Candidate Name	Centre Number					Candidate Number				

GCSE PHYSICS

COMPONENT 1

Concepts in Physics

HIGHER TIER

SAMPLE PAPER

(2 hours 15 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**17**	
2.	**13**	
3.	**17**	
4.	**15**	
5.	**11**	
6.	**16**	
7.	**9**	
8.	**16**	
9.	**6**	
Total	**120**	

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
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

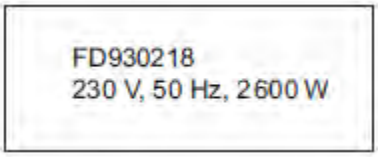
The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question **9.**

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 = 0.5 × 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	$p = h\rho g$

Answer **all** *questions*.

1. The following information is found on the base of a kettle.



(a) What does this information tell you about the type of current the kettle is designed to work with? Explain your reasoning. [2]

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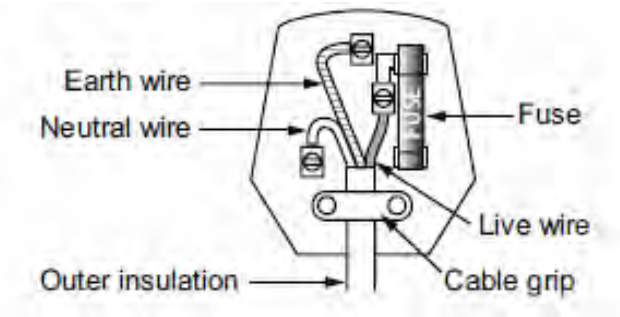
(b) The diagram shows the plug connected to the kettle.



(i) The ratings of fuses that are available for use in plugs are 3 A, 5 A, 7 A and 13 A. Determine which fuse should be chosen and state what would happen if each of the other fuses was used instead. [4]

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(ii) Explain the function of the fuse. [2]

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(iii) Describe how the earth wire helps to keep consumers safe. [2]

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(c) The kettle was tested to check its efficiency. The data collected are given below:

start temperature of water (^{o}C)	20
mass of water boiled (kg)	1.5
time taken for kettle to boil (min : s)	3 : 30
specific heat capacity of water (J / kg ^{o}C)	4 200
power of kettle (W)	2 600

(i) Select an equation from page 2 and use it to calculate the energy transferred to the water. [3]

energy transferred = ... J

(ii) The efficiency of the kettle is calculated to be 0.92; explain in terms of energy transfer what this means. [2]

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(d) Another kettle of similar design takes longer to boil the same quantity of water much more slowly. Explain whether this kettle is more or less environmentally efficient. [2]

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17

2. Rising moisture within a thundercloud collides with falling ice or sleet. The base of the thundercloud becomes negatively charged and the top becomes positively charged.

(a) Explain how a thundercloud becomes charged with static electricity. [3]

