Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

C420U10-1

S18-C420U10-1

PHYSICS – Component 1
Concepts in Physics

FOUNDATION TIER

WEDNESDAY, 23 MAY 2018 – AFTERNOON

2 hours 15 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	6	
2.	5	
3.	5	
4.	7	
5.	10	
6.	12	
7.	13	
8.	15	
9.	11	
10.	12	
11.	12	
12.	12	
Total	120	

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ADDITIONAL MATERIALS

In addition to this paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **10*(c)***.

EQUATION LIST

final velocity = initial velocity + acceleration × time	$v = u + at$
distance = ½ × (initial velocity + final velocity) × time	$x = \frac{1}{2}(u + v)t$
(final velocity)^2 = (initial velocity)^2 + 2 × acceleration × distance	$v^2 = u^2 + 2ax$
change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = mc\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$Q = mL$
energy transferred in stretching = ½ × spring constant × (extension)^2	$E = \frac{1}{2}kx^2$
for gases: pressure × volume = constant (for a given mass of gas at a constant temperature)	pV = constant
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	$V_1I_1 = V_2I_2$

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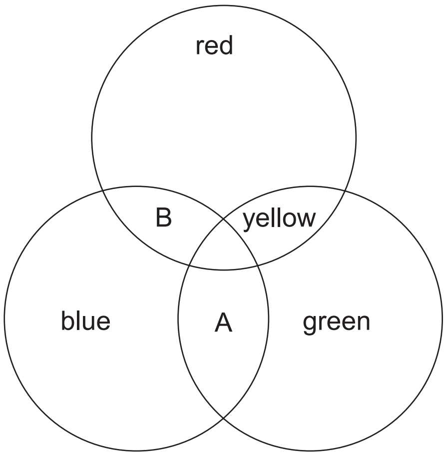
Answer **all** *questions.*

1. Theatre stages are lit up by using a number of spotlights.

(a) The beams from three spotlights overlap on a white stage as shown in the diagram.



(i) State the colour produced at A. .... [1]

(ii) State the colour produced at B. .... [1]

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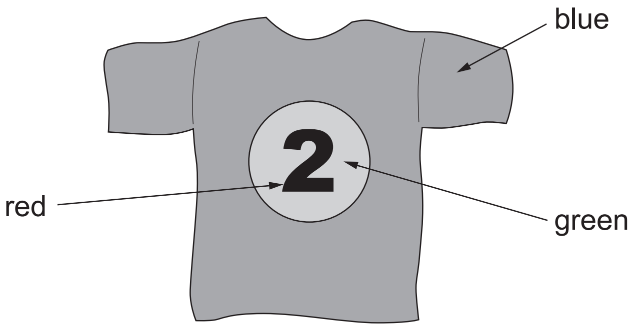
(b) The colours of a T-shirt, in daylight, are shown in the diagram.



Complete the table to show the appearance of the T-shirt under different colour spotlights. [2]

Spotlight colour	T-shirt colours		
white	red	green	blue
blue	....	black	blue
yellow	red	....	black

(c) Visible light is part of the electromagnetic (em) spectrum. Complete the diagram of the em spectrum given below. [2]

gamma rays	....	ultraviolet light	visible light	infra-red light	....	radio waves

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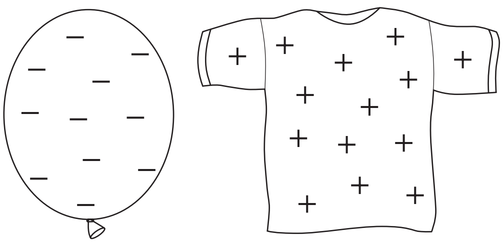
2. When a balloon is rubbed on a jumper, the balloon becomes negatively charged with static electricity.

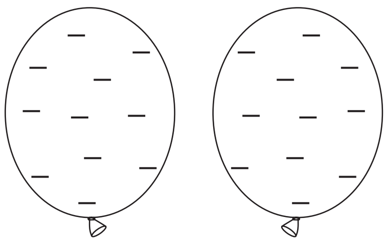
(a) (i) State whether protons, electrons or neutrons, have moved **from the jumper to the balloon**. [1]

....

(ii) In each of the boxes below, **complete the sentences** to say whether the objects repel, attract or do nothing. [2]

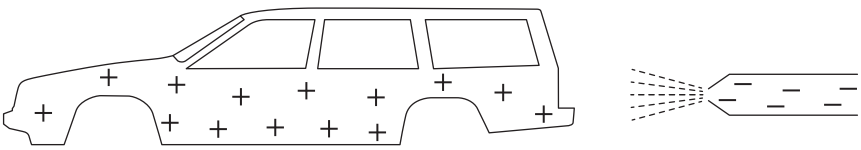


These objects ....



These objects ....

(b) Static electricity is used when paint spraying car bodies.
The car body is given a positive charge. The paint droplets are given a negative charge.



Suggest **two** advantages of making all the paint droplets negatively charged. [2]

1. ....

2. ....

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3. Some nuclei are unstable and decay by emitting alpha particles, beta particles, neutrons or gamma rays.

(a) **Complete** the following nuclear decay equations. [2]

(i) $^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} \ +$

(ii) $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} \ +$

(b) Complete the following paragraph about the contents of an atom of uranium ($^{238}_{92}\mathrm{U}$) in terms of the number of particles. [3]

There are .... electrons in each atom of uranium. Each nucleus contains .... protons and .... neutrons.

