Surname	Centre Number	Candidate Number
Other Names		0

GCSE

C420UA0-1

S19-C420UA0-1

PHYSICS – Component 1
Concepts in Physics

HIGHER TIER

WEDNESDAY, 22 MAY 2019 – AFTERNOON

2 hours 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**4**	
2.	**12**	
3.	**14**	
4.	**12**	
5.	**13**	
6.	**16**	
7.	**9**	
8.	**8**	
9.	**16**	
10.	**16**	
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. If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

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 **5***(a)*.

EQUATION LIST

final velocity = initial velocity + acceleration × time	$v = u + at$
distance = $\frac{1}{2}$ × (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 + $\frac{1}{2}$ × 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 = $\frac{1}{2}$ × 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. The model of the atom has changed over time. One model was proposed by Bohr.

(a) Describe the structure of the atom according to Bohr. [3]

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(b) A typical diameter of an atom is 3.0×10^{-10} m. State a typical diameter of a nucleus. Give your answer in standard form. [1]

Typical diameter of a nucleus = ... m

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4

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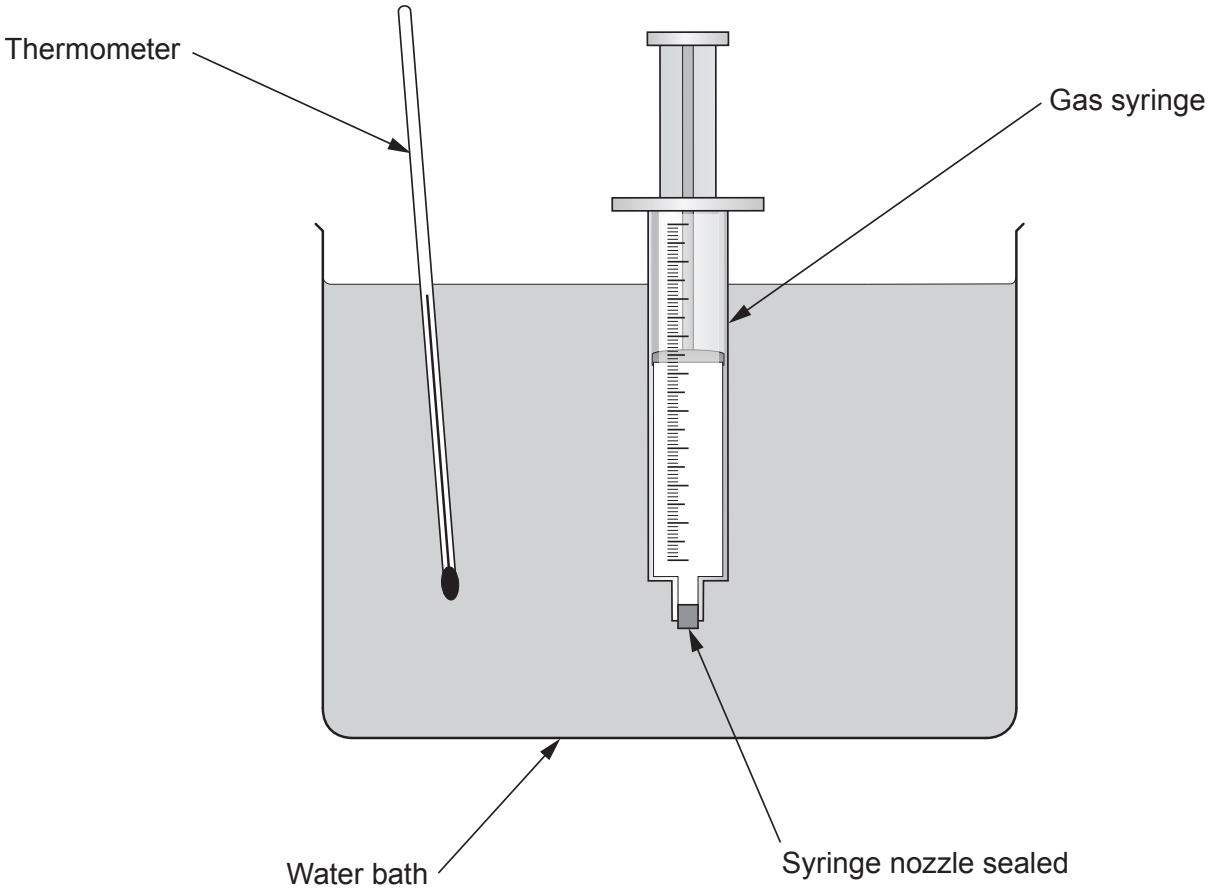
2. The volume a gas occupies varies according to the conditions. The apparatus shown in the diagram is used to investigate the variation of the volume of a gas with temperature.



(a) (i) Describe how a series of readings of volume and temperature can be obtained in this investigation. [3]

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(ii) Name the independent variable in this investigation. [1]

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(iii) Name **one** controlled variable. [1]

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Turn over.

