $A = 0.6$ m^2
Enter values	$1600 = F \div 0.6$
Result	$1600 \times 0.6 = F$
Y(units)	$F = 960$ N

127 **a** It is using up fuel. (Energy is being transferred from the chemical energy store to the kinetic energy store.)

b

Equation	$s = d \div t$
Values	$s = 12$ m/s $d = ?$ $t = 6.3$ s
Enter values	$12 = d \div 6.3$
Result	$12 \times 6.3 = d$
Y(units)	$d = 75.6$ m

c The car is staying at the same speed.

d

Equation	$E = P \times t$
Values	$E = 5386.5$ J $P = ?$ $t = 6.3$ s
Enter values	$5386.5 = P \times 6.3$
Result	$5386.5 \div 6.3 = P$
Y(units)	$P = 855$ W

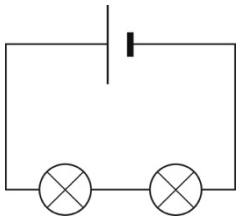
e Energy is transferred into the thermal energy store of the car and air, from the chemical energy store of the fuel.

P7.3 Series and parallel circuits

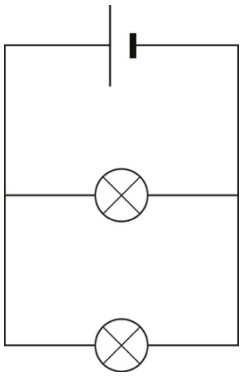
How can we connect components?

128 a They are in the same loop.
b They are in different loops.
c They are in the same loop.
d They are in different loops.

129 a



b



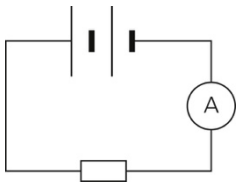
130

Equation	$I = V \div R$
Values	I = ? V = 20 V R = 5 Ω
Enter values	$I = 20 \div 5$
Result	$I = 4$
Y(units)	$I = 4$ A

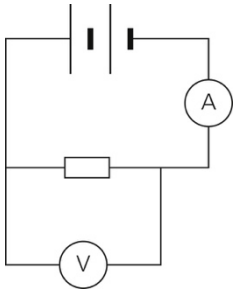
131 a Cell, bulb, voltmeter, ammeter
b It is in the same loop.
c It is in a different loop.

132 Just one

133 **a**



b



c

Equation	$I = V \div R$
Values	I = 2.5 A V = ? R = 0.3 kΩ = 300 Ω
Enter values	$2.5 = V \div 300$
Result	$2.5 \times 300 = V$ $750 = V$
Y(units)	V = 750 V

134 More than one

135 **a** Parallel

b Series

c Series

d Parallel

136 The rate of flow of electrical charge

137 **a** The particles of air hitting the sides of the tyre

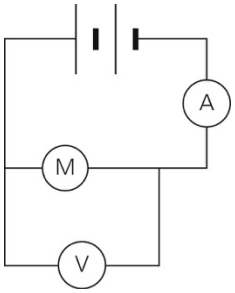
b There are more particles hitting the inside of the tyre.

c The fuel level in the battery decreases.

d The kinetic energy store

e Sound is a wave.

f



g 5 A = 5 C/s, so 5 coulombs of charge pass through the motor each second

What happens to the current when components are connected in parallel?

138 **a** They are in different loops.

b They are in the same loop.

c The two loops use the same wire at this point, so their currents add together: 2 A + 8 A = 10 A.

d The bulb is connected in series with the resistor so its loop is broken. No current flows in its loop and it turns off. The motor stays running as it is connected in parallel (it is in a different loop) so is unaffected by the resistor.

e Stay the same

139 7 A + 8 A = 15 A

140 No, they are independent of one another

141 Voltmeters connect in parallel, not in series.

142 **a** In parallel

b Ammeter (3) is where the bottom two loops join together, so the 3 A from the bottom bulb and the 2 A from the middle bulb add together to give 5 A.

c Ammeter (4) is where all the loops join together and share the same wire, so the 3 A from the bottom bulb, the 2 A from the middle bulb and the 1 A from the top loop all add together.

d They stay on.

143 They should be connected in parallel so that they do not affect one another and all of the bulbs can work independently.

144

Equation	$I = V \div R$
Values	$I = 5.1$ A $V = 20.4$ V $R = ?$
Enter values	$5.1 = 20.4 \div R$
Result	$5.1 \times R = 20.4$ $R = 20.4 \div 5.1$
Y(units)	$R = 4\ \Omega$

145 **a** 8 A + 3 A = 11 A

b 8 A + 3 A + 5 A = 16 A

146 9 V = 9 J/C, so the battery transfers 9 joules to every coulomb of charge that passes through.

147 The battery does not produce electrons; the electrons are already in the wires and metallic components. When the battery 'runs out', the electrons are still there, but the battery has run out of energy to make them move.

148 **a** They are connected in parallel as they are in different loops.

b They are connected in series as they are in the same loop.

c The 8 A from the top ammeter is for both loops. If the top loop has 2 A, then the bottom loop must have 6 A, since 8 A − 2 A = 6 A.

149

Equation	$E = P \times t$
Values	$E = 850$ J $P = ?$ $t = 17$ s
Enter values	$850 = P \times 17$
Result	$850 \div 17 = P$
Y(units)	$P = 50$ W

150 **a** 6 A + (12 A – 2 A – 6 A = 4 A) = 10 A

b 12 A – 2 A – 6 A = 4 A

What happens to the potential difference when components are connected in series?

151 When components are connected in series, the current is the same throughout the loop.

152 **a** 5.34 A

b The circuit drawn with two voltmeters, which are connected in parallel around each component

c Because of conservation of energy, whatever the potential difference supplied by the power source must be used up around the circuit.

153 The current is the same throughout the loop.

154 **a** The potential differences must add up to 8 V, so that the energy from the power source is used around the circuit.

b 3 A

155 The current from each loop adds together when they share the same wire.

156 **a** Series

b The voltmeter is connected in parallel with the cell.

c 3.6 V + 2.1 V = 5.7 V

157 The potential difference is shared between components (not necessarily equally).

158 The potential difference does not have to split equally, but it does have to add up to 10 V.

159 **a** It is on the same loop as another ammeter that reads 3 A.

b The cell has 12 V, so 12 V must be spent around each loop.

c The current in this loop must add together with the 3 A from the loop with the bulb to make 7 A (the current through the battery).

d The cell has given 8 V out of 12 V to the resistor, so the motor gets the rest: 12 V − 8 V = 4 V.

160 **a** 7.5 V + 2.5 V = 10 V

b 4 A + 7 A = 11 A

c 11 A

d 10 V

e 7 A

P8 Static electricity

P8.1 Static charges

What are charged materials?

1 **c** + to −

2 **a** + to + and **b** − to −

3 0

4 It will be attracted to the rod, because they have opposite charges.

5 It must be negative, because two negative charges repel each other.

6 There is no attraction or repulsion between neutral and charged objects.

How do we charge an insulator?