5

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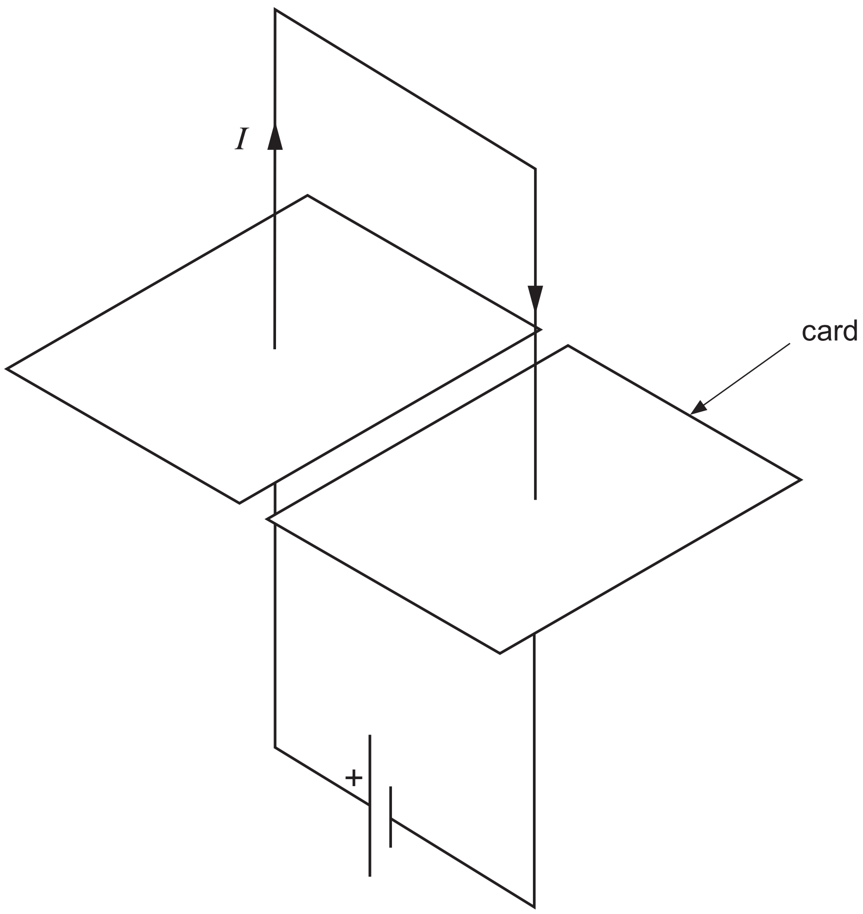
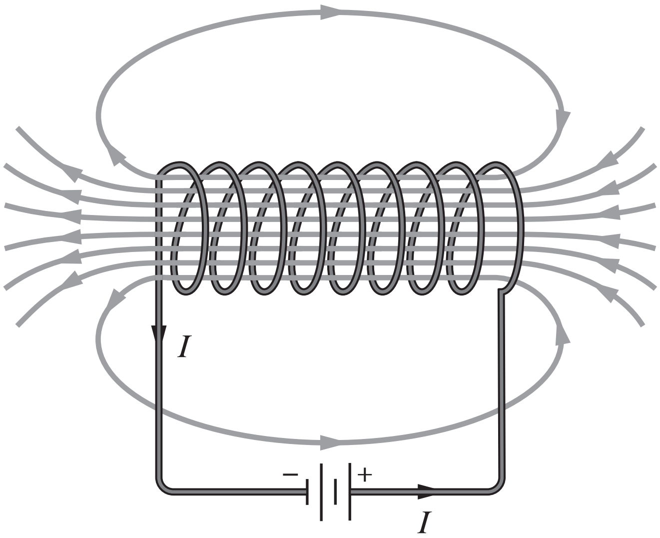
4. A class of students is investigating magnetic fields around wires of different shapes. A magnetic field is produced when there is an electric current in the wire. The shape and direction of the field depends on the shape of the wire and the direction of the current.

(a) The diagram shows the direction of the current, I in a rectangular frame of wire.



On each piece of card **draw** the magnetic field around each vertical side of the wire frame **including arrows** to show the direction of the field. [3]

(b) The diagram shows the magnetic field created by a current-carrying solenoid.



State how each of the following changes affects the magnetic field.

(i) One of the cells is removed from the circuit. [1]

....

(ii) The cells are reversed. [1]

....

(iii) More turns/coils are added to the solenoid. [1]

....

(iv) An iron bar is placed inside the solenoid. [1]

....

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5. Sir Isaac Newton was an English mathematician, astronomer and physicist. He is widely recognised as one of the most important scientists of all time.

(a) Tick (✓) the **three** boxes next to statements of Newton's Laws of Motion. [3]

If a body A exerts a force on body B then body B exerts an equal and opposite force on body A.

Vectors have both magnitude and direction but scalars only have magnitude.

An object will remain at rest or in uniform motion in a straight line unless acted upon by an external resultant force.

Resultant force = mass × acceleration

When an object is in equilibrium, the anticlockwise moments equal the clockwise moments.

Force is proportional to pressure and the area over which it acts.