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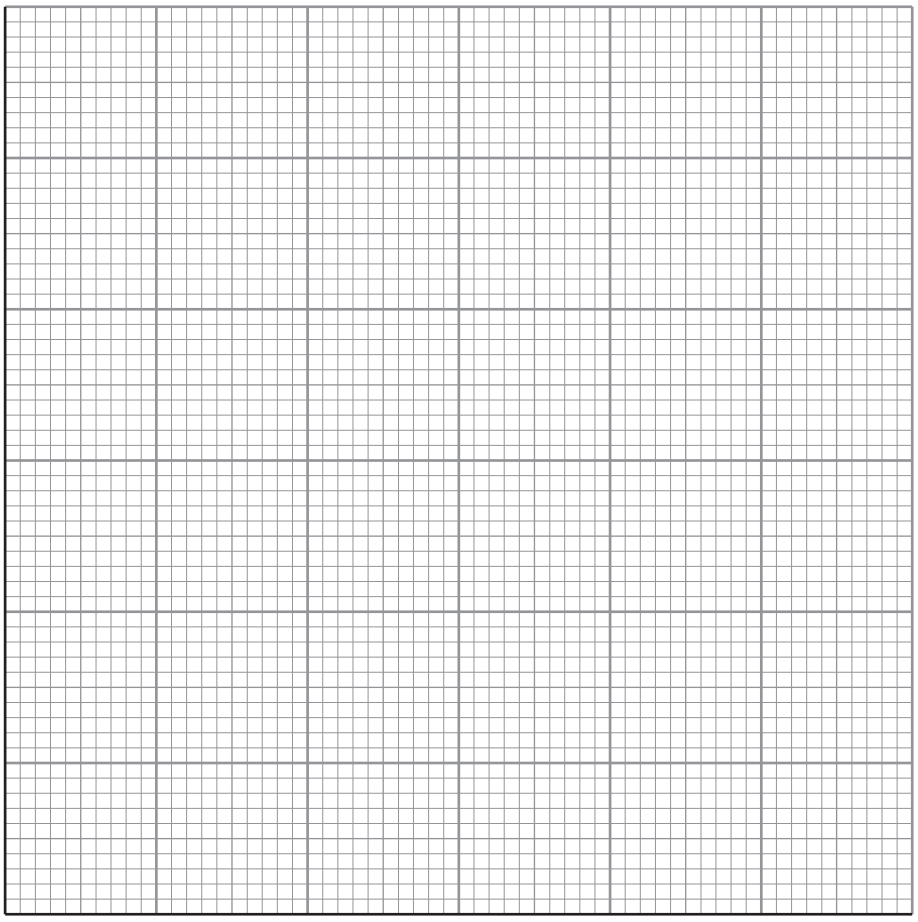
(b) The results from the investigation are shown in the table.

Temperature (°C)	Volume (cm^3)
20	54
25	55
30	56
40	58
45	59
50	60

(i) It is claimed that the volume of the gas in cm^3 is proportional to its temperature in °C. Use the data in the table and the grid below to explain whether you agree with this claim. [5]



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(ii) Explain in terms of molecules why the volume changes as the temperature increases. [2]

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3. A passenger jet aeroplane has a mass of 450 000 kg. To take-off, it accelerates 950 m along a runway from rest. Its take-off velocity is 80 m/s. It reaches a cruising height of 9.2 km.

(a) (i) Use the equation:

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

to calculate the gain in kinetic energy of the aeroplane as it accelerates from rest to its take-off velocity. [3]

Gain in KE = ... J

(ii) Use the equation:

work done = force × distance or $W = Fx$

to calculate the mean resultant force acting on the aeroplane as it accelerates along the runway. [3]

Mean resultant force = ... N

(iii) It is stated that the thrust produced by the engines must be greater than the mean resultant force. Explain whether you agree with this statement. [2]

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(b) (i) Calculate the gain in potential energy of the aeroplane as it rises off the runway to its cruising height. (g = 10 m/s^2). [3]

Gain in potential energy = ... J

(ii) The aeroplane takes 20 minutes to rise to its cruising height. Calculate the power developed by the lifting force. [3]

Power = ... W

C420UA01
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14

Turn over.

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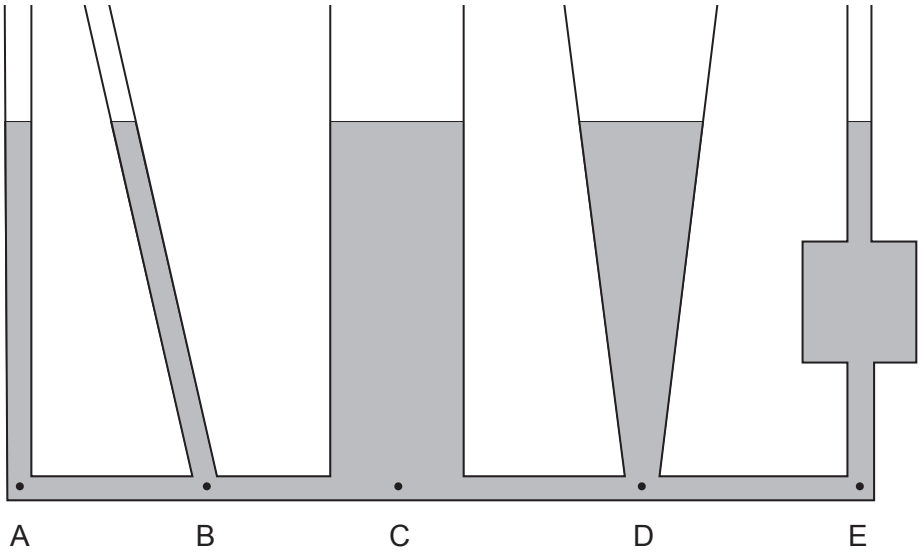
4. Liquids exert a pressure on any object that is in contact with them.