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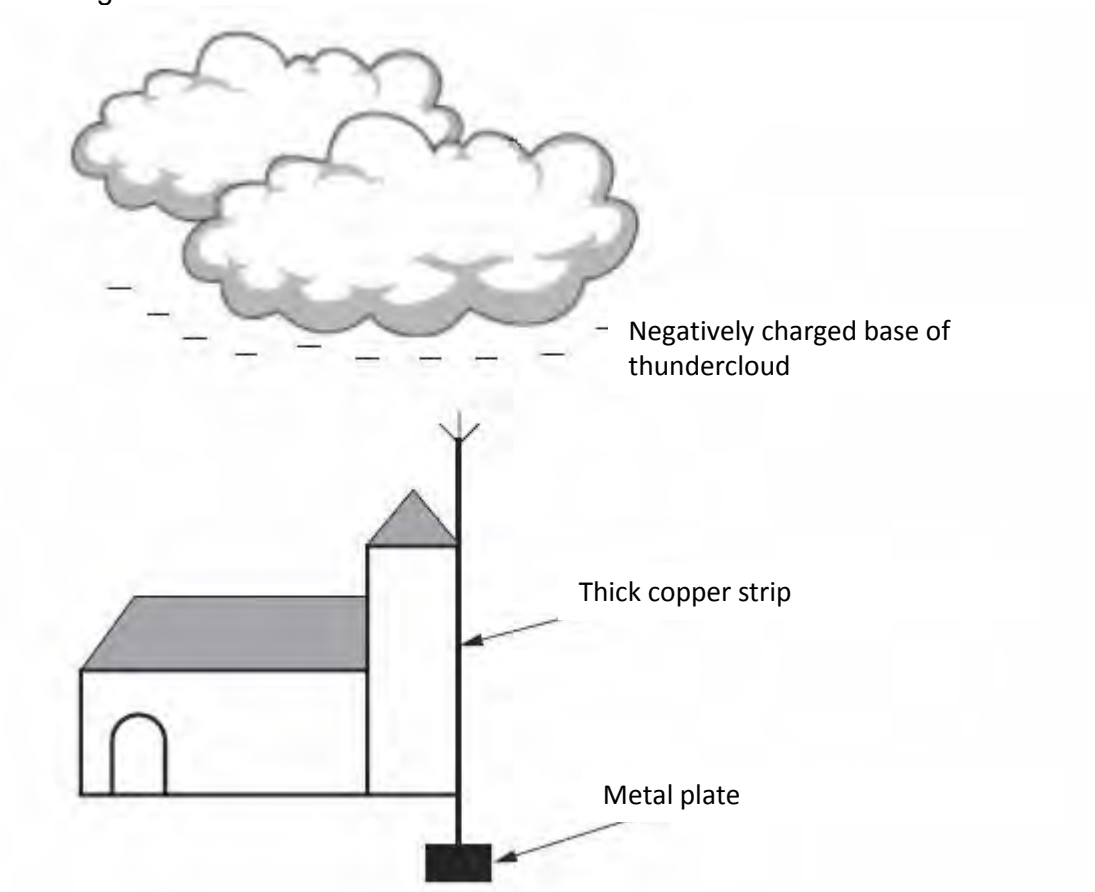
(b) A lightning conductor is a **very thick** strip of **copper**, which connects some sharp points above the top of a building to a metal plate buried deep in the ground.



The negatively charged base of the thundercloud causes a movement of charge in the lightning conductor. Positive and negative ions are produced in the air around the sharp points. The movement of these ions reduces the build-up of charge on the cloud making a lightning strike less likely.

(i) Describe how a positive charge is produced at the points of the lightning conductor. [2]

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(ii) Explain how the ions produced in the air around the points help to prevent the build-up of charge in the cloud. [2]

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(iii) Give **two** reasons why the lightning conductor, shown in the diagram, minimises the damage to the building by the lightning strike described above. [2]