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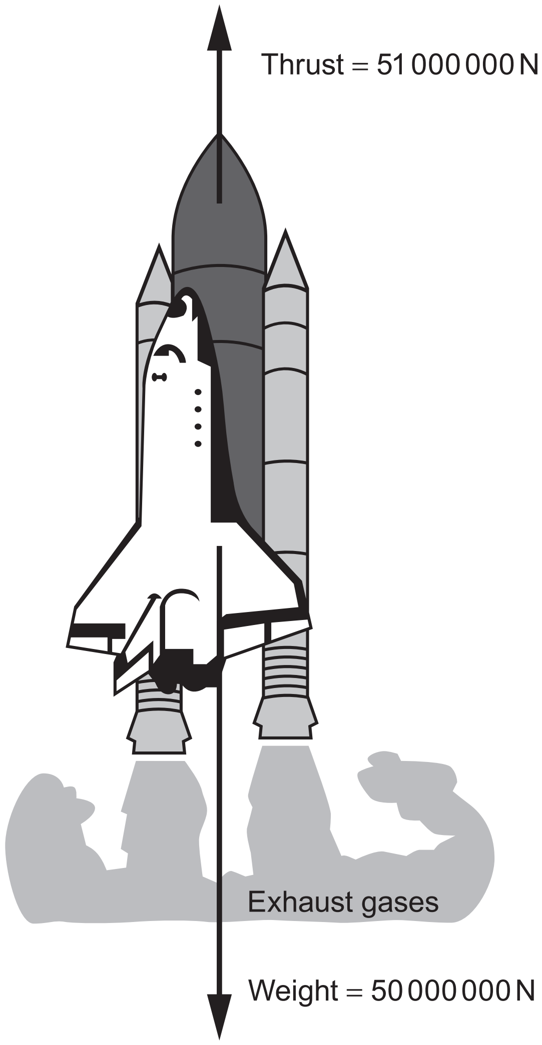
(b) The diagram shows the forces acting on a rocket at take-off. The force arrows are not drawn to scale.



(i) Explain, in terms of Newton's Third Law, why the rocket moves. [2]

....

....

....

(ii) Calculate the resultant force on the rocket. [1]

Resultant force = ... N

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(iii) The mass of the rocket is 5 000 000 kg.
Use the equation:

$$\text{acceleration} = \frac{\text{resultant force}}{\text{mass}}$$

to calculate the acceleration of the rocket. [2]

Acceleration = ... m/s^2

(iv) As the rocket uses fuel its mass and weight become smaller. Nazir suggests this will not affect the acceleration because the thrust remains constant. Explain whether or not you agree with this suggestion. [2]

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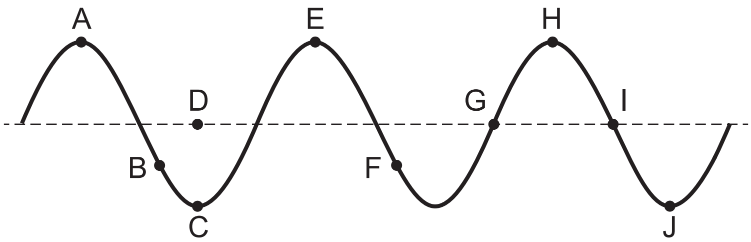
6. A group of students is investigating water waves.

(a) Look at the diagram of a wave and answer the questions below it.

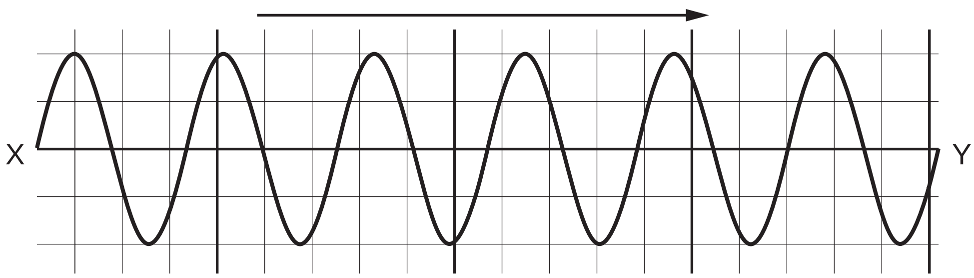


Circle the correct pair of labels in each sentence. [2]

(i) The amplitude of the wave is the distance between
(**AB / AC / BC / CD**).

(ii) The wavelength of the wave is the distance between
(**AE / AH / CJ / GI**).

(b) The diagram shows a wave travelling across the surface of water.



(i) Write down the number of waves (cycles) between X and Y. .... [1]

(ii) Calculate the wavelength of the wave if the distance XY is 270 cm. [1]

Wavelength = ... cm

(c) (i) State what is meant by the frequency of a wave. [1]

....

....

