KS4 YEAR 10 SCIENCE

HOME STUDY PACK

Ormiston RIVERS Academy

YEAR 10

SCIENCE

HOME STUDY BOOKLET

Name _____

Class _____

Teacher _____

Introduction & Contents page

Welcome to your home study pack for Year 10 Science. In this booklet you will find information and questions to answer on the topics we would like you to study at home.

Some of the content you may have covered before but that is fine, you can revise and improve your knowledge, or if it is new content then you have the information you need to attempt the questions.

Most of the questions have answers or mark schemes to self-assess your work and some are comprehension questions where you will find the answers in the text.

Confidence level: Before you start going through each section of activities and questions rate your confidence in each of the topics. Circle the smiley face for confident, the meh face for not sure and the sad face for not confident.

There is a box to tick when you have completed each section so you can keep track of the work you have completed.

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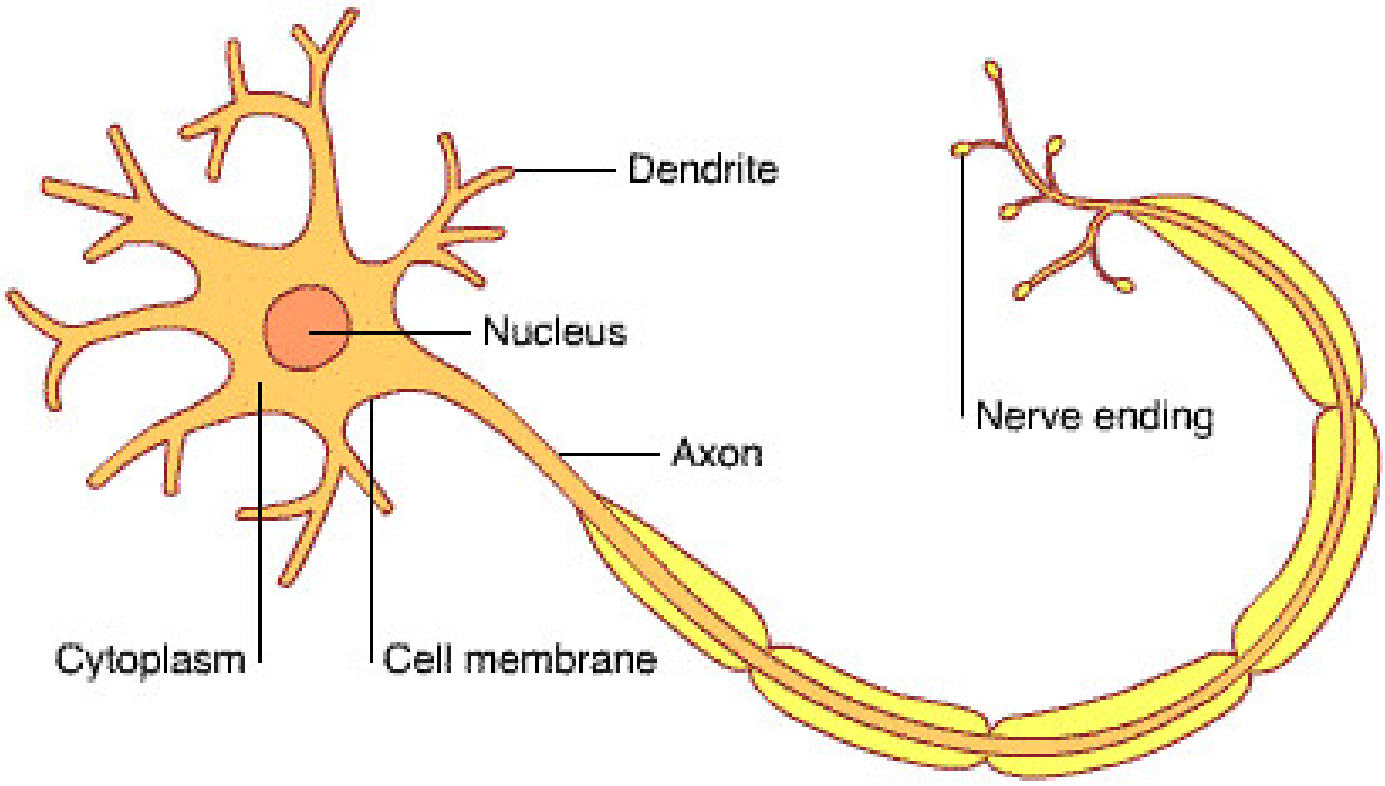
BIOLOGY

HOMEOSTASIS AND RESPONSE

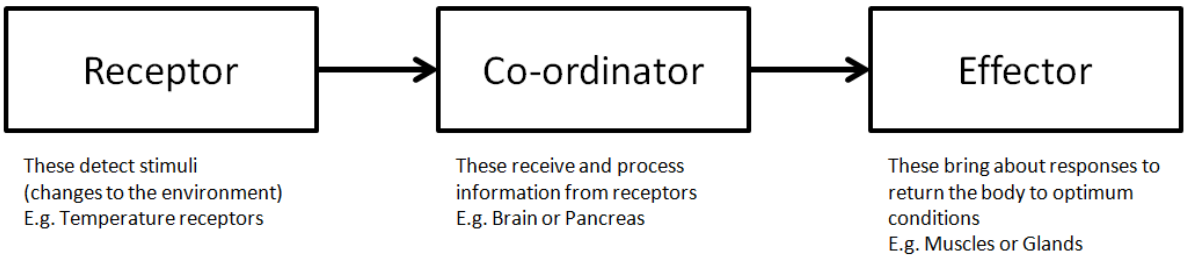


Part 1- Homeostasis

Humans have been able to colonise most of the earth. Even in extreme environments, like the Arctic Circle and the Sahara desert, humans can live and thrive. In spite of this we are actually not very good at surviving in these places if it was not for our technology. Humans, like all mammals need to maintain a constant internal environment. If our core body temperature, blood glucose levels, or water levels change too much we can get very ill or even die. If you recall in the organisation topic, enzymes are very specific. Changes in conditions affect their shape causing them to denature. Enzymes are the main reason for homeostasis.

To prevent this, our body has a number of systems which it uses to maintain a constant internal environment. **Homeostasis** is the regulation of the internal conditions of a cell or organism to maintain **optimum conditions** for function in response to internal and external changes.

Homeostatic mechanisms are so important for your survival that they are **automatic**. This means your body constantly makes adjustments without you having to consciously think about it. The all follow the same basic structure.



Homeostatic control mechanisms come in two forms:

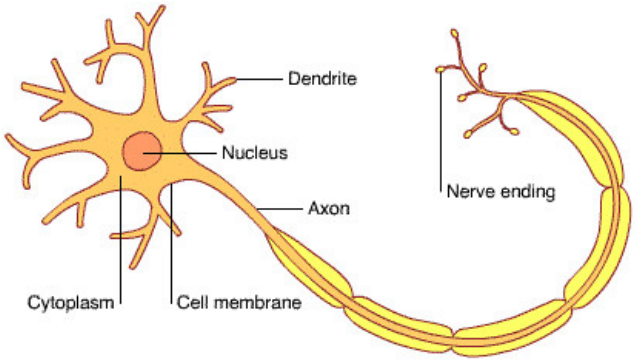
- **Nervous** responses: These use nerves to transfer information from the receptors to the brain and spinal cord (co-ordinators) and then to effectors.
- **Hormonal** responses: These use hormones which are released from various organs and travel through the blood stream to various effectors.

We will look at each in more detail as the topic progresses.

1. Define 'homeostasis'
2. List 3 things humans, and all mammals, must keep constant to survive.
3. Draw a 'lock and key' diagram to show the specific action of enzymes. Include the following labels: *Enzyme, substrate, active site, enzyme-substrate complex, product*
4. Define 'denatured' a diagram might help
5. What is a receptor? Give an example
6. What is a co-ordinator? Give an example
7. What is an effector? Give an example
8. What are two differences between nervous and hormonal responses?
9. Complete the sentences:
   Mammals need homeostasis because…
   Mammals need homeostasis but….

Part 2- The Human Nervous System

The nervous system is specifically adapted to react to our surroundings and coordinate our behaviour. The nervous system uses **electrical** and **chemical** signals so send information rapidly. Some can even reach speeds of over 100m/s which are as fast as a sports car!



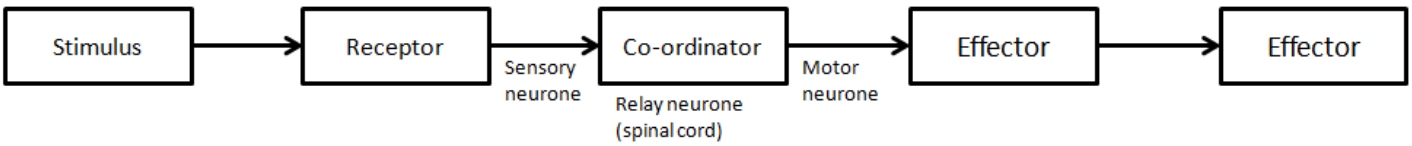
The nervous system is made of nerve cells (neurones). Neurones are specialised cells which can carry electrical impulses along their long thin cytoplasm, called an **axon**. Neurones come in 3 main forms **sensory** neurone, **relay** neurone and **motor** neurone.

Sensory neurone	These connect receptors to the coordinator
Relay neurones	These coordinate the correct response to the stimulus
Motor neurone	These send the signal from the coordinator to the effector

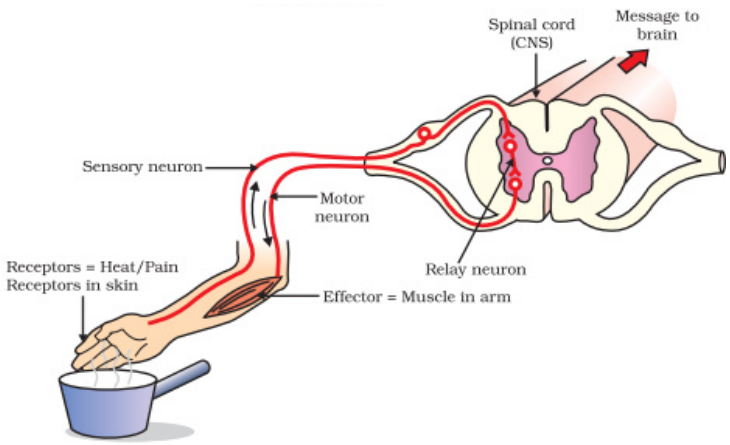
The coordinators for the nervous system are the **brain** and the **spinal cord**. These are known collectively as the **central nervous system (CNS)**. The CNS is responsible for coordinating all the sensory information around you, all your thoughts and maintaining all your internal systems (eg heart and breathing rate). Where a nerve ends and joins to another there is a gap. This gap is known as a **synapse**. At the synapse the electrical signal is transferred into a chemical signal that diffuses across the gap. The synapse is important as it allows the nervous system to direct the signal to the right location. A good analogy is the switches on a railway line that move to ensure a train goes along the right track.

The reflex arc

Reflexes are automatic responses hard-wired into your body. This means the signal never goes to your brain. The relay neurones in the spinal cord coordinate the response and your body will respond without the need for you to think about it. A good example is in the eye. When the light levels are low and it is dark your iris contracts and your pupil gets bigger. If you move into the light, your eyes detect the increase in light and automatically your iris will relax and the pupil will shrink. This happens without conscious thought. Below is a diagram showing the basic structure of a reflex arc.



Another example of a reflex arc is to pain. Imagine accidently touching something hot or a pin with your hand. Your body will respond by instantly withdrawing your hand.



in response

10. Complete the table below to show the stages of the reflex arc. The example of the eye has been completed for you

Stages of reflex arc	Moving from a dark room to a light room	Touching a hot saucepan
Stimulus	Increase in light intensity	
Receptor	Light receptors in eye	
Neurone that sends signal to coordinator	Sensory neurone	
Coordinator	Relay neurone in spinal cord	
Neurone that sends signal to effector	Motor Neurone	
Effector	Muscle (Iris)	
Response	Pupil gets smaller	

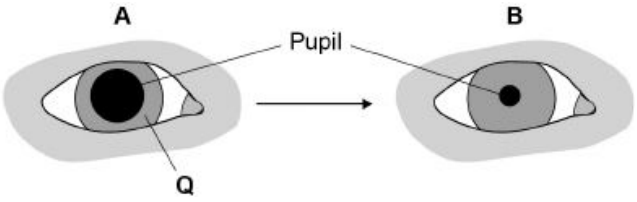
11. What is the scientific word for a nerve cell?
12. What kind of signal passes along neurones?
13. What is a synapse?
14. What is the name for the cells which detect changes in the environment?
15. Name the 3 types of neurone in a reflex arc
16. What are the two coordinators of the nervous system?
17. Why is a reflex arc automatic?
18. Define ‘effector’
19. What type of signal passes through a synapse
20. Define ‘diffusion’
21. What is the name of the organelle which contains the genetic material in the neurone?
22. List 2 ways a neurone is specialised to carry out its function
23. How is a motor neurone different from a sensory neurone?
24. Complete the sentences below:
    A reflex arc does not travel to the brain because….
    A reflex arc does not travel to the brain but……
    A reflex arc does not travel to the brain so…..
25. Roger sits on a pin. He screams and jumps up. Describe the journey of the signal through a reflex arc. Make sure you include as much detail as possible. *Hint: use the diagram earlier if you are stuck*

Sentence help; W*hen he sits on the pin…. This sends a signal to… The _____neurone then….*

26. Many human actions are reflexes. Which **two** of the following are examples of reflex actions?
    - Jumping in the air to catch a ball
    - Raising a hand to protect the eyes in bright light
    - Releasing saliva when food enters the mouth
    - Running away from danger
    - Withdrawing the hand from a sharp object

Figure 1 shows how the size of the pupil of the human eye can change by reflex action.

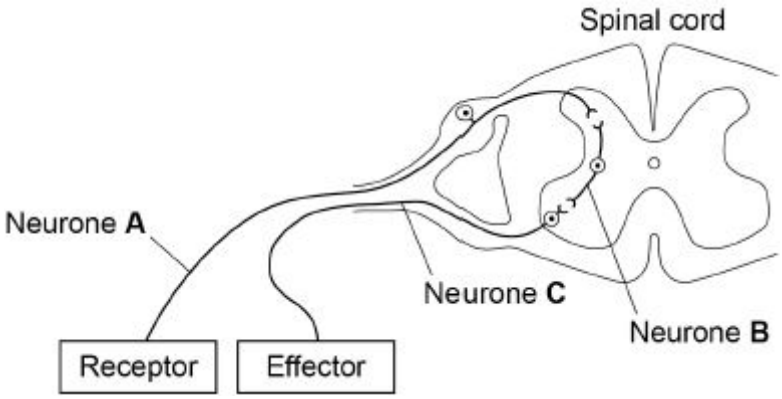
Figure 1



27. Name **one** stimulus that would cause the pupil to change in size from **A** to **B**, as shown in **Figure 1**.
28. Structure **Q** causes the change in size of the pupil. Name structure **Q**.
29. Describe how structure **Q** causes the change in the size of the pupil from **A** to **B**

Figure 2 shows some structures involved in the coordination of a reflex action.

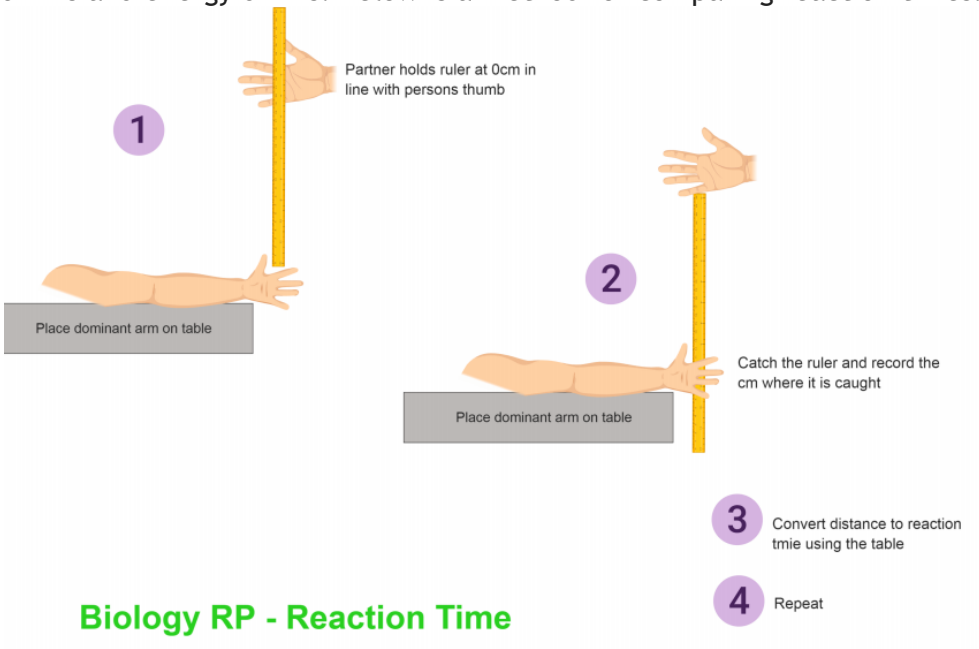
Figure 2



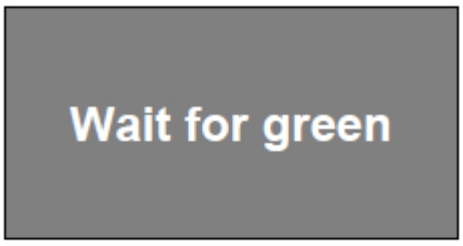
30. Describe how the structures shown in **Figure 2** help to coordinate a reflex action.

Human reaction time.

The time is takes the body to recognise a change and react to it is called the reaction time. The reaction times of human are all slightly different and can be affected by external factors. One of the factors that are thought to improve reaction times is caffeine. Caffeine is found in coffee, fizzy drinks and energy drinks. Below is a method for comparing reaction times.



31. What was the independent variable in your investigation?
32. What was the dependent variable in your investigation?
33. Give two sources of error in the method and one possible way of reducing their impact on the results.
34. Three students measured their reaction times. The students used a computer program. The image below shows the image displayed on the computer screen.



This is the method used:

1. Sit facing the computer screen.
2. Click the mouse button as quickly as possible when the computer screen turns green.
3. Record the time taken as shown on the computer screen.
4. Repeat steps 2 and 3 a further 9 times.

The table shows the students' results.

Attempt number	Time in milliseconds		
	Student A	Student B	Student C
1	275	260	272
2	259	268	268
3	251	251	275
4	261	256	266
5	260	244	270
6	263	280	283
7	259	468	274
8	256	258	278
9	255	255	286
10	248	277	275
Mean	259	282	275

(1 second = 1000 milliseconds)

(a) Suggest why measuring reaction time with a computer is more accurate than measuring reaction time with a stopwatch.

(b) The students measured 10 reaction times for each person rather than 3 reaction times. Explain why.

(c) Explain why the mean for student **B** has been calculated incorrectly. Use information from the table.

(d) Calculate the ratio of student **C**'s mean reaction time to student **A**'s mean reaction time.

Give your answer to 3 significant figures.

Ratio student **C** : student **A** = _____ : 1

(e) Student **A** wanted to present his mean result in seconds, in standard form.

What is the correct way of doing this? Choose from the answers below:

259×10^{-3} seconds 0.259×10^{-3} seconds 2.59×10^{-1} seconds 0.259×10^{-4} seconds

(f) Student **C** said the results from this investigation showed that he had the fastest reactions.

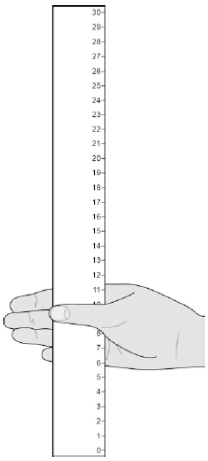
Give **two** reasons why student **C**'s statement is **not** correct.

(g) The reaction the students investigated is **not** a reflex action. Give the reason why.

35. Two students investigated reflex action times.

This is the method used.

1. Student **A** sits with her elbow resting on the edge of a table.
2. Student **B** holds a ruler with the bottom of the ruler level with the thumb of Student **A**.
3. Student **B** drops the ruler.
4. Student **A** catches the ruler and records the distance, as shown in the diagram below.
5. Steps **1** to **4** were then repeated.



(a) Suggest **two** ways the students could improve the method to make sure the test would give valid results.

(b) The table below shows Student **A**'s results.

Test Number	Distance ruler dropped in mm
1	117
2	120
3	115
4	106
5	123
6	125
7	106

What is the **median** result?

(c) The mean distance the ruler was dropped is 116 mm.

Calculate the mean reaction time.

Use the equation:

reaction time in s = $\sqrt{\frac{\text{mean drop distance in cm}}{490}}$ Give your answer to 3 significant figures

(d) The students then measured Student **A**'s reaction time using a computer program.

This is the method used.

1. The computer shows a red box at the start.

2. As soon as the box turns green the student has to press a key on the keyboard as fast as possible.

3. The test is repeated five times and a mean reaction time is displayed.

Student **A**'s mean reaction time was 110 ms.

Using a computer program to measure reaction times is likely to be more valid than the method using a dropped ruler.

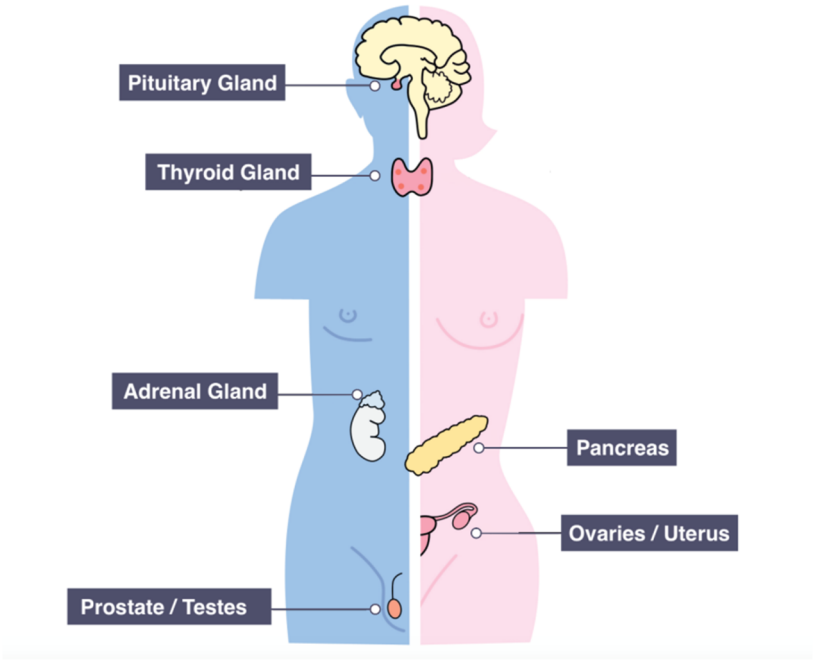
Give **two** reasons why.

Part 3- Hormonal coordination in humans

Hormones are chemical messengers that travel round the body. The endocrine system is the name of the series of organs and glands which coordinate changes in the body using hormones. A gland secretes a hormone into the blood. The hormone travels through blood stream until it reaches its target organ. The advantage of hormonal coordination is it can have a more long lasting effect. The disadvantage is that it takes longer to work. A good example of this is puberty. Sex hormones (oestrogen and testosterone) are released from the sexual organs and cause the changes to the body over a number of years.

The endocrine system has a 'master gland' called the pituitary gland. It secretes a number of hormones which in turn affect other glands which secrete different hormones. It plays a large role in both homeostasis and our body's stress response.

Below is a diagram showing the main organs of the endocrine system



Part 4- Blood glucose regulation

We need a supply of glucose in our blood so that our cells can respire efficiently. The problem is glucose is soluble so affects the osmotic potential of the blood plasma. If there is too much sugar in the blood then water will leave the red blood cells, by osmosis through the cell membrane. This causes the red blood cells to shrivel and become unable to carry oxygen. Conversely, if there is too little glucose in the plasma then the water will move from the plasma to the red blood cells by osmosis. This causes the red blood cells to swell and even burst. The endocrine system is responsible for maintaining a constant blood glucose level in the body.

The pancreas is the main organ responsible for detecting and controlling the blood glucose levels of the blood. The liver plays a role in the storing of glucose as insoluble glycogen.

When you eat your blood sugar rises:

- The pancreas detects the rise in blood glucose
- The pancreas secretes **insulin** into the blood stream
- The insulin travels to the liver
- The liver absorbs the glucose and converts it in to glycogen
- Blood glucose returns to normal

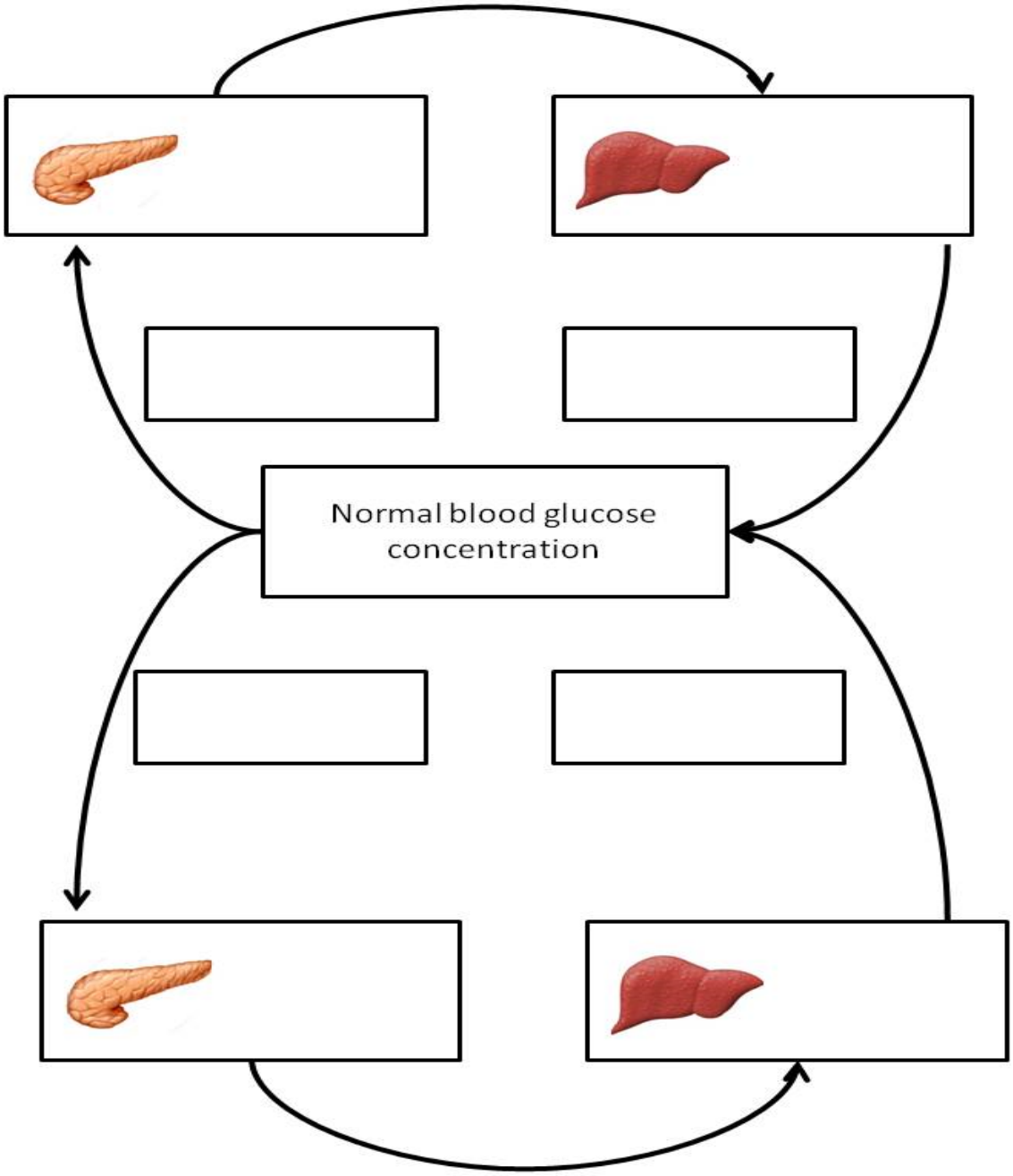
When you exercise your blood sugar falls:

- The pancreas detects the fall in blood glucose
- The pancreas secretes **glucagon** into the blood stream
- The glucagon travels to the liver
- The liver converts glycogen to glucose and releases it in to the blood
- Blood glucose returns to normal

Diabetes is a disorder where a person cannot control their blood glucose concentration on their own. It comes is two forms summarised below.