(a) The following container has differently shaped columns. When water is poured into one of the columns it settles at the levels shown.



It is suggested that the pressures at points A, B, C, D and E are different because each column contains a different weight of water.

Explain whether you agree with this suggestion. [3]

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(b) A river barge, whose cross-section is approximately rectangular, is designed to carry a load of grain. The barge is 8 m wide and 30 m long.

When unloaded, the bottom of the barge is 1.5 m below the surface of the water. When fully loaded with grain, this increases to 2.25 m.

(Density of water = 1 000 kg/m^3, g = 10 m/s^2)

(i) Use an equation from page 2 to calculate the water pressure on the bottom of the unloaded barge and state its unit. [3]

Pressure = ... unit .....

(ii) Calculate the weight of the unloaded barge. Show your working. [4]

Weight = ... N

(iii) It is claimed that the barge can carry half its weight in grain. Explain whether you agree with this claim. [2]

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C420UA01
11

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Turn over.

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5. Isotopes have many uses in industry, medicine and in the generation of electricity.

(a) The isotope uranium-235 (U-235) is used in the reactors of nuclear power stations. It has a half-life of 700 million years.

Explain how the design of a nuclear reactor includes safety measures **and** enables a controlled chain reaction to occur. [6 QER]

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(b) Radioactive isotopes can be used as tracers to investigate a patient's body without the need for surgery. A small amount of radioactive material is put into the patient's body. The radiographer puts a detector around the body to detect any radiation that passes out of the patient's body.

One isotope used in nuclear medicine, technetium-99m (Tc-99m), is so unstable it does not occur in nature. It is produced by the beta decay of molybdenum-99 (Mo-99).

The table gives some information about Tc-99m and Mo-99.

Isotope	Symbol	Number of neutrons inside an atom	Number of protons inside an atom	Half-life (hours)	Decay mode
Mo-99	$^{99}_{42}\mathrm{Mo}$	57	42	66	beta
Tc-99m	.....	.....	.....	6	gamma

(i) **Complete the table.** [3]

(ii) Explain why Tc-99m is a more suitable isotope for injecting into the human body than Mo-99. [4]

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6. There are many types of waves such as sound waves, electromagnetic waves and earthquake waves.

The electromagnetic (em) spectrum is a continuous range of wavelengths of several types of radiation that have different uses and dangers. All em waves are transverse waves. Earthquakes produce P (primary) and S (secondary) waves.

(a) (i) Sound waves are longitudinal waves and are not part of the em spectrum. They travel much more slowly than em waves.
State **one** other difference between sound and radio waves. [1]

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(ii) Describe the difference between transverse and longitudinal waves. [2]

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(iii) Radio waves are a type of em wave. Describe how radio waves are detected. [2]

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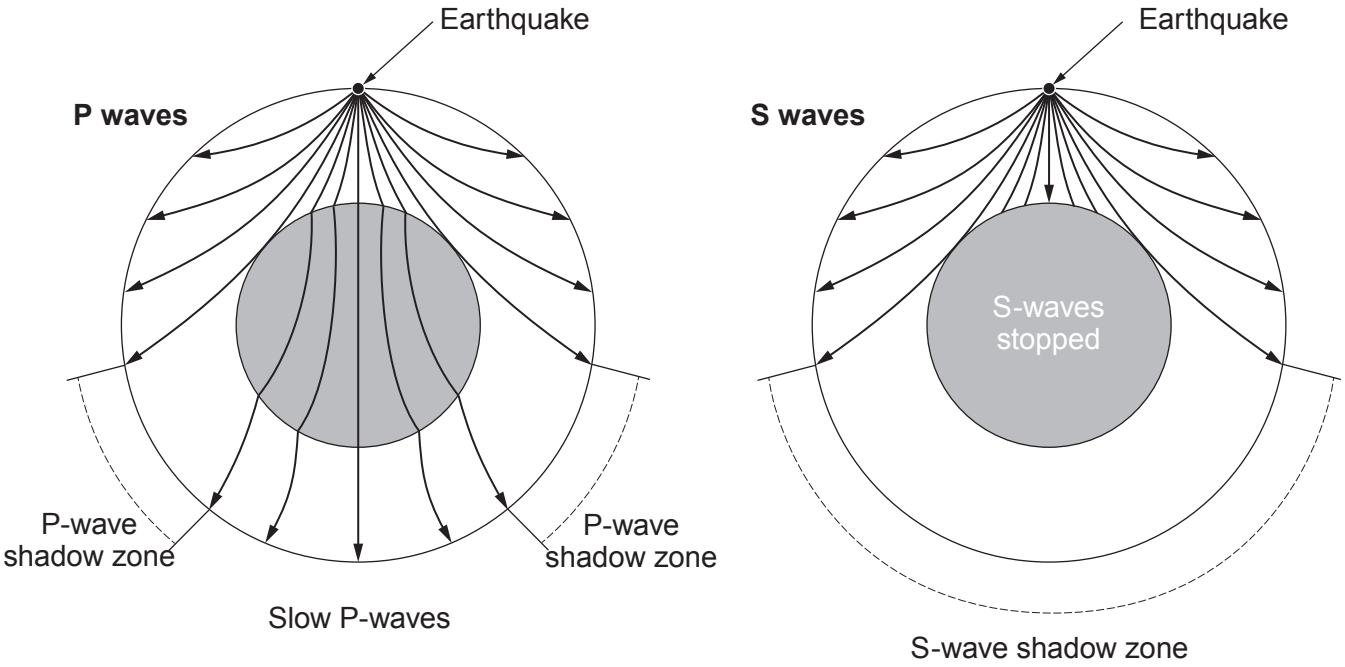
(b) The diagrams show the paths of P and S waves from an earthquake.



