Surname	Centre Number	Candidate Number
Other Names		0

GCSE – NEW

C420UA0-1

S18-C420UA0-1

PHYSICS – Component 1
Concepts in Physics

HIGHER TIER

WEDNESDAY, 23 MAY 2018 – AFTERNOON

2 hours 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**18**	
3.	**12**	
4.	**8**	
5.	**13**	
6.	**14**	
7.	**11**	
8.	**6**	
9.	**12**	
10.	**12**	
11.	**8**	
Total	**120**	

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01

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 **8**.

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	$v^2 = u^2 + 2ax$
distance = initial velocity × time + ½ × acceleration × time^2	$x = ut + \frac{1}{2}at^2$
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	$E = \frac{1}{2}kx^2$
force on a conductor (at right angles to a magnetic field) carrying a current = magnetic field strength × current × length	$F = BIl$
potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	$V_1I_1 = V_2I_2$
$\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
for gases: pressure × volume = constant (for a given mass of gas at a constant temperature)	pV = constant
pressure due to a column of liquid = height of column × density of liquid × gravitational field strength	$p = h\rho g$

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Answer **all** *questions.*

1. 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:

energy transferred = power × time

to investigate this claim. [2]

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

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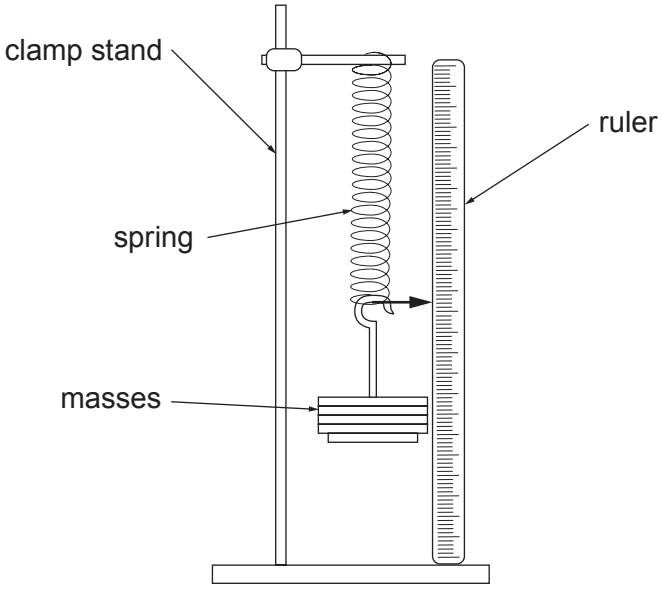
2. A group of students hangs masses from the end of the spring and uses a pointer to take readings of the position of the bottom of the spring against a metre ruler.



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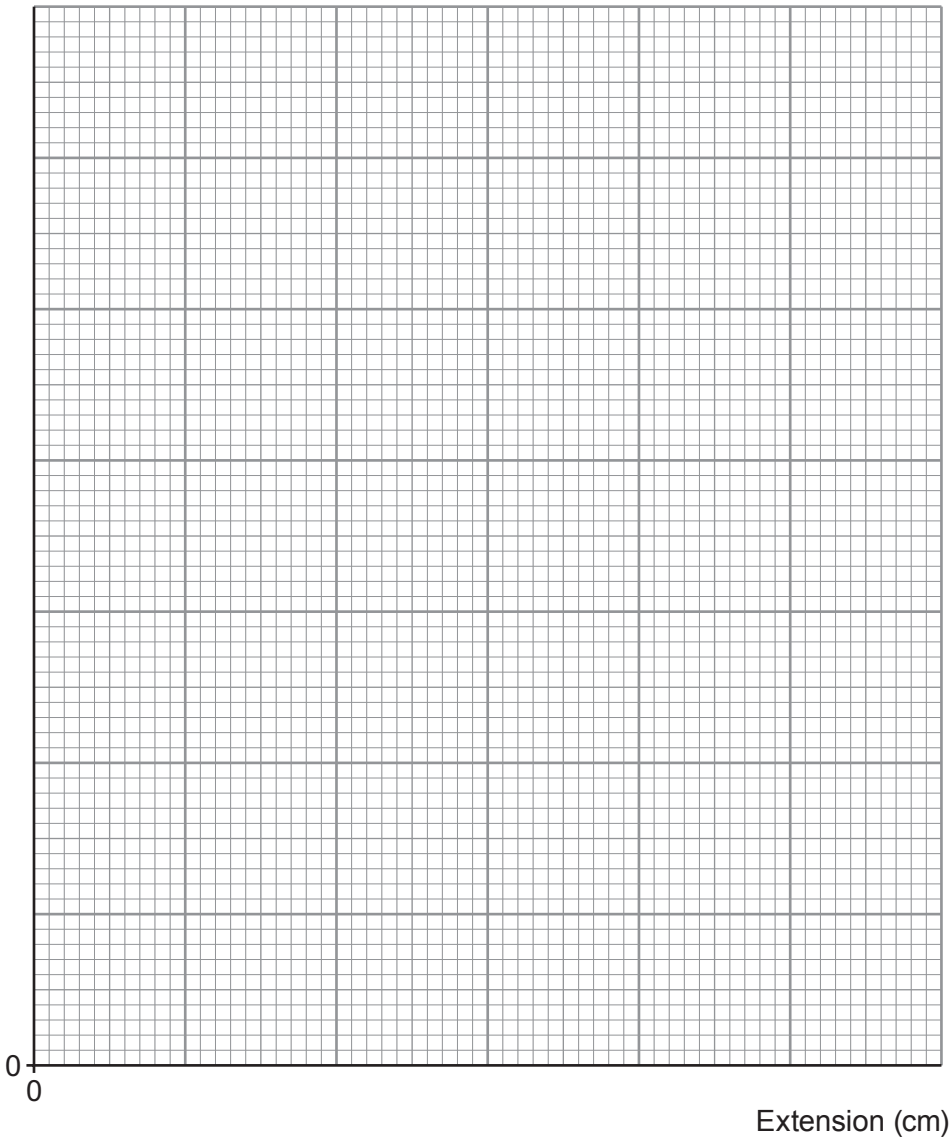
(b) (i) Use the data in the table to plot a graph and draw a suitable line. [4]