7 +, −, neutral

8 Proton = +1, neutron = 0, electron = −1

9 The paper is positive, because the positive rod repelled it away.

10 **a** Negative, because it is attracted to the rod.

b

Equation	$s = d \div t$
Values	s = ? d = 5 ÷ 100 = 0.05 m t = 2 s
Enter values	s = 0.05 ÷ 2
Result	s = 0.025
Y(units)	s = 0.025 m/s

11 **a** Friction

b Contact force, because the cloth and the rod have to touch

c The friction causes the negative charges (electrons) to move from the rod to the cloth.

d Negative

12 First, the student should rub the balloon on a woollen jumper to ensure it is negatively charged. Then, they should hang the balloon on a string, making sure it is free to move.
Next, the student should bring each material close to the balloon one at a time without touching it, and observe the reaction between the balloon and the material.
If the material is positively charged, the student will observe that the negatively charged balloon is attracted to the material. This is because opposite charges attract each other.
If the material is negatively charged, the student will observe that the negatively charged balloon is repelled by the material. This is because like charges repel each other.
If the material is neutral, the student will observe that the negatively charged balloon does not move.

13 Negative

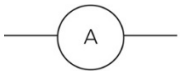
14 Positive

15 **a** A material that does not allow electricity to pass through it/has no free charges to move/has a very high resistance

b Coulombs (C)

c The rate of flow of charge

d Ammeter

e 

f Series

g How electrons are slowed down by the circuit

h As the resistance increases, the current (rate of flow of charge) decreases.

16 a When the balloon is rubbed, friction causes the negative electrons to move from the balloon to the jumper. The balloon has now lost electrons so is positively charged.

b When the positive balloon was brought near the hair, it attracted it because the hair was negatively charged.

c Rubbing the balloon for longer removes more electrons so makes the charge greater. This means it will create a stronger electrostatic force and lift more hair.

17 a A circuit in which all components are connected so charges can flow

b −1

c Electric current

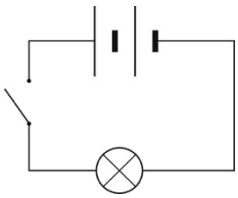
18 The student's prediction is wrong. Because the plastic strip is made of the same material, it will have the same charge all over. That means the two sides will repel, as like charges repel.

19 a The friction from rubbing the strip with the cloth caused the electrons to move from the cloth to the strip, making it negatively charged.

b Plastic strip A is negatively charged because they are both made of the same material.

c Plastic strip A will be repelled. This will cause strip A to move away and begin to turn.

d As the whole strip is negatively charged, the opposite charges will still cause repulsion. This will stop the original rotation and cause it to turn in the opposite direction.

20 a 

b The cells

c Potential difference

d In parallel with the bulb

e How electrons can be slowed down by the circuit

f

Equation	$I = V \div R$
Values	I = ? V = 2.4 V R = 64 Ω
Enter values	$I = 2.4 \div 64$
Result	$I = 0.0375$
Y(units)	$I = 0.0375$ A

g The bulb gets brighter.

h

Equation	$I = V \div R$
Values	I = ? V = 3.6 V R = 64 Ω
Enter values	$I = 3.6 \div 64$
Result	$I = 0.056$
Y(units)	$I = 0.056$ A

i Increasing the number of cells increases the potential difference in the circuit. This increases the flow of charge around the circuit so the current increases.

j Ammeter

k In series

21 a The student's arms are doing work, transferring energy to the kinetic energy store of their arm and the cloth by a force.

b The kinetic energy store of the cloth is transferring energy to the thermal energy store of the cloth by the force of friction.

c The chemical energy store of the cloth is not changing because the chemical bonds in the material are not being broken or made.

P8.2 Electric fields

What is the electrostatic force?

22 The electrostatic force

23 Weight, magnetism, the electrostatic force

24 Opposite

25 As the distance between the charges increases, the force between them decreases.

26 a A, D, F

b B, C, E

c E

d F

e B

f C

27 A material that has no free charges that can move/that does not allow electricity to pass through it.

28 If electrons are gained by the object then it will become negatively charged.

29 a By rubbing the rod with the cloth

b Friction

c Contact force

d The friction between the rod and the cloth caused electrons to move from the rod to the cloth so the rod became positively charged.

e To make sure the electrostatic force is strong enough to attract it – this force decreases as distance increases

f The electrostatic force is a non-contact force.

g Negative

How do field lines explain how an electrostatic force changes with distance?

30 Field lines

31 From positive to negative

32 Negative

33 The closer the field lines, the stronger the electrostatic field is.

34 It is neutral/has no charge.

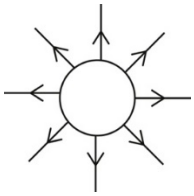
35 a Weak, positive
b Medium, positive
c Strong, negative
d Weak, negative
e Strong, positive
f Medium, negative

36 a Away from the object
b It will accelerate and begin moving away.
c

Equation	$s = d \div t$
Values	s = ? d = 1.2 m t = 0.006 s
Enter values	$s = 1.2 \div 0.006$
Result	$s = 200$
Y(units)	s = 200 m/s

d The field lines spread out/become further apart so the electrostatic field gets weaker.

37 a 
b Parallel, because they are in different loops
c Ammeter
d 0.12 × 3 = 0.36 A
e 3.0 V

38 a Rub it with a cloth
b Ball A must be negatively charged because it is attracting the positively charged ball.
c Ball B loses electrons because it is positively charged.
d 
e Move ball A nearer to ball B so it attracts it more./Increase the charge on ball A.

39 a They are wrong, because it is the electrons that move due to the force of friction.
b The number of electrons on the fleece was reduced as it became positively charged.
c Friction; contact force

40 a Current/rate of flow of charge

b 7.2 − 4.8 = 2.4 A

c There are two bulbs in the A2 branch so the resistance is greater.

P9 Magnets

P9.1 Magnets and magnetic fields

How does a magnet work?

1 The north and south poles

2 It gets stronger.

3 The magnetic field is strongest at both poles.

4 North to south

5 If you sprinkle iron filings around a permanent magnet, the iron filings line up with the magnetic field lines as they feel a force from the permanent magnet.

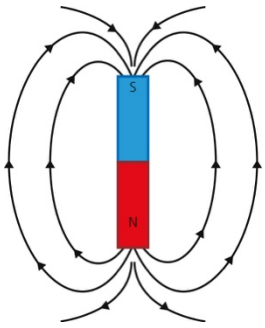
6 To show the direction of the force

7 Both are invisible. Both lead to forces. When the field lines are closer, the force is stronger. The field lines point in opposite directions for opposite poles/charges.

8 Magnetic fields surround magnets. Electric fields surround charges. Magnetic fields are always loops. Electric fields can be straight lines.

9 a Newtons (N)
b With arrows
c Electrostatic force, weight
d Contact forces require the objects to touch for them to interact; non-contact forces do not.