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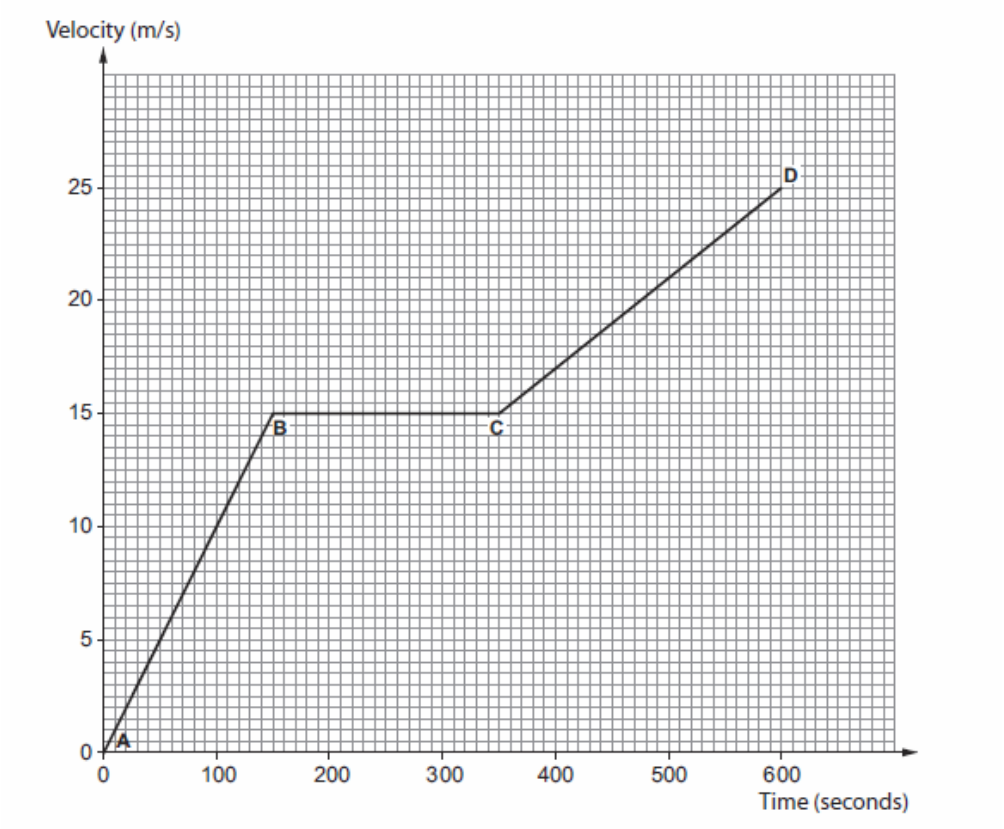
(c) In a lightning strike, a current of 3 000 A flows through the lightning conductor for 0·005 s. Calculate the amount of charge transferred from the cloud and state its unit. [4]

charge = ...
unit = ...

13

3. The graph below shows the motion of a train during part of its journey.



(a) (i) How does the appearance of the lines **AB** and **CD** show that the acceleration is greater for **AB**? [1]

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(ii) A student concludes that the train must travel further between **CD** than between **BC** as the velocity is higher. Use the graph to decide whether or not this conclusion is correct. [3]

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(iii) Calculate the acceleration of the train from **CD**. [3]

acceleration = ... m/s^2

(iv) What conclusions can be made about how the size of the resultant force compares in the regions **AB**, **BC** and **CD**?
(Calculations are not required.) [4]

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(b) A driver estimates the stopping distance for his train to be approximately 800 m. The train is travelling at 25 m/s and decelerates to rest at 0.4 m/s^2. Choose an equation from page 2 and use it to explain if the driver's estimate of the stopping distance is consistent with this information. [4]

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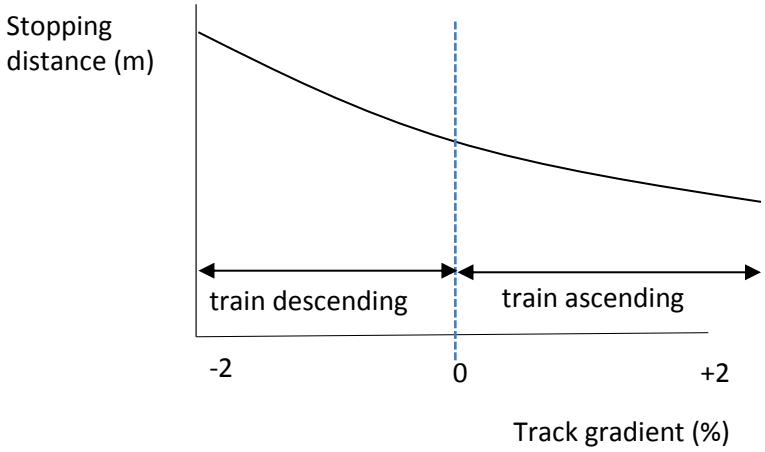
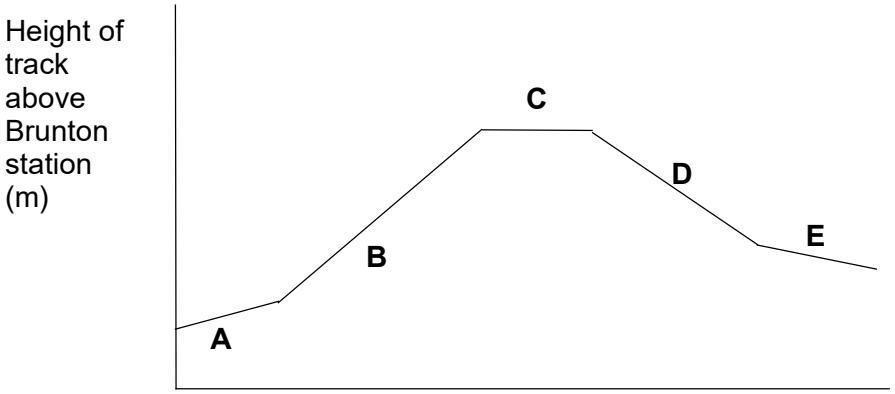
(c) The stopping distance for a train depends upon the gradient of the track it travels on. The stopping distance for a train moving at **constant** speed against the gradient of the track is shown on the diagram below.