Force applied to spring (N)



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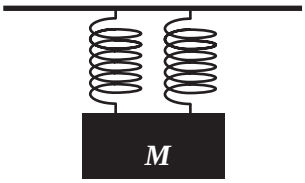
(iv) Two springs, identical to the one above, are now hung side-by-side as shown below.



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]

(c) (i) The **original single spring** is now stretched by 1.6 cm. Use an equation from page 2 to calculate the energy stored. [2]

Energy stored = ... J

(ii) The spring is held with a 1.6 cm extension when it is laid down on a frictionless surface and fixed at one end. A mass of 20 g is attached to its other end and the spring is released. Use the equation:

kinetic energy = 0.5 × mass × (velocity)^2 or $E_k = \frac{1}{2}mv^2$

to calculate the maximum velocity of the mass when the spring is released. [2]

Velocity = ... m/s

(iii) Explain how the maximum velocity of the mass would be affected if the spring is stretched twice as far before being released. [2]

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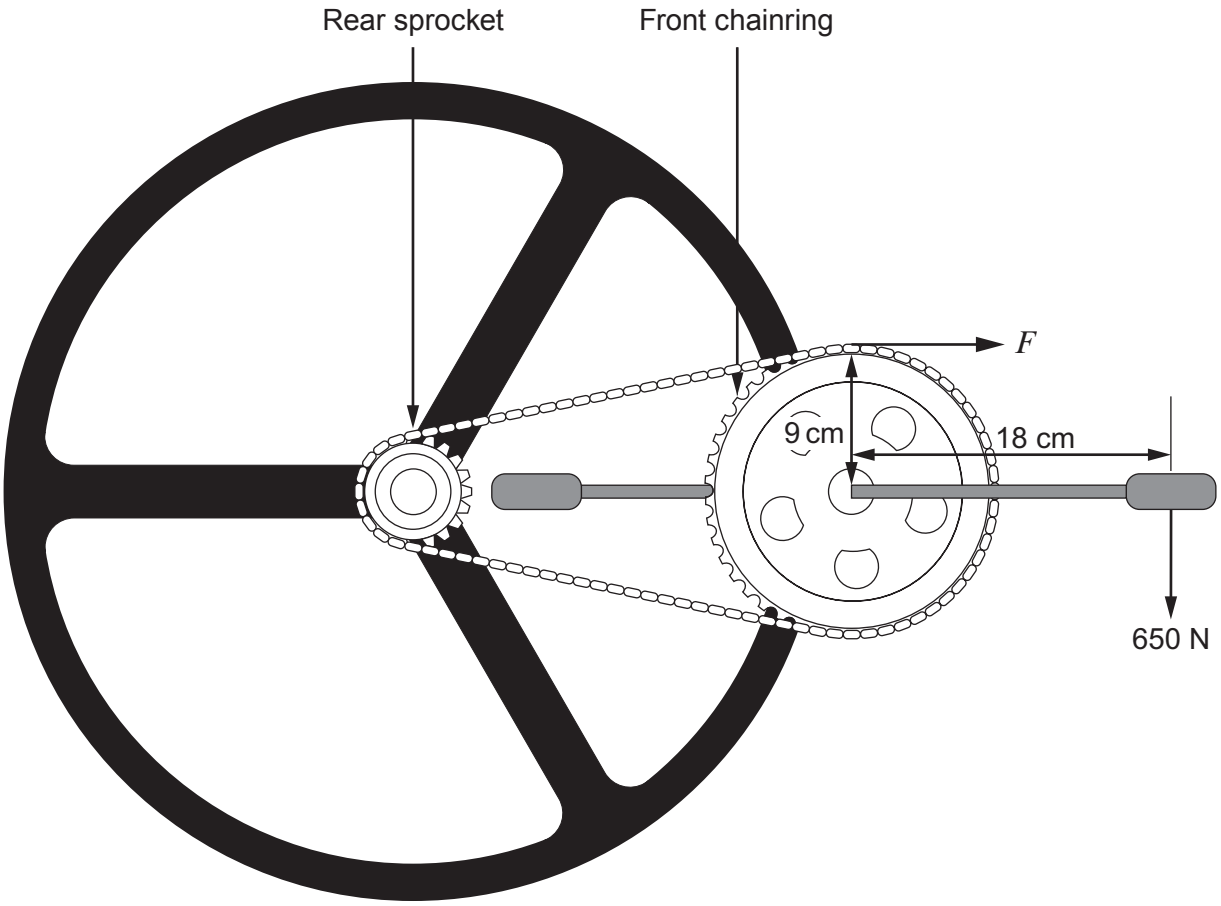
3. Riding a bike is a matter of balance and strength. Gears on bikes help the rider when the gradient of the road changes.