10



11 The lines should all point away from the north pole and towards the south pole.

12 A – north pole, B – south pole

13 Magnetic fields go on forever, they just get weaker. The tails that we draw are because we eventually run out of space to draw the entire loop from N to S.

What substances are magnetic?

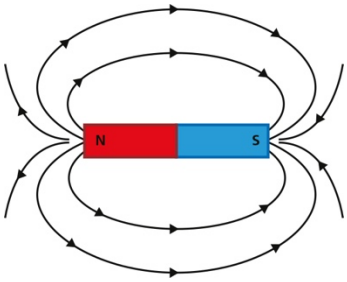
14 Iron, nickel, cobalt

15 Not all metals are magnetic – only iron, nickel and cobalt are magnetic from the Periodic Table.

16 It contains iron.

17 a It does not contain iron, nickel or cobalt.
b Sprinkle iron filings around brass to see that they do not form a pattern of field lines.

18



19 It will be magnetic, because it contains all three magnetic elements.

20 The invisible region around a permanent magnet that causes it to exert a force on other magnetic objects

21 The iron that is in the alloy

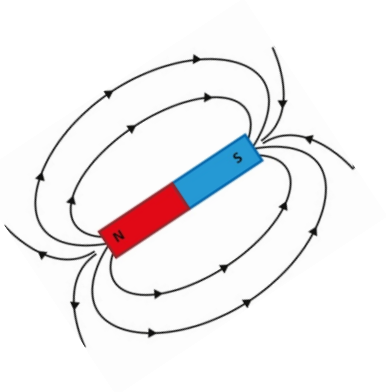
How do we know the shape and direction of magnetic field lines?

22 It spins to line up with the magnetic field line.

23 Use a compass or sprinkle iron filings around the permanent magnet.

24 Use a compass – it will line up with the magnetic field lines and point towards the south pole.

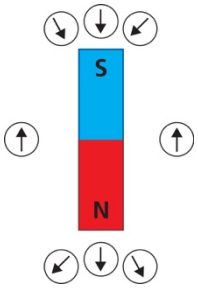
25



26 a It will be magnetic, because it contains two magnetic elements.

b Sprinkle iron filings around a piece of permalloy or place a compass near to it and move it around.

27



28 The iron filings are moved by the magnet without them having to touch the magnet.

29 Magnetism is a non-contact force, so the magnet does not have to touch the iron filings to exert a force on them. Lots of other iron filings experience a force from the magnet without being touched.

30 The magnetic field is strongest at the poles so there is a stronger force here, which pulls in more iron filings.

31 For example:

a … there is a magnetic field around the magnet.

b … magnets may end up touching other magnetic objects.

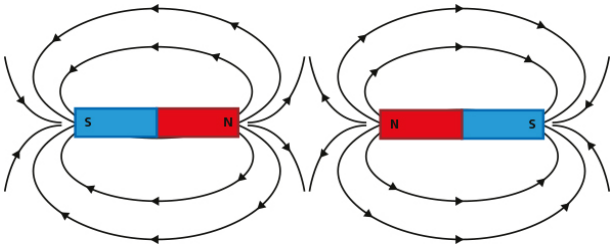
c … objects can experience the magnetic force from a permanent magnet without having to touch it.

What happens when we have more than one magnet?

32 It repels it.

33 When a force pushes two objects further apart

34



35 It attracts it.

36 When a force pushes two objects closer together

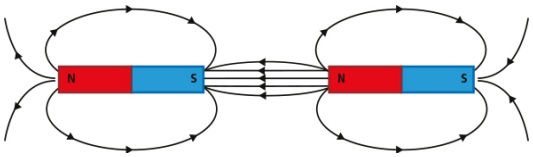
37 It repels it.

38 It attracts it.

39 a Positive and negative charges/opposite charges

b Positive and positive or negative and negative/charges that are the same

40



41 a The kinetic energy store

b

Equation	$s = d \div t$
Values	s = ? d = 105 cm = 1.05 m t = 2.1 s
Enter values	$s = 1.05 \div 2.1$
Result	$s = 0.5$
Y(units)	s = 0.5 m/s

c The magnetic field lines are closest together at the poles.

P9.2 Earth's magnetism

How does a compass work?

42 A permanent magnet that can rotate

43 a Opposite poles – a north pole and a south pole
b They will repel.
c Now the poles will be like poles and these always repel.

44 It cannot easily rotate.

45 The north pole

46 A compass is a small permanent magnet, so it feels a magnetic force that makes it spin when it is placed inside a magnetic field.

47 The south pole

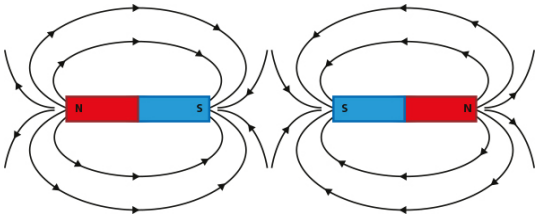
48 Float a magnet on water/Suspend a magnet from a piece of string so that it lies horizontally

49 The invisible region around a permanent magnet that causes it to exert a force on other magnetic objects

50 Iron, nickel or cobalt

51 a Friction
b The thermal energy store of the magnets and of the surface
c The resultant force is zero.

52



Why does the Earth have a magnetic field?

53 The core of the Earth is made of iron and nickel.

54 South pole

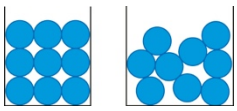
55 Copper is not magnetic.

56 It points towards the geographic North Pole of the Earth.

57 North pole

58 a The layer of gases around the Earth
b It gets lower.
c The pressure decreases since there are fewer particles in the atmosphere as you get higher (the density decreases) so there are fewer collisions.
d The pressure increases because the particles in the air are moving faster so there are more frequent collisions.

59 a



solid liquid

b In a solid, the particles vibrate in position. In a liquid, the particles move freely past one another.

60 a So that it can collide with the particles in the air and make them vibrate, creating the sound wave

b The oscillations of the particles in the air are parallel to the direction that the wave is travelling (or the direction of the energy transfer).

c It must vibrate with a bigger amplitude.

d Sound travels faster in solids than in liquids.

e

Equation	$s = d \div t$
Values	s = ? d = 4.125 km = 4125 m t = 12.5 s
Enter values	$s = 4125 \div 12.5$
Result	$s = 330$
Y(units)	s = 330 m/s

61 At the poles

P9.3 Electromagnets and motors

How can wires produce magnetic fields?

62 When there is an electrical current flowing through it

63 Amps (A)

64 Rate of flow of charge

65 The electrons

66 A circle

67 It would line up with the magnetic field.

68 a Weight/electrostatic force

b Newtons (N)

c A force in which the two objects do not need to touch to interact

d The overall force when you add all the forces on an object together

e It can speed up, slow down or change direction.

69 They move more slowly.

70 With an ammeter connected in series

How can we make an electromagnet?