(ii) If it took 0·5 s for the wave at X to travel to Y, calculate the frequency of the wave. [2]

Frequency = ... Hz

Examiner only

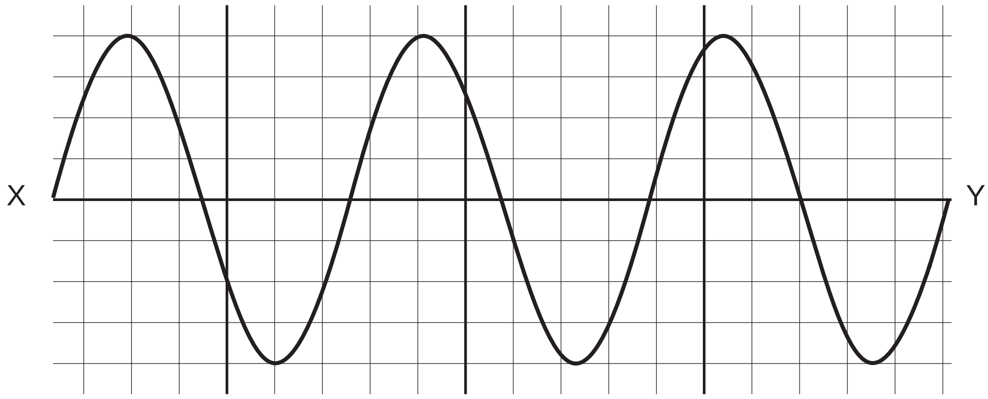
(d) Use the equation:

wave speed = frequency × wavelength

to calculate the wave speed of the wave shown. [2]

Wave speed = ... cm/s

(e) A different water wave is now observed. The distance between X and Y remains at 270 cm. The time for this wave to travel from X to Y remains at 0.5 s.



One student claims that the wave speed of this wave is faster than the first wave because the wavelength is longer. By referring to the equation in part *(d)*, explain whether or not you agree with this claim. [3]

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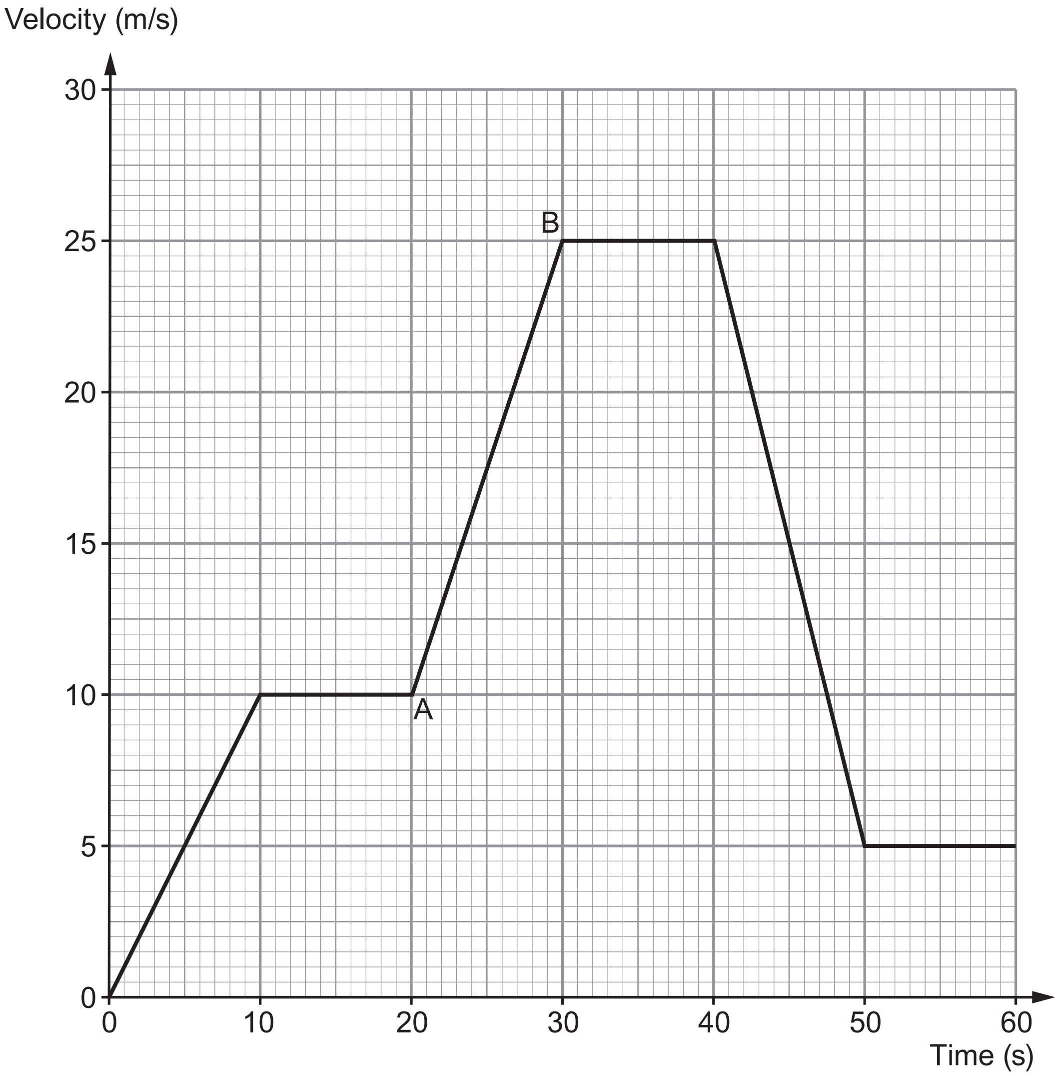
7. The graph shows part of the journey of a car.



Use the graph to answer the questions below.

(a) (i) State the maximum velocity of the car. .... m/s [1]

(ii) Jeremy says the total time the car moves at a constant velocity is 10 s. State **whether** you agree or disagree with Jeremy. Give **one** reason for your answer. [1]

....