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]

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(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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4. Scientists in the U.K. have drawn up plans to build the world's first nuclear fusion power station by the year 2030.

(a) Describe and explain the conditions that are necessary for nuclear fusion to occur. [4]

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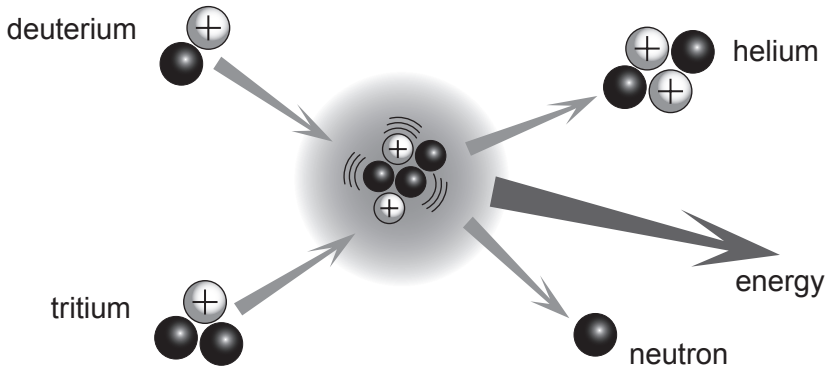
(b) The most promising fusion reaction is between two isotopes of hydrogen. These are deuterium and tritium. The reaction between the nuclei is shown in the diagram.



(i) Complete the balanced **nuclear equation** for this reaction. [2]

$$\text{.....}^{\text{.....}}\text{H} + \text{.....}^{\text{.....}}\text{H} \longrightarrow \quad + \quad$$

(ii) A student makes the statement that the helium shown in the diagram is no different from **an atom** of $^{3}_{2}\text{He}$.
Explain in terms of particles whether or not his statement is true. [2]

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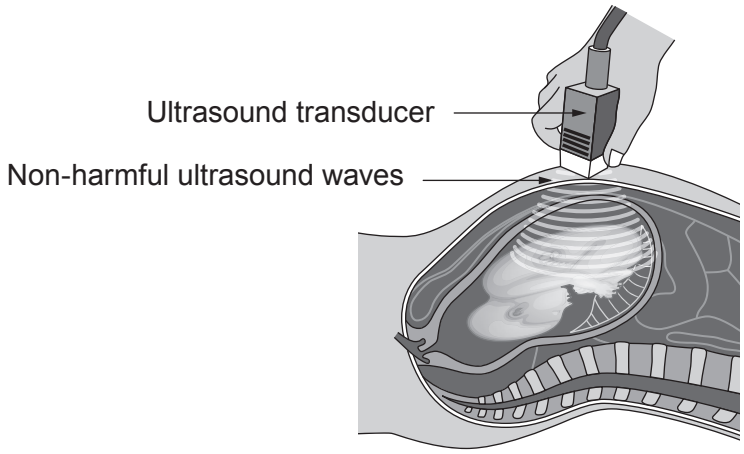
5. Ultrasound frequencies in the range 1 MHz to 20 MHz are generally used in scanning a foetus. An ultrasound scan of a foetus depends on echoes of the ultrasound waves which produce an image on a nearby screen.



(a) Explain what is meant by the phrase "a frequency of 20 MHz". [2]

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(b) State **two** things that happen to the ultrasound waves during a scan that allow an image to be formed. [2]

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(c) Explain why **low frequency** ultrasound waves (in the range of 1 MHz to 20 MHz) are used for scanning a foetus. [2]

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Examiner only

(d) The mean speed of ultrasound waves travelling through the human body is 1 540 m/s at a frequency of 20 MHz.