71 A coil of wire

72 A piece of wire, a power source (battery), a magnetic core

73 To increase the strength of the magnetic field

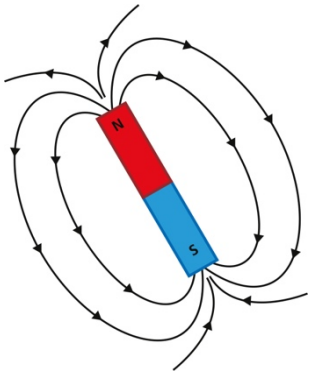
74 To increase the strength of the magnetic field

75 When the circuit is not switched on, because when the circuit is not on there is no current so there is no magnetic field

76 a Something that is not always magnetic; they become magnetic when they are in a magnetic field

b The iron core

77



78 a Left is south because the magnetic field lines are pointing towards it. Right is north because the magnetic field lines are pointing away from it.

b The magnetic field is strongest where the field lines are closest together, so at the poles.

79 a Weight, magnetic force

b Weight acts downwards and the magnetic force acts upwards.

c Newtons (N)

d The forces are equal in size and in opposite directions. There is no resultant force.

e The paperclip will fall downwards and get faster. This is because there is a resultant force acting downwards on it (its weight) as there is no longer an upwards force from the electromagnet.

f

Equation	$s = d \div t$
Values	s = ? d = 45 cm = 0.45 m t = 0.3 s
Enter values	$s = 0.45 \div 0.3$
Result	$s = 1.5$
Y(units)	s = 1.5 m/s

How do we strengthen an electromagnet?

80 A solenoid with a magnetic core whose overall magnetic field can be turned on or off

81 Fewer turns on the coil, less current in the wire

82 Reduce the potential difference, increase the electrical resistance

83 It must be a north pole since opposite poles attract.

84 The magnetic field around an electromagnet can be turned on and off (by turning the electromagnet itself on and off), and the strength of the magnetic field can be varied.

85 a Fewer paperclips than originally (maybe two)
b Fewer paperclips than originally, and fewer than in part a (maybe one)
c Fewer paperclips than originally, but more than in part b (maybe two)
d More paperclips than originally (maybe 10)
e More paperclips than originally, but fewer than in part d (maybe eight)
f About the same number of paperclips as originally (five)

86 It is a random error because only one value does not fit the pattern (the value for 30 turns).

What is precision?

87 a How does the power of a kettle affect the time it takes to boil water?
b The power of the kettle
c The time it takes to boil water
d Student A
e Student A's results are closer together/more bunched up.

88 a How does the height a ball is dropped from affect the width of the crater it makes?
b The height of the ball
c The width of the crater
d Student B

89 How close the results of an experiment are to each other when you repeat the experiment

90 The data is precise because it is very bunched together.

91 a Example: (4), 3, 4, 5
b Example: (4), 1, 7, 2
c Increase the current, add more turns on the coil

92 Iron, cobalt, nickel

93 Two from: Magnetic force, weight, electrostatic force

How can we make an electric motor?

94 A coil of wire with a current in it and a permanent magnetic field

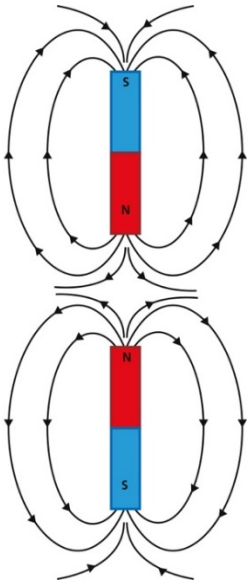
95 The current has a magnetic field around it. When this magnetic field interacts with the magnetic field of the permanent magnet, we get a force.

96 Increase the current in the wire, increase the number of turns on the coil, have a stronger permanent magnet

97 A permanent magnet that can rotate

98 A north pole

99



100 The core of the Earth is made of iron and nickel.

101 The magnetic field of the permanent magnet is stronger than the Earth's magnetic field when it is close.

102 **a** How does the current in a wire affect the speed of a motor?

b The current

c The speed of the motor

d Student B

e Student B's results are closest together/most bunched up.

f Student C

g Student C's results are the most spread out.

103

Equation	$I = V \div R$
Values	I = 1.25 A V = 2.5 V R = ?
Enter values	$1.25 = 2.5 \div R$
Result	$1.25 \times R = 2.5$ $R = 2.5 \div 1.25$
Y(units)	R = 2 Ω

104

Equation	$E = P \times t$
Values	E = 3600 J P = ? t = 2 minutes = 120 s
Enter values	$3600 = P \times 120$
Result	$3600 \div 120 = P$
Y(units)	P = 30 W

105

Equation	$s = d \div t$
Values	s = 6.3 m/s d = ? t = 12.5 s
Enter values	6.3 = $d \div$ 12.5
Result	6.3 × 12.5 = d
Y(units)	d = 78.75 m

106

Equation	$M = F \times d$
Values	M = ? F = 200 N d = 50 cm = 0.5 m
Enter values	M = 200 × 0.5
Result	M = 100
Y(units)	M = 100 Nm

107

Equation	$F = k \times e$
Values	F = 750 N k = ? e = 50 cm = 0.5 m
Enter values	750 = k × 0.5
Result	750 ÷ 0.5 = k
Y(units)	k = 1500 N/m

108

Equation	$s = d \div t$
Values	s = 15 m/s d = 52.5 m t = ?
Enter values	15 = 52.5 ÷ t
Result	15 × t = 52.5 t = 52.5 ÷ 15
Y(units)	t = 3.5 s

P10 Particle model

P10.1 Particle motion and density

What is density?

1 1 kg of lead, because it has less volume for the same mass

2 The lead, because it has the higher density

3 a Volume = 2 × 2 × 1 = 4 m^3; density = 8 ÷ 4 = 2 kg/m^3
b Volume = 2 × 3 × 1 = 6 m^3; density = 3 ÷ 6 = 0.5 kg/m^3
c Volume = 7 × 2 × 1 = 14 m^3; density = 28 ÷ 14 = 2 kg/m^3
d Volume = 2 × 2 × 1 = 4 m^3; density = 16 ÷ 4 = 4 kg/m^3
e Volume = 4 × 2 × 1 = 8 m^3; density = 4 ÷ 8 = 0.5 kg/m^3
f Volume = 5 × 2 × 1 = 10 m^3; density = 100 ÷ 10 = 10 kg/m^3

How can density be used to calculate mass?