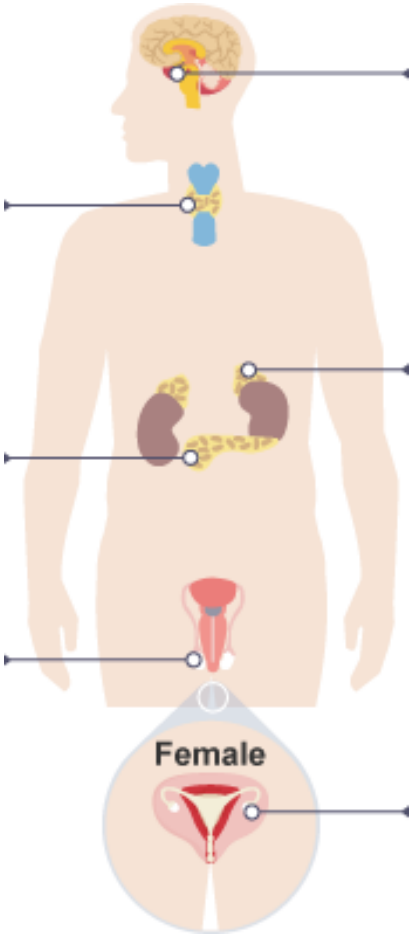
	Type 1	Type 2
Caused by	Body's immune system accidently attacking pancreas cells	Poor diet and obesity over a long period of time
Effect	Pancreas no longer makes insulin	Liver is unable to recognise insulin in the blood
Consequence	Blood sugar rises	Blood sugar rises
Treated by	Injections of insulin	Carbohydrate controlled diet, exercise and medication

36. Use the information above to complete the flow diagram below to summarise how the pancreas and liver control blood glucose concentrations



37. Define ‘osmosis’
38. What is the food test for glucose?
39. What is the role of the pancreas in homeostasis?
40. Ruby says “the liver is an organ because it has more than one function” is she correct? Give a reason.
41. What are hormones?
42. Compare nervous coordination to hormonal coordination. How are they similar? How are they different?
43. Name the system apart from the nervous system that coordinates the body.
44. Where are hormones produced?
45. How are hormones transported from one organ to another?
46. Name the ‘master gland’ and describe how it brings about impact on the body.

47. Label the endocrine glands.



48. Name the endocrine gland that controls blood glucose level (BGL).
49. What is the effect of insulin on BGL?
50. Name the hormone that increases BGL.
51. Name the organ that secretes the two hormones to regulate BGL.
52. When would a person's BGL increase during a day (24hr)?
53. Explain the **primary** reason why a person's BGL would decrease eventually.
54. Describe the actions of insulin – how does it lower BGL?
55. Describe the actions of glucagon.
56. Explain the importance of maintaining a stable blood glucose level.
57. What is diabetes?
58. Describe two differences between types 1 and 2 diabetes.
59. State three symptoms of diabetes.
60. *Explain why diabetic patients may lose weight.
61. Suggest two risk factors for developing diabetes.
62. *State two ways to diagnose someone as diabetic.
63. Compare the treatments of types 1 and 2 diabetes.
64. One type of diabetes can be cured. State which one it is and explain how.
65. *Following the question above, suggest a problem with the treatment. What is a possible solution to this problem?
66. *Explain why insulin must be injected rather than taken by mouth.
67. *Explain why insulin injection is not an appropriate treatment for type 2 diabetes.

68. It is important that the concentration of glucose (sugar) in the blood is controlled.

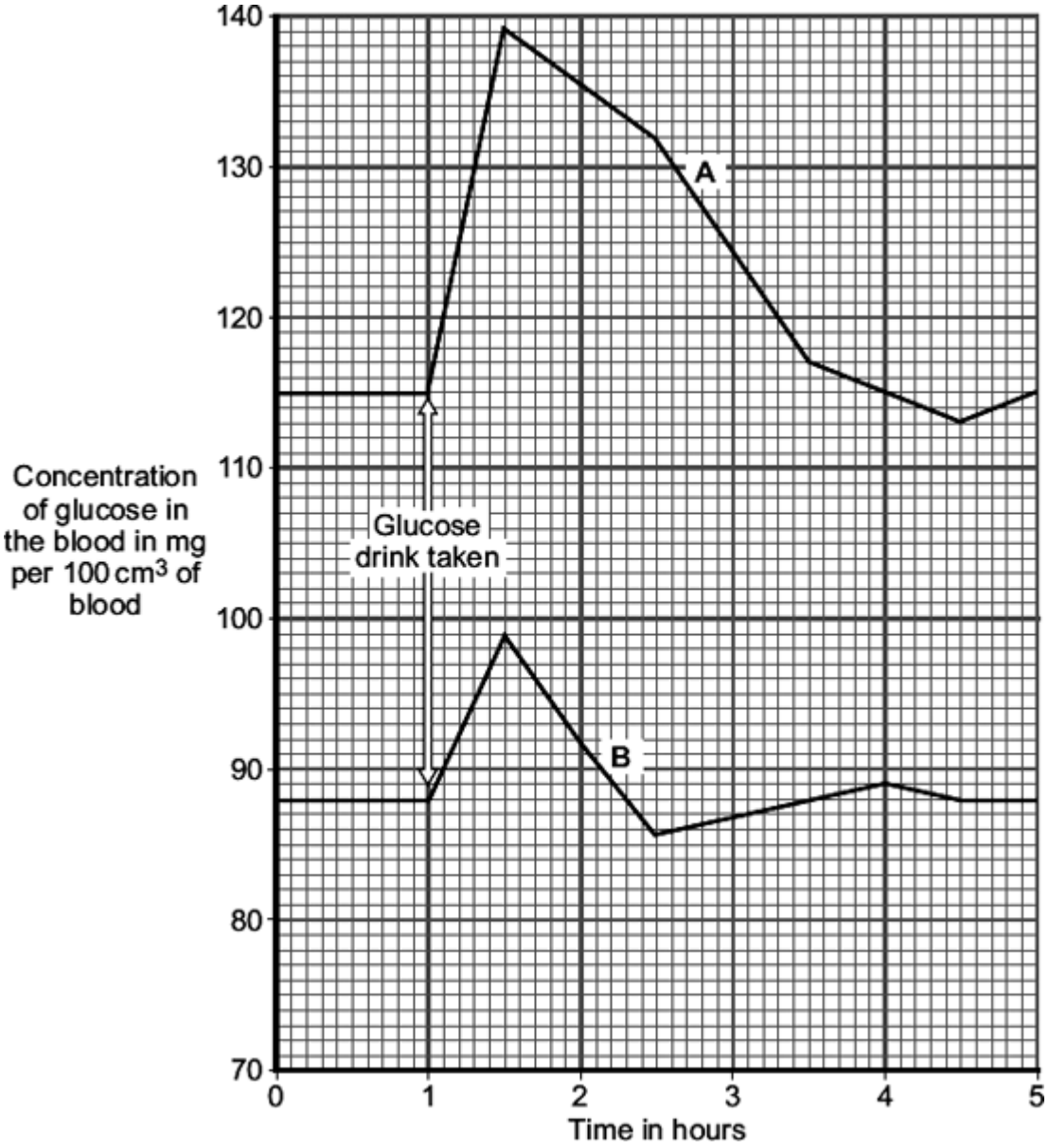
(a) (i) Which hormone controls the concentration of glucose in the blood?

(ii) Which organ produces this hormone?

(b) The concentration of glucose in the blood of two people, **A** and **B**, was measured every half an hour.

One hour after the start, both people drank a solution containing 50 g of glucose.

The graph shows the result.



(i) By how much did the blood glucose concentration in person **B** rise after drinking the glucose drink?

(ii) A doctor suggests that person **A** has diabetes.

Give **two** pieces of evidence from the graph to support this suggestion.

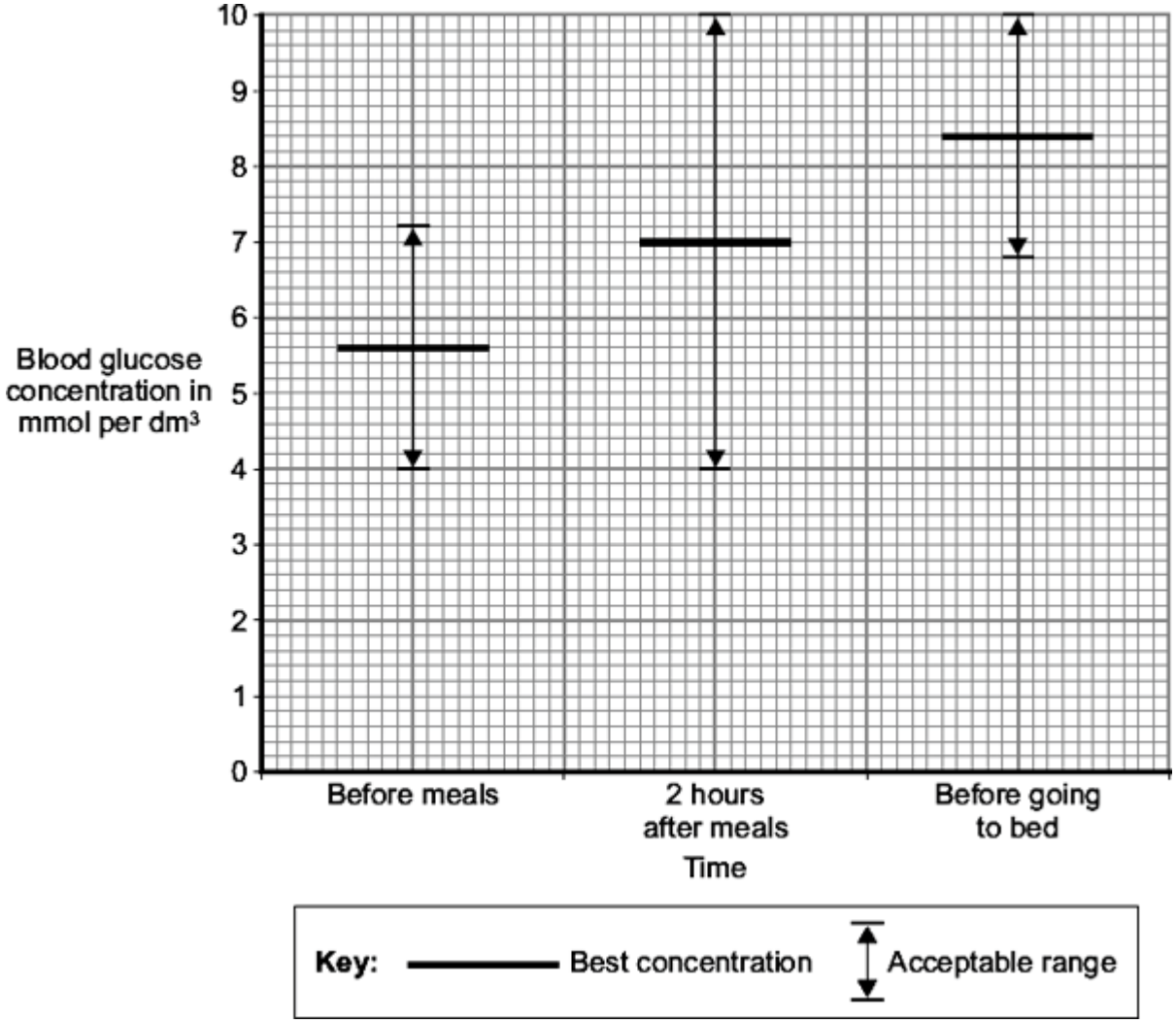
(iii) Give **one** reason for the fall in blood glucose concentration in person **B**, shown in the graph.

69. In diabetics blood glucose concentrations are sometimes abnormal.

(a) Name the organ that monitors the concentration of glucose in the blood.

(b) Diabetics can measure their blood glucose concentration.

The graph shows the best blood glucose concentration and the acceptable range of blood glucose concentration at different times.



What is the acceptable range for the blood glucose concentration before meals?

(c) The amount of insulin a diabetic injects can be changed so that blood glucose concentration is kept near to the best level. Two hours after eating breakfast a diabetic measures his blood glucose concentration. His blood glucose concentration is 13 mmol per dm^3.

He reads these instructions:

- for every 2 mmol per dm^3 of blood glucose *above* the best concentration, inject 1 unit *more* of insulin
- for every 2 mmol per dm^3 of blood glucose *below* the best concentration, inject 1 unit *less* of insulin.

How should he change his normal insulin injection to bring his blood glucose level to the best concentration?

70. Diabetes is a disease in which a person's blood glucose concentration rises to higher levels than normal. Diabetes is caused by insufficient insulin being produced.

(a) (i) Which organ monitors blood glucose concentration?

(ii) Insulin reduces the concentration of glucose in the blood. Describe how insulin does this.

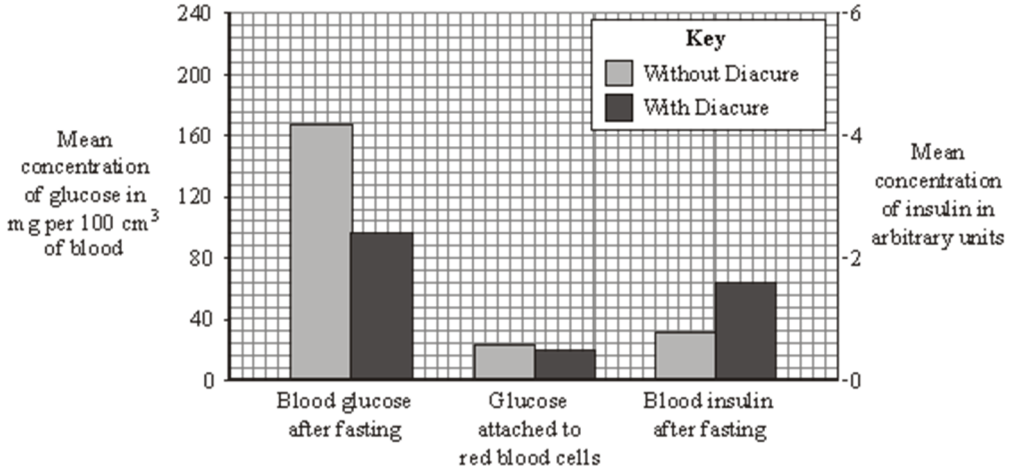
(b) A person with diabetes can be monitored in three ways:

- measuring the blood glucose concentration after fasting (going without food for 12 hours)
- measuring the amount of glucose attached to red blood cells: this is a measure of the average blood glucose concentration over the previous three months
- measuring the concentration of insulin in the blood after fasting

The manufacturer of a new treatment for diabetes, called Diacure, publishes the following two claims.

98.6% of all people who used Diacure reported an improvement in their condition.

An independent study of 30 diabetic patients showed a significant reduction in blood glucose concentrations and a significant increase in insulin production, as shown by the graph.



(i) Which of the manufacturer's claims is **not** based on scientific evidence?

(ii) Why might the data in this study be unreliable?

(iii) The manufacturer did **not** draw attention to the data for the amount of glucose attached to red blood cells. Suggest an explanation for this.

(iv) The study of diabetic patients was carried out by an independent company. Why is it important that the study should be independent?

Part 5- Human reproductive hormones

One of the most vital roles of the endocrine system is in coordinating the **reproductive system**. As mentioned before, during puberty **testosterone** is made in the testes in high levels. This causes males to develop the secondary sex characteristics of body hair, deeper voice, sperm production etc.. Likewise the ovaries secrete **oestrogen** which causes females to develop breasts, grow body hair, widen their hips and they begin to **ovulate**.

Hormones also play a vital role in coordinating the female **menstrual** cycle. The function of the menstrual cycle is to ensure the female body is prepared to conceive a baby at regular intervals. Most women have a menstrual cycle of 28 days although this can vary. The menstrual cycle is a complex system coordinated by 4 main hormones;

Follicle stimulating hormone (FSH): This causes an egg cell to mature in the ovaries

Luteinising hormone (LH): Stimulates the ovary to release the egg

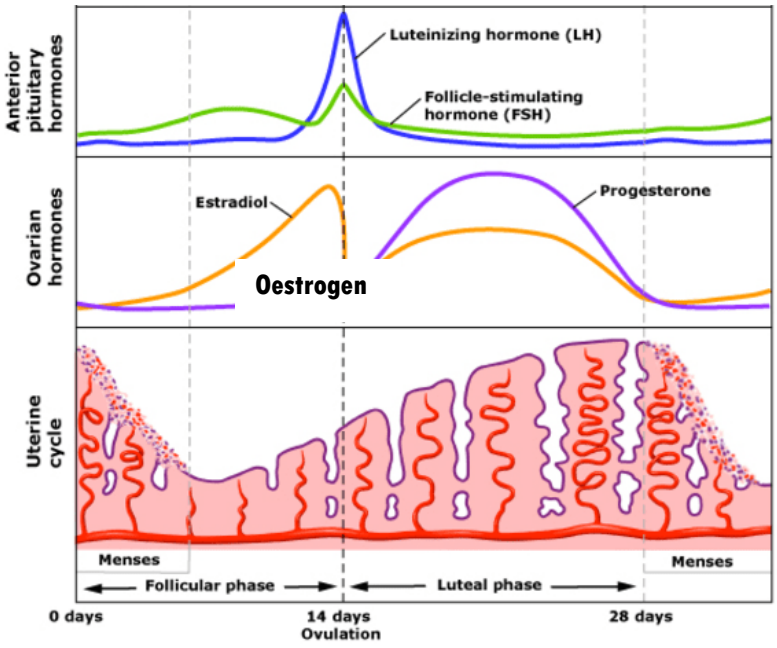
Progesterone and Oestrogen: These maintain the uterus lining so a fertilised egg can be implanted and develop into an embryo.

If the egg is not fertilised the lining and egg are shed. This is noticed as a small volume of blood. This is called menstruation, although it is also know as a 'period'

71. What is the function of the endocrine system?
72. What is the name of the male sex hormone and where is it produced?
73. What is the name of the female sex hormone and where is it produced?
74. What hormone causes and egg to develop in the ovary?
75. What hormone causes the egg cell to be released?
76. What is the role of progesterone?
77. Why might women with love levels of FSH find it hard to conceive a baby?

Controlling the menstrual cycle (HT ONLY)

The female reproductive hormones are synchronised to ensure the menstrual cycle follows a regular pattern. This is summarised in the diagram below



The cycle starts with menstruation. The lining is shed because oestrogen and progesterone levels are low. At the same time FSH begins to rise slightly, triggering a new egg cell to begin developing. FSH stimulates Oestrogen production so oestrogen levels begin to rise and the lining of the uterus begins to re-grow.

A day or two before ovulation the levels of oestrogen, LH and FSH all reach their maximum. Once the egg is released they all begin to drop. Progesterone and oestrogen rise to maintain the lining of the uterus. If the egg is fertilised it will embed in the lining and progesterone and oestrogen will remain high. Oestrogen inhibits FSH and when combined with progesterone inhibits FSH. This prevents a second egg being released during the 9 months of a gestation. If the egg is not fertilised then progesterone drops and menstruation happens. The cycle repeats.

78. Which hormone stimulates the release of Oestrogen from the ovaries?
79. What is the function of the uterus lining?
80. What happens when FSH rises?
81. What happens when FSH and LH rise suddenly
82. Why doe progesterone increase after ovulation?
83. The human body produces many hormones.

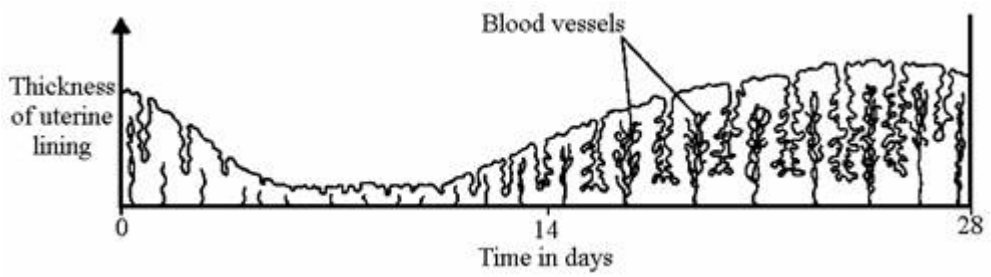
(a) (i) What is a *hormone*?

(ii) Name an organ that produces a hormone.

(iii) How are hormones transported to their target organs?

(b) Describe how the hormones FSH, oestrogen and LH are involved in the control of the menstrual cycle.

122. The diagram shows changes in the uterus lining during 28 days of a menstrual cycle.



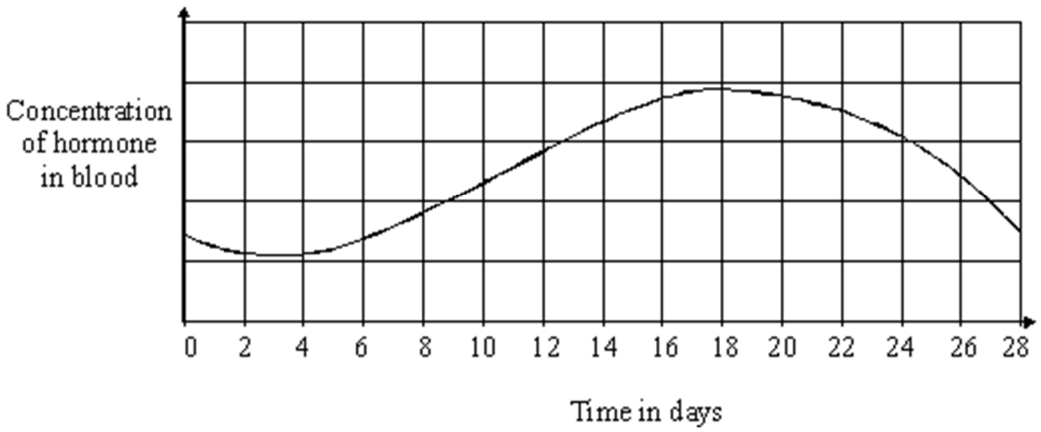
Describe how changes in the lining shown in the diagram adapt it for its function if an egg is fertilised.

(b) The concentration of a certain hormone in the blood of a woman was measured during her menstrual cycle. The woman's temperature was also measured each day during this cycle.

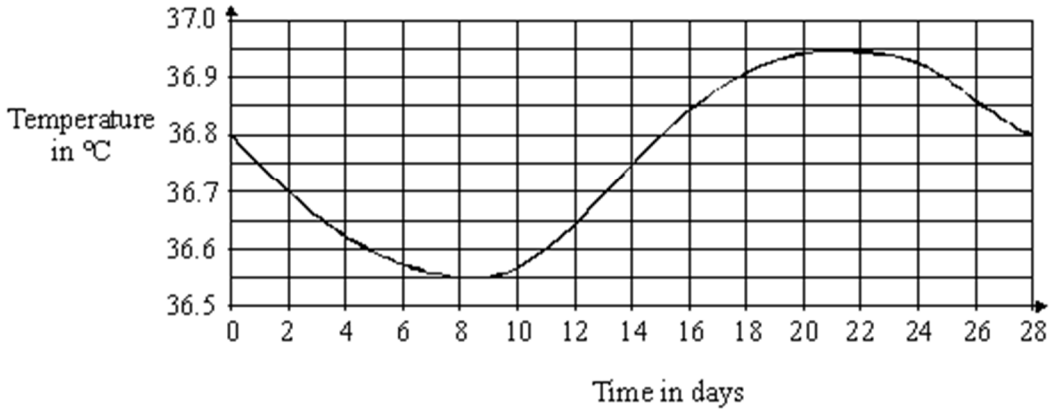
Graph 1 shows the results obtained for the measurement of the concentration of the hormone.

Graph 2 shows the results obtained for the measurement of her body temperature.

Graph 1



Graph 2



(i) What evidence is there that changes in the concentration of the hormone may be connected with changes in body temperature?

(ii) What is the difference between the minimum and maximum temperatures shown by **Graph 2**? Show your working.

Part 6- Contraception

It's hard to think of a world before contraception was available. Before contraception every time a man and woman had sex there was a significant chance a baby would be conceived. Some forms of contraception have also helped to stop the spread of sexually transmitted diseases like syphilis, gonorrhoea and HIV.

Contraception is the word used to describe any technology that prevents pregnancy. Type of contraception broadly fall into two main categories; Hormonal and Non-hormonal

Hormonal:

Give that we have just learnt about the complex roles the hormones play in the menstrual cycle it makes sense that we can manipulate them to trick the body and prevent pregnancy.

- Oral contraceptive pill: Contains oestrogen and progesterone to inhibit FSH. This prevents an egg maturing.
- Contraceptive implant: Contains a slow release version of progesterone. This ensures that an egg is not released from the ovary.

The balance of each hormone in an individual is **similar** but not **identical**. This means that pharmaceutical companies make a variety of mixtures of the hormones. The aim is to find a version which work for the woman without **side effects**.

Non-hormonal:

These are a broad range of very different strategies. Some only prevent pregnancy, others also provide protection from STI's

- *Barrier methods:* Mainly the condom or the diaphragm. Both of these provide a physical barrier that prevents sperm entering the uterus. The condom has an added advantage of preventing the spread of STI's. Correctly used a condom is 98% effective at preventing pregnancy, which is the best of all the methods available.

- *Interuterine devices (IUD):* Often called 'the coil' they are tiny plastic or metal devices that are inserted into the uterus. They aim to mimic an implanted embryo, stimulating progesterone and oestrogen and prevent a mature egg begin released.

- *Spermacidal gels:* These kill sperm on contact. Often added to barrier methods to improve their effectiveness. Does not prevent the spread of STI's.

- *Abstinence:* Various apps are now available to monitor the menstrual cycle. By doing this they can predict when you will have a low chance of conceiving if you have sex. This is the least effective method as sperm can survive inside the oviduct for a number of days. Does not prevent the spread of STI's.
- *Surgical sterilisation:* This is when a person is preventing from releasing sperm or eggs due to a small surgical procedure. In males a vasectomy involved the sperm ducts being stitched up to prevent the sperm made in the testes reaching the penis. In women the oviducts can have a similar procedure to prevent eggs travelling to meet the sperm. In both cases these are permanent procedures and come with some short term discomfort while you recover from the operation. They do not prevent the spread of STI's.