Explain what can be deduced about the structure of the Earth from the information in the diagrams. [3]

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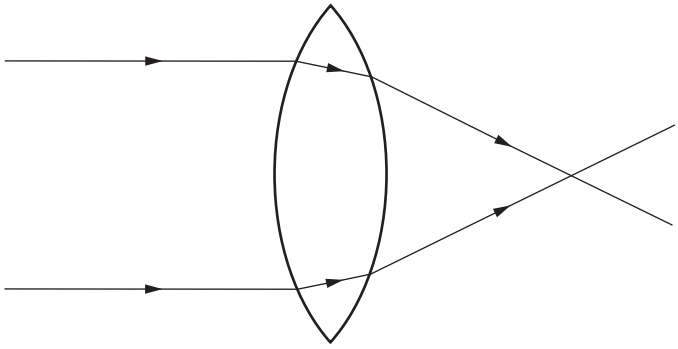
(c) Visible light is one type of electromagnetic wave. Students investigate the behaviour of light using lenses. They find that rays of light change direction as they travel through the lenses.

(i) The effect of a convex lens is shown in the diagram below.



Name and explain the effect that causes the light to change direction in the way shown in the diagram. [2]

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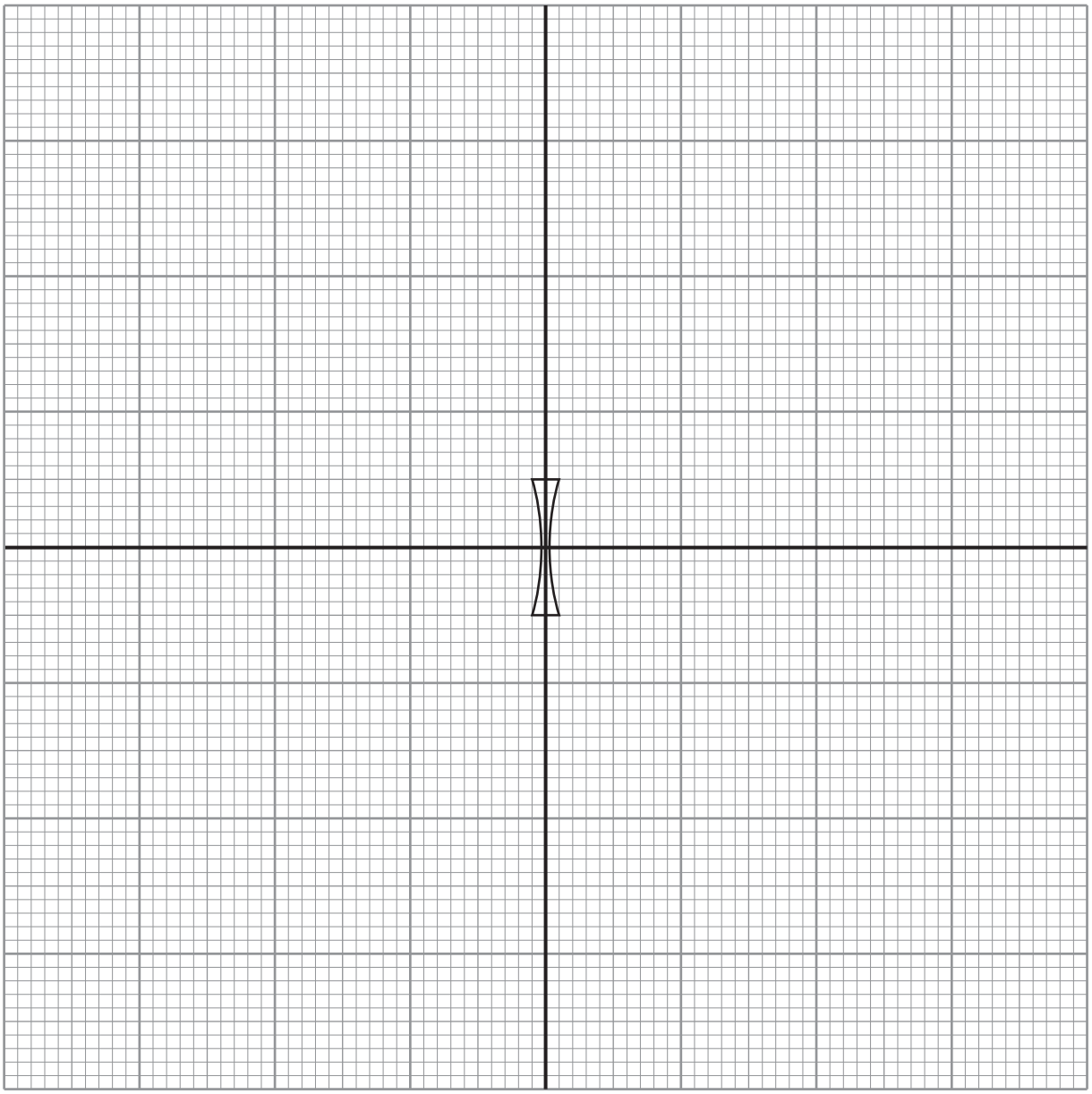
(ii) The students place an object 5 cm tall, 6 cm in front of a concave lens of focal length, f, 4 cm. Using the grid below, draw an accurate scale diagram to find the distance of the image from the lens, its size, its nature and its orientation. [6]