(i) Calculate the time interval between a pulse of an ultrasound wave being transmitted from the probe and it being received back at the probe again. The nearest part of the foetus is 4.0 cm below the skin. [3]

Time = ... s

(ii) Calculate the number of wavelengths that are contained in the distance between the probe and the nearest part of the foetus. [4]

Number of wavelengths = ...

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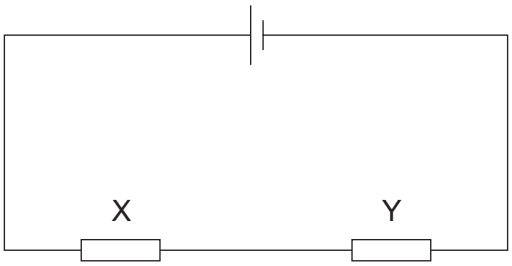
Turn over.

Examiner only

6. A group of students sets up series and parallel circuits. They use two resistors, X and Y. **The resistance of X is greater than the resistance of Y.**

(a) In the first case, they connect the two resistors X and Y in series with a cell.

Circuit A



(i) For circuit A, compare the potential differences across, and the currents in, X and Y. [2]

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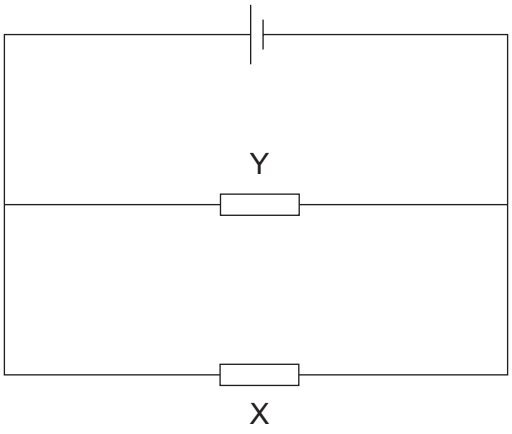
(ii) In the second case, they connect the two resistors in parallel with the cell.

Circuit B



For circuit B, compare the potential differences across, and the currents in, X and Y. [2]

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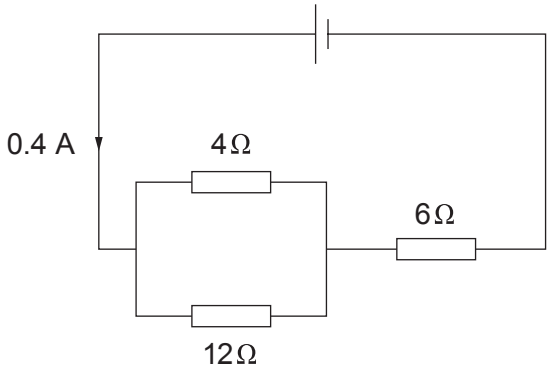
(b) (i) The following circuit shows three resistors connected together in a circuit with a cell.



I. Calculate the total resistance of the 4 Ω and 12 Ω resistors in parallel. [2]

Resistance = ... Ω

II. Calculate the current in each of the 4 Ω and the 12 Ω resistors. [3]

Current in 4 Ω = ... A

Current in 12 Ω = ... A

III. Calculate the potential difference across the cell. [3]

Potential difference across the cell = ... V

(ii) James predicts that if the three resistors in this circuit had been connected in series, the current in the circuit would have been less than 0.4 A. Explain whether his prediction is correct. [2]

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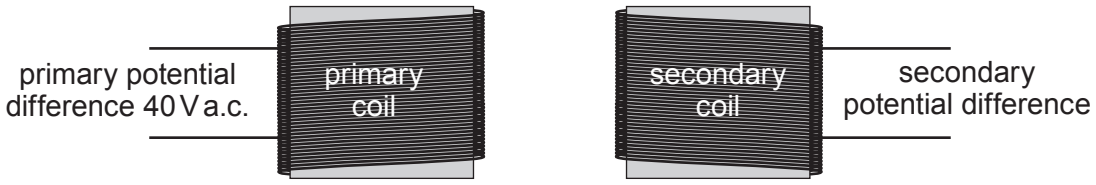
Examiner only

7. A group of students sets up a transformer in a physics lesson. They set up two coils of wire which they call the primary coil and the secondary coil. The diagram shows the coils of their transformer which is incomplete.



(a) **Draw** and **label** the missing part and state its function. [3]

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(b) The students keep a fixed number of turns in the **secondary coil**. The number of turns in its **primary coil** are changed, which affects the **potential difference across the secondary coil** in the way shown on the graph below.