....

(b) (i) State the time for the car to accelerate from A to B. .... s [1]

(ii) State the change in velocity of the car between A and B.

.... m/s [1]

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(iii) Calculate the acceleration of the car between A and B. [2]

Acceleration = ... m/s^2

(iv) Explain how the acceleration of the car between 0 s and 10 s compares with your answer to part *(b)*(iii). [2]

....

....

....

(c) (i) Use an equation to calculate the distance travelled by the car between 50 s and 60 s. [3]

Distance = ... m

(ii) Explain how the distance travelled by the car between 30 s and 40 s compares with your answer to part *(c)*(i). [2]

....

....

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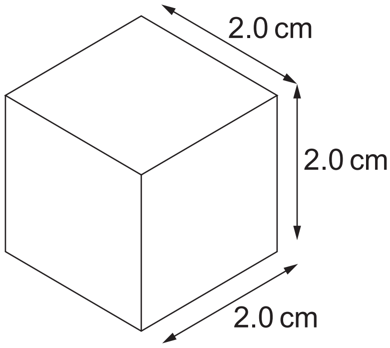
8. Students are investigating the density and change of state of ice.

(a) An ice cube tray is filled with water. When placed in a freezer it produces ice cubes such as the one shown below.



Each side of the cube is 2.0 cm long.

The ice cube has a mass of 7.2 g.

(i) Calculate the volume of the ice cube. [1]

Volume = ... cm^3

(ii) Calculate the density of ice. [2]

Density of ice = ... g/cm^3

(iii) When ice melts it produces water of density $1.0\,g/cm^3$.
Compare the mass and volume of one ice cube with the mass and volume of the water produced when it melts. [2]

....

....

(b) The graph shows how the temperature changes as ice from the freezer melts.

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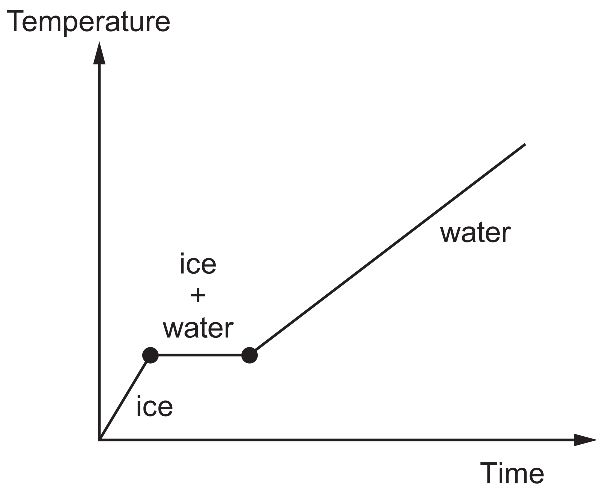

(i) The change of state from ice → water is an example of a physical change. Explain how this is different from a chemical change. [2]

....

....

(ii) Complete the table to state what happens to the molecules in each stage of the graph. [3]

Stage	Effect on molecules
Temperature of ice increases	....
Ice melts into water	....
Temperature of water increases	....

(iii) An ice cube of mass 7.2 g is at its melting point. Use an equation from page 2 to calculate the thermal energy required to melt the ice cube.
(Specific latent heat of ice, L = 334 J/g). [3]

Energy = ... J

(c) Explain, **in terms of molecules**, how the density changes when water is changed into steam. [2]

....

....

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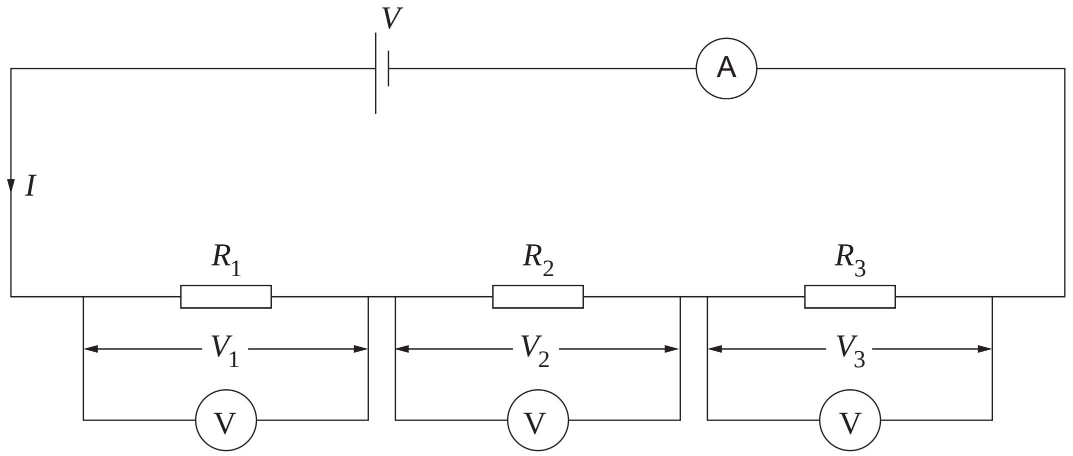
Examiner only

9. Ranvir and Greg have completed practical work involving setting up circuits. They first set up the series circuit shown below.