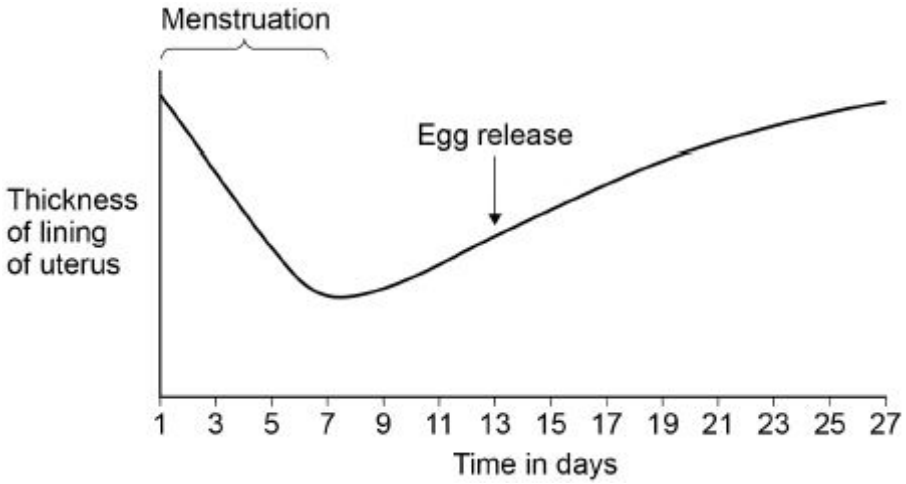
84. What is the common purpose of all forms of contraception?
85. What are the two main categories of contraception?
86. Which forms of contraception also prevent STI's?
87. Which forms of contraception are permanent?
88. Which hormone is in both hormonal contraceptive methods?
89. Brad says "I can't catch an STI because my girlfriend is on the pill" Is he right or wrong? Give a reason.
90. Complete the sentences below:

The Abstinence method is not a very reliable method of contraception because..

The Abstinence method is not a very reliable method of contraception but..

The Abstinence method is not a very reliable method of contraception so..

91. Duncan says "I don't like the feeling of a condom, but my girlfriend has bad side effects on the pill. I'm not sure what to do?" What advice would you give Duncan? Make sure you include reasons for any advice you give.
92. Why would it still be recommended that a homosexual male wear a condom?
93. The graph below shows some changes that occur during the menstrual cycle.



(a) The graph above shows that the lining of the uterus thickens between days 7 and 27.

What is the purpose of thickening the lining of the uterus?

Choose from:

- To allow implantation of the embryo
- To break down waste
- To prevent sperm reaching the egg

(b) Which hormone causes thickening of the lining of the uterus?

(c) On which day is fertilisation most likely to occur? Use information from the graph above.

Contraception can be used to lower the chance of pregnancy.

(d) Draw **one** line from each method of contraception to how the method works.

Method of contraception	**How the method works**
	Barrier to prevent sperm reaching the egg

Contraceptive pill	
	Contains hormones to stop eggs maturing
Diaphragm	
	Kills sperm
Spermicidal cream	
	Slows down sperm production

(e) The table below gives information about some different methods of contraception.

Method	**Number of pregnancies per 100 women in one year**	**Possible Side effects**
Diaphragm and spermicidal cream	8	Usually none, but can cause bladder infection in some women
Condom	2	None
Contraceptive pill	1	Mood swings, headaches, high blood pressure, blood clots, breast cancer

A man and a woman decide to use the condom as their method of contraception.

Suggest **three** reasons for this decision.

Use information from the table above and your own knowledge.

Part 7- Using hormones to treat infertility (HT ONLY)

It is a cruel twist of irony that while some people spend a lot of time ensuring they cannot fall pregnant during sex, others spend years desperately trying to have child and not succeeding.

Fortunately scientific developments over the last 50 years have been able to help couples in this situation.

Fertility drugs: These are mixtures of FSH and LH taken over a series of days. The aim is to help the egg cells to mature and be released. The woman can then fall pregnant in a traditional fashion.

IVF: In-Vitro Fertilisation is a sophisticated process that can help a couple conceive.

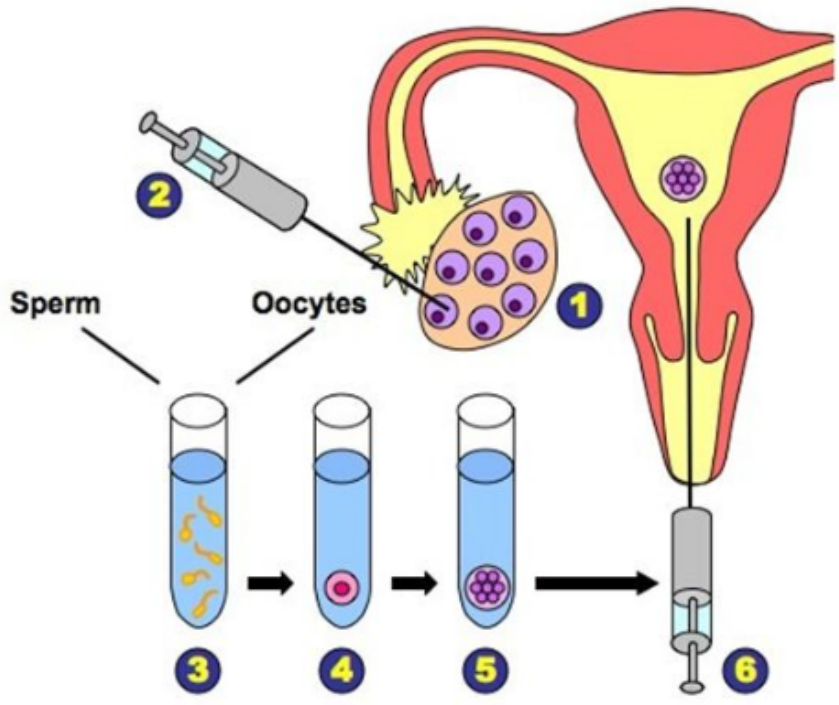
1. The woman is given a large dose of FSH and LH so she matures and releases many eggs
2. The eggs are collected and fertilised by the sperm from the father. This is done in laboratory conditions. The words 'in vitro' mean 'outside of the body'
3. The embryos develop in the lab
4. When the embryos are developed into a ball of cells they are implanted into the mother to be carried to term like a normal pregnancy.

About 60,000 of the 755,000 babies born last year were conceived via IVF. It is a vital service for some couples but it is not without its risks:

- It is physically and emotionally stressful on the woman
- Its success rates are also not very high (under 30%)
- There is a high chance of multiple births, which can put extra pressure on the mother and babies as they develop in the uterus. This increases the chance of complications during pregnancy.

IVF is also expensive; luckily it is available on the NHS in the UK for free.

94. Add labels to the diagram below to explain how IVF works



95. Which hormones are in the fertility drugs? Why are they chosen?
96. Define 'fertilisation'
97. What is the difference between sexual and asexual reproduction?
98. Calculate the percentage of births in the UK which were as a result of IVF
99. Poppy says "IVF is not sexual reproduction because the couple don't have sex" IS she

right? give a reason for your answer

100. Egg cells and sperm are gametes. Define ‘gametes’. Refer to the number of chromosomes in your answer.
101. Why are women undergoing IVF more likely to have multiple babies developing simultaneously?
102. Hormones are involved in controlling the menstrual cycle and fertility.

(a) (i) Use the correct answer from the box to complete the sentence.

auxin	**follicle stimulating hormone FSH)**	**thalidomide**

A hormone produced by the pituitary gland is _____

(ii) Use the correct answer from the box to complete the sentence.

luteinising hormone (LH)	**oestrogen**	**statin**

A hormone produced by the ovaries is _____

(b) (i) Why are fertility drugs given to some women?

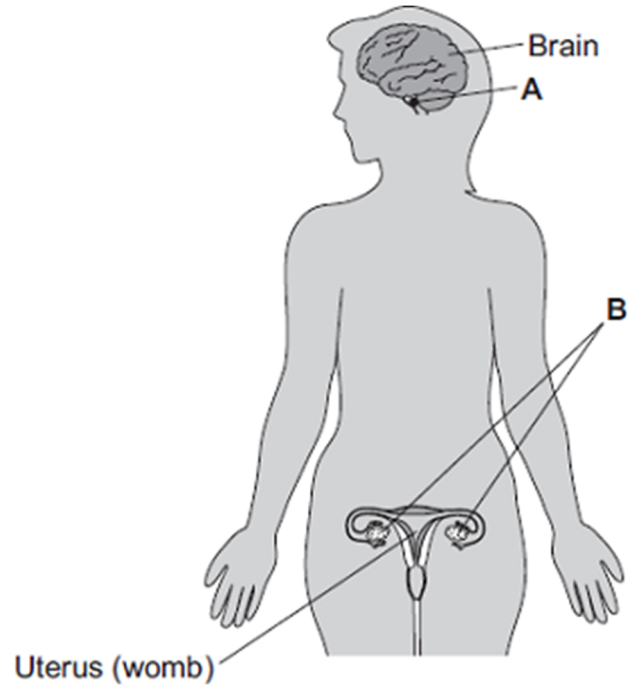
(ii) A doctor injects fertility drugs into a woman. After the injection, the hormones travel to the woman’s ovaries. How do the hormones travel to the ovaries?

(c) Which **two** hormones are used in contraceptive pills?

Tick (✔) **two** boxes.

FSH	☐	oestrogen	☐
LH	☐	progesterone	☐

103. The diagram shows the position of two glands, **A** and **B**, in a woman.



(a) (i) Name glands **A** and **B**.

(ii) Gland **A** produces the hormone Follicle Stimulating Hormone (FSH).

FSH controls changes in gland **B**.

How does FSH move from gland **A** to gland **B**?

(b) (i) A woman is not able to become pregnant. The woman does not produce mature eggs. The woman decides to have In Vitro Fertilisation (IVF) treatment.

Which **two** hormones will help the woman produce and release mature eggs?

(ii) Giving these hormones to the woman helps her to produce several mature eggs. Doctors collect the mature eggs from the woman in an operation.

Describe how the mature eggs are used in IVF treatment so that the woman may become pregnant.

(iii) IVF clinics have been set a target to reduce multiple births.

> At least 76% of IVF treatments should result in single babies and a maximum of 24% of treatments should result in multiple births.

Suggest **one** reason why the clinics have been set this target to reduce multiple births.

(c) Two clinics, **R** and **S**, used IVF treatment on women in 2007. Doctors at each clinic used the results of the treatments to predict the success rate of treatments in 2008.

The table shows the information.

	Total number of IVF treatments in 2007	Number of IVF treatments resulting in pregnancy in 2007	Predicted percentage success rate in 2008
Clinic **R**	1004	200	18–23
Clinic **S**	98	20	3–56

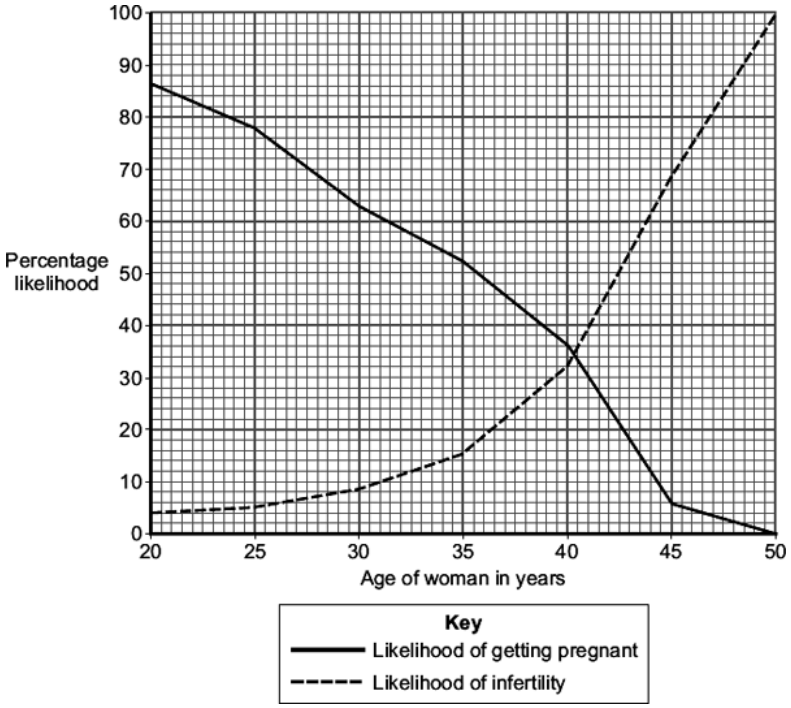
(i) Compare the success rates of the two clinics in 2007.

(ii) The range of the predicted success rate in 2008 for clinic **R** is much smaller than the range of the predicted success rate for clinic **S**.

Suggest why.

104. The graph shows how the likelihood of getting pregnant and the likelihood of infertility change with a woman's age.

The data is for healthy women who have unprotected sexual intercourse during one year.



(a) Use information from the graph to answer this question.

A woman in her mid-twenties is thinking about waiting until her late-thirties before she has children. A doctor advises the woman not to wait.

Explain why the doctor gives this advice.

(b) The hormones FSH and LH are used in fertility treatment.

Give the function in fertility treatment of FSH and LH

(c) In the first stage of in-vitro fertilisation (IVF), eggs from the mother are fertilised with sperm from the father. Describe the next stages of IVF.

Part 8-Illustrating Negative feedback: Adrenalin vs Thyroxin. (HT ONLY)

If you remember from the beginning of the homeostasis topic we have come across various forms of negative feedback. Thermoregulation, the regulation of water levels and blood glucose regulation all demonstrate negative feedback. A negative feedback control system responds when conditions change from the ideal or set point and returns conditions to this set point. There is a continuous cycle of events in negative feedback because the change inhibits the signal (hormonal or nervous) causing the change.

Thyroxin is a hormone made in your thyroid gland. Its function is to stimulate the **basal metabolic rate** in your body. Basal means 'base' so the basal metabolic rate is your base level of all your chemical processes in all your cells, just to live. It is vital to growth and development. The release of thyroxin by the thyroid is itself controlled by the pituitary gland of the hypothalamus. If the metabolic rate gets too high, thyroxin levels in the blood drop and it lowers. If the basal metabolic rate gets too low the thyroid secretes more thyroxin and the metabolic rate increases. By using a negative feedback loop the body tries to have a stable basal metabolic rate that is just right.

Adrenalin does not follow a negative feedback loop. Adrenalin is a hormone secreted by the adrenal glands above the kidneys. It is release when the body is in danger. The 'fight of flight' situations occur when a threat is perceived. The glands flood the body with adrenalin, raising the heart rate, breathing rate and increasing blood supply to the muscles and brain. This is an evolved response to provide the best chance of escaping a dangerous situation.

105. Describe how negative feedback works.
106. Suggest two hormonal controls that involve negative feedback.
107. What does thyroxine control?
108. Which organ secretes thyroxine?
109. *Some people do not produce enough thyroxine. Suggest two possible reasons.
110. Describe how the level of thyroxine is regulated in the body.
111. Under what situation would adrenaline be released?
112. *Describe three differences between thyroid glands and adrenal glands.
113. Describe three effects of adrenaline.
114. Explain why blood is directed to the brain and muscles and away from the digestive system when there is more adrenaline.
115. What are the 4 components of the blood? Give a function for each
116. Endocrine glands produce hormones.

(a) Hyperthyroidism is caused by an overactive thyroid gland.

Suggest what would happen in the body of a person with hyperthyroidism.

(b) Describe the roles of FSH and LH in the menstrual cycle.

(c) The combined pill is a contraceptive that contains progesterone **and** oestrogen.

The 'mini-pill':

- is a contraceptive that **only contains** the progesterone hormone
- has to be taken at the same time each day to prevent pregnancy.

The success rate of the mini-pill in preventing pregnancy is lower than that of the combined pill. Explain why missing a dose of the mini-pill would reduce the success rate of the mini-pill.

Part 9- Topic review

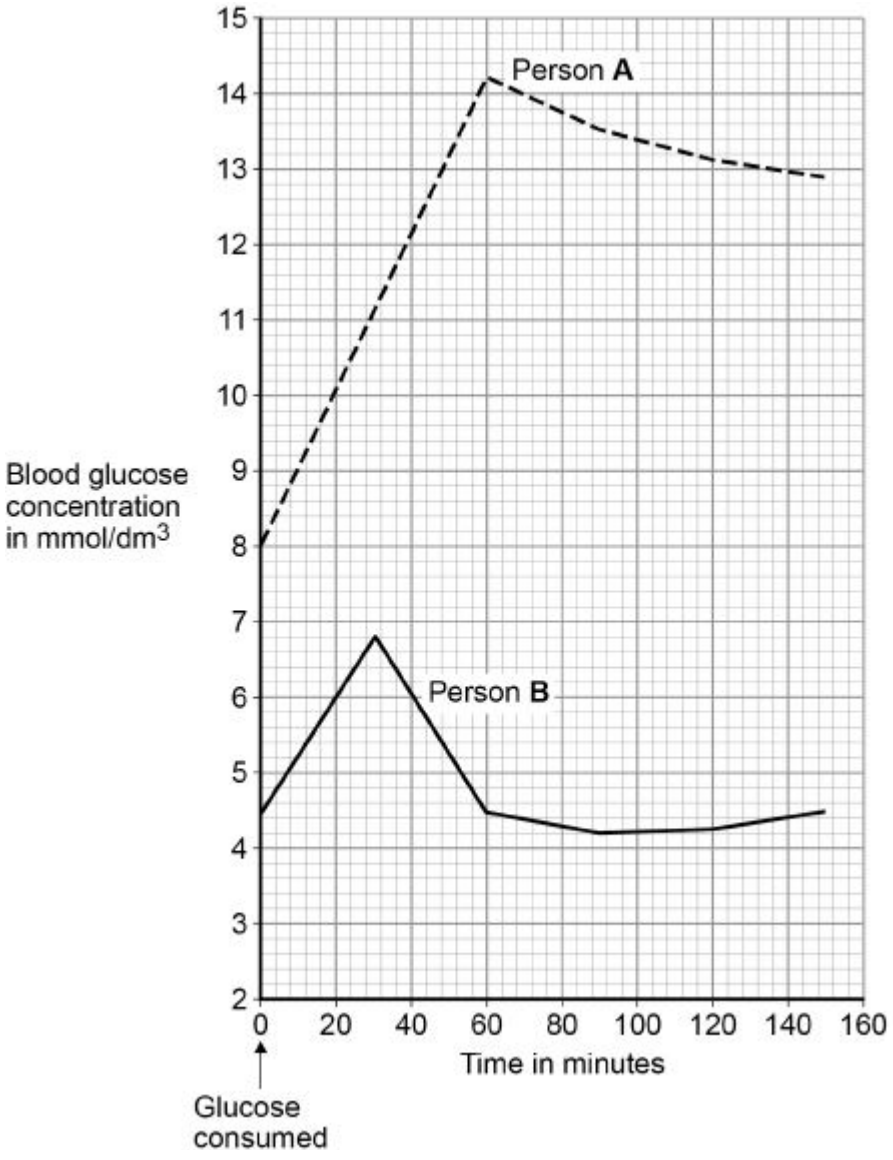
Summary of hormones and endocrine glands

Complete the table by filling in the blank spaces.

Endocrine gland	**Hormone produced**	**Role of hormone**
	Growth hormone	Controls growth in children
	TSH	Stimulates thyroid gland to make ……
		Affects amount of urine produced by kidneys
	FSH	Stimulates ovaries to make …… and eggs
	LH	Stimulates testes to make testosterone and sperm
Thyroid	Thyroxine	Controls …… ……
Pancreas	Insulin	
	Glucagon	
	Adrenaline	Prepares body for stressful situations – 'fight or flight' response
Ovaries	Oestrogen	- Trigger development of female secondary sexual characteristics - Stimulates development of …… …… - …… release of LH - …… release of FSH
		- Maintains uterus lining - …… release of FSH and LH
		Triggers ovulation
Testes		Trigger development of male secondary sexual characteristics

Goal free tasks. For each of the following graphs write as much information as you can to explain what is causing the changes.

117.



118. Evaluate this data

Method	What it is	How it works	How long does it last?	Chances of getting pregnant	Side effects
Hormone implant	Rod containing slow-release hormone inserted under the skin	Stops ovaries releasing eggs	3 years	Less than 1 in 1000	Acne in some women
Hormone injection	Injection that slowly releases hormone	Stops ovaries releasing eggs	12 weeks	Less than 4 in 1000	Weight gain in some women
IUD	Small plastic and copper coil placed in womb	Stops fertilized eggs developing in womb	5–10 years	Less than 20 in 1000	Heavier or more painful periods in some women
IUS	Plastic device containing slow-release hormone placed in womb	Stops fertilized eggs developing in womb	5 years	Less than 10 in 1000	Irregular periods in some women

Chemistry

Topic: The Rate and Extent of Chemical Change

Rates of Reactions

Rates of Reactions

Please complete the activities and you can self-assess your answers using the section at the back of the book.

The rate of a reaction is how quickly a reaction proceeds. As a reaction proceeds, the amount of reactant will decrease and the amount of product will be increased. The amount of time this takes determines the rate of the reaction.

Part 1: Measuring the rate

The rate can therefore be measured as:

$Rate\ of\ reaction = \frac{mass\ of\ reactant\ lost\ (g)}{time\ (s)}$ and the unit would for the rate would be g/s

The same can be achieved by measuring the mass of the products:

$Rate\ of\ reaction = \frac{mass\ of\ product\ gained\ (g)}{time\ (s)}$ and the unit would for the rate would be g/s

Worked example 1:

A reaction is set up between magnesium and hydrochloric acid. After 30 seconds, the magnesium had decreased in mass by 45g. What was the rate of this reaction?

$$Rate\ of\ reaction = \frac{mass\ of\ reactant\ lost\ (g)}{time\ (s)} = \frac{45}{30} = 1.5g/s$$

When the reaction involves a gas, the equation is the same but we measure the amount of gas in cm^3 and not g. The rate is therefore given in cm^3/s

Worked example 2:

A reaction is set up between magnesium and hydrochloric acid. After 30 seconds, $81cm^3$ of gas had been produced. What was the rate of this reaction?

$$Rate\ of\ reaction = \frac{volume\ of\ product\ gained\ (cm^3)}{time\ (s)} = \frac{81}{30} = 2.7cm^3/s$$

Mastery questions:

1. In a reaction the mass of a reactant decreases by 58g in 233 seconds. What is the rate?
2. In a reaction the mass of a reactant decreases by 0.43g in 80 seconds. What is the rate?
3. In a reaction the mass of a product increases by 3kg in 210 seconds. What is the rate?

4. In a reaction the mass of a reactant decreases by 41g in 2 seconds. What is the rate?
5. In a reaction the 48cm^3 of gas is produced in 97 seconds. Remember to check worked example 2 and calculate the rate of reaction.
6. In a reaction the mass of a reactant changes from 43g at the start to 22g at the end. This takes 79 seconds. What is the rate? (*hint – you can use the two masses to work out the mass of reactant lost)*
7. In a reaction 480g of reactant is completely used up in 1300 seconds. What is the rate?
8. In a reaction the mass of a product changes by 3.1kg in 95 seconds. What is the rate?
9. In a reaction the mass of a reactant changes by 0.845kg in 450 seconds. What is the rate?
10. In a reaction the mass of a product changes by 21kg in 10 minutes. What is the rate? (*hint – see the maths for science box to turn minutes into seconds)*
11. In a reaction the mass of a reactant changes by 19kg in 0.902 minutes. What is the rate?
12. In a reaction, 641cm^3 of gas is produced in 55 minutes. What is the rate?
13. In a reaction the mass of a reactant changes by 3.1kg in 2 hours. What is the rate?
14. In a reaction, the mass of reactant changes from 4.5kg to 381g in 5 hours. What is the rate?

Maths for science:
to change g into kg you need to divide by 1000
to change kg into g you need to multiply by 1000
to change minutes into seconds you need to multiply by 60
to change hours into seconds you need to multiply by 3600

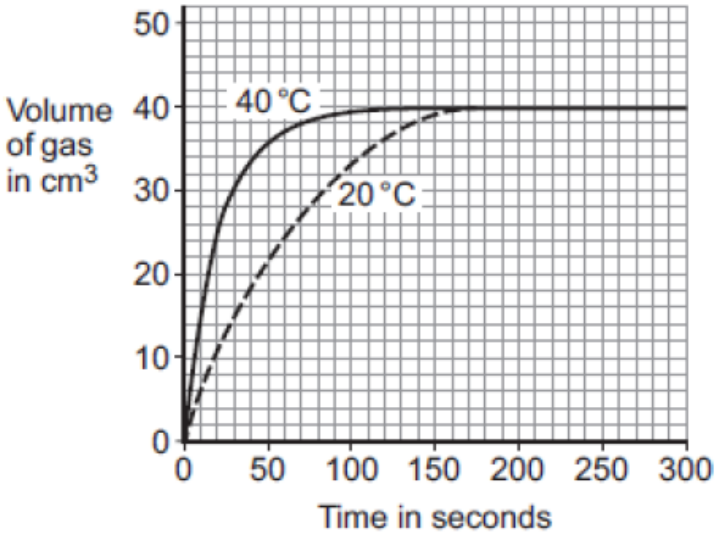
Challenge: a reaction has a rate of 0.026g/s. This was established from measuring the mass lost from a sample of calcium carbonate across three and a half days. If the sample of calcium carbonate had a mass of 581kg at the beginning of the reaction, what was its mass at the end?

Part 2: Using graphs to measure the rate of a reaction

Often, you will not be given the mass values but will have to work them out from a graph. The graph will either be provided for you or you will have to draw it yourself.

Worked example:

The graph on the right shows how the volume of gas produced in a reaction changes with time. The reaction was conducted at two different temperatures.



Question: For the reaction conducted at 40°C, what is the rate of reaction across the first 150 seconds?

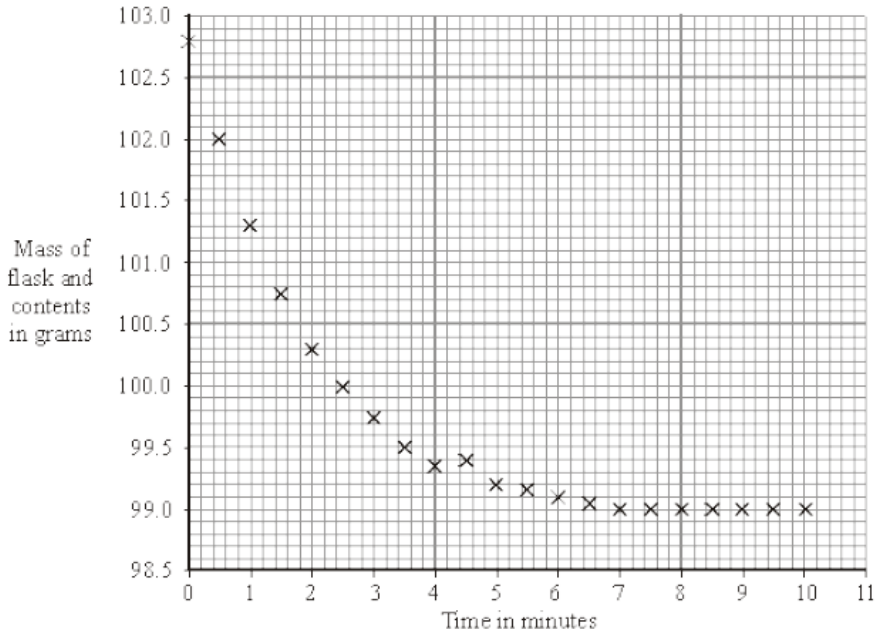
After 150 seconds on the graph, 40cm³ of gas had been produced:

$$Rate\ of\ reaction = \frac{volume\ of\ product\ gained\ (cm^3)}{time\ (s)} = \frac{40}{150} = 0.27 cm^3/s$$

Mastery questions:

15. For the reaction above conducted at 40°C, what is the rate of reaction across the first 50 seconds?
16. For the reaction above conducted at 40°C, what is the rate of reaction across the first 10 seconds?
17. For the reaction above conducted at 40°C, what is the rate of reaction across the first 300 seconds?
18. For the reaction above conducted at 20°C, what is the rate of reaction across the first 50 seconds?
19. For the reaction above conducted at 20°C, what is the rate of reaction across the first 80 seconds?
20. For the reaction above conducted at 20°C, what is the rate of reaction across the first 20 seconds?
21. For the two reactions above, what is the difference in rates across the first minute?