Distance = ... cm

Size = ... cm

Nature = ...

Orientation = ...

16

Turn over.

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7. Static electricity is the build up of an electrical charge on the surface of an object. Static electricity is often created when two objects that are not good electrical conductors are rubbed together.

(a) When a piece of polythene is rubbed with fur, electrons are transferred from the fur to the polythene.

Explain how this transfer of electrons affects the fur and the polythene. [2]

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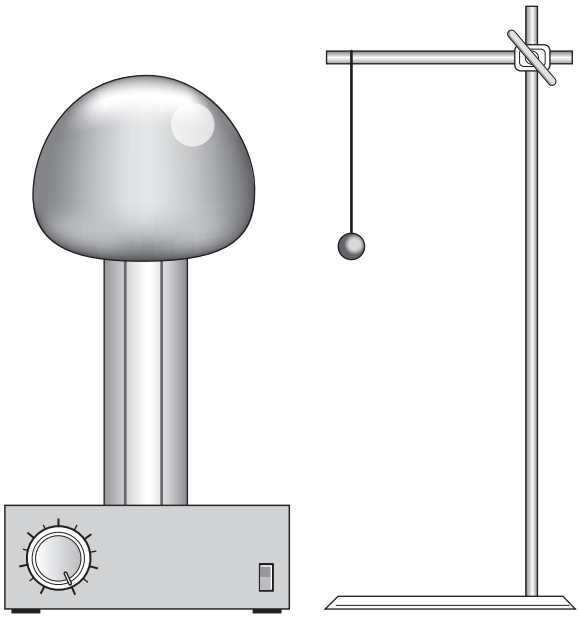
(b) (i) A polystyrene ball is suspended from string near a Van der Graaf generator.



During operation, a charge builds up on the dome. The polystyrene ball is initially pulled towards the dome, touches it, then moves away.

Explain these observations. [3]

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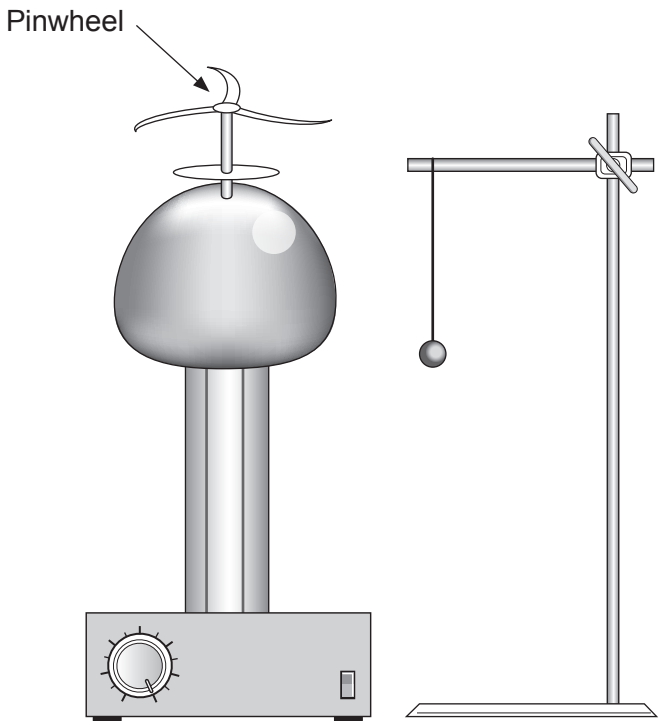
(ii) The demonstration is repeated with a pinwheel attached to the dome.