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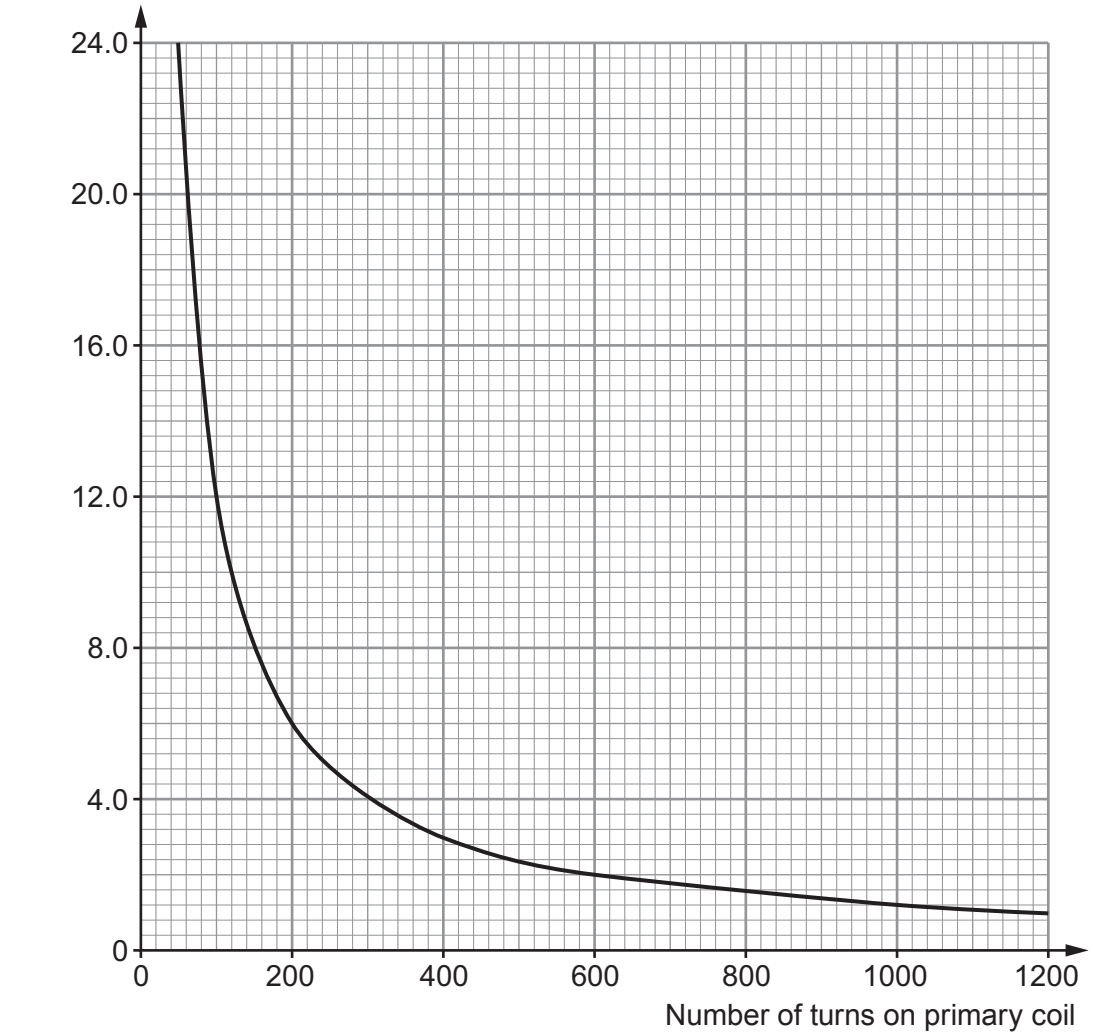

(i) Describe how the potential difference across the secondary coil changes as the number of turns on the primary coil is increased. [2]

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(ii) The potential difference across the primary coil is kept at 40 V a.c. throughout. Use an equation from page 2 and information from the graph to calculate the number of turns used in the **secondary coil**. [3]

Number of turns = ...

Examiner only

(c) The students then connect a different transformer to the same power supply and use it to power a 3.6 W lamp connected to the secondary coil. Use an equation from page 2 to calculate the current in its primary coil. State any assumption that you make in arriving at your answer. [3]

Current = ... A

Assumption*:* .....

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Examiner only

8. Describe and explain the changes that take place in atoms when visible light and gamma rays are absorbed and emitted. [6 QER]