4 Mass = density × volume, $m = \rho \times V$

5 kg/m^3

6 a Sulfur
b Sulfur
c Same
d Sodium

7

Equation	$m = \rho \times V$
Values	m = ? ρ = 6 kg/m^3 V = 6 m^3
Enter values	$m = 6 \times 6$
Result	$m = 36$
Y(units)	m = 36 kg

8

Equation	$m = \rho \times V$
Values	m = ? ρ = 6 kg/m^3 V = 0.5 m^3
Enter values	$m = 6 \times 0.5$
Result	$m = 3$
Y(units)	m = 3 kg

9

Equation	$m = \rho \times V$
Values	m = ? ρ = 0.6 kg/m^3 V = 145 m^3
Enter values	$m = 0.6 \times 145$
Result	$m = 87$
Y(units)	m = 87 kg

10

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 5.8$ kg/m^3 $V = 0.16$ m^3
Enter values	$m = 5.8 \times 0.16$
Result	$m = 0.928$
Y(units)	$m = 0.928$ kg

11

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 7800$ kg/m^3 $V = 0.025$ m^3
Enter values	$m = 7800 \times 0.025$
Result	$m = 195$
Y(units)	$m = 195$ kg

12

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 7400$ kg/m^3 $V = 2.3$ m^3
Enter values	$m = 7400 \times 2.3$
Result	$m = 17\,020$
Y(units)	$m = 17\,020$ kg

13

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 2400$ kg/m^3 $V = 2.5 \times 2 \times 1 = 5$ m^3
Enter values	$m = 2400 \times 5$
Result	$m = 12\,000$
Y(units)	$m = 12\,000$ kg

How can mass be used to calculate density?

14

Equation	$m = \rho \times V$
Values	$m = 12$ kg $\rho = ?$ $V = 2.5$ m^3
Enter values	$12 = \rho \times 2.5$
Result	$\rho = 12 \div 2.5$ $\rho = 4.8$
Y(units)	$\rho = 4.8$ kg/m^3

15

Equation	$m = \rho \times V$
Values	$m = 18$ kg $\rho = ?$ $V = 0.5$ m^3
Enter values	$18 = \rho \times 0.5$
Result	$\rho = 18 \div 0.5$ $\rho = 36$
Y(units)	$\rho = 36$ kg/m^3

16

Equation	$m = \rho \times V$
Values	$m = 315$ kg $\rho = ?$ $V = 105$ m^3
Enter values	$315 = \rho \times 105$
Result	$\rho = 315 \div 105$ $\rho = 3$
Y(units)	$\rho = 3$ kg/m^3

17

Equation	$m = \rho \times V$
Values	$m = 1$ kg $\rho = ?$ $V = 0.001$ m^3
Enter values	$1 = \rho \times 0.001$
Result	$\rho = 1 \div 0.001$ $\rho = 1000$
Y(units)	$\rho = 1000$ kg/m^3

18

Equation	$m = \rho \times V$
Values	$m = 36$ kg $\rho = ?$ $V = 0.6$ m^3
Enter values	$36 = \rho \times 0.6$
Result	$\rho = 36 \div 0.6$ $\rho = 60$
Y(units)	$\rho = 60$ kg/m^3

19

Equation	$m = \rho \times V$
Values	$m = 0.018$ kg $\rho = ?$ $V = 200$ m^3
Enter values	$0.018 = \rho \times 200$
Result	$\rho = 0.018 \div 200$ $\rho = 0.000\ 09$
Y(units)	$\rho = 0.000\ 09$ kg/m^3

20

Equation	$m = \rho \times V$
Values	$m = 45$ kg $\rho = ?$ $V = 5 \times 2 \times 0.5 = 5$ m^3
Enter values	$45 = \rho \times 5$
Result	$\rho = 45 \div 5$ $\rho = 9$
Y(units)	$\rho = 9$ kg/m^3

21

Equation	$m = \rho \times V$
Values	$m = 2646.27$ kg $\rho = ?$ $V = 55 \times 3 \times 11 = 1815$ m^3
Enter values	$2646.27 = \rho \times 1815$
Result	$\rho = 2646.27 \div 1815$ $\rho = 1.458$
Y(units)	$\rho = 1.458$ kg/m^3

22

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 7800$ kg/m^3 $V = 0.000\,75$ m^3
Enter values	$m = 7800 \times 0.000\,75$
Result	$m = 5.85$
Y(units)	$m = 5.85$ kg

23

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 45$ kg/m^3 $V = 0.18 \times 0.12 \times 0.5 = 0.0108$ m^3
Enter values	$m = 45 \times 0.0108$
Result	$m = 0.486$
Y(units)	$m = 0.486$ kg

24

Equation	$m = \rho \times V$
Values	$m = ?$ $\rho = 11$ kg/m^3 $V = 21 \times 7 \times 0.14 = 20.58$ m^3
Enter values	$m = 11 \times 20.58$
Result	$m = 226.38$
Y(units)	$m = 226.38$ kg

25 **a**

Equation	$m = \rho \times V$
Values	$m = 8.65$ kg $\rho = ?$ $V = 0.0005$ m^3
Enter values	$8.65 = \rho \times 0.0005$
Result	$\rho = 8.65 \div 0.0005$ $\rho = 17\,300$
Y(units)	$\rho = 17\,300$ kg/m^3

b The gold is impure because the density is lower than/different to pure gold.

What is the difference between repeatability and reproducibility?

26 When another person does the same experiment and gets similar results

27 When the same person does the experiment again and gets similar results

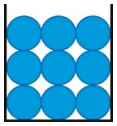
28 Repeatable, because they did it themselves a second time and got similar results

29 Reproducible, because a different person did the same experiment and got similar results

30 a Repeatable, because the same pattern in data was found by the same person
b Neither, because the results are not similar
c Neither, because the results are not similar
d Reproducible, because different people did separate experiments and got similar results

How is density related to the states of matter?

31



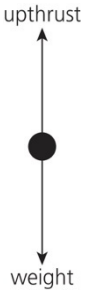
32 Iron nail

33 The stone

34 a Iron, magnesium, chromium, beryllium
b Silver, lead
c Beryllium, magnesium
d Lead
e The particles are not as closely packed together.
f The particles are more spread out.

35 a Upthrust
b Contact force

36 a



b

How is density related to the states of matter? *continued*

37 Liquid

38 Solid

39 The particles are closely packed/all touching so their volume is as small as possible.

40 a Upthrust
b Contact force

41 The ice is less dense than the liquid water so it floats.

42 Less than 1000 kg/m^3

43 a It is denser than water.
b It is less dense than water.
c

Equation	$m = \rho \times V$
Values	m = 260 ÷ 1000 = 0.26 kg ρ = ? V = 0.0001 m^3
Enter values	0.26 = ρ × 0.0001
Result	ρ = 0.26 ÷ 0.0001 ρ = 2600
Y(units)	ρ = 2600 kg/m^3

d

Equation	$m = \rho \times V$
Values	m = ? ρ = 160 kg/m^3 V = 5 × 0.0001 = 0.0005 m^3
Enter values	m = 160 × 0.0005
Result	m = 0.08
Y(units)	m = 0.08 kg m = 0.08 × 1000 = 80 g

How does Brownian motion prove the movement of particles?

44 Milk in tea, swirling patterns in smoke (accept any other valid answer)

45 That all particles are moving

46 They are moving randomly.

47 a

Equation	image size = actual size × magnification
Values	image size = 1.2 mm actual size = ? magnification = ×400
Enter values	1.2 = actual size × 400
Result	actual size = 1.2 ÷ 400 actual size = 0.003
Y(units)	actual size = 0.003 mm

b The density of the pollen grain is lower than the density of water.