This time the polystyrene ball does not move **and** the pinwheel rotates.

Explain these observations. [4]

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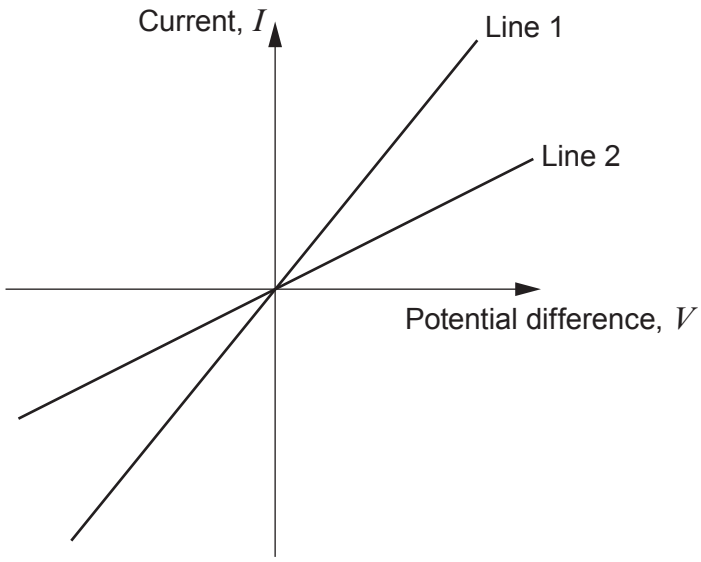
8. *(a)* (i) The I–V graphs below are for a light dependent resistor (LDR).



Explain which line represents the LDR in the dark. [2]

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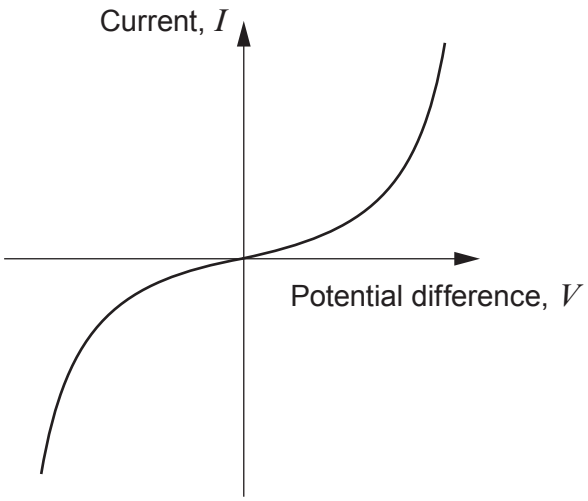
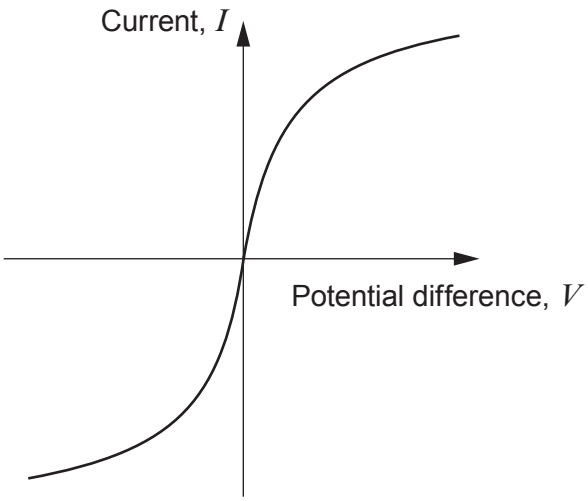
(ii) The graphs show the I–V characteristics of a lamp and a thermistor.

Graph 1



Graph 2



Explain how you can decide which graph is related to each component. [2]

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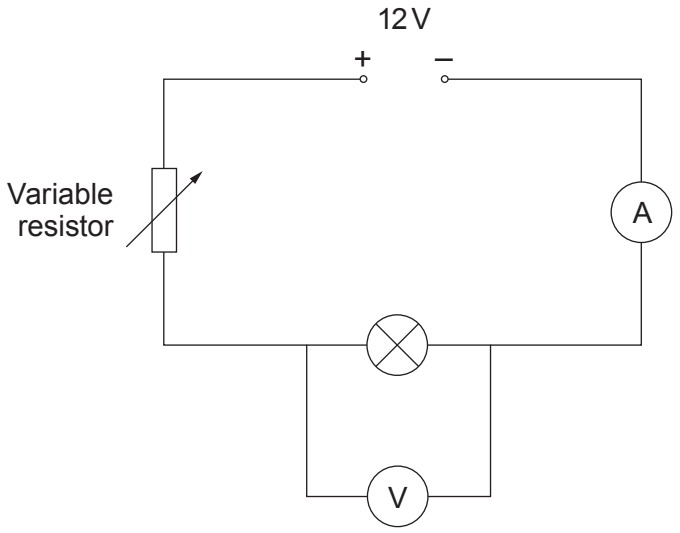
(b) The circuit below is used to investigate the I–V characteristic of a component. The power supply is fixed at 12 V. The filament lamp can be changed for other components.