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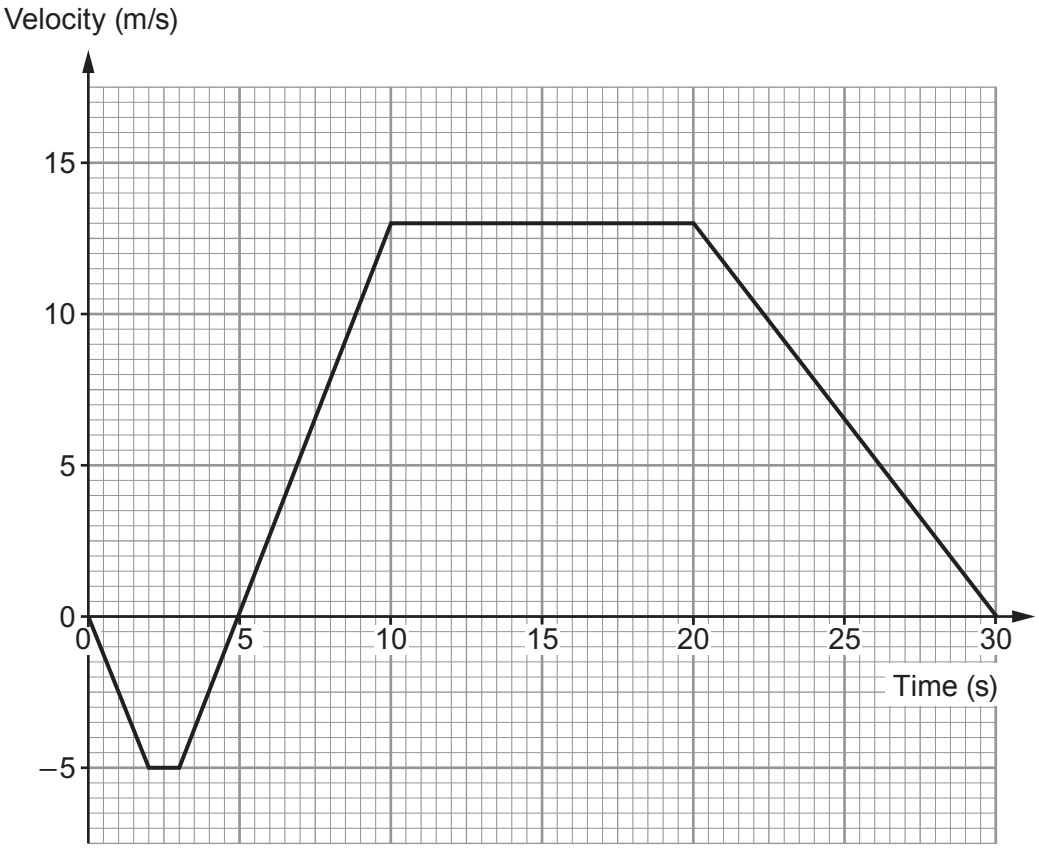
Examiner only

9. Part of the motion of a bus on its journey in the morning is shown by the following velocity-time graph. The bus just stays within the speed limit.



(a) State the length of time that the bus was moving in reverse. ..... s [1]

(b) (i) Calculate the change in velocity between 3 s and 10 s. [2]
Clearly show your workings.

Change in velocity = ... m/s

(ii) During the period shown, the bus travels backwards a distance of 15.0 m and then travels forwards 227.5 m. By calculating the distance travelled by the bus and its displacement, explain why they are different. [3]

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Examiner only

(c) Calculate the deceleration of the bus between 20 and 30 s and the resultant force needed to bring a passenger of mass 90 kg to rest. [4]