22. For the two reactions above, what is the difference in rates across 200 seconds?



23. An experiment was conducted to see how the mass of magnesium changes with time after it has been placed in acid. The graph to the left was plotted. Draw a line of best fit to complete the graph.

24. One result is **anomalous**. This means it does not fit the pattern shown by the other results. Which result is the anomalous one?

25. What is the rate of reaction across the first five minutes? (*hint – this is similar to question 15-20. Look at the mass at 0 minutes and the mass at 5 minutes to calculate the change in mass)*

26. What is the rate of reaction across ten minutes?

27. What is the rate of reaction:
    a. Across the last five minutes?
    b. Across the last three minutes?
    c. Across the first 450 seconds?
    d. Between the second and eighth minute?
    e. Between the second and third minute?
    f. What is the difference in the rate of reaction between the first and last minute of the reaction?

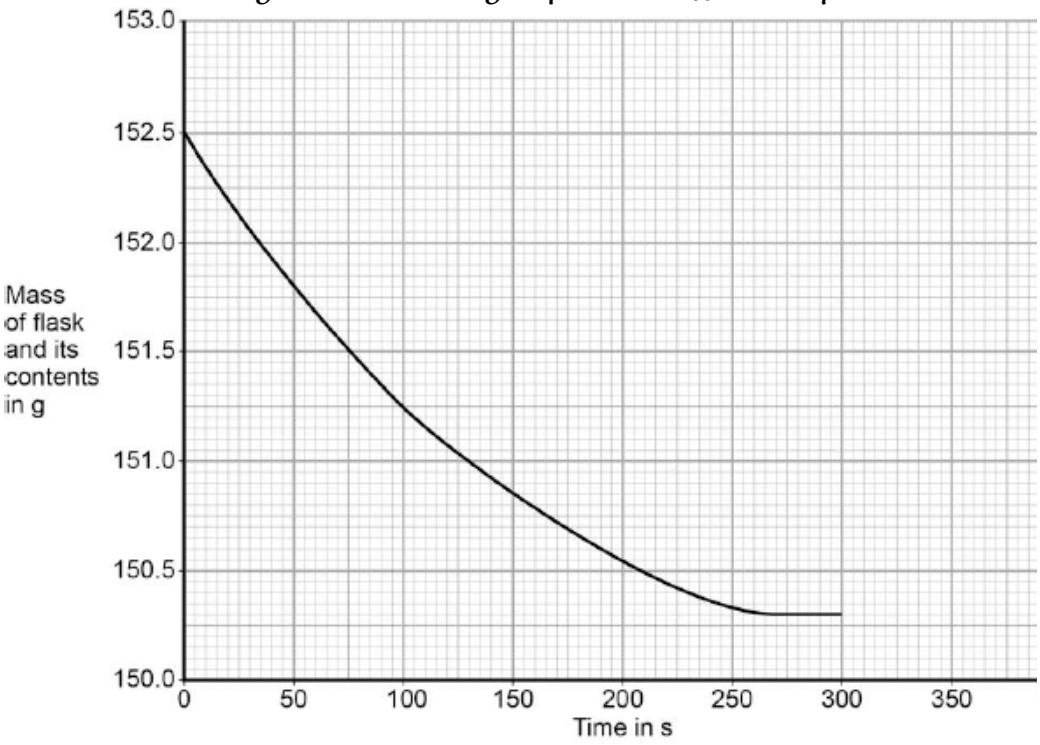
Part 3: Using graphs to measure the rate of a reaction at a specific time by drawing a tangent

The **gradient** of a line is how steep it is. The graphs above show curved lines, which means that the gradient (steepness) is different at different times. In both graphs, the gradient is steepest at the start of the reaction.

Drawing a **tangent** to the curve at a specific point means we can see what the rate is at that point. If the tangent is steep, the rate is large..

Worked example:

The graph on the right shows the change in mass of a reactant with time. *As a class, we will draw tangents to this graph at different points and look at the rate.*



Part 4: How the rate is measured in the lab

There are three main ways to measure the rate of a reaction:

1) Conduct the experiment on a balance. This enables you to watch the mass changing as the reaction proceeds. **Only suitable for reactions where a gas is produced** – the gas escapes the vessel and the mass decreases.
2) Collect gas in a syringe or cylinder. You can use a stopwatch to see how much gas is produced with time. **Only suitable for reactions where a gas is produced.**
3) The "Disappearing Cross" method is where you start with clear reactants which become cloudy as the reaction goes on. This occurs because the reaction produces a solid (precipitate). You can time how long it takes for a cross underneath the reaction vessel (the flask) to become completely blocked by the precipitate. **Only suitable for reactions which start with solutions and produce a solid.**

Mastery questions:

For each of the reactions below, state which methods would be most suitable. For some of them you will have to work out what the products are from previous topics. **You will also need to balance the equations**.

37. $Mg(s) + HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
38. $Na_2S_2O_3(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$
39. $PbNO_3(aq) + KI(aq) \rightarrow KNO_3(aq) + PbI(s)$
40. When calcium carbonate is added to sulphuric acid, what are the products?

Part 5: Collision Theory

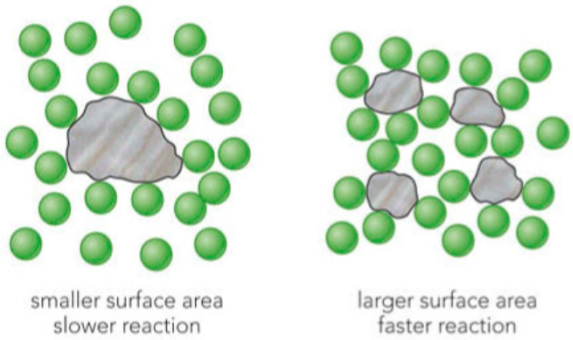
In order for a chemical reaction to take place, the atoms or molecules involved need to collide with each other. However, they also need to collide with enough energy before a reaction will take place. If they don't have enough energy they will just bump off each other. We call this amount of energy the **activation energy**.

In order to increase the rate of reaction, you must therefore either

1) Increase the frequency of collisions
2) Increase the energy that reactants have when they collide

These are the variables which can be changed to increase the rate of reaction:

1) Surface area
2) Concentration (for solutions)
3) Pressure (for gases)
4) Temperature
5) Catalyst



Part 5.1: The effect of surface area on the rate of reaction

By increasing the surface area of a substance, you are increasing the number of particles available to react

In this diagram, a lump of metal is being reacted with a solution. In the first image, only the particles at the very edge of the metal can collide with particles from solution. Particles from inside the metal cannot collide.

In the second image, particles from the inside are now on the edges of the material and are free to collide with the solution. This results in **more frequent collisions** and a greater rate of reaction. In order to increase the surface area of a solid, it can be crushed up into smaller pieces.

Worked examples (past GCSE questions)

Example 1:

A student investigated the rate of reaction between calcium carbonate (marble chips) and hydrochloric acid.

Explain, in terms of particles and collisions, the effect that increasing the surface area of the marble chips has on the rate of reaction (3).

The rate of reaction is increased. This is because more particles are available to collide , resulting in more frequent collisions.

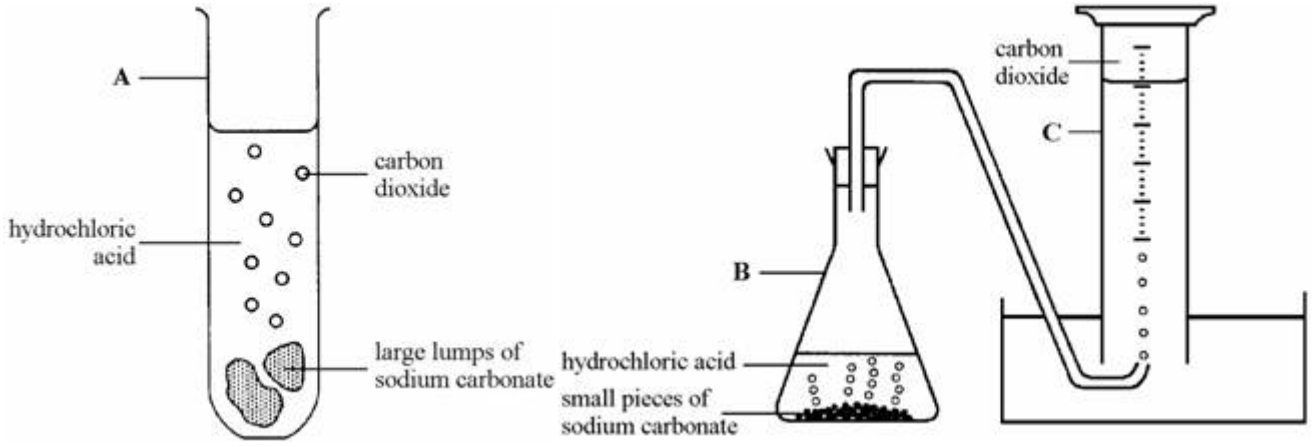
Teacher's notes: this answer correctly references the most important ideas of particles colliding more **frequently**. Students often write "more collisions" but the important part is that they are more **frequent**, meaning that there are more collisions in the same amount of time. Students also often forget to actually state the effect (the rate increases) so this answer avoids that problem.

Example 2:

Dilute hydrochloric acid reacts with sodium carbonate. The word equation for this reaction is:

sodium carbonate + hydrochloric acid → sodium chloride + water + carbon dioxide

(a) The diagram on the left shows apparatus used by student X to investigate this reaction. The diagram



on the right shows the apparatus used by student Y.

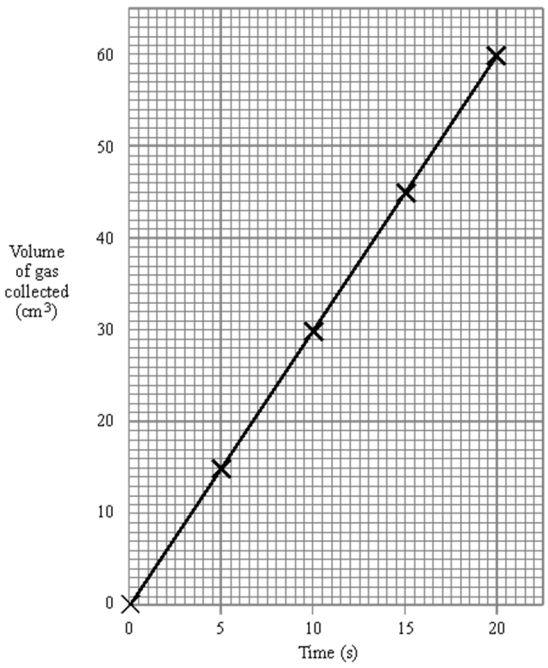
(ii) Both students X and Y used the same volume of acid, concentration of acid, temperature, mass of sodium carbonate. Use information from the diagrams to explain why the reaction that student Y carried out was faster. (3)

Student Y's reaction was faster because the pieces of sodium carbonate were smaller. This meant there were more collisions and a greater rate of reaction.

Teacher's notes: the student has correctly identified that there was a greater rate of reaction in Y than X. However, they just wrote that there were more collisions, not more **frequent** collisions. They also did not specifically mention that the smaller pieces of sodium carbonate meant a **greater surface area**

Mastery questions:

41. A number of questions related to surface area have been provided, as well as suggested answers. Assess each one to see if it contains all the most important information.
    a. Explain why the acid in your stomach is more effective at digesting food if the food has been chewed.
    Chewing food into smaller pieces gives it a larger surface area. This results in a greater rate of reaction
    b. A student leaves an iron nail and some iron wool out in the air. Which will rust quicker?
    The iron nail is made of smaller bits so will have a greater rate of reaction.
    c. A student wishes to investigate the rate of reaction of marble chips with acid and different temperatures. Explain why the student must use the same sized chips for both experiments.
    Different sized chips will have different rates of reactions due to more collisions.

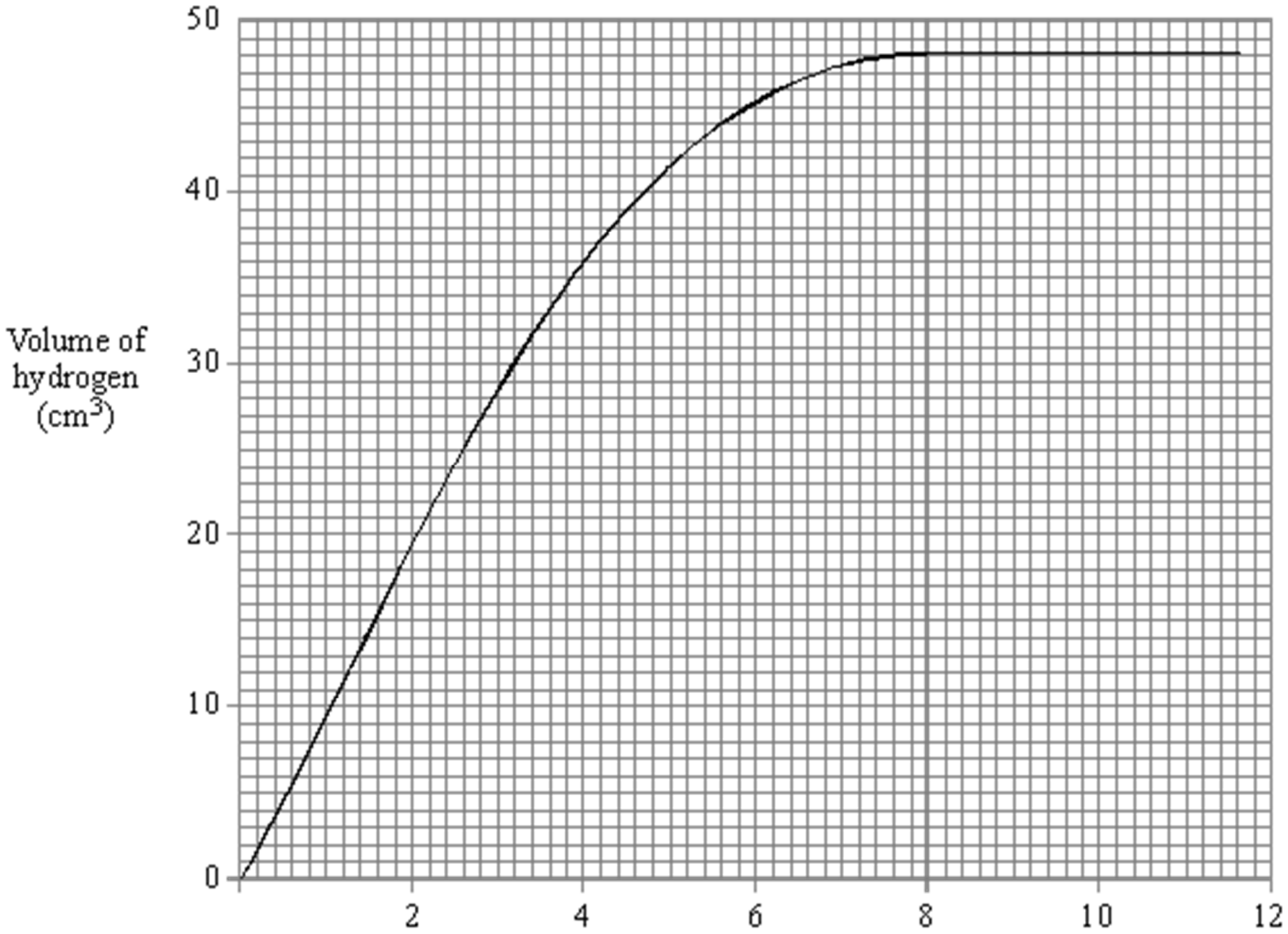


42. The graph to the left shows the amount of gas produced when medium sized chips of calcium carbonate are added to acid. Draw a line to predict how much gas would be produced for:
    a. Small chips of calcium carbonate
    b. Large chips of calcium carbonate
    c. Explain your answers.
43. Calculate the mean rate of reaction between 10 and 20 seconds.
44. Calculate the mean rate of reaction between 0 and 10 seconds.

45. The graph below shows the amount of gas produced when large lumps of iron are added to acid with minutes being on the x axis.
    a. Calculate the mean rate of reaction across the first 8 minutes.
    b. Draw a tangent to the line at 6 minutes and at 4 minutes.

c. Is the rate greater at 6 minutes or 4 minutes?

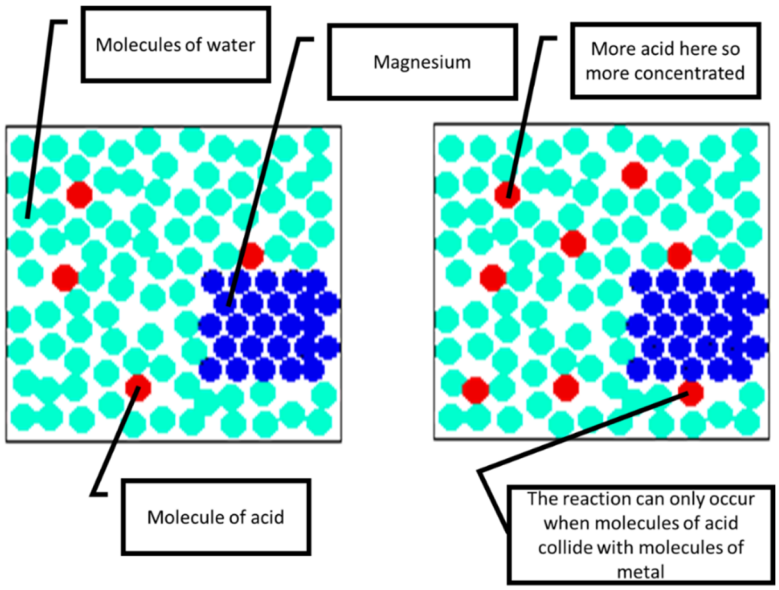
d. Draw a line to predict how much gas is produced from a reaction involving



the same mass of iron but used as a powder. Explain your answer.

Part 5.2: The effect of concentration on the rate of reaction

When a reaction involves a solution (like an acid), the greater the concentration, the greater the number of particles. So a concentrated acid has more acid particles in it than not. More particles mean more frequent collisions, so a greater concentration increases the rate of reaction. The diagram below on the left shows a less concentrated acid, and the one on the right shows a more concentrated acid.

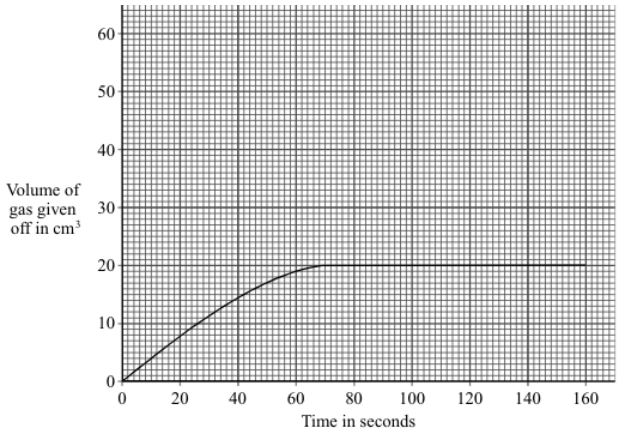


Remember also that if you are increasing the concentration, you are also increasing the amount of reactant which will also increase the amount of product.

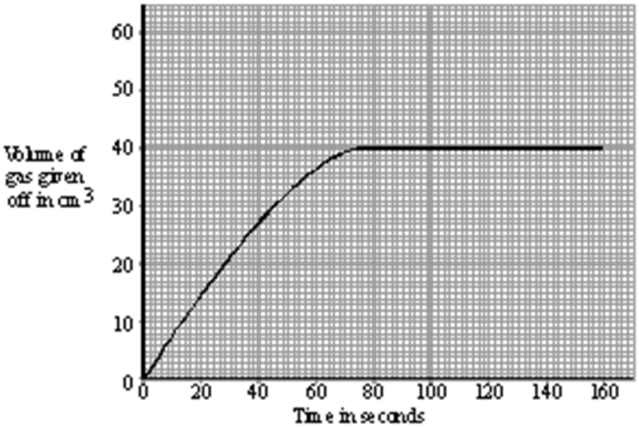
Worked Example (past GCSE question)

The graph shows the volume of gas given off during an experiment using hydrogen peroxide solution and manganese oxide.

Draw on the graph to show the result you would expect if the volume of hydrogen peroxide solution had been the same, but it was **twice** as concentrated. **(Total 3 marks)**



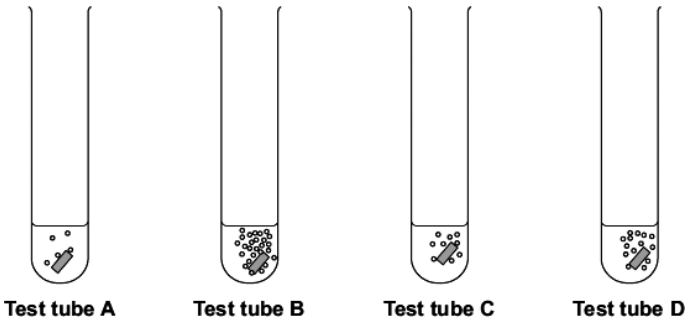
The line would have to be steeper as the rate of reaction would be increased. But it would also have to go higher. If you generated 20cm³ of gas in the first experiment, you would expect double that if you double the concentration. The second line would therefore go up to 40cm³:



Mastery Questions:

46. A student investigates the reaction between magnesium and hydrochloric acid.

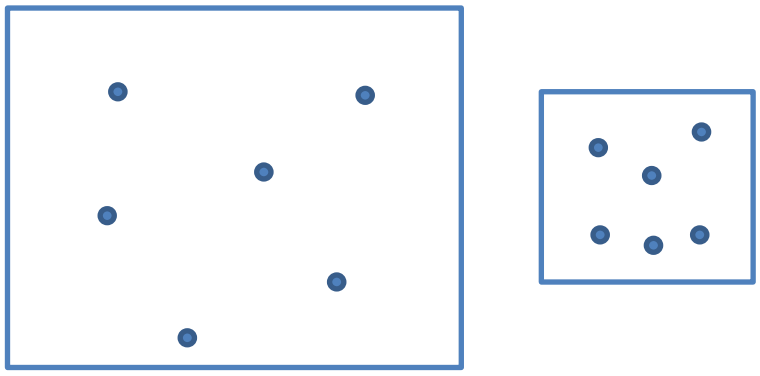
a. Write a word and symbol equation for this reaction.
b. What ions does hydrochloric acid release?
c. The student investigated how changing the concentration of the hydrochloric acid affects this reaction. Each test tube below contained a different concentration of hydrochloric acid. The diagrams show the results of this experiment.



   i. Which test tube had the most concentrated acid?
   ii. How can you tell from the diagram?
   iii. Which test tube had the least concentrated acid?
   iv. Once the reaction in each test tube had finished, which one will have produced the most gas?
   v. Suggest one control variable for this experiment.
   vi. State the effect of increasing the concentration on the rate of reaction.
   vii. Explain your answer to vi.

Part 5.3: The effect of pressure on the rate of reaction

When reactions involve a gas as a reactant, increasing the pressure means you have moved the gas particles closer to each other by reducing the space available to them.



When a reaction is conducted under high pressure, there are more frequent collisions as the particles are closer together. This results in a greater rate of reaction.

Worked Example:

Methane reacts with steam as below:

$CH_4(g) + H_2O(g) \rightarrow CO(g) + H_2(g)$

State and explain the effect of increasing the pressure on the rate of the reaction (3 marks)

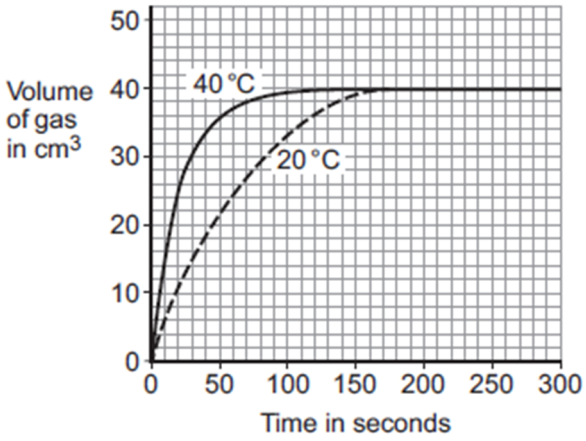
Increasing the pressure will increase the rate of the reaction. This is because the molecules of gas will be closer together, resulting in more frequent collisions.

47. Methane (formula above) reacts with oxygen (O_2) to produce carbon dioxide (CO_2) and steam (H_2O). Write a balanced symbol equation for this reaction.
48. The reaction becomes very hot. Is this reaction endo or exothermic?
49. The pressure under which the reaction is conducted is decreased. State the effect this has on the rate of reaction.
50. Explain your answer to Q49.

Part 5.4: The effect of temperature on the rate of reaction

Increasing the temperature increases the rate of reaction. This is for **two separate reasons**. It is important that you do not confuse these reasons – this is a common student error.

Figure 2



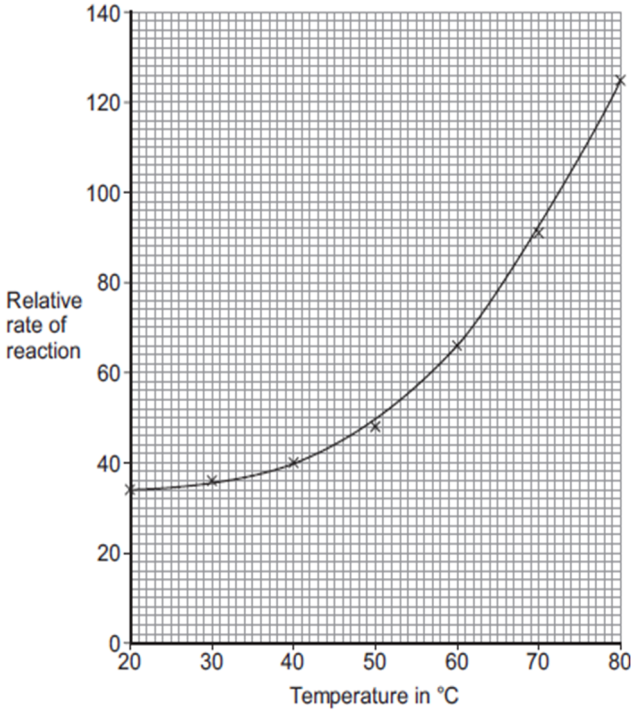
1) Increasing the temperature makes the particles move faster
    a. This results in more frequent collisions
2) Increasing the temperature means that more particles have the activation energy
    a. This means that more collisions result in a reaction

Worked example

The graph below shows the amount of gas produced in a reaction which was conducted at two different temperatures.

Explain, in terms of particles and collisions, the effect of increasing the temperature on the rate of reaction. Use data from the graph to support your answer. (6 marks)

Figure 2



The graph shows that as the temperature increases, the gas is produced quicker. This can be proved at 50 seconds, where the 20˚C reaction had produced 22cm³, but the 40˚C reaction had produced 36cm³.

This proves that as temperature is increased, the rate of reaction increases.