(a) (i) Complete the following equation to show the relationship between all the potential differences shown in the diagram. [1]

$V =$ ....

(ii) The current in R_1 is 0.2 A. State the current in R_3. [1]

Current = ... A

(iii) A 12 V battery is used. Use the equation:

potential difference = current × resistance

to calculate the total resistance of the circuit. [2]

Resistance = ... Ω

(iv) The values of two of the resistors are known. $R_1 = 20\ \Omega$ and $R_3 = 15\ \Omega$. Calculate the value of resistor R_2. [2]

$R_2 =$ ....Ω

(b) The circuit is now set up without R_3. A student states that this will **have an effect** on V_1 and V_2. Explain whether or not you agree with this statement. [2]

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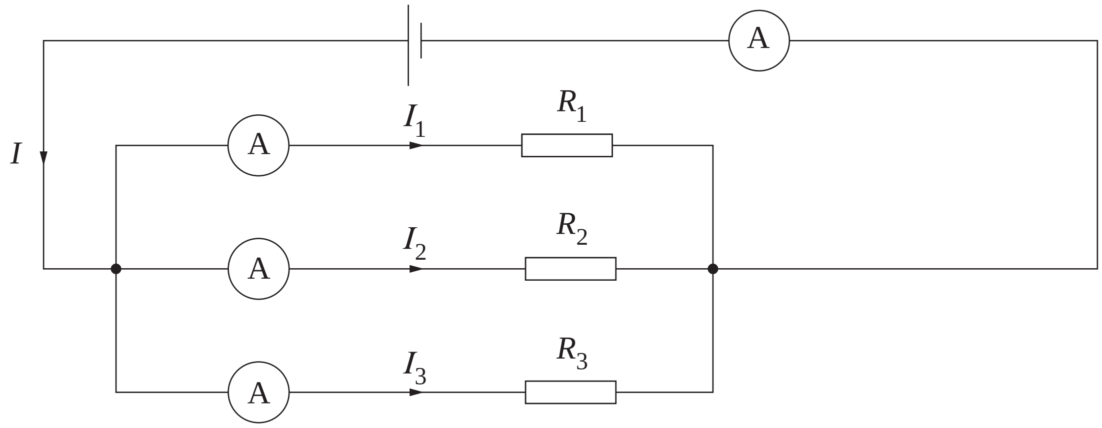
(c) Ranvir and Greg now connect the three resistors in parallel.



(i) Complete the equation to show the relationship between all the currents. [1]

$I =$ ....

(ii) Choose words from the box to complete the following sentences about the parallel circuit. Each statement may be used once, more than once, or not at all. [2]

stays the same	increases	decreases

When resistors are connected in parallel the total resistance ....

....

When a voltmeter is connected across R_1 and then R_3 its reading ....

....

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10. On a particular day in the summer of 2015, the power of the wind striking a wind turbine near Bristol was 1 500 W. The power wasted in the turbine was 600 W.

(a) Calculate the efficiency of the turbine from these figures. [3]

Efficiency = ...

(b) A coal power station releases 120 grams of CO_2 into the atmosphere for every million joules of electricity produced but wind turbines release none whilst they are working.

(i) One person claims that generating 1 000 W for 9 000 s (2.5 hours) using a wind turbine saves over 1 kg of CO_2 emissions into the atmosphere compared with using coal.

Use the equation:

$$\text{energy transferred} = \text{power} \times \text{time}$$

to investigate this claim. [2]

....

....

(ii) Give a reason why it is important to attempt to reduce the amount of CO_2 produced when generating electricity. [1]

....

....

Examiner only

(c) There is a debate about whether our future demands for electricity will be met from renewable sources alone or whether nuclear power will also be needed.
The table below compares a wind turbine with a nuclear power station.

	How they compare	
	wind turbine	a nuclear power station
expected lifetime (years)	20	60
mean power output (MW)	2	2000
land area needed (km^2)	0.7	4.5
cost to commission (£)	3 million	4000 million
waste produced	none	radioactive waste
lifetime carbon footprint per kWh generated (units)	4.6	5

Explain what conclusions you can make about how wind turbines compare with nuclear power stations in terms of economic, environmental and sustainability issues. [6 QER]

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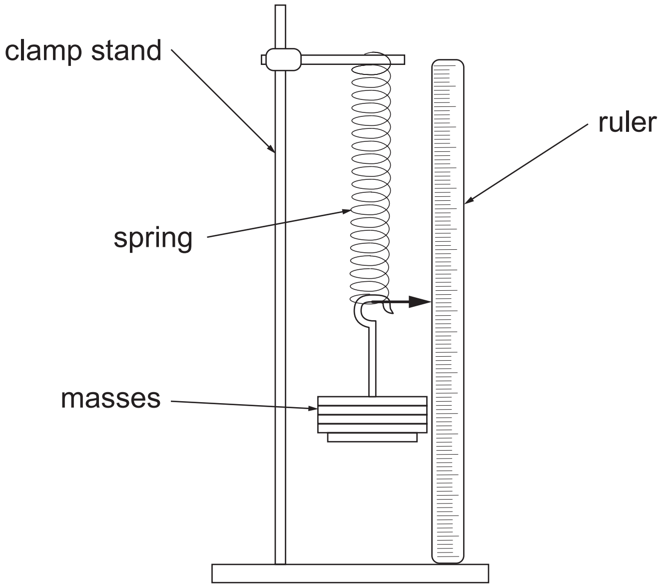
11. A group of students hangs masses from the end of the spring and uses a pointer to take readings of the position of the bottom of the spring against a metre ruler.