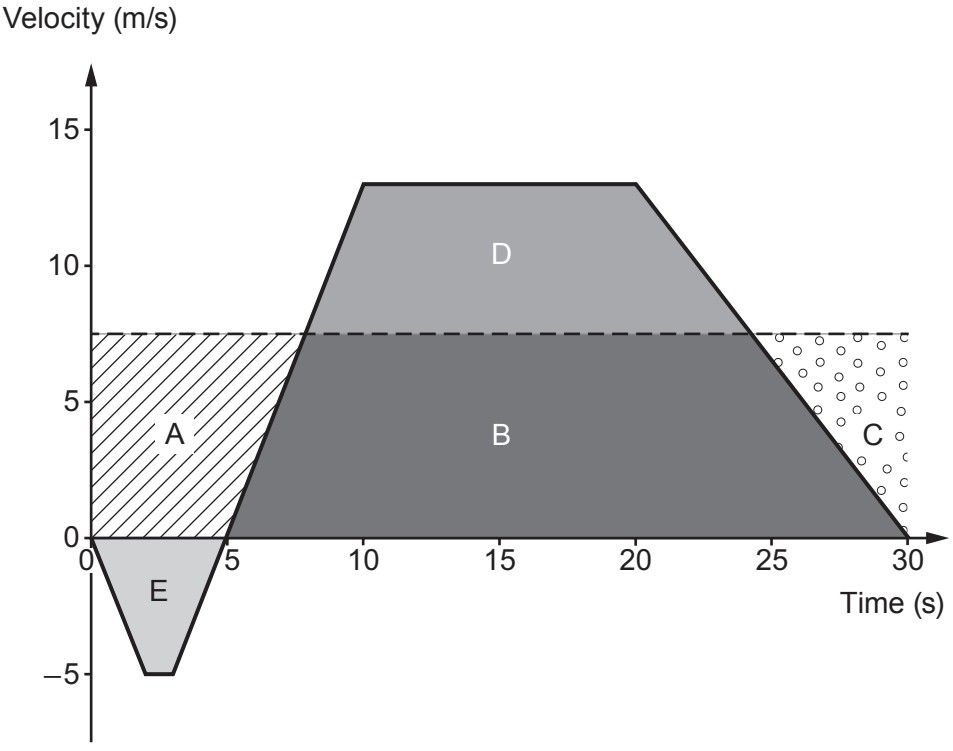
Deceleration = ... m/s^2

Resultant force = ... N

(d) The mean velocity of the bus is shown by the dotted line below.
Complete the **equations** below by inserting the mathematical symbols (+, –, ×, ÷) to show the relationship between the shaded areas of the graph. [2]

B D E = A B C

D E = A C



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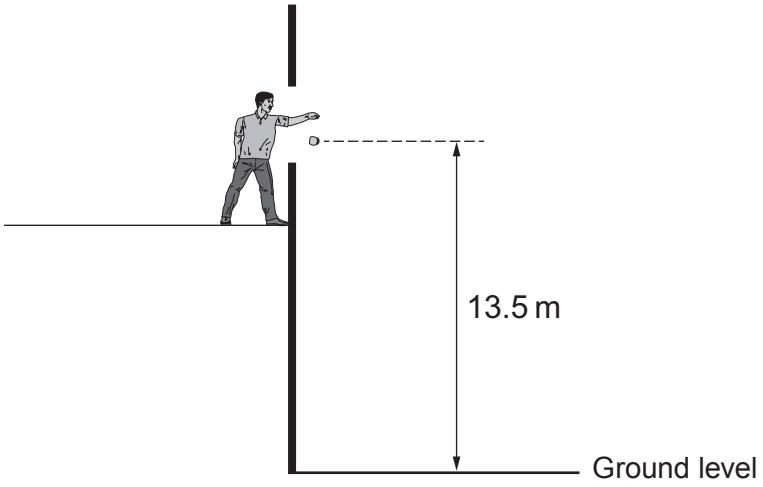
10. One of two students drops a lump of soft putty of mass 0.4 kg out of a high window at a measured height of 13.5 m to the hard ground below.



(a) The two students used a stopwatch to measure the time of fall and used it to calculate the drop height. Explain how the time could be measured more accurately and how it is **used to calculate the drop height**. [3]

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(b) The putty has potential energy before it is dropped and all of this energy is thought to be transferred into thermal energy on collision with the ground. The putty's temperature shows an increase from 18.0 °C to 19.5 °C in the experiment.
Use equations (one from page 2) to calculate its specific heat capacity. [5]
[Gravitational field strength, g = 10 N/kg]

Specific heat capacity = ... J/kg °C

Examiner only

(c) Suggest **two** reasons why your calculated value for specific heat capacity may not be close to its true value. For each reason explain why it leads to an overly high or a low value of the calculated answer. [4]

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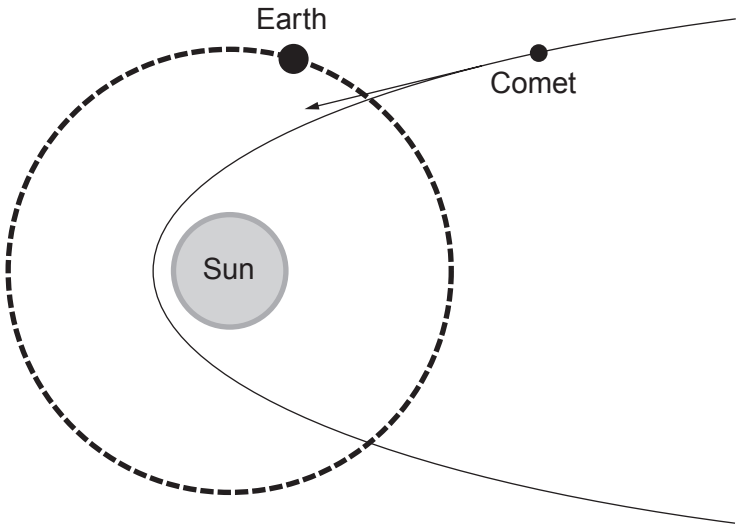
11. The diagram below (not drawn to scale) shows a comet and Earth orbiting the Sun. The Earth orbits the Sun once in a time of 1 year at a distance of 1 astronomical unit (AU) from the Sun. It moves at a speed of nearly 30 km/s in its orbit. The speed and velocity of a **comet** change as it approaches the Sun and then moves away from it.