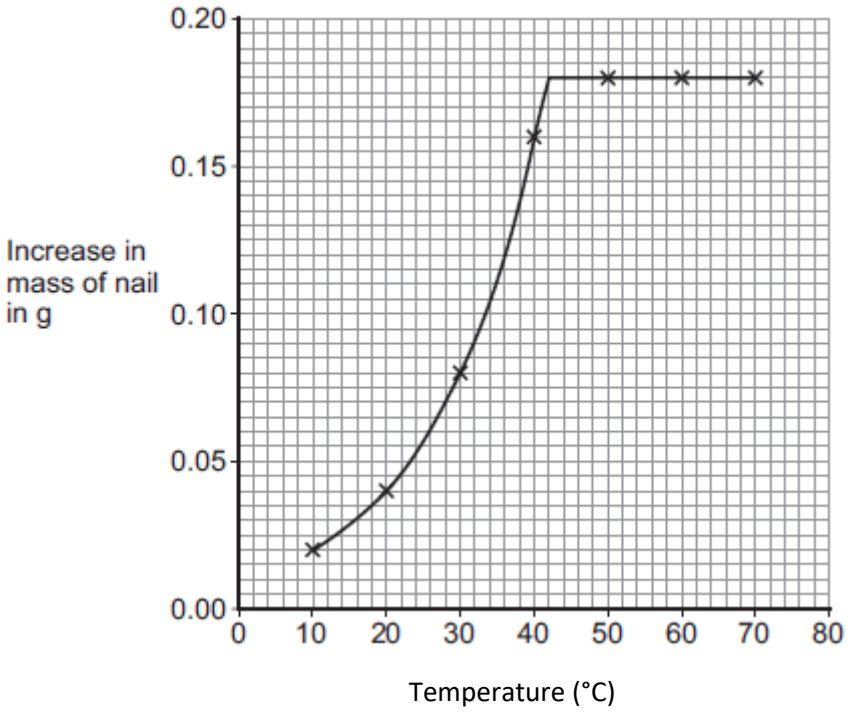
This is because as the temperature is increased, the particles move faster and collide more frequently.

Also, a higher temperature means that more particles have the activation energy so more collisions result in a reaction.

Mastery Questions

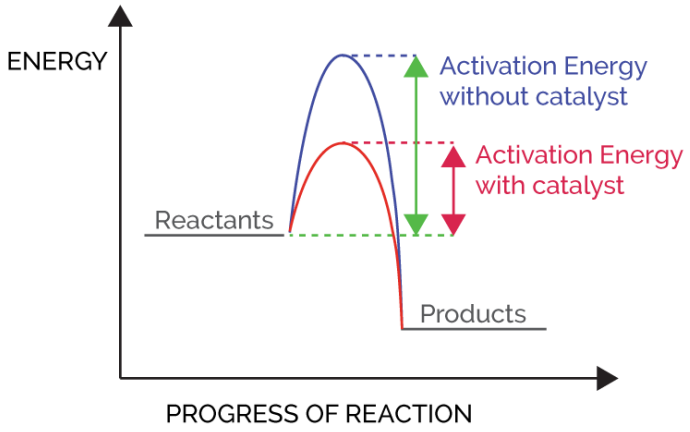
The graph above shows the rate of reaction at a number of different temperatures for a reaction between marble and acid.

52. Describe how the rate of reaction changes as the temperature is increased.
53. Explain this effect.
54. State three variables that would need to be controlled for this reaction.
55. State and explain the effect of using the same mass of marble but larger pieces on the rate of reaction.
56. The experiment was repeated with acid that was twice as concentrated. State two differences you would expect in the results.
57. A student investigate the change in mass of a nail that was sealed in a box with air and water.
58. The experiment was conducted at a number of different temperatures. The results are shown in the graph to the right. Use the graph to describe the relationship between the temperature and the increase in mass of the nail.
59. The student increased the pressure inside the box. How would this affect the rate of reaction?
60. Explain your answer.
61. The nail was cut up into smaller pieces. How would this affect the rate of reaction?
62. Explain your answer.



Part 6: Catalysts

A catalyst is something which is added to a reaction to increase its rate. It is not used up as part of the reaction. It works by lowering the activation energy of the reaction, so when particles with less energy collide a reaction can still occur.



Worked Example

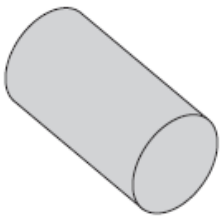
A reaction is conducted between magnesium and oxygen. At the end of the reaction, the mass of the magnesium had increased by 14g. This took 4 minutes. The reaction was repeated again, but a catalyst had been added to the reaction. It took 3 minutes for the magnesium to increase by 14g. Explain this observation.

Catalysts increase the rate of a reaction by lowering the activation energy required for the reaction to take place.

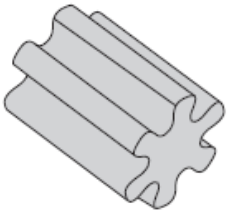
Mastery Questions:

63. For the reaction above, calculate the rate of reaction in both cases.
64. The catalyst initially had a mass of 5.5g. At the end of the reaction it was re-weighed and had a mass of 5.5g. Explain this result.
65. Hydrogen peroxide decomposes into water and oxygen gas in the presence of a catalyst. The formula for hydrogen peroxide is $H_2O_2(aq)$. Write a word and balanced symbol equation for this reaction.
66. Draw a covalent bonding diagram for water (*hint – use your notes or page 44 to help)*.
67. Draw a covalent bonding diagram for oxygen.
68. Explain the effect of a catalyst on the rate of reaction.
69. The diagram below shows the shapes of different catalysts

A



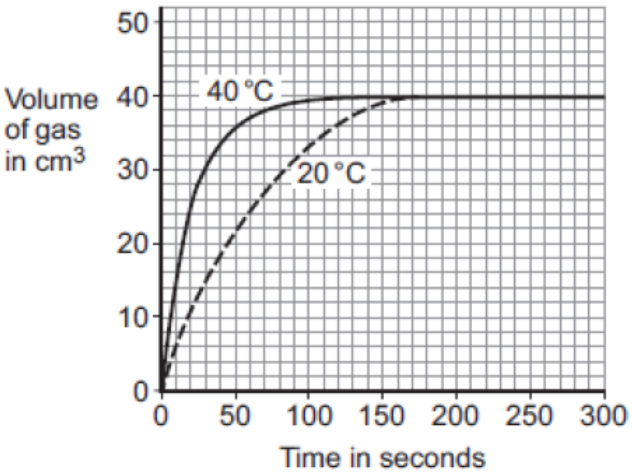
B



Suggest and explain why shape B is more effective as a catalyst than shape A.

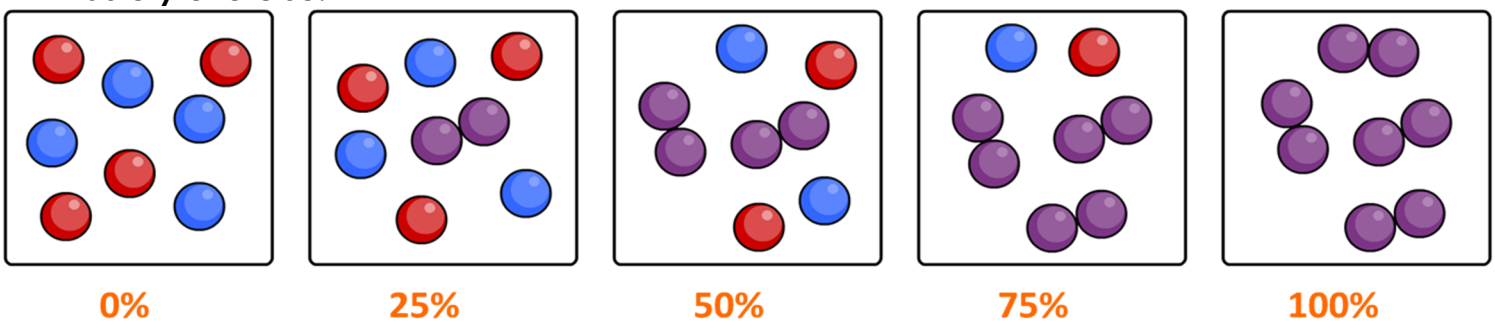
Part 7: How the rate changes with time

You may have noticed that in all the graphs we have seen so far, the curve always starts off very steep, then becomes less steep and then completely flat. This is because at the beginning of a reaction the rate is very high, but as the reaction goes on the rate decreases until it is zero; this is when the reaction has finished.



This is because as a reaction proceeds, the reactant particles collide with each other and turn into product. As time goes on, there is less and less reactant and more and more product. If there is less reactant it makes collisions between reactants less likely, reducing the rate of the reaction. By the end of the reaction there are no reactants left, only products. At this point the reaction has completed and the rate is zero.

Mastery exercise:



In your exercise book, outline a method to investigate the rate of reaction for marble chips added to acid. The reaction produces carbon dioxide gas.

- Draw a sketch graph to predict the results
- Describe the shape of your graph fully
- Explain how you could use the graph to establish the mean rate of reaction
- Describe and explain how the rate changes with time
- State and explain the effect of increasing the temperature on the reaction
- State and explain the effect of increasing the concentration of the acid used
- State and explain the effect of crushing the marble chips
- State and explain the effect of using a catalyst

Rates of reaction answers

1. 58/233 = 0.25g/s
2. 0.43/80 = 5.375×10^{-3}g/s
3. 3000/210 = 14.29g/s
4. 41/2 = 21g/s
5. 48/97 = 0.5cm^3/s
6. 21/79 = 0.27g/s
7. 480/1300 = 0.4g/s
8. 3100/95 = 32.63g/s
9. 845/450 = 1.88g/s
10. 21000/600 = 35g/s
11. 19000/54.12 = 351.07g/s
12. 641/(60x55) = 0.19cm^3/s
13. 3100/7200 = 0.43g/s
14. 4119/18000 = 0.23g/s
15. 36/50 = 0.72cm^3/s
16. 14/10 = 1.4 cm^3/s
17. 40/300 = .13 cm^3/s
18. 22/50 = 0.44cm^3/s
19. 29/80 = 0.36 cm^3/s
20. 10/20 = 0.5 cm^3/s
21. First reaction: 37/60 = 0.62 cm^3/s

    Second reaction: 24/60 = 0.4 cm^3/s difference = 0.22 cm^3/s
22. (40/200) – (40/200) = 0 cm^3/s
23.
24. 4.5mins

25. (102.8-99.2)/300 = 0.012g/s
26. (102.8-99)/600 = 0.0063g/s or 0.01g/s
27.
    a. (99.2-99)/300 = 0.0007g/s
    b. (99-99)/180 = 0g/s
    c. (102.8-99)/450 = 0.01g/s
    d. (100.3-99)/360 = 0.00361g/s
    e. (100.3-99.75)/60 = 0.01g/s
    f. (102.8-101.3)/60 – (99-99)/60 = 0.03g/s

37. $Mg + 2HCl \rightarrow MgCl_2 + H_2$
    Use gas collection or balance
38. $Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2 + S$
    Disappearing cross, gas collection, balance
39. Calcium carbonate + sulphuric acid → calcium sulphate + water + carbon dioxide
    balance or gas syringe
40. $PbNO_3 + KI \rightarrow KNO_3 + PbI$

Disappearing cross

41.
    a. Misses out increased frequency of collisions
    b. The wool would have greater rate as greater surface area so more frequent collisions
    c. Misses more frequent collisions and state that small marble chips have larger area etc

42.

a. Steeper line
b. Shallower line
c. A has increased rate, b has decreased rate

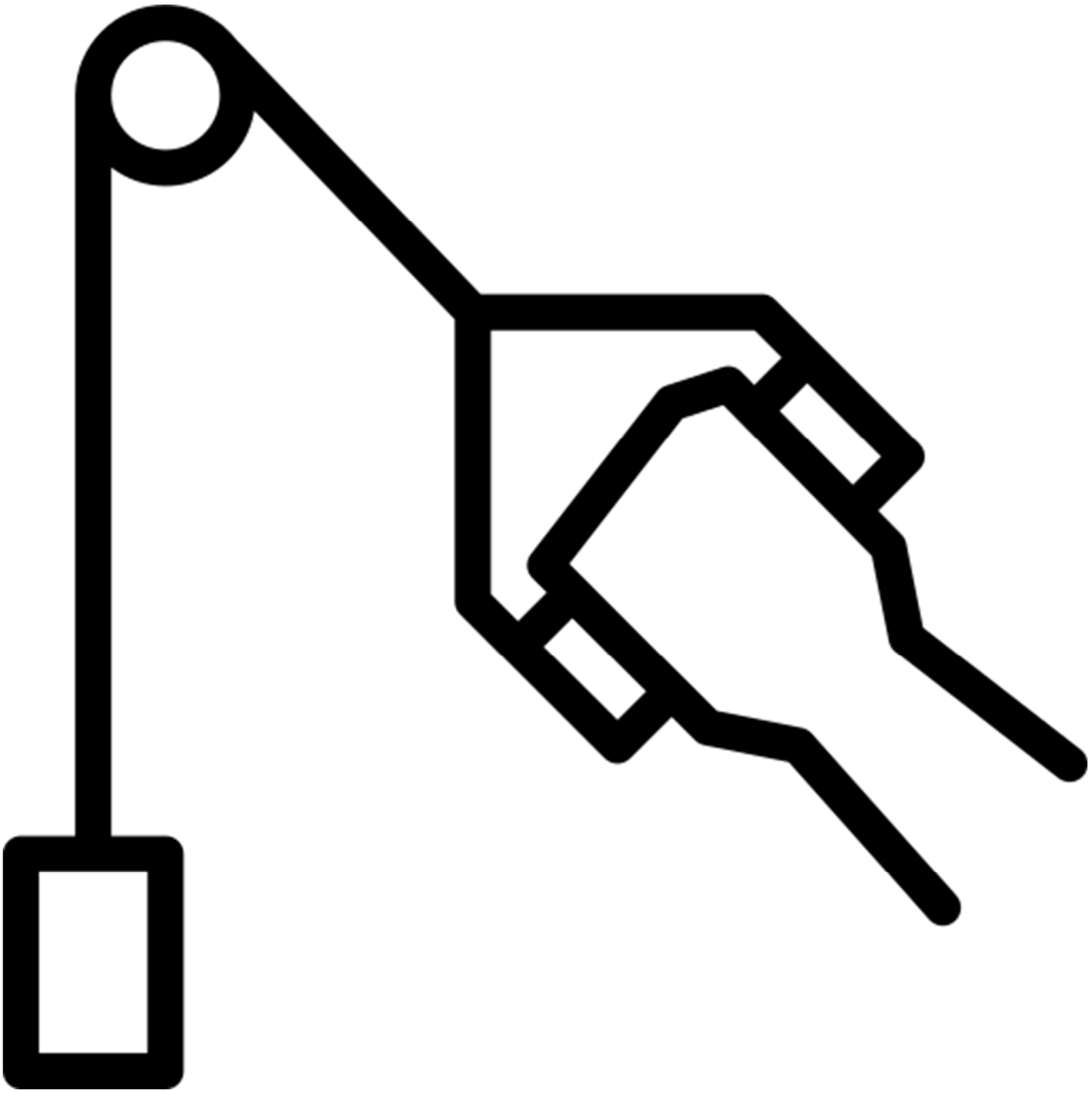
43. (60-30)/(20-10) = 3cm^3/s
44. Same as straight line
45.

a. 0.1cm^3/s
b. 0.05-0.06cm^3/s
c. Steeper line but goes to the same point

46. Magnesium + hydrochloric acid → magnesium chloride
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
47. $CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$
48. -270 (from memory needs checking)
49. Exothermic
50. Decreases
51. More space between particles, less frequent collisions
52. As the temperature increases, the rate increases (slowly at first then rapidly)
53. This is because as the temperature is increased, the particles move faster and collide more frequently. **Also**, a higher temperature means that more particles have the activation energy so more collisions result in a reaction.
54. Surface area, concentration, mass of reactant, volume of acid

55. Decrease rate due to smaller surface area, less frequent collisions
56. Increased rate, increased amount of product
57. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$
58. You have added oxygen atoms to the substance being weighed
59. As temperature increases, the mas increase increases until a point 42 degrees
60. Increase
61. Less space between particles, increased frequency of collisions
62. Increase
63. Increase surface area
64. 14/(4x60) = 0.06g/s, 14(3x60) = 0.08g/s
65. Catalysts are not used up in a reaction
66. $2H_2O_2 \rightarrow 2H_2O + O_2$
67. Oxygen in centre, two single bonds to hydrogen atoms
68. Two oxygen atoms with a double covalent bond
69. Increases it due to lowering the activation energy
70. B has a greater surface area so more frequent catalyst-reactant collisions

FORCES



Forces facts

1) What is a scalar?
2) What is a vector?
3) What does the direction of an arrow of a vector quantity represent?
4) What does the size of the arrow of a vector quantity represent?
5) What is a force?
6) What is the unit of a force?
7) What can we use to measure a force?
8) What is a contact force?
9) What is a non-contact force?

10) Give four examples of contact forces.
11) Give three examples of non-contact forces.
12) Give some examples of scalars.
13) Give some examples of vectors.
14) What is mass?

15) What is the equation for weight?
16) What is the value for gravitational field strength on Earth?
17) What is a resultant force?

18) What is work done?

19) What is the equation for work done?
20) What does work done against frictional forces cause?
21) What does one newton-metre equal in joules?
22) What is elastic deformation?

23) What is inelastic deformation?

24) What is the equation for Hooke's law
25) What type of energy is stored in a stretched spring?
26) What is the relationship between the force applied and the extension of an elastic object?

Fold page here

1) A quantity with magnitude (size) but no direction.
2) A quantity with magnitude (size) and direction.
3) The magnitude of the vector.

4) The direction of the vector.

5) A force is a push or pull that acts on an object.
6) A Newton.
7) A Newton meter.
8) A contact force is a force that needs to touch to act.
9) A non-contact force is a force that does not need to touch to act.
10) Friction, air resistance, tension and normal reaction.
11) Gravitational, electrostatic and magnetic.
12) Energy, mass, distance, time, power, speed.
13) Velocity, acceleration, force, displacement.
14) It is the amount of matter in an object. It is constant for an object everywhere.
15) $W = m \times g$
16) 9.8 N/kg

17) A single force that has the same effect as all forces acting together.
18) It is an energy transfer. One joule of work is done when a force of one newton causes a displacement of one metre.
19) $W = F \times s$
20) A rise in temperature of the object.

21) One newton-metre equals one joule.

22) When an object is stretched but can still return to its original size.
23) When an object is stretch but does not return to its original size.
24) $F = k \times e$
25) Elastic potential energy.

26) The extension of an elastic object is directly proportional to the force applied.

Introduction to forces

A force is a push or pull; and forces have unit of **Newtons**. To measure a force we can use a device called a **Newton meter**.

Scalar quantities have size ("magnitude") only and no direction.

An example of a scalar quantity is mass.

Scalar quantities can be added up normally

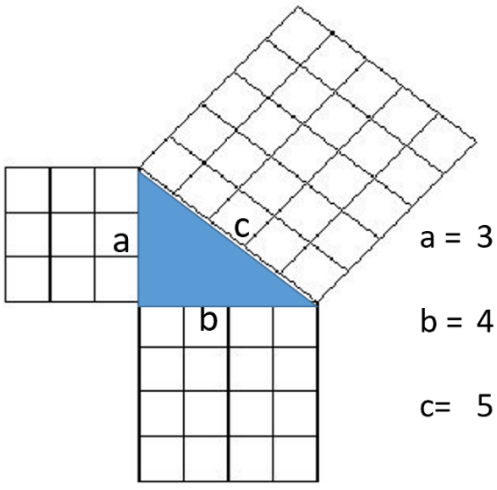
Example: 36 kg + 14 Kg = 50 kg

Vectors have both size and direction.

Scalar	Vector

Sort the quantities into the correct column:

Mass distance acceleration speed velocity energy time power force displacement



If one vector is at right angles to another then we can use **Pythagoras' theorem** to find out the **resultant vector** (combined effect of more than one vector).

$c^2 = a^2 + b^2$

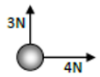
We can also use **scale diagrams** to find a resultant vector.

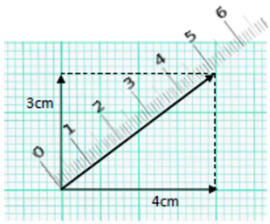
Task: Complete in exercise book or on paper

Basic

1. What is a force?
2. What is the unit of a force?
3. What do we use to measure forces?
4. What is the definition of a scalar? Give three examples of scalars.
5. What is the definition of a vector? Give three examples of vectors.
6. What is the equation for Pythagoras' theorem?
7. Draw scale diagrams (1cm = 1N) to work out the resultant force in each of the cases to the right.

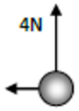
Example:





Answer: The Resultant force = 5N

a



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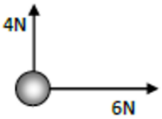
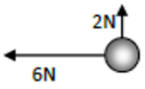
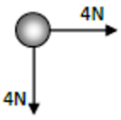


c

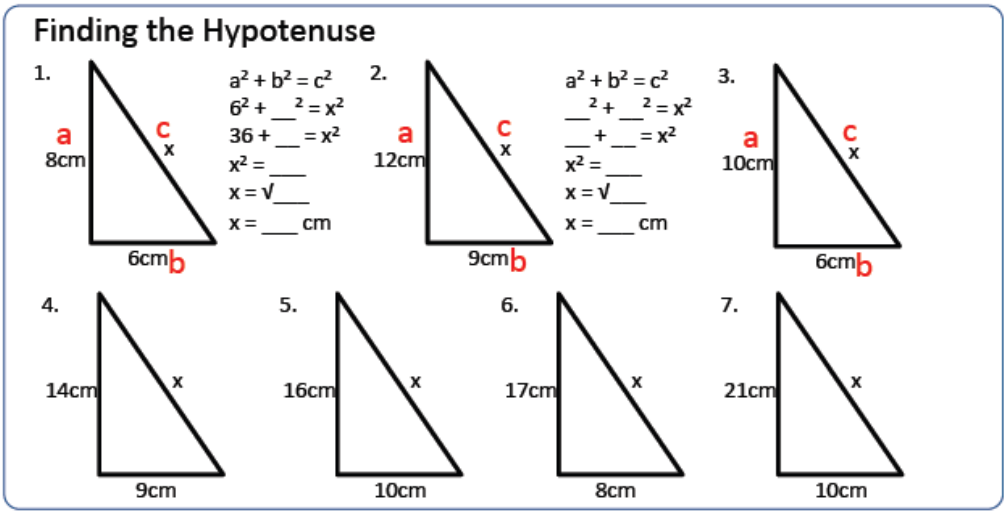


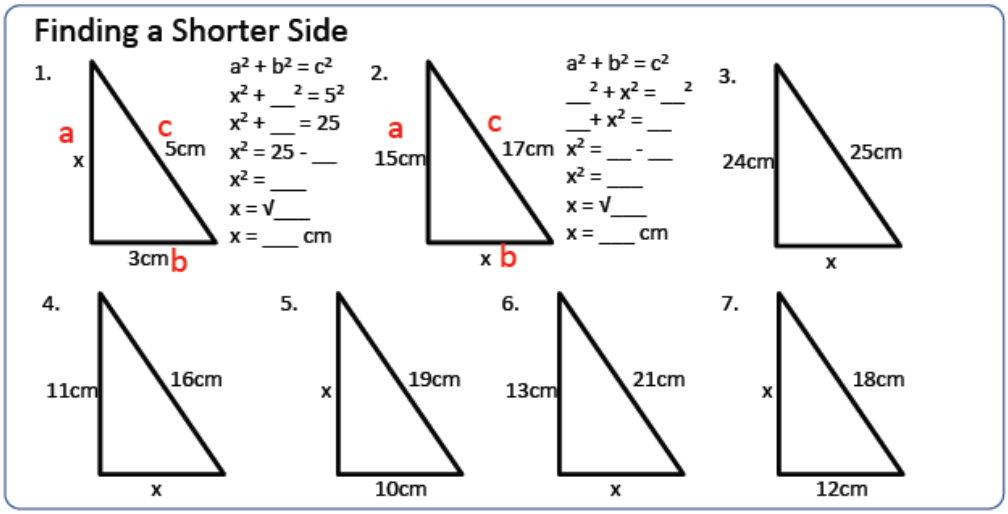
d



Medium

8. Describe the difference between distance and displacement.
9. Use Pythagoras' theorem to calculate the missing lengths of each triangle to the right.





Hard

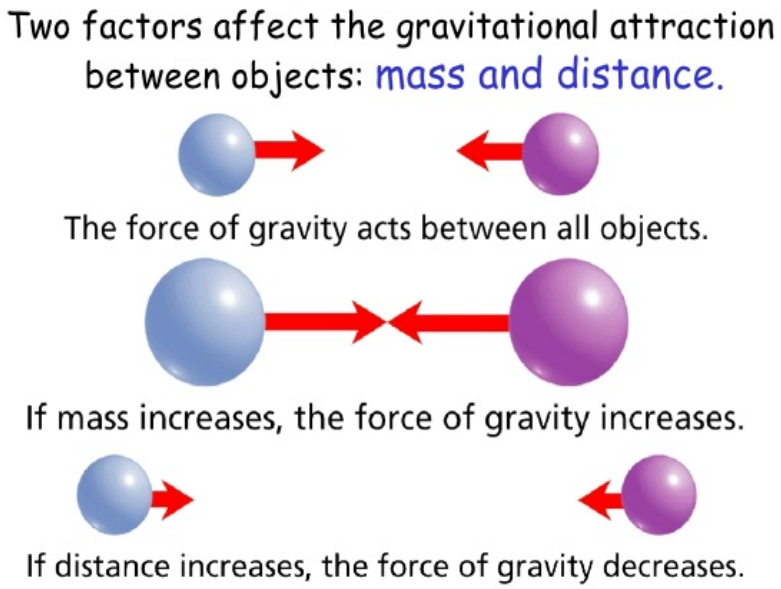
10. A woman walks 200m east and then 100m south.
    a) Find the total distance travelled.
    b) Now find the resultant displacement.
11. Dr. Edmunds' cat Lola runs after a squirrel 40m North and 30m West.
    a) What is the distance that Lola has run?
    b) What is Lola's resultant displacement?
12. An aeroplane travels with a speed of 100 m/s North, and a speed of 20 m/s East. What is the plane's overall velocity?

Mass, weight and gravity

All objects have a force that attracts them towards each other. This force is due to **gravity.**

Even you attract other objects to you because of gravity, but you have too little mass for the force to be very strong.

The strength of gravity at the surface of a planet is determined by its mass. g is a measurement of the gravitational field strength



The gravitational field strength on the surface of the earth is **9.8 N/kg**

Weight is the force caused by gravity. The weight of an object can be calculated using the formula:

W = m x g

Where W is weight (in Newtons)

M is mass (in kg)

g is gravitational field strength (in N/kg)

The **mass** of an object is the amount of matter it contains.

The mass of an object **stays the same** wherever it is, but its **weight can change** depending on the gravitational field strength.

This happens if the object goes somewhere where gravity is stronger, or weaker, such as the Moon.

The Moon has less mass than the Earth, so its gravity is less than the Earth's gravity.

Basic:

Arnie and Markey have been travelling the Solar System on a mission to find out about weight on all the planets. They came to Earth and found out their mass in kilograms (shown in the picture).

Complete the tables for Arnie and Markey and fill in the missing numbers. *Hint* – information from elsewhere in the table could be useful!

Arnie

Planet	Mass (kg)	Gravitational Field strength (N/kg)	Weight (N)
Mercury	30	3.78	113.4
Venus	30	9.07	
Earth	30	9.8	
Moon	30	1.66	
Mars	30	3.77	
Jupiter	30	23.64	709.2
Saturn	30	9.16	
Uranus	30	8.89	
Neptune	30	11.25	
Pluto	30	0.67	

Markey

Planet	Mass (kg)	Gravitational Field strength (N/kg)	Weight (N)
Mercury	0.5		
Venus			
Earth			
Moon			
Mars			
Jupiter			
Saturn			
Uranus			
Neptune		11.25	
Pluto			

Medium: For these questions you need to re-arrange the formula. (g = 9.8 N/kg for questions 1-5).