Describe how sufficient readings are taken to plot an I–V graph. [4]

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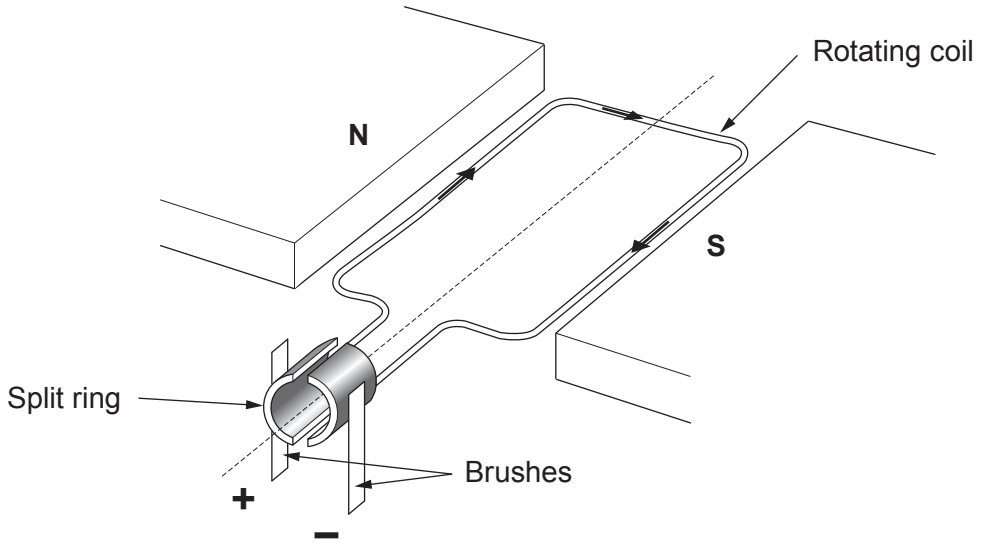
9. The diagram shows a simple electric motor consisting of a coil of one turn of wire. The direction of the current in the coil of wire is shown by the arrows.



(a) (i) Determine the direction of rotation of the coil and name the rule you used. [2]

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(ii) Explain how the design of the motor ensures it keeps rotating in one direction. [2]

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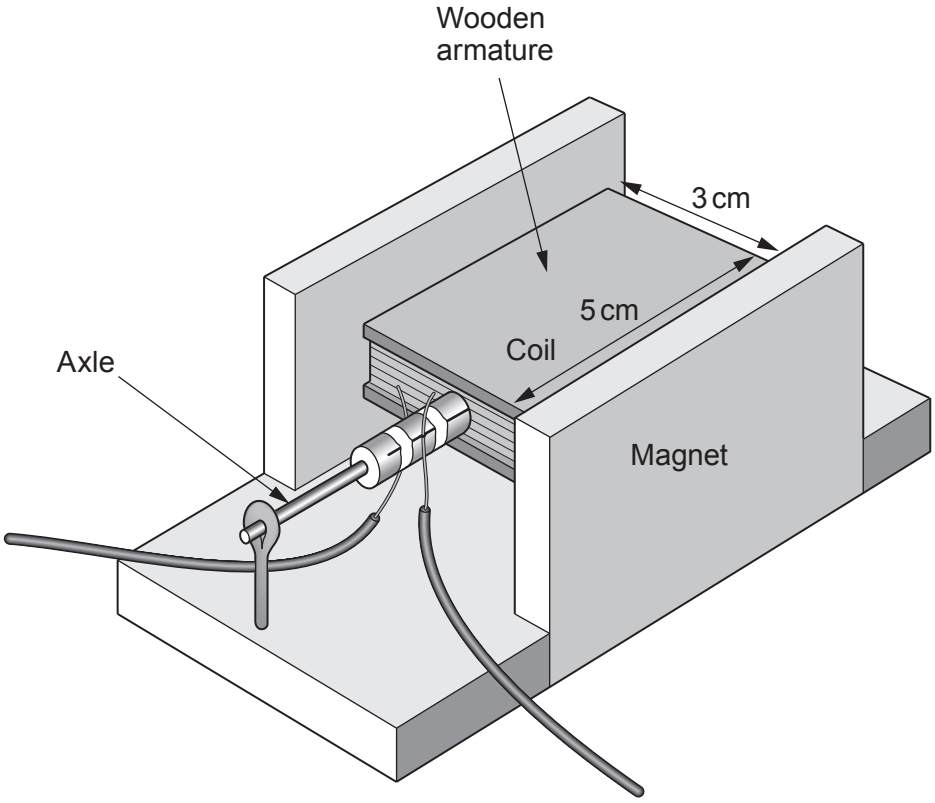
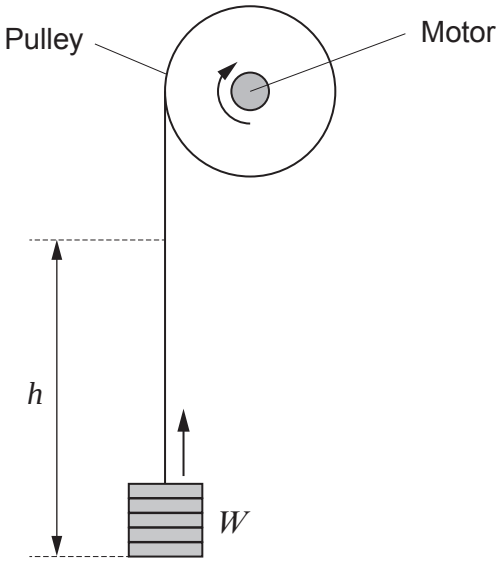
(b) In practice a motor coil has more than one turn of wire. Students are investigating how quickly the motor is able to lift different weights, W. They make a motor as shown below. Turns of wire are wound around a wooden armature.