The results of their experiment are shown below.

Mass loaded on spring (g)	Force applied to spring (N)	Reading on ruler (cm)	Extension (cm)
20	0.2	5.7	0.8
40	0.4	6.5	1.6
60	0.6	....	2.5
80	0.8	8.0	3.1
120	....	9.7	4.8
140	1.4	10.5	5.6

(a) **Complete the table** above. [2]

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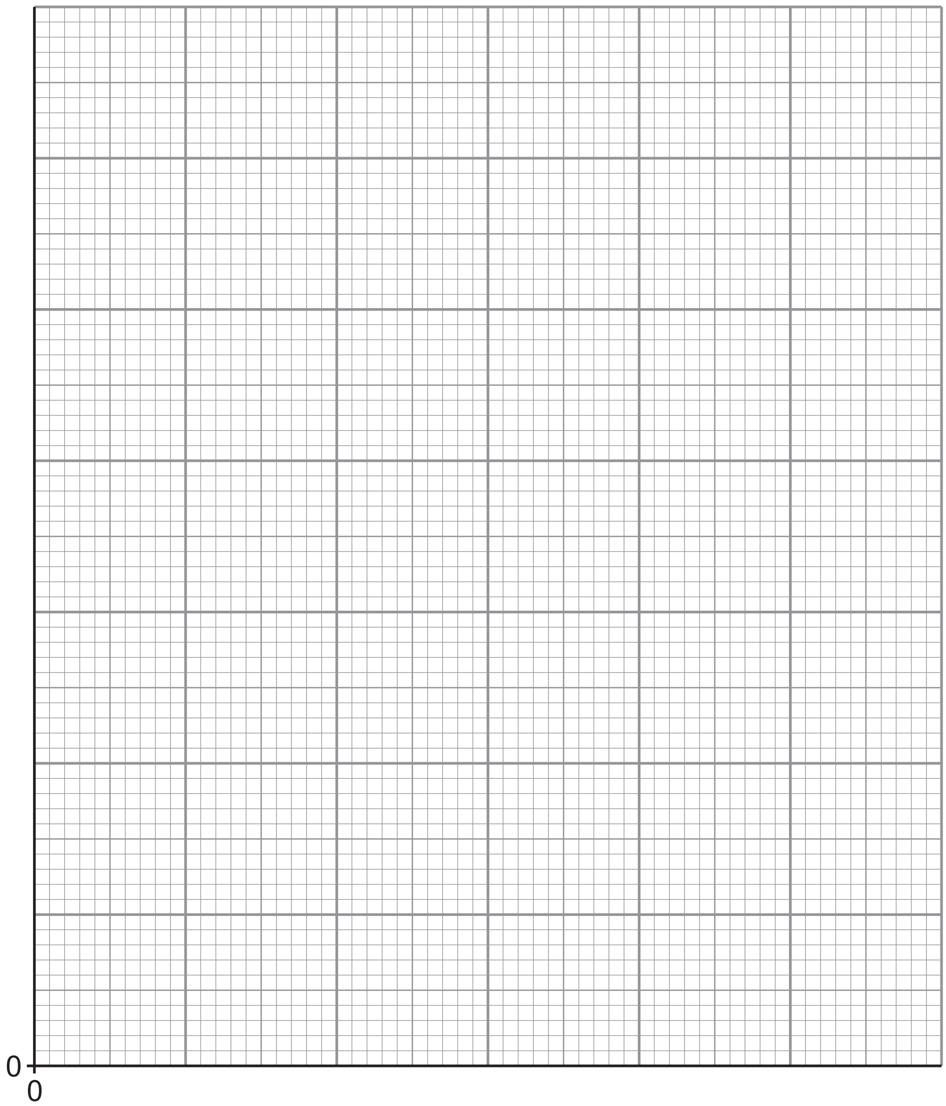
(b) (i) Use the data in the table to plot a graph and draw a suitable line. [4]

Force applied to spring (N)



Extension (cm)

(ii) State the **force** that produces an extension of 4.4 cm. [1]

Force = ... N

(iii) Calculate the spring constant, k, of the spring. Give your answer in **N/m**. [3]

Spring constant, k = ... N/m

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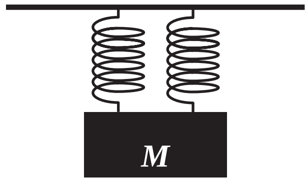
(iv) Two springs, identical to the one above, are now hung side-by-side as shown below.