1) A Formula 1 car weighs 7150N, calculate its **mass**.
2) A cat weighs 42 N, calculate it's **mass.**
3) A dog weighs 180 N, calculate it's **mass**.
4) An iPad weighs 2.2 N, calculate its **mass in.**
5) A Boeing 747 airplane weighs 1.9×10^6 N, calculate it's **mass.**
6) A man of mass 70 kg is standing on a planet where he weighs 1750 N. Calculate the planet's **gravitational field strength.**
7) The curiosity Rover was sent to search Mars. It has a mass of 900 kg weighs 3400 N while on Mars. Calculate Mars' **gravitational field strength.**

Hard: Rearranging and unit conversion.

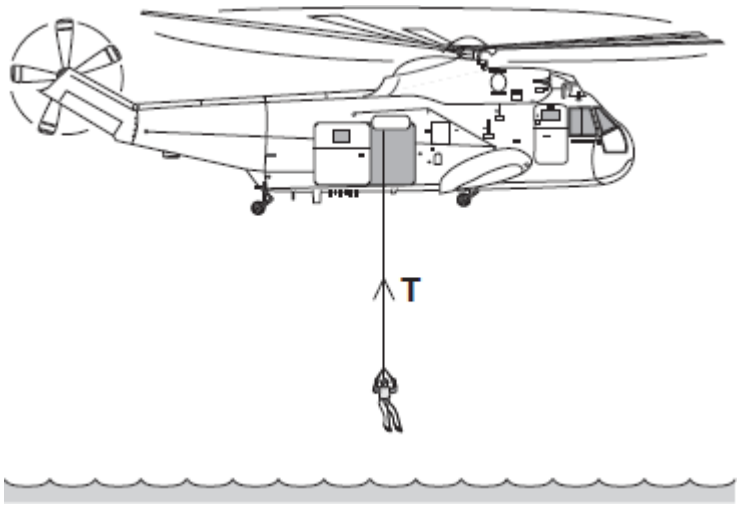
8) An iPhone has a weight of 1.2N on Earth. Calculate its mass in grams.

9) A bottle of water has a weight of 10N on Earth. Calculate its mass in grams.

10) A car has a weight of 12 kN on Earth. Calculate its mass in kg.

11) A rocket of mass 133,000 kg has a weight of 500 kN on Mars. Calculate the gravitational field strength on Mars.

The diagram shows a helicopter being used to rescue a person from the sea.



(a) The mass of the rescued person is 72 kg.

gravitational field strength = 9.8 N/kg

Show clearly how you work out your answer. **(2)**

_____

_____

Weight = _____ N

(b) To lift the person up to the helicopter, the electric motor transformed 21 600 joules of energy usefully.

(i) Use a form of energy from the box to complete the following sentence.

gravitational potential	heat	sound

The electric motor transforms electrical energy to kinetic energy. The kinetic energy is then transformed into useful _____ energy.

(1)

(ii) It takes 50 seconds for the electric motor to lift the person up to the helicopter.

Show clearly how you work out your answer and give the unit.

Choose the unit from the list below. **(3)**

coulomb (C) **hertz (Hz)** **watt (W)**

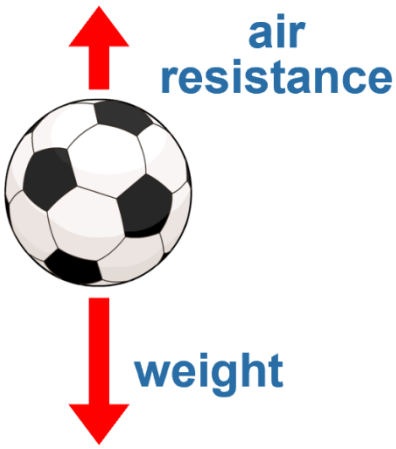
_____

_____

Power = _____

Resultant forces

The forces acting on any object can be shown using a **force diagram**. A force diagram uses labelled arrows to show all the forces acting on the object.

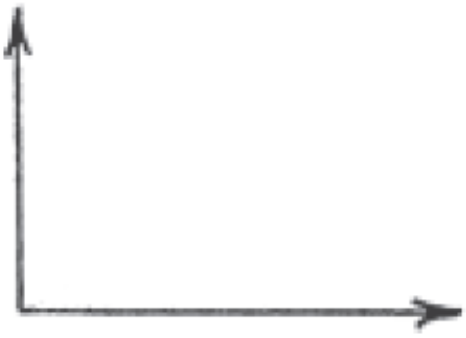


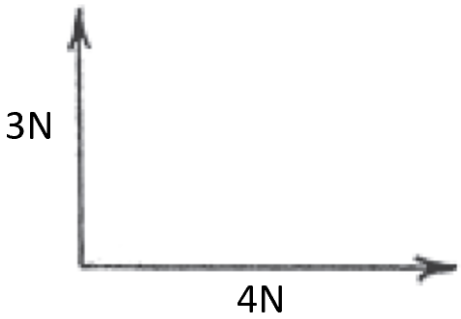
- The **direction** of each arrow shows the **direction** of each force.
- The **length** of each arrow is proportional to the **size** of the force.

The motion of the object will depend on the **resultant force**. This is calculated by adding all the forces together, taking their direction into account. When more than one force acts on an object, the forces combine to form a **resultant force.**

To draw resultant force you need to add one force onto the end of the other and draw a line from the start to the finish.

Mini task: Draw the resultant force of the force diagram to the right.



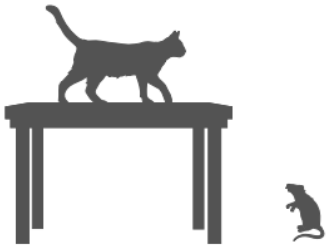


We can draw a scale diagram to find value of resultant force.

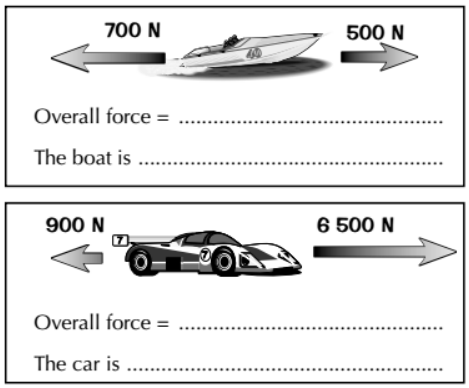
Mini task: In the space below draw a diagram (1 cm = 1N) of the force diagram to the left.

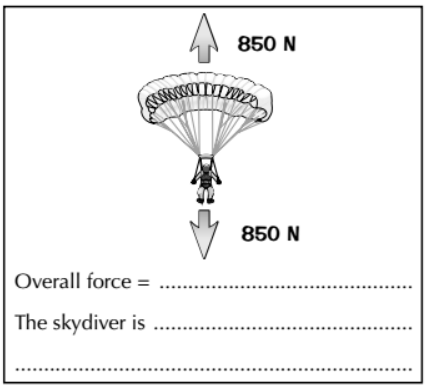
Basic

1. What does the length of an arrow in a force diagram show?
2. What does the direction of an arrow in a force diagram show?
3. A cat has a weight of 35N and is standing still on a table.
   a) What direction does the weight of the cat act in?
   b) What is the name of the other force acting on the cat?
   c) What direction does the force named in b) act in?
   d) Give the size of the force named in b).
   e) Draw two arrows on the diagram to represent the two forces acting on the cat. Label your arrows with the name and size of the force they show.



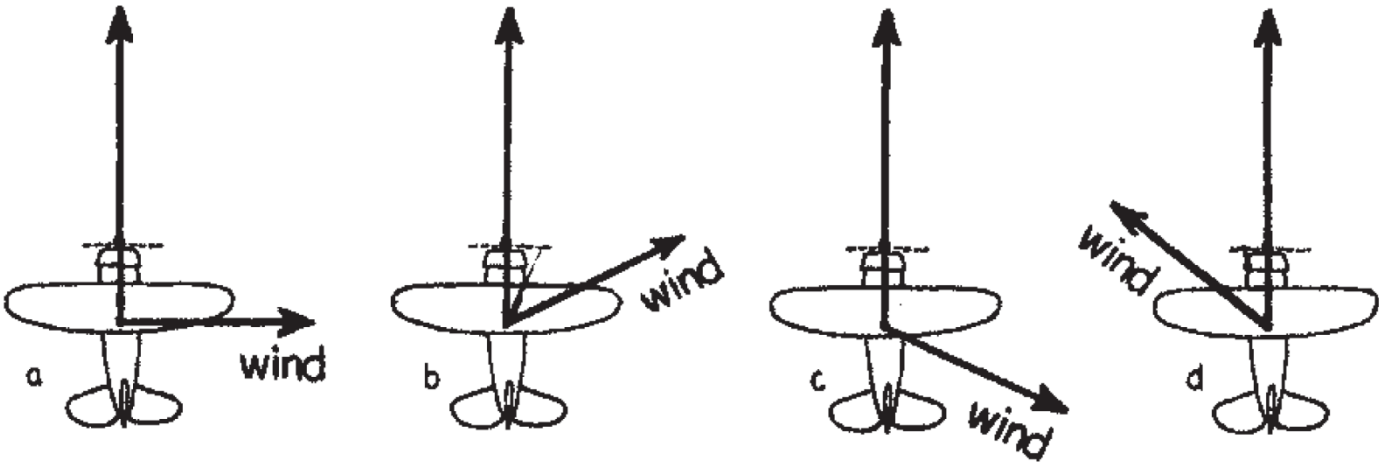
4. In each of the examples to the right, work out the overall force and say whether the object is accelerating, decelerating or moving at a constant speed.





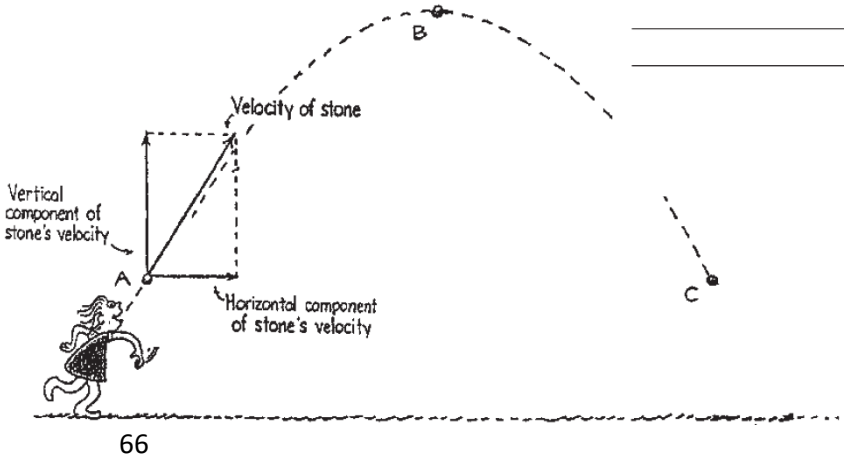
Medium

5. Below we see a top view of an airplane being blown off course by wind in various directions. Draw the resultant speed and direction of travel for each case. In which case does the airplane travel fastest & slowest?



Hard

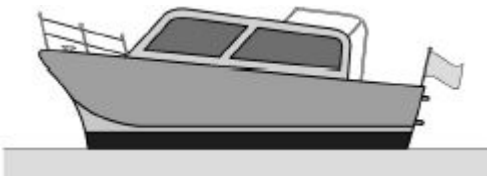
6. If we ignore air resistance, we can assume that the horizontal velocity of an object does not change.
   a) Since there is no acceleration in the horizontal direction, how does the horizontal component of velocity compare for positions A, B and C?
   b) What is the value of the vertical component of velocity at position B?
   c) How does the vertical component at position C position with that of position A?



d) Draw the resultant velocities at positions B and C.

Figure 1 shows a boat floating on the sea. The boat is stationary.

Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2

(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**.

gravitational field strength = 9.8 N/kg

Give your answer to **two** significant figures. **(4)**

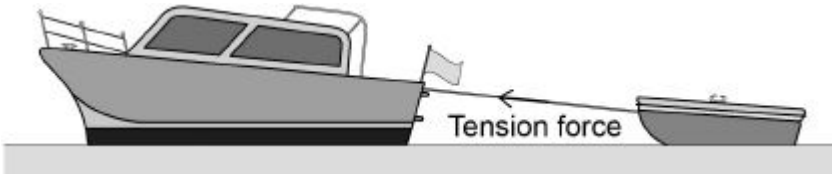
_____

_____

Mass = _____ kg

(c) **Figure 3** shows the boat towing a small dinghy.

Figure 3



The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

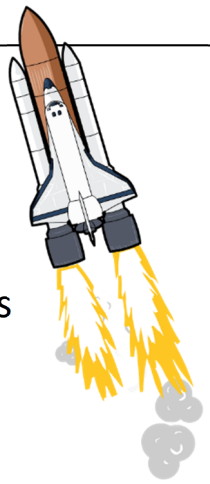
horizontal force forwards = 150 N
vertical force upwards = 50 N

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.

Magnitude of the tension force in the tow rope = _____ N

Direction of the force on the dinghy caused by the tension force in the tow rope = _____

Work done and energy transfer



What happens when a rocket is launched into space?

When the rocket's engines are fired, chemical energy in the fuel is **transferred** to kinetic energy in the rocket. This transfer of energy is called **work**.

work done = energy transferred

This means the units for work are the same as the units for energy – **joules**. For example, if a person does 500 J of work, then 500 J of energy is transferred.

Work done can be calculated using the following equation:

$$W = F \times s$$

Where W is the work done (in Joules)

F is the force applied (in Newtons)

s is the distance travelled (in metres)

Example question: Mo Farah uses 50,000 Joules of energy while running, at a force of 10 N. How far has he run?

Step 1: Write the equation. Rearrange if necessary.

s = W ÷ F

Step 2: Write down the variables

W = 50,000 J

F = 10 N

Step 3: Calculate the answer

s = 50,000 ÷ 10 = 5,000m

Task: Complete in exercise book or on paper

Basic:

$$W = F \times s$$

1. What is **work done**?
2. Write the equation for **work done**. Include the units.
3. Rearrange the equation for **force** and **distance**.
4. Calculate the **work done** if:
   a) F = 5 N, d = 5 m b) F = 150 N, d = 0.1 m c) F = 0.2 N, d = 200 m
   d) F = 2000 N, d = 1.5 m e) F = 800 N, d = 25 m f) F = 150,000 N, d = 0.5 m
5. What is the **work done** if we apply a 1.2N force and we move 4m in the direction of force?
6. What is the **work done** if we apply a 7N force and we move 8m in the direction of the force?
7. A car drives with a force of 300,000 N over a distance of 200m. What is the **work done** by the car?

Medium: Rearranging needed

8. Calculate the **distance** moved if:
   a) W = 20 J, F = 10 N b) W = 150 J, F = 7.5 N c) W = 200,000 J, F = 2 N
   d) W = 300 J, F = 0.5 N e) W = 90,000 J, F = 4.5 N f) W = 3,000 J, F = 9 N
9. Calculate the **force** if:
   a) W = 15 J, d = 0.75 m b) W = 450 J, d = 225 m c) W = 9000 J, d = 3000 m
   d) W = 5000 J, d = 1250 m e) W = 140 J, d = 35 m f) W = 800 J, d = 0.2 m
10. What **distance** is moved if we have a 8 N force and the work done is 90 J?
11. What is the **distance** moved if we have a 70 N force and work done is 8 J?
12. What **force** is required to move 7 m if the work done is 9 J?

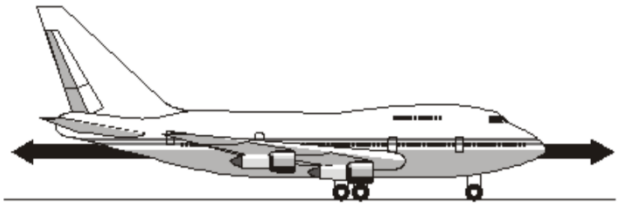
Hard: Rearranging and unit conversion

13. What is the **work done** when a force of 5kN is applied to a ball and it moves 0.8km?
14. What is the **work done** to a car if a force of 9kN is applied and it moves 7km?
15. What **force** is required if 2.5kJ moves and object 56cm?
16. Dr. Edmunds' cat Lola accelerates with a force of 220 N along a distance of 80 cm. Calculate the **work done**.
17. A teacher is late for a lesson and expends 400,000 J of energy sprinting to a lesson. If the distance covered is 0.2 km, with what **force** does the teacher sprint?
18. An aeroplane does 1.2×10^8 J of work in flying a distance of 400 km. With what **force** is the aeroplane flying?
19. a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The resultant force on the aircraft is zero.
    i) What is meant by the term **resultant force**?
    ii) Describe the movement of the aircraft when the resultant force is zero.

To go from kN to N → × 1000

To go from km to m → × 1000

To go from cm to m → ÷ 100



b) The aircraft has a take-off mass of 320,000 kg. Each of the 4 engines can produce a force of 240 kN. The aircraft takes a distance of 0.8 km to take off. Calculate the **work done** by the aircraft in taking off.

Q1.

The diagram shows an adult and a child pushing a loaded shopping trolley.

(a) (i) What is the *total force* on the trolley due to the adult and child?

_____ **(1)**

(ii) Which **one** of the terms in the box means the same as *total force*?

Draw a ring around your answer.

answer force	**mean force**	**resultant force**

(1)

(iii) The trolley is pushed at a constant speed for 80 metres.

Calculate the work done to push the trolley 80 metres.

Show clearly how you work out your answer.

_____

_____

Work done = _____

(2)

(b) Complete the following sentences by drawing a ring around the correct word in each of the boxes.

(i) The unit of work done is the

joule
newton
watt

.

(1)

(ii) Most of the work done to push the trolley is transformed into

heat
light
sound

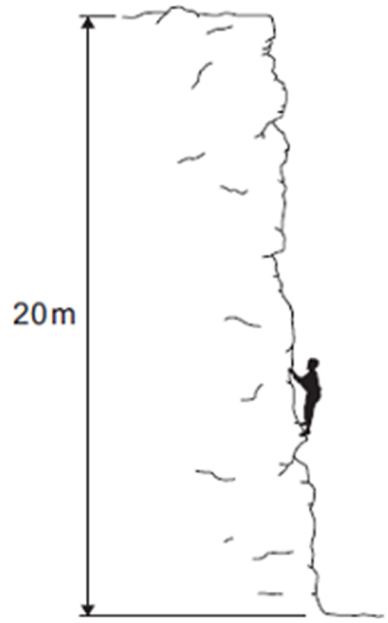
.

(1)

(Total 6 marks)

Q2.

The diagram shows a climber part way up a cliff.



(a) Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational _____ energy.

(1)

(b) The climber weighs 660 N.

(i) Calculate the work the climber must do against gravity, to climb to the top of the cliff.

_____

_____

Work done = _____ J

(2)

(ii) It takes the climber 800 seconds to climb to the top of the cliff.
During this time the energy transferred to the climber equals the work done by the climber.

Use the equation in the box to calculate the power of the climber during the climb.

$$\text{power} = \frac{\text{energy transformed}}{\text{time}}$$

Calculate the power of the climber during the climb.

_____

_____

Power = _____ W

(2)

(Total 5 marks)

Hooke's law

Hooke's law says that the amount a spring stretches is proportional to the amount of force applied to it.

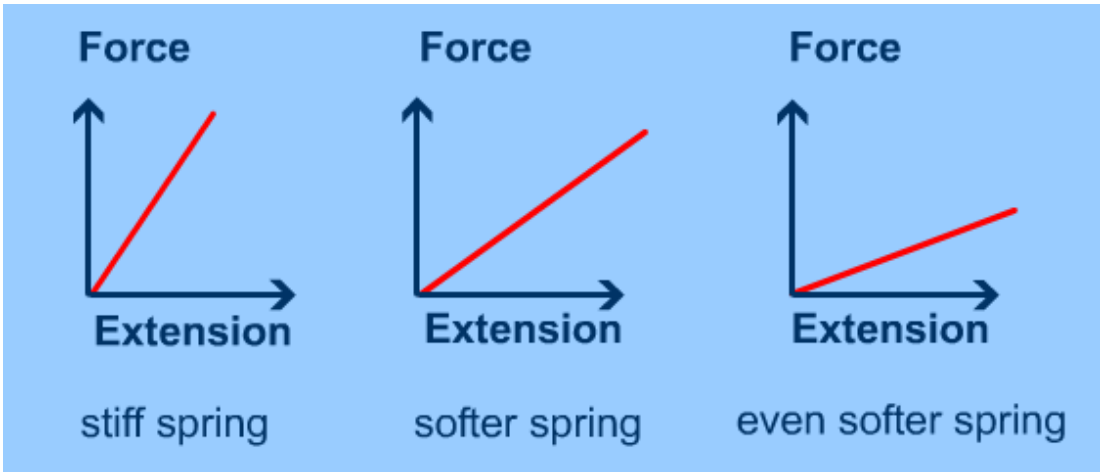
$$F = k \times e$$

Where:

- F is the applied force (in newtons, N),
- e is the extension (in metres, m)
- k is the spring constant (in N/m).

The **spring constant** measures how difficult it is to compress or stretch a spring.

The larger the spring constant the more difficult is to compress or stretch.



If a material returns to its original size and shape when you remove the forces stretching or deforming it (reversible deformation), we say that the material is demonstrating **elastic behaviour.**

A **plastic** (or **inelastic**) material is one that stays deformed after you have taken the force away. If deformation remains (irreversible deformation) after the forces are removed then it is a sign of **plastic behaviour.**

If you apply too big a force a material will lose its elasticity.

Task: Complete in your exercise book

Basic

1. a) What is the equation that links force, spring constant and extension?
   b) What are the units of force, spring constant and extension?
2. Calculate the force on a spring if:
   a) k = 10 N/m, e = 0.20 m.
   b) k = 25 N/m, e = 0.05 m.
   c) k = 150 N/m, e = 0.15 m.
3. If the spring constant is 30 N/m and a spring is stretched by 0.3m, how much force has been applied?
4. If the spring constant is 12.6 N/m and a spring is stretch by 0.25m, how much force has been applied?
5. What force would be needed to extend a spring with a spring constant k = 10 N/m by an extension of 0.3 m?

Medium

6. Re-arrange Hooke's law to give equations for the spring constant k, and the extension e. You will need to use these equations for the rest of the medium questions.
7. Calculate the spring constant if:
   a) F = 150 N, e = 0.075 m.
   b) F = 50 N, e = 0.1 m.
8. Calculate the extension if:
   a) F = 15 N, k = 150 N/m.
   b) F = 45 N, k = 90 N/m.
9. If a 6N weight is hung on a spring, and it extends by 0.2m, what is the spring constant?
10. If the force applied is 4.5 N and the spring constant is 9 N/m, how much will the spring extend by?

Hard

11. A mass of 620 g is hung on a spring of spring constant 31 N/m.
    a) Convert 620 g into kg.
    b) Using F = m × g, what is the force of the mass acting on the spring (g = 10 N/kg)?
    c) Calculate the extension of the spring.

To go from g to kg → ÷ 1000

12. A spring of spring constant 40 N/m starts at a length of 13 cm, and it extends to a length of 21 cm.
    a) What is the extension of the spring (in cm)?
    b) Convert this extension into metres.
    c) What is the force on this spring?

To go from cm to m → ÷ 100

13. A spring has a weight of 200g hanging on it, and has a spring constant of 40 N/m. Calculate the extension of the spring.
14. A spring has a weight of 500g hanging on it, and is stretched from a length of 5cm to a length of 15 cm. What is the spring constant of the spring?
15. A spring has a weight of 750g hanging on it, and is stretched from a length of 2.5cm to a length of 10 cm. What is the spring constant of the spring?

Stretch: Write some of your own questions and solve them. To make them hard, put extension in cm/mm or give a mass in grams. Try to make the numbers realistic.

(a) When a force is applied to a spring, the spring extends by 0.12 m.
The spring has a spring constant of 25 N / m.

Calculate the force applied to the spring.

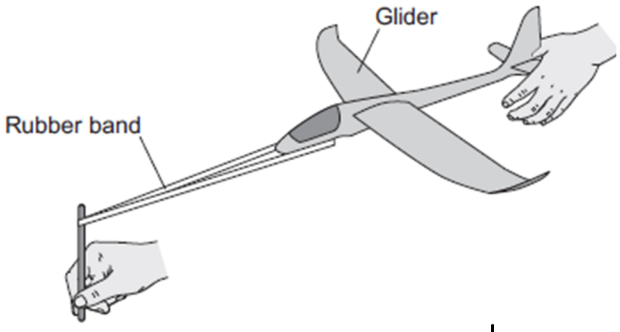
_____

_____

Force = _____ N

(b) **Figure 1** shows a toy glider. To launch the glider into the air, the rubber band and glider are pulled back and then the glider is released.

Figure 1



(i) Use the correct answers from the box to complete the sentence.

chemical	**elastic potential**	**kinetic**	**thermal**

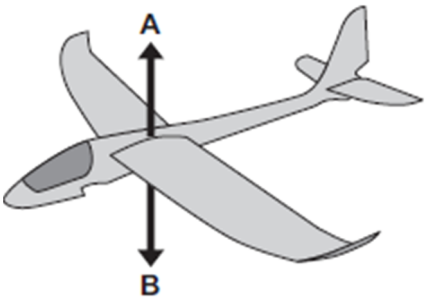
When the glider is released, the _____ energy

stored in the rubber band decreases and the glider gains

_____ energy.

(c) **Figure 3** shows the vertical forces, **A** and **B**, acting on the glider when it is flying.

Figure 3



(i) What name is given to the force labelled **B**?

Draw a ring around the correct answer.

drag **friction** **weight**

(ii) Which **one** of the following describes the downward speed of the glider when force **B** is greater than force **A**?

Tick (✓) **one** box.

Downward speed increases ☐

Downward speed is constant ☐

Downward speed decreases ☐

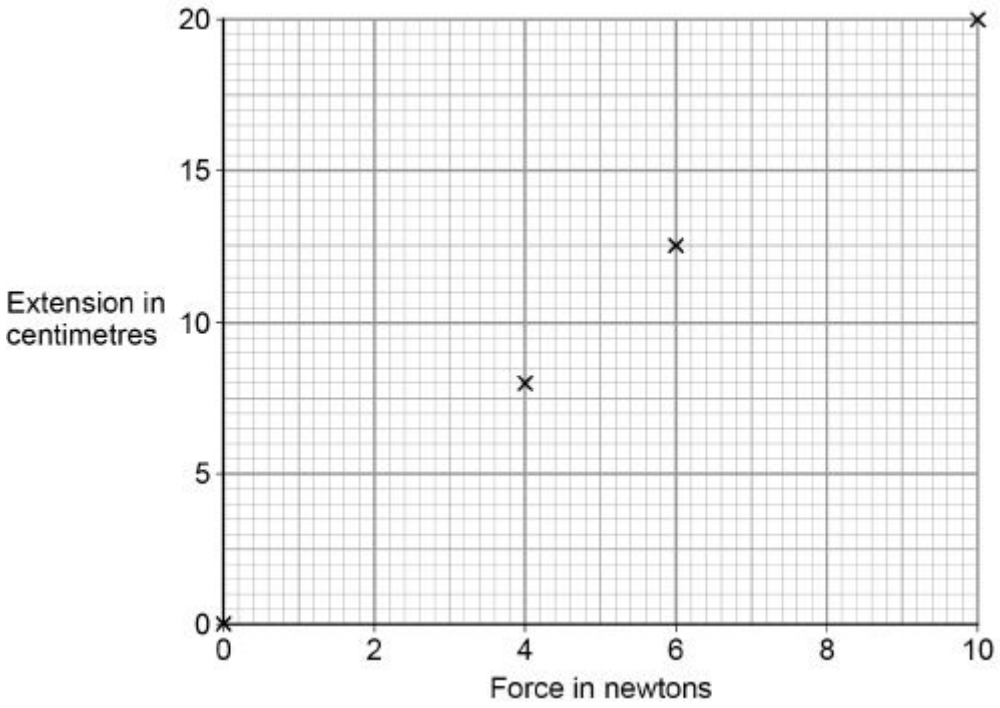
A student carried out an investigation to determine the spring constant of a spring.