P10.2 Energy in matter

What happens to particles when they are heated?

48 It turns from a liquid to a gas.

49 Boiling point

50 It turns from a liquid to a solid.

51 It can increase in temperature or change state (it can melt and then it can boil).

52 As the temperature increases, the energy in the kinetic energy store increases.

53 The temperature does not change (until the substance has all melted).

54 The kinetic energy store is unchanged.

55 The spacing between the particles increases.

56 a 40 °C
b 80 °C
c 20 seconds
d At 30 seconds
e 30 seconds

What happens to particles when they are cooled?

57 It is a gas, and it condenses at the boiling point to a liquid. It then freezes at the melting point to a solid.

58 It does not change (until the substance has all boiled).

59 They are not correct, because the ice is melting, which requires it to gain energy. The temperature is the same because the ice is melting.

60 a Gas
b Liquid
c The substance's kinetic energy store increases until it reaches 30 °C. When at 30 °C, the kinetic energy store stays the same while the substance melts. The substance is now a liquid. From 31 °C to 55 °C the kinetic energy store increases.

61 a How does the time since heating affect the temperature of the substance?
b The time since heating
c The temperature
d Volume/mass of stearic acid, temperature of room
e Cooling curve, because the temperature decreases over time
f Liquid
g Solid
h 4 minutes
i The stearic acid starts as a liquid. Its particles are touching but randomly arranged and moving past each other freely. As the stearic acid cools, the particles begin to move more slowly. At the melting point, the particles begin to change arrangement. They get closer together and begin to form neat rows. After the melting point, the stearic acid is now a solid. The particles are in fixed positions and vibrating in neat rows. As the stearic acid continues to cool down, the particle arrangement does not change but the particles begin to vibrate more slowly.

62 a 80 seconds

b

Equation	$E = P \times t$
Values	$E = 240\,000$ J $P = ?$ $t = 80$ s
Enter values	$240\,000 = P \times 80$
Result	$P = 240\,000 \div 80$ $P = 3000$
Y(units)	$P = 3000$ W $P = 3000 \div 1000 = 3$ kW

c The water boils at 100 °C so it escapes as steam.

d

Equation	$I = V \div R$
Values	$I = ?$ $V = 230$ V $R = 25\ \Omega$
Enter values	$I = 230 \div 25$
Result	$I = 9.2$
Y(units)	$I = 9.2$ A

e It is systematic because all values are 10 °C less than the first student's values. (Accept answers that link to water boiling at 100 °C.)

P11 Space

P11.1 Stars, planets and galaxies

What is in our solar system?

1 Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune

2 Jupiter

3 All planets are spherical.

4 Mercury, Venus, Earth, Mars

5 Pluto is a dwarf planet.

6 The star that is closest to the Earth

7 A star, e.g. our Sun

8 Planets

9 Planets go around a star, but moons go around a planet. A moon is always smaller than the planet it goes around.

10 Earth has one moon, but other planets have many moons, and some planets have no moons at all.

11 a Sound needs particles to oscillate for the wave to travel.
b Longitudinal
c Light does not need particles to oscillate for the wave to travel.
d Transverse

What is an orbit?

12 Elliptical

13 The motion of one astronomical object around another due to gravity – these are elliptical paths

14 The force of gravity between the star and the planet

15 The force of gravity between the moon and the planet

16 a 30 000 m

b

Equation	$s = d \div t$
Values	s = 30 000 m/s d = ? t = 1 minute = 60 s
Enter values	30 000 = $d \div 60$
Result	30 000 × 60 = d
Y(units)	d = 1 800 000 m

c 1800 km

17 Pluto is still orbiting the Sun, as it goes around the Sun and is pulled by the gravitational field of the Sun. Planets are not the only things that orbit.

18 Jupiter, Saturn, Uranus, Neptune

19

Equation	$s = d \div t$
Values	s = ? d = 150 km = 150 000 m t = 2.5 s
Enter values	$s = 150\,000 \div 2.5$
Result	$s = 60\,000$
Y(units)	s = 60 000 m/s

20 a The thin layer of gases that surrounds the Earth

b As the height above the Earth's surface increases, the density decreases.

c As the height above the Earth's surface increases, the air pressure decreases.

d The moon does not have an atmosphere.

e There is air in the helmet of astronauts along with a microphone and a speaker, so astronauts can communicate. If they took off their helmets, they would not be able to hear one another, but they also would not be able to breathe.

What is beyond our solar system?

21 The Milky Way

22 A collection of millions of stars that travels around the universe together (along with their planets and moons)

23 No. Galaxies come in different shapes: elliptical, spiral, irregular.

24 Stars were made in huge clouds of gas and dust called nebulae.

25 Stars eventually run out of fuel and either shrink or explode.

26 Maryam is right, because there are billions of stars, planets and moons in the universe, along with huge clouds of dust and gas. Rahees is right, because in between these billions of objects there is absolute nothingness.

27 A solar system is one star with its planets and moons. A galaxy is made of billions of stars (each with planets and moons) so contains billions of solar systems, making it much larger.

28 The universe is mainly comprised of empty space but contains billions of galaxies far apart from one another. Each galaxy is made of billions of stars. Each star may have a number of planets orbiting it. Some planets have moons orbiting them. Stars may also have dwarf planets, asteroids and comets orbiting them. There are also huge clouds of dust and gas, called nebulae, where stars form.

How do we measure such gigantic distances?

29 The distance that light can travel in one Earth year

30 Astronomical distances are so large.

31 a 300 000 000 m

b

Equation	$s = d \div t$
Values	s = 300 000 000 m/s d = ? t = 2 s
Enter values	$300\,000\,000 = d \div 2$
Result	$300\,000\,000 \times 2 = d$
Y(units)	d = 600 000 000 m

c

Equation	$s = d \div t$
Values	s = 300 000 000 m/s d = ? t = 1 minute = 60 s
Enter values	300 000 000 = $d \div 60$
Result	300 000 000 × 60 = d
Y(units)	d = 18 000 000 000 m

32 The motion is not caused by the gravitational pull of an object in the centre.

33 The universe is mainly comprised of empty space but contains billions of galaxies far apart from one another. Each galaxy is made of billions of stars. Each star may have a number of planets orbiting it. Some planets have moons orbiting them. Stars also have dwarf planets, asteroids and comets orbiting them. There are also huge clouds of dust and gas, called nebulae, where stars form.