The motor is connected to a pulley so it can lift a weight, W, through a known height, h.



The wooden armature is 5 cm long and 3 cm wide. They wrap 10 turns of wire around the armature. The magnets produce a magnetic field of strength 0.6 T.

For each value of weight, the time taken to lift it is recorded.

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(i) Use the information opposite and an equation from page 2 to calculate the size of the force on each of the four sides of the coil due to a current of 1.2 A, when the coil is in the position shown. [4]

Force on each 5 cm side = ... N

Force on each 3 cm side = ... N

(ii) Calculate the moment produced by the coil about the axle. [3]

Moment = ... N m

(iii) One student states that the moment produced by the coil remains constant as it spins. Explain whether you agree with this statement. [2]

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(iv) Describe how the investigation could be developed to determine how the efficiency of the motor is affected by the size of the weight to be lifted. [3]

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16

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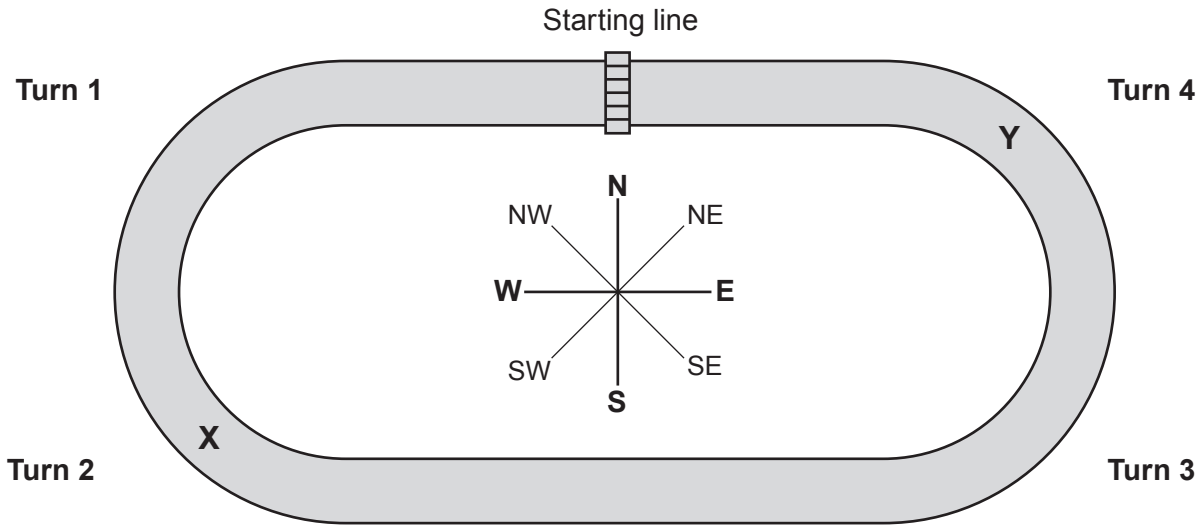
10. The diagram shows a horse racing track. The distance travelled in a lap is 1.8 km. During a race, the winning horse crossed the starting line at 1 m/s and accelerated westwards to a maximum speed of 15 m/s as it reached **Turn 1**. It remained at this speed for the rest of the race.



(a) Compare the speed of the winning horse at points **X** and **Y** in **Turn 2** and **Turn 4** and also compare its velocity at the same points. [3]

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(b) The distance between the starting line and **Turn 1** is 0.3 km.
Use equations from page 2 to calculate:

(i) the mean acceleration of the horse; [3]

Mean acceleration = ... m/s^2

(ii) the time taken for the horse to reach **Turn 1**. [2]

Time = ... s

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(iii) One spectator suggests that the horse will complete the one-lap race in 2 minutes. Show whether you agree with the spectator. [3]

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(c) Another horse, of mass 550 kg, was ridden by a jockey of mass 50 kg. The horse was galloping at 14 m/s when it suddenly bucked and threw the jockey forward at a velocity of 16 m/s over its head.

Calculate the new velocity of the horse. Show your working. [5]

Neither horse nor jockey was badly injured.

Velocity = ... m/s

16

END OF PAPER

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For continuation only.