The table gives the data obtained by the student.

(a) The student measured the extension for five different forces rather than just measuring the extension for one force. Suggest why. **(1)**

_____

The diagram below shows some of the data obtained by the student.



(b) Complete the diagram above by plotting the missing data from the table above. Draw the line of best fit. **(2)**

(c) Write down the equation that links extension, force and spring constant. **(1)**

_____

(d) Calculate the spring constant of the spring that the student used.

Give your answer in newtons per metre. **(4)**

_____

_____

_____

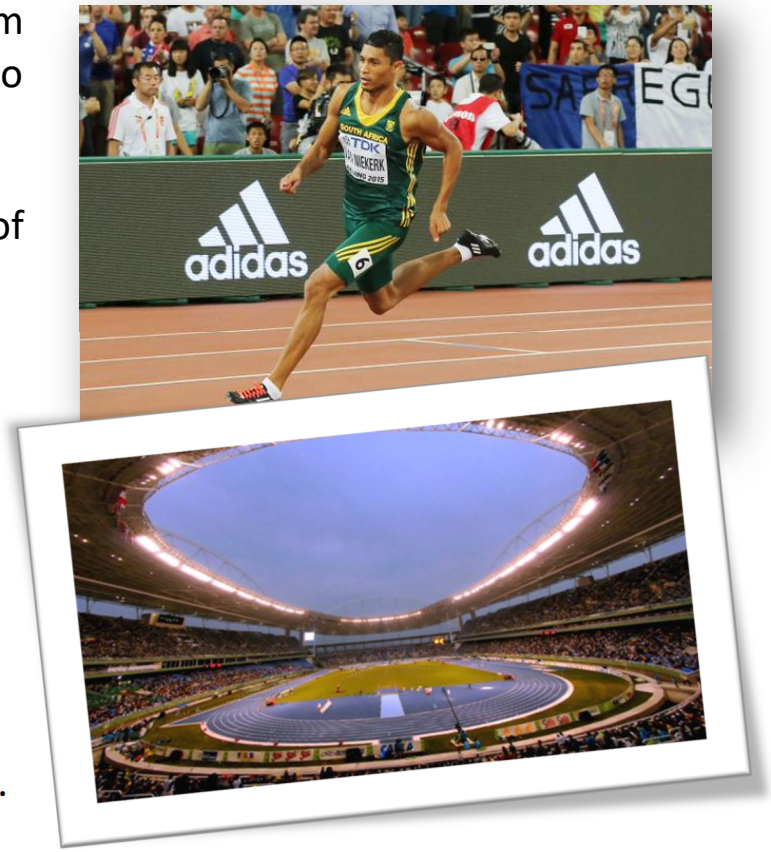
Spring constant = ______________________ N/m

Distance and displacement

Distance is a **scalar** because it gives how far an object moves regardless of direction.

Displacement is a **vector** because it gives how far an object moves from its start position (measured in a straight line from the start point to the finish point)

This is Wayde van Niekerk, the 400 m world and Olympic champion. Wayde also holds the 400 m world record at 43.03 s.



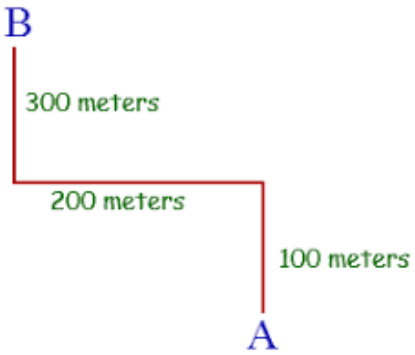
During a race, Wayde travels a distance of 400 m from start to finish.

If he runs on an oval track, what will his displacement be?

Because he ends up back where he started his displacement is 0 m.

Example question:

A cat walks along a path from A to B. Calculate:



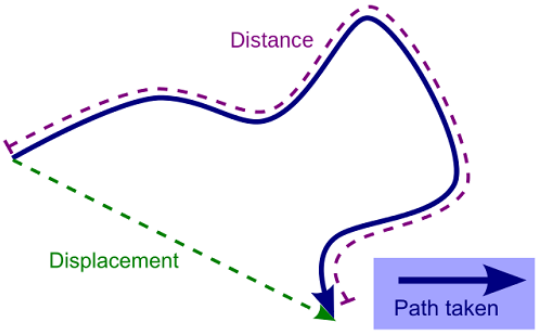
a) The distance travelled.
   Distance travelled = 100 + 200 + 300= 600 m
b) The displacement.
   This is more complicated:

1. Draw a **straight line** between the start and finish points.
2. Draw a **triangle** showing how far horizontally and vertically the cat has travelled.
3. Use **Pythagoras** to calculate the displacement and give a direction.

$$a^2 + b^2 = c^2$$
$$\rightarrow 200^2 + 400^2 = c^2$$

$\rightarrow c = \sqrt{200{,}000} = 447\ m$ North West

Basic

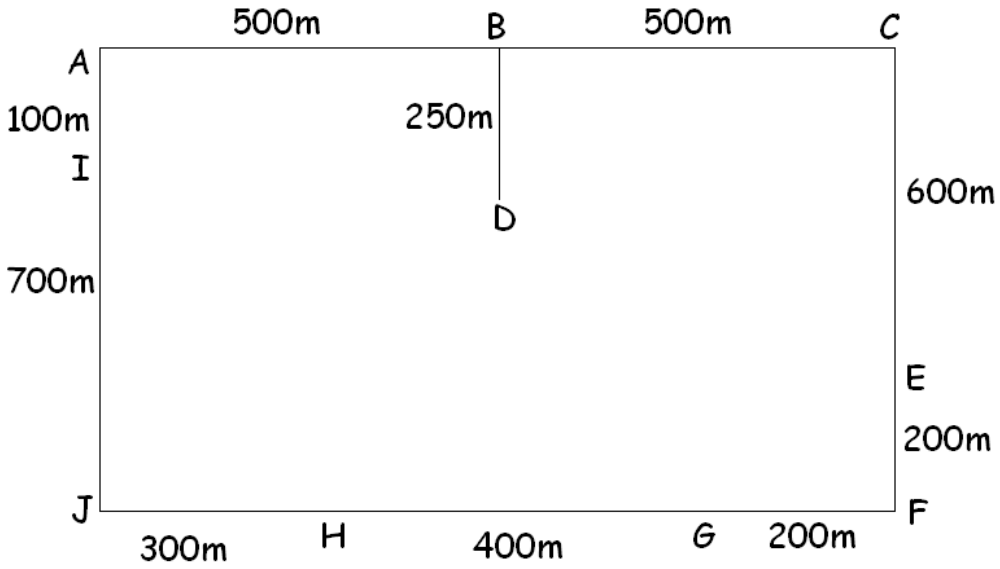


1. **Distance** is how _____ an object has moved.
2. Its value _____ (can/cannot) be zero.
3. It _____ (depends/doesn't depend on direction).
4. Distance is a _____ (scalar/vector).
5. **Displacement** is how _____ an object has moved from its _____ position.
6. Its value _____ (can/cannot) be zero.
7. It _____ (depends/doesn't depend) on direction.
8. Displacement is a _____ (scalar/vector).

Medium

9. A man swims clockwise around a swimming pool and wants to know how far he has travelled at certain points. Calculate the **distance** travelled between:

A → C	A → F	A → G
B → H	F→ A	H → A



10. If he swims around the pool 4.5 times, what is the **distance** that he has travelled?

Hard: For some you will need to draw a triangle and use Pythagoras. Remember the direction it's going in as well.

11. Now find his **displacement** between the following points:

A → C	A → F	A → G
B → H	F→ A	H → A

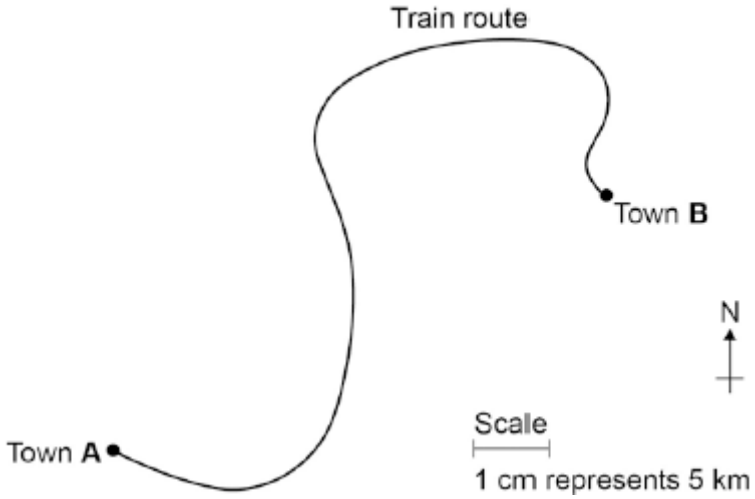
12. He swims from point A → B → D for a chat with his friend.
    a) Calculate the **distance** (in km) he has swum.
    b) Calculate his **displacement** (in km).
13. He completes 3 laps of the pool.
    a) Calculate the **distance** (in km) he has swum.
    b) Calculate his **displacement** (in km).

To go from m to km → ÷ 1000

A train travels from town **A** to town **B**.

Figure 1 shows the route taken by the train.
Figure 1 has been drawn to scale.

Figure 1



(a) The distance the train travels between **A** and **B** is not the same as the displacement of the train.

What is the difference between distance and displacement?

_____

_____

_____

(1)

(b) Use **Figure 1** to determine the displacement of the train in travelling from **A** to **B**.

Show how you obtain your answer.

_____

_____

Displacement = _____ km

Direction = _____

(2)

(c) There are places on the journey where the train's velocity changes without changing

speed.

Explain how this can happen. **(2)**

_____

_____

_____

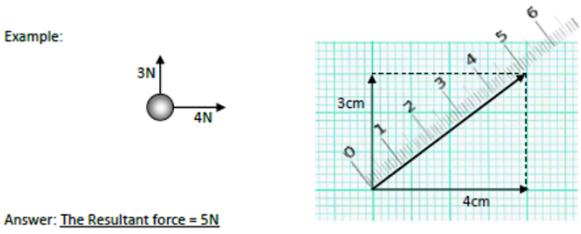
Forces
Answers

Introduction to forces

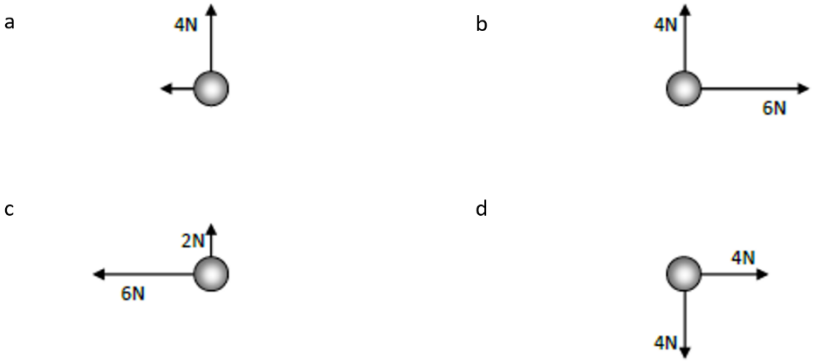
Scalar	Vector
Mass	**Force**
Distance	**Displacement**
Speed	**Velocity**
Energy	**Acceleration**
Time	
Power	

Task: Complete in exercise book

Basic



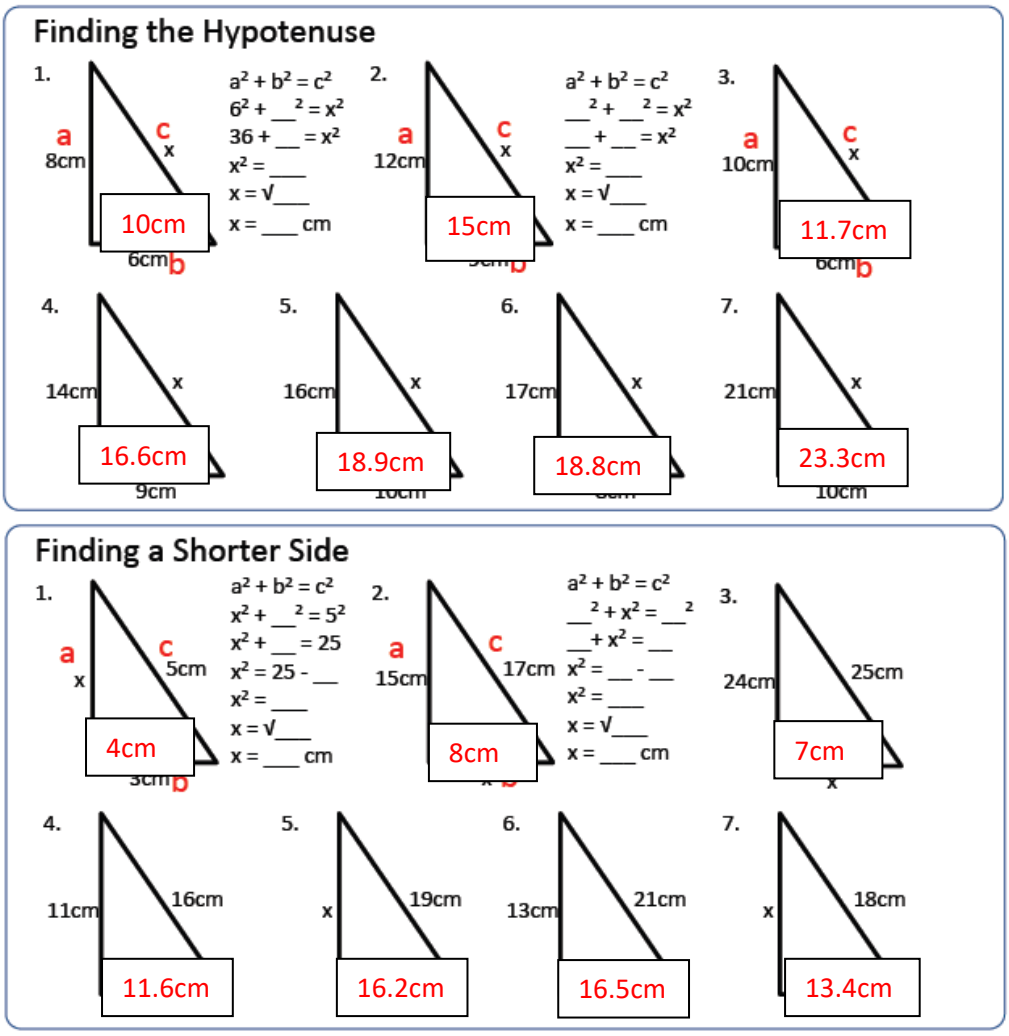
1. What is a force? A force is a push or pull
2. What is the unit of a force? newton (N)
3. What do we use to measure forces? newton meter
4. What is the definition of a scalar? A scalar quantity has size only but no direction. Give three examples of scalars. mass, distance, speed
5. What is the definition of a vector? A vector quantity has size and direction. Give three examples of vectors. Velocity, displacement, force
6. What is the equation for Pythagoras' theorem? $a^2+b^2=c^2$



7. Draw scale diagrams (1cm = 1N) to work out the resultant force in each of the cases to the right. a. 4.5N b. 7.2N c. 6.3N d. 5.7N

Medium

8. Describe the difference between distance and displacement. Distance is how far an object has moved. It is scalar. Displacement is a vector quantity. It measures the distance and direction in a straight line from the start point to the finish point.
9. Use Pythagoras' theorem to calculate the missing lengths of each triangle to the right.



Hard

10. A woman walks 200m east and then 100m south.
    c) Find the total distance travelled. 300m
    d) Now find the resultant displacement. 224m
11. Dr. Edmunds' cat Lola runs after a squirrel 40m North and 30m West.
    c) What is the distance that Lola has run? 70m
    d) What is Lola's resultant displacement? 50m
12. An aeroplane travels with a speed of 100 m/s North, and a speed of 20 m/s East. What is the plane's overall velocity? 102m/s NE

Mass, weight and gravity

Complete the tables for Arnie and Markey and fill in the missing numbers. *Hint* – information from elsewhere in the table could be useful!

Basic:

Arnie

Planet	Mass (kg)	Gravitational Field strength (N/kg)	Weight (N)
Mercury	30	3.78	113.4
Venus	30	9.07	272.1
Earth	30	9.8	294
Moon	30	1.66	49.8
Mars	30	3.77	113.1
Jupiter	30	23.64	709.2
Saturn	30	9.16	274.8
Uranus	30	8.89	266.7
Neptune	30	11.25	337.5
Pluto	30	0.67	20.1

Markey

Planet	Mass (kg)	Gravitational Field strength (N/kg)	Weight (N)
Mercury	0.5	3.78	1.89
Venus	0.5	9.07	4.54
Earth	0.5	9.8	4.9
Moon	0.5	1.66	0.83
Mars	0.5	3.77	1.89
Jupiter	0.5	23.64	11.8
Saturn	0.5	9.16	4.58
Uranus	0.5	8.89	4.45
Neptune	0.5	11.25	5.63
Pluto	0.5	0.67	0.34

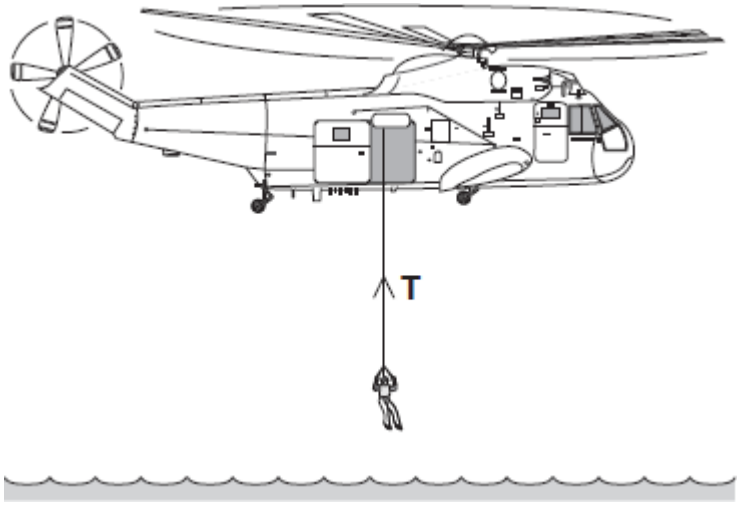
Medium: For these questions you need to re-arrange the formula. (g = 9.8 N/kg for questions 1-5).

1) A Formula 1 car weighs 7150N, calculate its **mass**. 729.6kg
2) A cat weighs 42 N, calculate its **mass.** 4.29kg
3) A dog weighs 180 N, calculate its **mass**. 18.37kg
4) An iPad weighs 2.2 N, calculate its **mass.** 0.22kg
5) A Boeing 747 aeroplane weighs 1.9×10^6 N, calculate its **mass.** 193878kg
6) A man of mass 70 kg is standing on a planet where he weighs 1750 N. Calculate the planet's **gravitational field strength.** 25N/kg
7) The curiosity Rover was sent to search Mars. It has a mass of 900 kg weighs 3400 N while on Mars. Calculate Mars' **gravitational field strength.** 3.78N/kg

Hard: Rearranging and unit conversion.

8) An iphone has a weight of 1.2N on Earth. Calculate its mass in grams. 122.4g
9) A bottle of water has a weight of 10N on Earth. Calculate its mass in grams. 1020g
10) A car has a weight of 12 kN on Earth. Calculate its mass in kg. 1224.5kg
11) A rocket of mass 133,000 kg has a weight of 500 kN on Mars. Calculate the gravitational field strength on Mars. 3.76N/kg

The diagram shows a helicopter being used to rescue a person from the sea.



(a) The mass of the rescued person is 72 kg.

gravitational field strength = 9.8 N/kg

Show clearly how you work out your answer. **(2)**

Weight = mass x gravitational field strength

Weight = 72 x 9.8

Weight = 705.6

Weight = 705.6N

(b) To lift the person up to the helicopter, the electric motor transformed 21 600 joules of energy usefully.

(i) Use a form of energy from the box to complete the following sentence.

gravitational potential	heat	sound

The electric motor transforms electrical energy to kinetic energy. The kinetic energy is then transformed into useful gravitational potential energy.

(1)

(ii) It takes 50 seconds for the electric motor to lift the person up to the helicopter.

Show clearly how you work out your answer and give the unit.

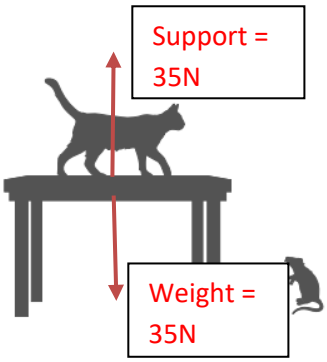
Choose the unit from the list below. **(3)**

coulomb (C) **hertz (Hz)** **watt (W)**

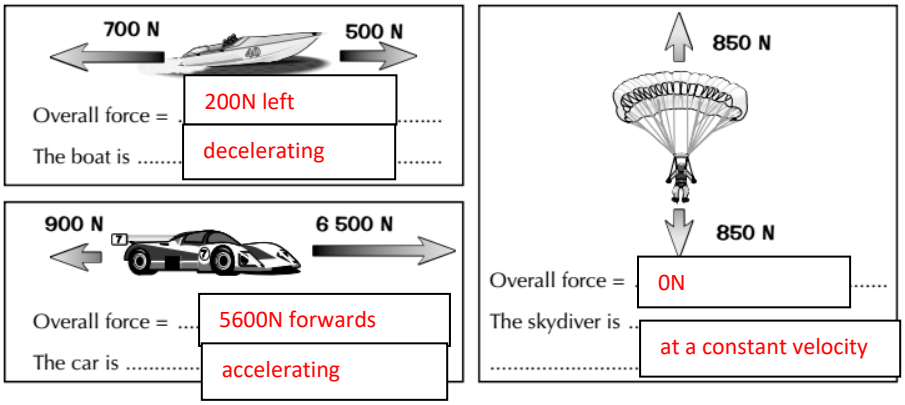
Power = $\frac{energy\ transferred}{time}$ Power = $\frac{21000}{50}$ Power = 420 Power = 420W

Resultant forces

Basic

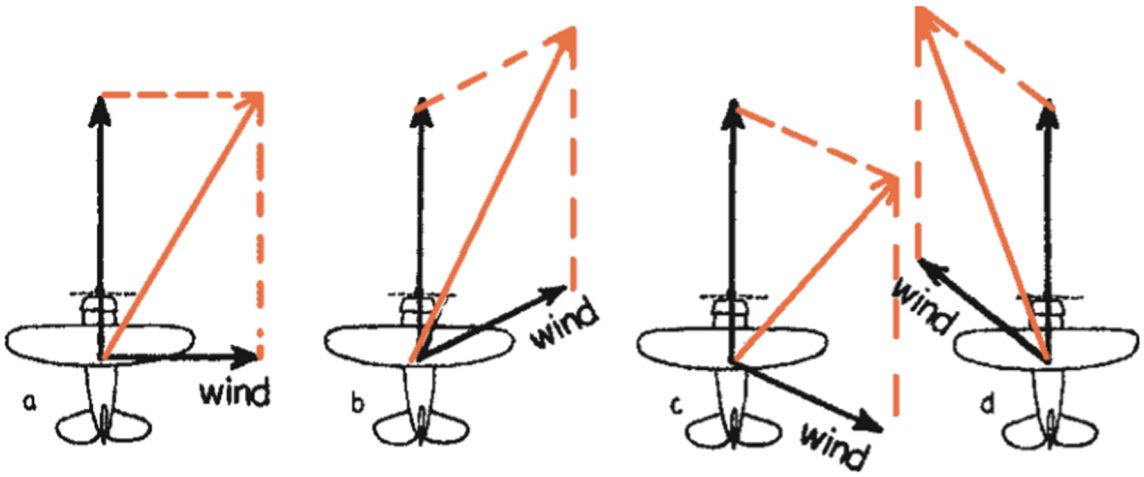


1. What does the length of an arrow in a force diagram show? Size of force
2. What does the direction of an arrow in a force diagram show? Direction of force
3. A cat has a weight of 35N and is standing still on a table.
   f) What direction does the weight of the cat act in? downwards
   g) What is the name of the other force acting on the cat? reaction/support
   h) What direction does the force named in b) act in? upwards
   i) Give the size of the force named in b). 35N (equal to weight of cat)
   j) Draw two arrows on the diagram to represent the two forces acting on the cat. Label your arrows with the name and size of the force they show.
4. In each of the examples to the right, work out the overall force and say whether the object is accelerating, decelerating or moving at a constant speed.



Medium

5. Below we see a top view of an airplane being blown off course by wind in various directions. Draw the resultant speed and direction of travel for each case. In which case does the airplane travel fastest (d) & slowest (c) ?



Hard

6. If we ignore air resistance, we can assume that the horizontal velocity of an object does not change.

   a. Since there is no acceleration in the horizontal direction, how does the horizontal component of velocity compare for positions A, B, and C? Same

   b. What is the value of the vertical component of velocity at position B? 0 m/s

   c. How does the vertical component of velocity at position C compare with that of position A? Equal and opposite

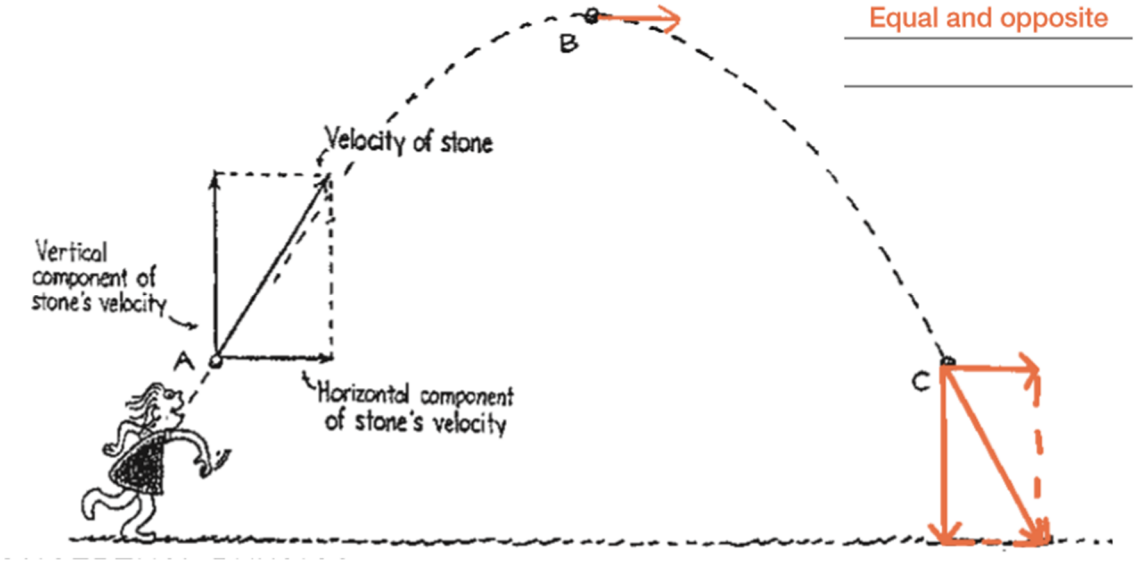
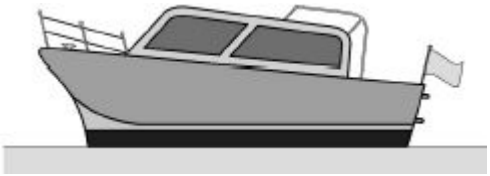


Figure 1 shows a boat floating on the sea. The boat is stationary.