34

Equation	$m = \rho \times V$
Values	m = ? ρ = 800 kg/m^3 V = 125 m^3
Enter values	m = 800 × 125
Result	m = 100 000
Y(units)	m = 100 000 kg

35

Equation	$I = V \div R$
Values	I = 2 A V = ? R = 5 Ω
Enter values	2 = $V \div 5$
Result	2 × 5 = V 10 = V
Y(units)	V = 10 V

36

Equation	$s = d \div t$
Values	s = 90 m/s d = ? t = 1 minute = 60 s
Enter values	90 = $d \div 60$
Result	90 × 60 = d
Y(units)	d = 5400 m

37

Equation	$E = P \times t$
Values	E = ? P = 60 W t = 5 hours = 300 minutes = 18 000 s
Enter values	E = 60 × 18 000
Result	E = 1 080 000
Y(units)	E = 1 080 000 J

38

Equation	image size = actual size × magnification
Values	image size = 50 mm actual size = 5 mm magnification = ?
Enter values	50 = 5 × magnification
Result	50 ÷ 5 = magnification
Y(units)	magnification = ×10

39

Equation	$m = \rho \times V$
Values	m = 100 kg ρ = 500 kg/m^3 V = ?
Enter values	100 = 500 × V
Result	100 ÷ 500 = V
Y(units)	V = 0.2 m^3

40

Equation	$I = V \div R$
Values	I = 3 A V = 9 V R = ?
Enter values	3 = 9 ÷ R
Result	3 × R = 9 R = 9 ÷ 3
Y(units)	R = 3 Ω

41

Equation	$s = d \div t$
Values	s = ? d = 9.6 km = 9600 m t = 20 minutes = 1200 s
Enter values	s = 9600 ÷ 1200
Result	s = 8
Y(units)	s = 8 m/s

42

Equation	$E = P \times t$
Values	E = 99 000 J P = ? t = 5 minutes = 300 s
Enter values	99 000 = P × 300
Result	99 000 ÷ 300 = P
Y(units)	P = 330 W

P11.2 The seasons

How do we get day and night on Earth?

43 A sphere cut in half

44 Northern hemisphere and southern hemisphere

45 The equator

46 The axis of the Earth should be tilted (by 23.4°).

47 The northern hemisphere

48 When we face the Sun

49 When we face away from the Sun

50 The Earth spins on its axis.

51 The southern hemisphere

52 Light travels in straight lines so it cannot bend around the Earth to light it up.

53 Light is a transverse wave since the oscillations that make it up are perpendicular to the direction of the wave.

54 Transfer by waves

55 The northern hemisphere

56 Its axis

57 a Iron and nickel
b Compasses (and other magnets) will point to the North Pole (to line up with the Earth's magnetic field).
c A south pole

58 As we go deeper, the density of water increases due to the weight of water above increasing. This means there are more frequent collisions between an object and the water particles, which is an increase in pressure.

59 The southern hemisphere

How do we get summer and winter on Earth?

60 Warmer

61 Diagram A shows summer as the light is spread over a small area and is hitting the Earth directly, so it is warmer. Diagram B shows winter since the light is at a more glancing angle so is spread over a larger area and it is therefore colder.

62 Countries along the equator experience direct sunlight all year round.

63 Winter

64 When the northern half of the Earth's axis is tilted towards the Sun

65 As the Earth spins, the Sun 'rises' as we turn to face the Sun. As we turn away from the Sun, the Sun 'sets'.

66 When the southern half of the Earth's axis is tilted towards the Sun

67 Summer

68 When the northern half of the Earth's axis is tilted away from the Sun

69 We get day and night because the Earth spins, not because of its orbit. If the Earth did not spin, we would have no day and night.

70 a The blue object appears black as blue objects reflect blue light and absorb all other colours. The blue object absorbs the red light and appears black.
b When something allows light to pass through
c The light is absorbed. Green filters only transmit green light.

71 **a**

Equation	$E = P \times t$
Values	E = ? P = 80 W t = 15 s
Enter values	$E = 80 \times 15$
Result	$E = 1200$
Y(units)	E = 1200 J

b Transfer by waves

c Transfer by electric current

d

Equation	$I = V \div R$
Values	I = 8 A V = 10 V R = ?
Enter values	$8 = 10 \div R$
Result	$8 \times R = 10$ $R = 10 \div 8$
Y(units)	R = 1.25 Ω

72 At sunrise/sunset, the light from the Sun becomes much redder in colour.

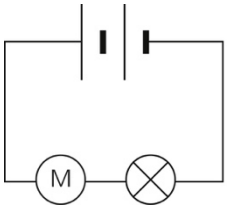
How do the lengths of the days change?

73 The summer

74 Because of the tilt of the Earth, we face the Sun for less time in the winter.

75 Autumn

76 **a**

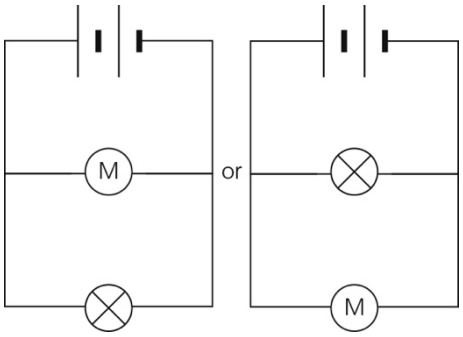


b The motor would also stop working.

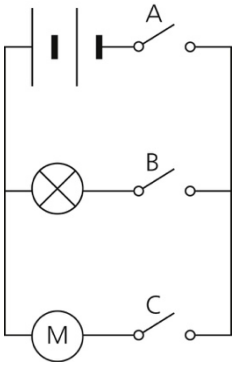
c

Equation	$s = d \div t$
Values	s = ? d = 30 cm = 0.3 m t = 12 s
Enter values	$s = 0.3 \div 12$
Result	$s = 0.025$
Y(units)	s = 0.025 m/s

d



e For example, if the circuit is drawn with the bulb above the motor:



77 Because of the tilt of the Earth, we face the Sun for more time in the summer.

78 Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune

79 **a** Jupiter
b Venus
c They spin at different speeds.
d The two hemispheres of Mercury are not tilted towards or away from the Sun, so the angle of the sunlight does not change.

80 In winter, the light from the Sun hits the Earth at a more glancing angle. This is because the hemisphere that is experiencing winter is tilted away from the Sun, and this causes the glancing light.

81 Both are imaginary lines. The equator is a curved line around the middle of the Earth. The Earth's axis is a straight line from the geographical North Pole to the South Pole through the centre of the Earth.

P11.3 Weight

What is mass?

82 When it is out in deep space, not in a gravitational field

83 A force acting on a mass due to it being in a gravitational field

84 Towards the centre of the Earth

85 Newtons (N)

86 **a** Has mass
b Has no mass
c Has mass
d Has mass

e Has no mass

f Has no mass

87 It must not be made from atoms/it must have no atoms at all.

88 A measure of how much matter is in an object

89 Kilograms (kg)

90

Equation	$m = \rho \times V$
Values	m = ? ρ = 5500 kg/m^3 V = 0.05 m^3
Enter values	$m = 5500 \times 0.05$
Result	$m = 275$
Y(units)	m = 275 kg

91 Weight is measured in newtons, not kilograms. When we measure ourselves in kilograms, we are measuring our mass.

92 Magnetic force, electrostatic force, weight (gravitational force)

93 Contact forces require the two objects that are interacting to be in physical contact, but non-contact forces do not.

How can we change our weight on other planets?