Draw a line on the grid on the previous page to show how the extension changes with force for this parallel arrangement of springs. [2]

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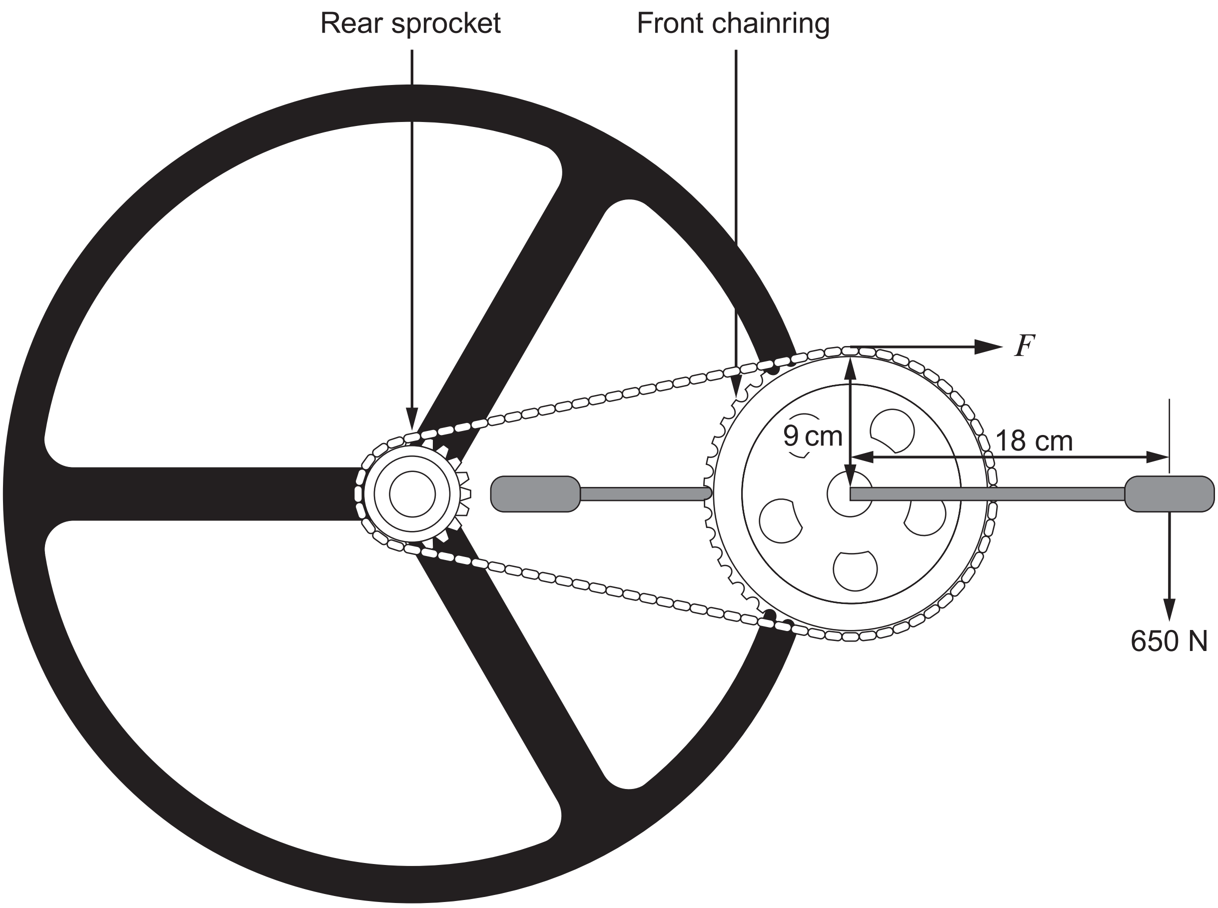
12. Riding a bike is a matter of balance and strength. Gears on bikes help the rider when the gradient of the road changes.

The diagram below shows the pedal arm of length 18 cm at a position level with the ground. At this instant a force of 650 N is applied vertically downwards.



(a) (i) Calculate the moment of the 650 N force on the pedal in **N m**. [3]

Moment = ... N m

(ii) This moment applies a force, F, to the chain which is at **half** the distance of the pedal from the axle (9 cm). **Circle** the box that gives the correct value of the force, F. [1]

58.5 N	117 N	234 N	325 N	1 300 N

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(b) The following table gives the gear ratio of the number of teeth on the front chainring to the number of teeth on the sprocket on the rear wheel on a 21 gear bike. For example, 12t represents 12 teeth.

Number of teeth on the front chainring	Number of teeth on rear sprocket wheels						
	12t	13t	15t	17t	20t	24t	28t
	Gear ratios in each gear						
	1st gear	2nd gear	3rd gear	4th gear	5th gear	6th gear	7th gear
28t (1st gear)	2.33:1	2.15:1	1.87:1	1.65:1	1.40:1	1.17:1	1.00:1
38t (2nd gear)	3.17:1	2.92:1	2.53:1	2.24:1	1.90:1	1.58:1	1.36:1
48t (3rd gear)	4.00:1	3.69:1	3.20:1	2.82:1	2.40:1	2.00:1	1.71:1

(i) When the front chainring is in second gear, the gear ratios range from 1.36:1 to 3.17:1. Suggest a reason why it is not essential to have the second gear on the front chainring of a bike. [1]

....

....

....

(ii) The pedals of the bike rotate once every 0.8 s.

I. Calculate the frequency of rotation of the front chainring. [2]

Frequency = ... Hz

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II. The cyclist is riding on a level road, using the 2nd gear on the front chainring and 6th gear on the rear sprocket. Use the information in the table and your answer to *(b)*(ii)I to calculate the number of rotations of the rear wheel each second. [3]

Number of rotations per second = ...

III. The rear wheel has a circumference of 236 cm.
Use your answer to *(b)*(ii)II to calculate the speed of the bike in m/s. [2]

Speed = ... m/s

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END OF PAPER