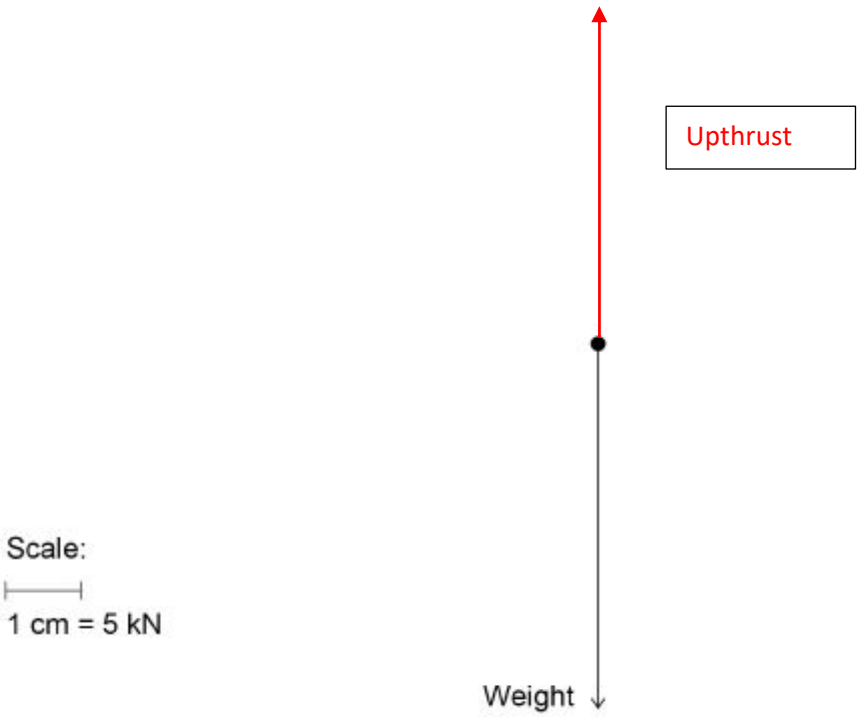
Figure 1



(a) **Figure 2** shows part of the free body diagram for the boat.

Complete the free body diagram for the boat.

Figure 2



(2)

(b) Calculate the mass of the boat.

Use the information given in **Figure 2**.

gravitational field strength = 9.8 N/kg

Give your answer to **two** significant figures. **(4)**

Weight = 5 x 5kN = 25kN = 25000N

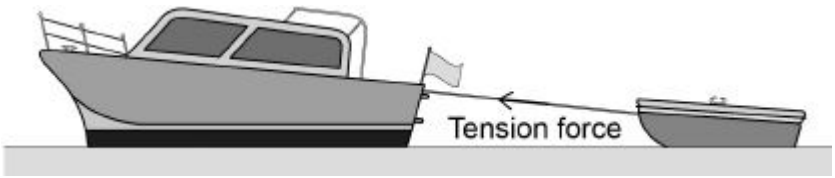
25000 = mass x 9.8

mass = 25000/9.8 = 2551

Mass = 2600 kg

(c) **Figure 3** shows the boat towing a small dinghy.

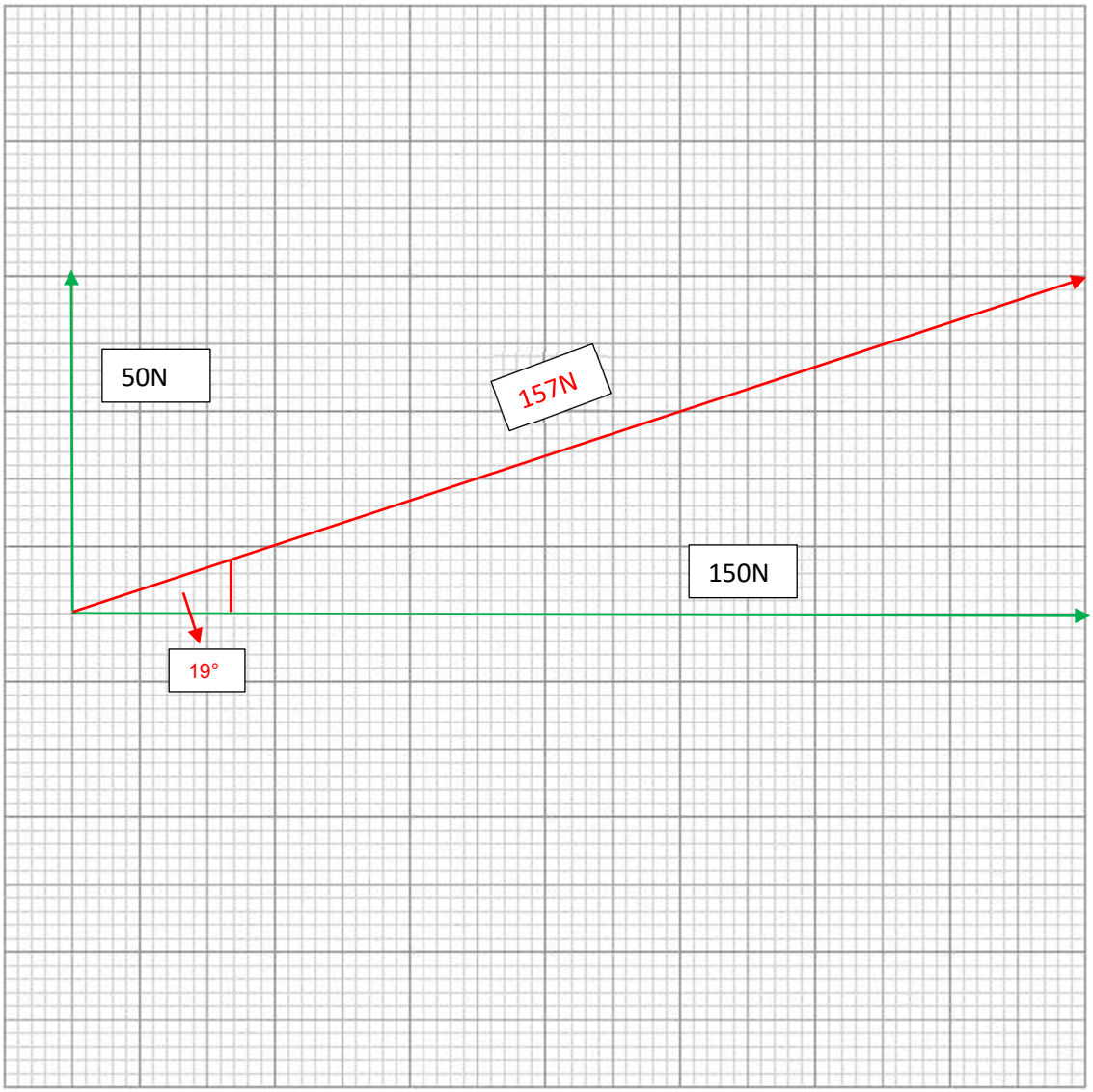
Figure 3



The tension force in the tow rope causes a horizontal force forwards and a vertical force upwards on the dinghy.

horizontal force forwards = 150 N
vertical force upwards = 50 N

Draw a vector diagram to determine the magnitude of the tension force in the tow rope and the direction of the force this causes on the dinghy.



Magnitude of the tension force in the tow rope = 157 N

Direction of the force on the dinghy caused

Work done and energy transfer

by the tension force in the tow rope = 19°

Task: Complete in exercise book

Basic:

1. What is **work done**? Energy transferred
2. Write the equation for **work done**. Include the units.

W (joules) = F (newtons) × s (metres)

3. Rearrange the equation for **force** and **distance**.

$Force = \frac{work\ done}{distance}$ $distance = \frac{work\ done}{force}$

4. Calculate the **work done** if:
   b) F = 5 N, s = 5 m 25J b) F = 150 N, s = 0.1 m 15J c) F = 0.2 N, s = 200 m 40J
   e) F = 2000 N, s = 1.5 m 3000J e) F = 800 N, s = 25 m 20kJ f) F = 150,000 N, s = 0.5 m 75kJ
5. What is the **work done** if we apply a 1.2N force and we move 4m in the direction of force? 4.8J
6. What is the **work done** if we apply a 7N force and we move 8m in the direction of the force? 56J
7. A car drives with a force of 300,000 N over a distance of 200m. What is the **work done** by the car? 60MJ

Medium: Rearranging needed

8. Calculate the **distance** moved if:
   b) W = 20 J, F = 10 N 2m b) W = 150 J, F = 7.5 N 20m c) W = 200,000 J, F = 2 N 100km
   e) W = 300 J, F = 0.5 N 600m e) W = 90,000 J, F = 4.5 N 20km f) W = 3,000 J, F = 9 N 333.3m
9. Calculate the **force** if:
   c) W = 15 J, s = 0.75 m 20N b) W = 450 J, s = 225 m 2N c) W = 9000 J, s = 3000 m 3N
   e) W = 5000 J, s = 1250 m 4N e) W = 140 J, s = 35 m 4N f) W = 800 J, s = 0.2 m 1600N
10. What **distance** is moved if we have a 8 N force and the work done is 90 J? 11.25m
11. What is the **distance** moved if we have a 70 N force and work done is 8 J? 11.4cm
12. What **force** is required to move 7 m if the work done is 9 J? 1.29N

Hard: Rearranging and unit conversion

13. What is the **work done** when a force of 5kN is applied to a ball and it moves 0.8km? 4000000J or 4MJ
14. What is the **work done** to a car if a force of 9kN is applied and it moves 7km? 63000000J or 63MJ
15. What **force** is required if 2.5kJ moves an object 56cm? 4464N
16. Dr. Edmunds' cat Lola accelerates with a force of 220 N along a distance of 80 cm. Calculate the **work done**. 176J
17. A teacher is late for a lesson and expends 400,000 J of energy sprinting to a lesson. If the distance covered is 0.2 km, with what **force** does the teacher sprint? 2000N or 2kN

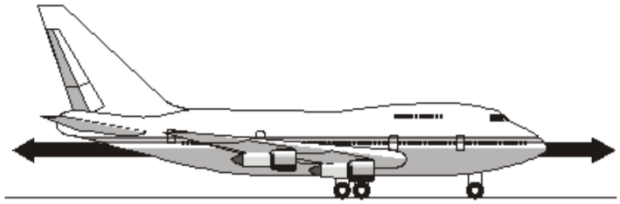
To go from kN to N → × 1000

To go from km to m → × 1000

To go from cm to m → ÷ 100

18. An aeroplane does 1.2×10^8 J of work in flying a distance of 400 km. With what **force** is the aeroplane flying? 300N

19. a) The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The resultant force on the aircraft is zero.



iii) What is meant by the term **resultant force**?
The combined force acting on an object

iv) Describe the movement of the aircraft when the resultant force is zero. Constant velocity

d) The aircraft has a take-off mass of 320,000 kg. Each of the 4 engines can produce a force of 240 kN. The aircraft takes a distance of 0.8 km to take off. Calculate the **work done** by the aircraft in taking off. 768MJ

Q1.

The diagram shows an adult and a child pushing a loaded shopping trolley.

(a) (i) What is the *total force* on the trolley due to the adult and child?

50N **(1)**

(ii) Which **one** of the terms in the box means the same as *total force*?

Draw a ring around your answer.

answer force	mean force	resultant force

(1)

(iii) The trolley is pushed at a constant speed for 80 metres.

Calculate the work done to push the trolley 80 metres.

Show clearly how you work out your answer.

Work done = force x distance

Work done = 50 x 80

Work done = 4000J

(2)

(b) Complete the following sentences by drawing a ring around the correct word in each of the boxes.

(i) The unit of work done is the

joule
newton
watt

.

(1)

(ii) Most of the work done to push the trolley is transformed into

heat
light
sound

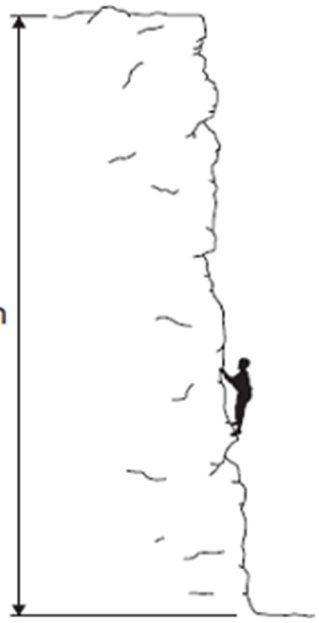
.

(1)

(Total 6 marks)

Q2.

The diagram shows a climber part way up a cliff.



(a) Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational potential energy.

(1)

(b) The climber weighs 660 N.

(i) Calculate the work the climber must do against gravity, to climb to the top of the cliff.

Work done = force x distance

Work done = 660 x 20

Work done = 13200J

(2)

(ii) It takes the climber 800 seconds to climb to the top of the cliff.
During this time the energy transferred to the climber equals the work done by the climber.

Use the equation in the box to calculate the power of the climber during the climb.

$$\text{power} = \frac{\text{energy transformed}}{\text{time}}$$

Calculate the power of the climber during the climb.

Power = $\frac{13200}{800}$

Power = 16.5W

(2)

(Total 5 marks)

Hooke's law

Task: Complete in your exercise book

Basic

1. a) What is the equation that links force, spring constant and extension? Force = spring constant x extension
   b) What are the units of force, spring constant and extension? Force = newtons, spring constant = newtons/metre, extension = metres
2. Calculate the force on a spring if:
   d) k = 10 N/m, e = 0.20 m. 2N
   e) k = 25 N/m, e = 0.05 m. 1.25N
   f) k = 150 N/m, e = 0.15 m. 22.5N
3. If the spring constant is 30 N/m and a spring is stretched by 0.3m, how much force has been applied? 9N
4. If the spring constant is 12.6 N/m and a spring is stretch by 0.25m, how much force has been applied? 3.15N
5. What force would be needed to extend a spring with a spring constant k = 10 N/m by an extension of 0.3 m? 3N

Medium

6. Re-arrange Hooke's law to give equations for the spring constant k, and the extension e. You will need to use these equations for the rest of the medium questions. $spring\ constant = \frac{force}{extension}$ $extension = \frac{force}{spring\ constant}$
7. Calculate the spring constant if:
   c) F = 150 N, e = 0.075 m. 2000N/m
   d) F = 50 N, e = 0.1 m. 500N/m
8. Calculate the extension if:
   c) F = 15 N, k = 150 N/m. 0.1m
   d) F = 45 N, k = 90 N/m. 0.5m
9. If a 6N weight is hung on a spring, and it extends by 0.2m, what is the spring constant? 30N/m
10. If the force applied is 4.5 N and the spring constant is 9 N/m, how much will the spring extend by? 0.5m

Hard

11. A mass of 620 g is hung on a spring of spring constant 31 N/m.

d) Convert 620 g into kg. 0.62kg

e) Using F = m × g, what is the force of the mass acting on the spring (g = 10 N/kg)? 6.2N

f) Calculate the extension of the spring. 0.2m

To go from g to kg → ÷ 1000

12. A spring of spring constant 40 N/m starts at a length of 13 cm, and it extends to a length of 21 cm.

d) What is the extension of the spring (in cm)? 8cm

e) Convert this extension into metres. 0.08m

f) What is the force on this spring? 3.2N

To go from cm to m → ÷ 100

13. A spring has a weight of 200g hanging on it, and has a spring constant of 40 N/m. Calculate the extension of the spring. 0.05m
14. A spring has a weight of 500g hanging on it, and is stretched from a length of 5cm to a length of 15 cm. What is the spring constant of the spring? 50N/m
15. A spring has a weight of 750g hanging on it, and is stretched from a length of 2.5cm to a length of 10 cm. What is the spring constant of the spring? 100N/m

Stretch: Write some of your own questions and solve them. To make them hard, put extension in cm/mm or give a mass in grams. Try to make the numbers realistic.

(a) When a force is applied to a spring, the spring extends by 0.12 m.
The spring has a spring constant of 25 N / m.

Calculate the force applied to the spring.

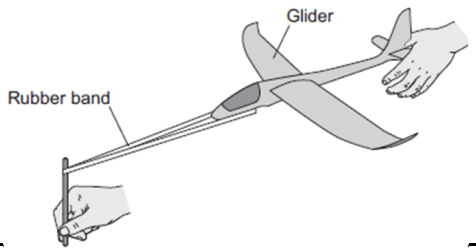
F = k x e

F = 25 x 0.12

Force = 3N

(b) **Figure 1** shows a toy glider. To launch the glider into the air, the rubber band and glider are pulled back and then the glider is released.

Figure 1



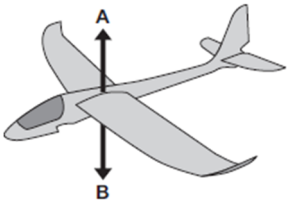
(i) Use the correct answers from the box to complete the sentence.

chemical	**elastic potential**	**kinetic**	**thermal**

When the glider is released, the elastic potential energy stored in the rubber band decreases and the glider gains kinetic energy.

(c) **Figure 3** shows the vertical forces, **A** and **B**, acting on the glider when it is flying.

Figure 3



(i) What name is given to the force labelled **B**?

Draw a ring around the correct answer.

drag **friction** **weight**

(ii) Which **one** of the following describes the downward speed of the glider when force **B** is greater than force **A**?

Tick (✓) **one** box.

Downward speed increases ☐

Downward speed is constant ☐

Downward speed decreases ☐

A student carried out an investigation to determine the spring constant of a spring.

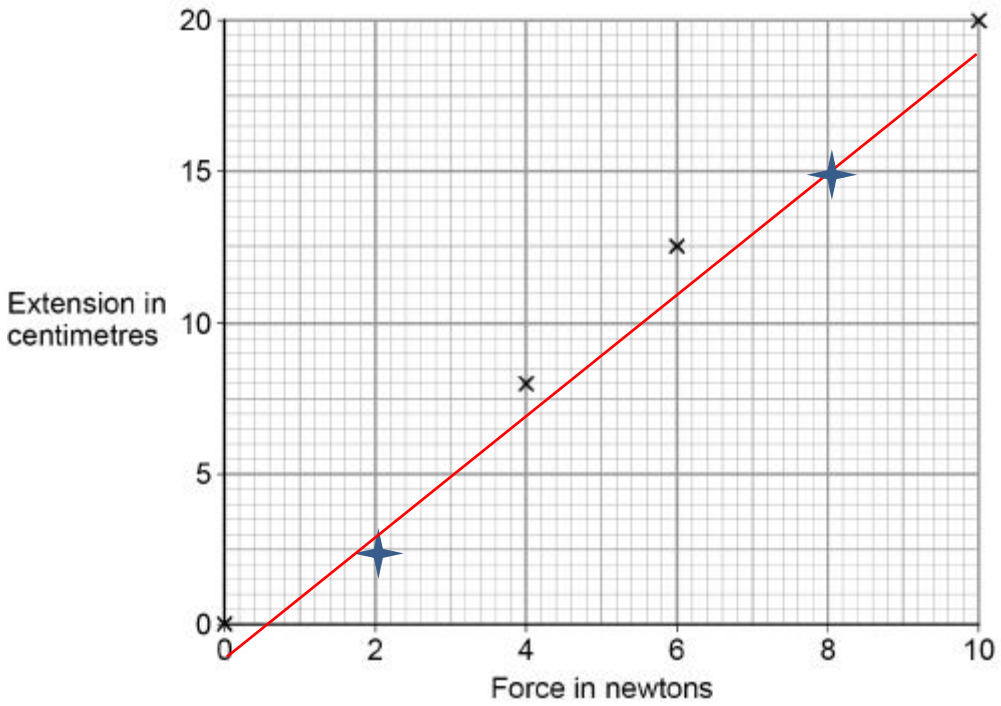
The table gives the data obtained by the student.

Force in N	Extension in cm
0	0.0
2	3.5
4	8.0
6	12.5
8	16.0
10	20.0

(a) The student measured the extension for five different forces rather than just measuring the extension for one force. Suggest why. **(1)**

To identify anomalies

The diagram below shows some of the data obtained by the student.



(b) Complete the diagram above by plotting the missing data from the table above. Draw the line of best fit. **(2)**

(c) Write down the equation that links extension, force and spring constant. **(1)**

Force = spring constant x extension

(d) Calculate the spring constant of the spring that the student used.

Give your answer in newtons per metre. **(4)**

F = 10N extension = 20cm = 0.2m

10 = spring constant x 0.2

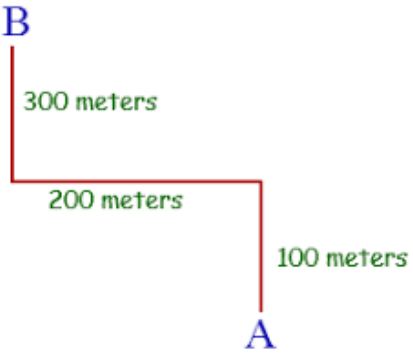
Spring constant = 50 N/m

Distance and displacement

A cat walks along a path from A to B. Calculate:

a) The distance travelled.
Distance travelled = 100 + 200 + 300= 600 m

b) The displacement.
This is more complicated:



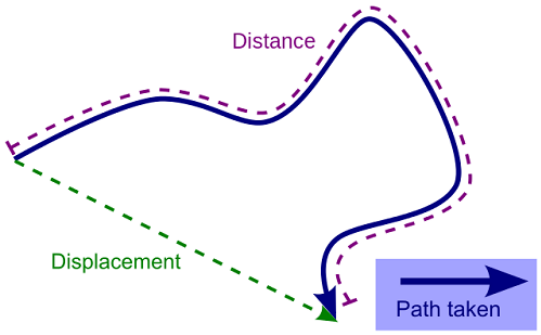
1. Draw a **straight line** between the start and finish points.
2. Draw a **triangle** showing how far horizontally and vertically the cat has travelled.
3. Use **Pythagoras** to calculate the displacement and give a direction.

$$a^2 + b^2 = c^2$$

$$\rightarrow 200^2 + 400^2 = c^2$$

$\rightarrow c = \sqrt{200{,}000} = 447\ m$ North West

Basic



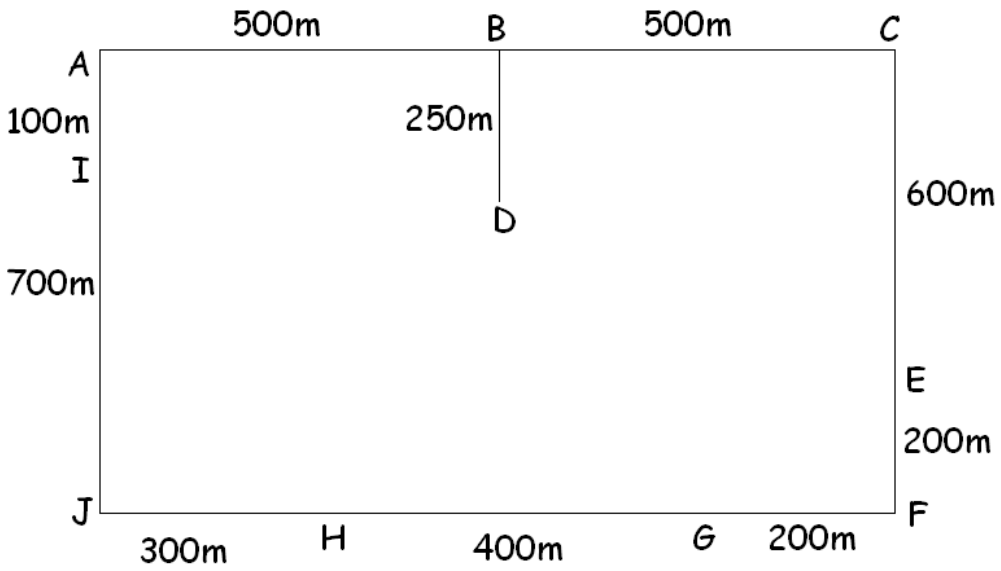
1. **Distance** is how far an object has moved.
2. Its value cannot be zero.
3. It doesn't depend on direction.
4. Distance is a scalar
5. **Displacement** is how far an object has moved from its original position.
6. Its value can be zero.
7. It depends on direction.
8. Displacement is a vector.

Medium

9. A man swims clockwise around a swimming pool and wants to know how far he has travelled at certain points. Calculate the **distance** travelled between:

A → C 1000m A → F 1800m A → G 2000m

B → H 1900m F→ A 1700m H → A 1100m



10. If he swims around the pool 4.5 times, what is the **distance** that he has travelled? 4.5 x 3500m = 15750m

Hard: For some you will need to draw a triangle and use Pythagoras. Remember the direction it's going in as well.

11. Now find his **displacement** between the following points:

A → C 1000m E A → F 1281m SE A → G 1130m SSE

B → H 830m SSW F→ A 1281m NW H → A 850m NNW

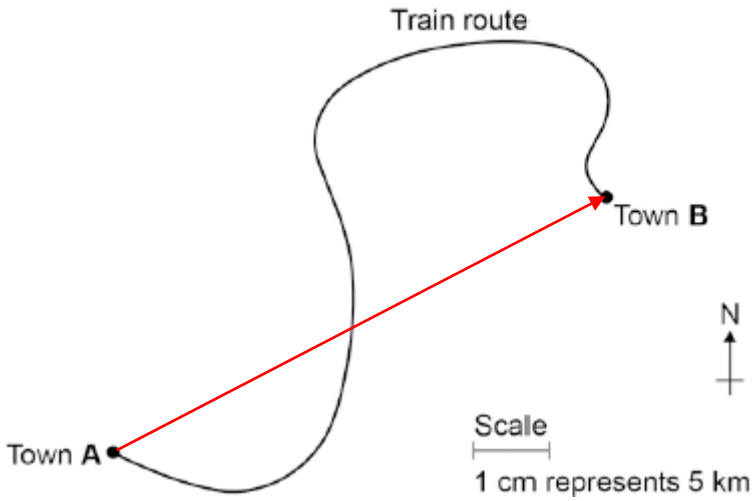
12. He swims from point A → B → D for a chat with his friend.
    c) Calculate the **distance** (in km) he has swum. 0.75km
    d) Calculate his **displacement** (in km). 0.56km ESE
13. He completes 3 laps of the pool.
    c) Calculate the **distance** (in km) he has swum. 10.5km
    d) Calculate his **displacement** (in km). 0km

To go from m to km → ÷ 1000

A train travels from town **A** to town **B**.

Figure 1 shows the route taken by the train.
Figure 1 has been drawn to scale.

Figure 1



(a) The distance the train travels between **A** and **B** is not the same as the displacement of the train.

What is the difference between distance and displacement?

Distance is a scalar quantity (magnitude only) and displacement is a vector quantity (magnitude and direction)

(1)

(b) Use **Figure 1** to determine the displacement of the train in travelling from **A** to **B**.

Show how you obtain your answer.

7.4cm x 5km = 37.0

Displacement = 37.0 km

Direction = 61°NE

(2)

(c) There are places on the journey where the train's velocity changes without changing speed.

Explain how this can happen. **(2)**

Velocity is a vector quantity and can be calculated by $\frac{displacement}{time}$. Speed is scalar and can be calculated by $\frac{distance}{time}$. Because displacement is distance *with* direction, if direction changes then there must be a change in velocity (acceleration) even though there may not be a change in speed.