(a) State Newton's first law of motion. [2]

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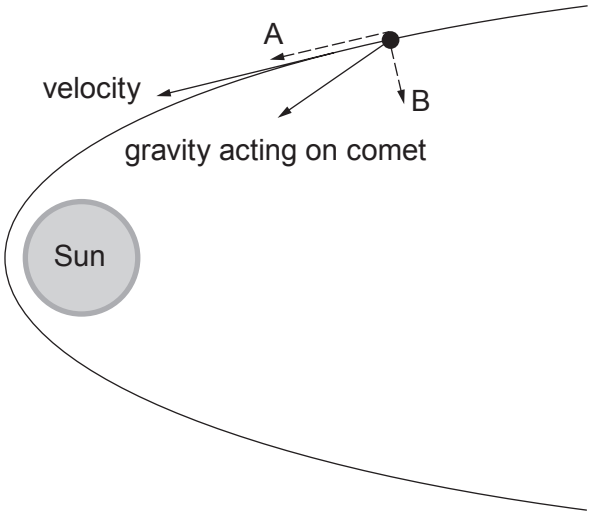
(b) The two components of the force of gravity between the comet and Sun are shown as dashed lines (A and B). Explain the effect of these components on the **velocity** of the comet. [2]



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(c) Explain why the force of gravity acting between the Earth and the Sun does no work on the Earth. [1]

Examiner only

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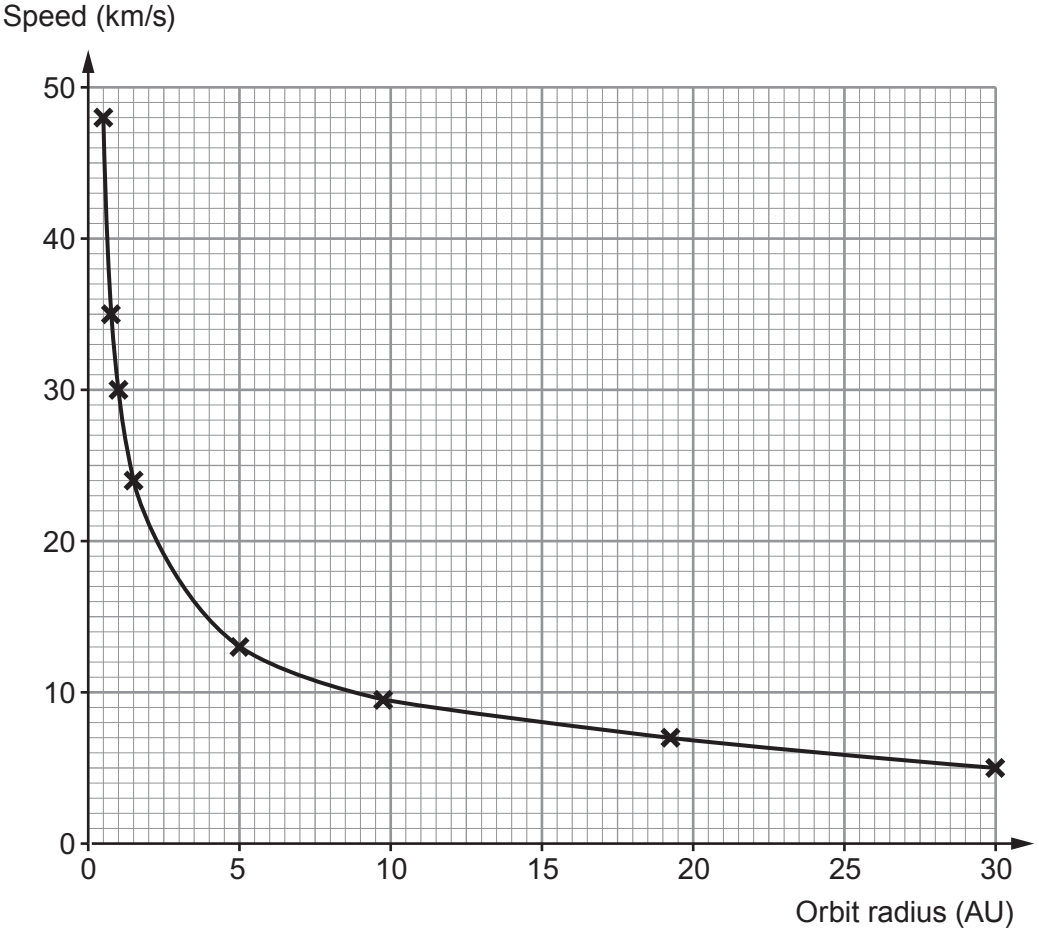
(d) The speed of each planet as it orbits the Sun remains constant but the speed of each planet is different from others, depending on the distance from the Sun. Eight major planets have been discovered in our solar system, Earth being the third planet from the Sun.
The graph below shows the way in which the speed of the planets in our solar system vary with their orbit radius around the Sun.



Use the graph to calculate the period of Jupiter's orbit in Earth years. [3]
[1 AU = 149.6 million km, 1 year = 3.16×10^7 s]

Orbit period = ... years

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