94 No

95 Yes

96 10 N

97 20 N

98 As the mass of an object increases, its weight increases.

99 1.6 N

100 3.2 N

101 As the strength of gravity increases, the weight of an object increases.

102 11.7 N

103 23.4 N

104 Changing the planet does not change how much matter is in the object (the amount of stuff in the object), so the mass is unaffected by it being moved around.

105 Changing the planet changes the strength of gravity. This changes how much the object is pulled down, and this pull down is the weight. So changing planets changes the weight due to the strength of gravity changing.

106 On Earth, since the strength of gravity is larger

107 The mass of the object does not change; it is the same on the Earth and on the moon.

108 The mass has decreased since there is less of the object now.

109 **a** Their mass has not changed, since mass does not depend on where you are.

b Their weight is a lot smaller on the moon because the force of gravity is weaker there, so the force from their legs when they jump is much larger than their weight.

c Less high, since the strength of gravity on Jupiter is larger

How do we calculate the weight of an object?

110 Gravitational field strength

111 Weight = mass × gravitational field strength

112 $W = m \times g$

113 N/kg

114 10 N/kg

115 **a**

Equation	$W = m \times g$
Values	W = ? m = 6 kg g = 26.0 N/kg
Enter values	$W = 6 \times 26.0$
Result	$W = 156$
Y(units)	W = 156 N

b

Equation	$W = m \times g$
Values	W = ? m = 55 kg g = 9 N/kg
Enter values	$W = 55 \times 9$
Result	$W = 495$
Y(units)	W = 495 N

c

Equation	$W = m \times g$
Values	W = ? m = 0.2 kg g = 3.7 N/kg
Enter values	$W = 0.2 \times 3.7$
Result	$W = 0.74$
Y(units)	W = 0.74 N

d

Equation	$W = m \times g$
Values	W = ? m = 500 g = 0.5 kg g = 8.8 N/kg
Enter values	$W = 0.5 \times 8.8$
Result	$W = 4.4$
Y(units)	W = 4.4 N

e

Equation	$W = m \times g$
Values	W = ? m = 25 g = 0.025 kg g = 10.5 N/kg
Enter values	$W = 0.025 \times 10.5$
Result	$W = 0.2625$
Y(units)	W = 0.2625 N

f On Jupiter:

Equation	$W = m \times g$
Values	W = ? m = 25 kg g = 26.0 N/kg
Enter values	$W = 25 \times 26.0$
Result	$W = 650$
Y(units)	$W = 650$ N

On Earth:

Equation	$W = m \times g$
Values	W = ? m = 25 kg g = 10 N/kg
Enter values	$W = 25 \times 10$
Result	$W = 250$
Y(units)	$W = 250$ N

So the difference is 400 N.

116

Equation	$P = F \div A$
Values	P = 400 kN/m^2 = 400 000 N/m^2 F = ? A = 2.5 m^2
Enter values	$400\,000 = F \div 2.5$
Result	$400\,000 \times 2.5 = F$
Y(units)	F = 1 000 000 N

117

Equation	$I = V \div R$
Values	I = ? V = 12 V R = 8 Ω
Enter values	$I = 12 \div 8$
Result	$I = 1.5$
Y(units)	I = 1.5 A

118

Equation	$s = d \div t$
Values	s = ? d = 75.6 km = 75 600 m t = 2.5 hours = 150 minutes = 9000 s
Enter values	$s = 75\,600 \div 9000$
Result	$s = 8.4$
Y(units)	s = 8.4 m/s

119

Equation	$E = P \times t$
Values	E = ? P = 60 W t = 5 minutes = 300 s
Enter values	$E = 60 \times 300$
Result	$E = 18\,000$
Y(units)	E = 18 000 J

How do we calculate the mass of an object?

120 a

Equation	$W = m \times g$
Values	W = 30 N m = ? g = 10 N/kg
Enter values	30 = m × 10
Result	30 ÷ 10 = m
Y(units)	m = 3 kg

b

Equation	$W = m \times g$
Values	W = 142.45 N m = ? g = 3.7 N/kg
Enter values	142.45 = m × 3.7
Result	142.45 ÷ 3.7 = m
Y(units)	m = 38.5 kg

c

Equation	$W = m \times g$
Values	W = ? m = 300 g = 0.3 kg g = 9.0 N/kg
Enter values	W = 0.3 × 9.0
Result	W = 2.7
Y(units)	W = 2.7 N

d

Equation	$W = m \times g$
Values	W = 12.95 kN = 12 950 N m = ? g = 3.7 N/kg
Enter values	12 950 = m × 3.7
Result	12 950 ÷ 3.7 = m
Y(units)	m = 3500 kg

121 Mass is how much matter an object is made of, measured in kilograms. Weight is the force of gravity on an object, so is measured in newtons. Your weight can change on different planets, but your mass does not.

122 a The elliptical path that one object takes around another due to the force of gravity

b The gravitational energy store

c Thrust

d Weight

e The chemical energy store (of the fuel)

f The weight of the rocket decreases.

g Out in deep space

123 There are no particles in space as it is a vacuum, and sound needs particles to be able to travel.

124

Equation	$m = \rho \times V$
Values	$m = 2.4$ kg $\rho = 800$ kg/m^3 $V = ?$
Enter values	$2.4 = 800 \times V$
Result	$2.4 \div 800 = V$
Y(units)	$V = 0.003$ m^3

125

Equation	$P = F \div A$
Values	$P = 20$ kN/m^2 $= 20\,000$ N/m^2 $F = ?$ $A = 5$ m^2
Enter values	$20\,000 = F \div 5$
Result	$20\,000 \times 5 = F$
Y(units)	$F = 100\,000$ N

126

Equation	$I = V \div R$
Values	$I = 0.2$ A $V = 10$ V $R = ?$
Enter values	$0.2 = 10 \div R$
Result	$0.2 \times R = 10$ $R = 10 \div 0.2$
Y(units)	$R = 50\ \Omega$

127

Equation	$s = d \div t$
Values	$s = 9.5$ m/s $d = ?$ $t = 3$ hours $= 180$ minutes $= 10\,800$ s
Enter values	$9.5 = d \div 10\,800$
Result	$9.5 \times 10\,800 = d$
Y(units)	$d = 102\,600$ m

128

Equation	$E = P \times t$
Values	$E = 806\,400$ J $P = ?$ $t = 4$ hours $= 240$ minutes $= 14\,400$ s
Enter values	$806\,400 = P \times 14\,400$
Result	$806\,400 \div 14\,400 = P$
Y(units)	$P = 56$ W

What is the difference between accurate and precise?

129 **a** 1.65 m

b 1.534 m

c The mean of the results is close to/the same as the true value.

d The mean of the results is far away from the true value.

e Data set 2, since the values are closer together than in data set 1

f They are not reproducible, since different people performed the experiment.

130 **a** 50 s

b 63.8 s

c Data set 2, since the mean is closer to the true value

d Data set 1, since the values are the most spread out

e Because the same result was not achieved after repeating.

f Reproducible

131 When the results of an experiment are close to what they should be

132 When the results of repeating an experiment are close together