The diagram below shows the height of track above Brunton station as you head south.



[2]

Use the information above to explain where from (**A**, **B**, **C, D** or **E**) you would expect the train to have the shortest stopping distance.

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17

4. Light is an electromagnetic wave and forms part of the electromagnetic spectrum.

(a) Name **two** other regions of the electromagnetic spectrum. [1]

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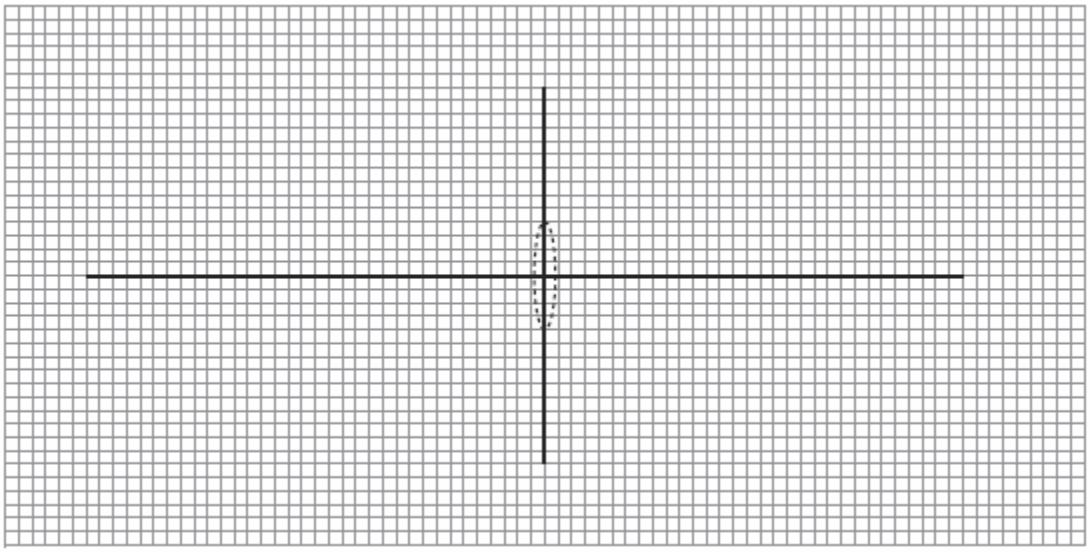
(b) A student investigates the behaviour of light using lenses. They place an object 2 cm tall, 30 cm in front of a convex lens of focal length 10 cm. Using the grid below, draw an accurate scale diagram to find the distance of the image formed in the lens and its size. [6]



distance = ... cm

size = ... cm

(c) Unlike light waves, sound waves are longitudinal waves.

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

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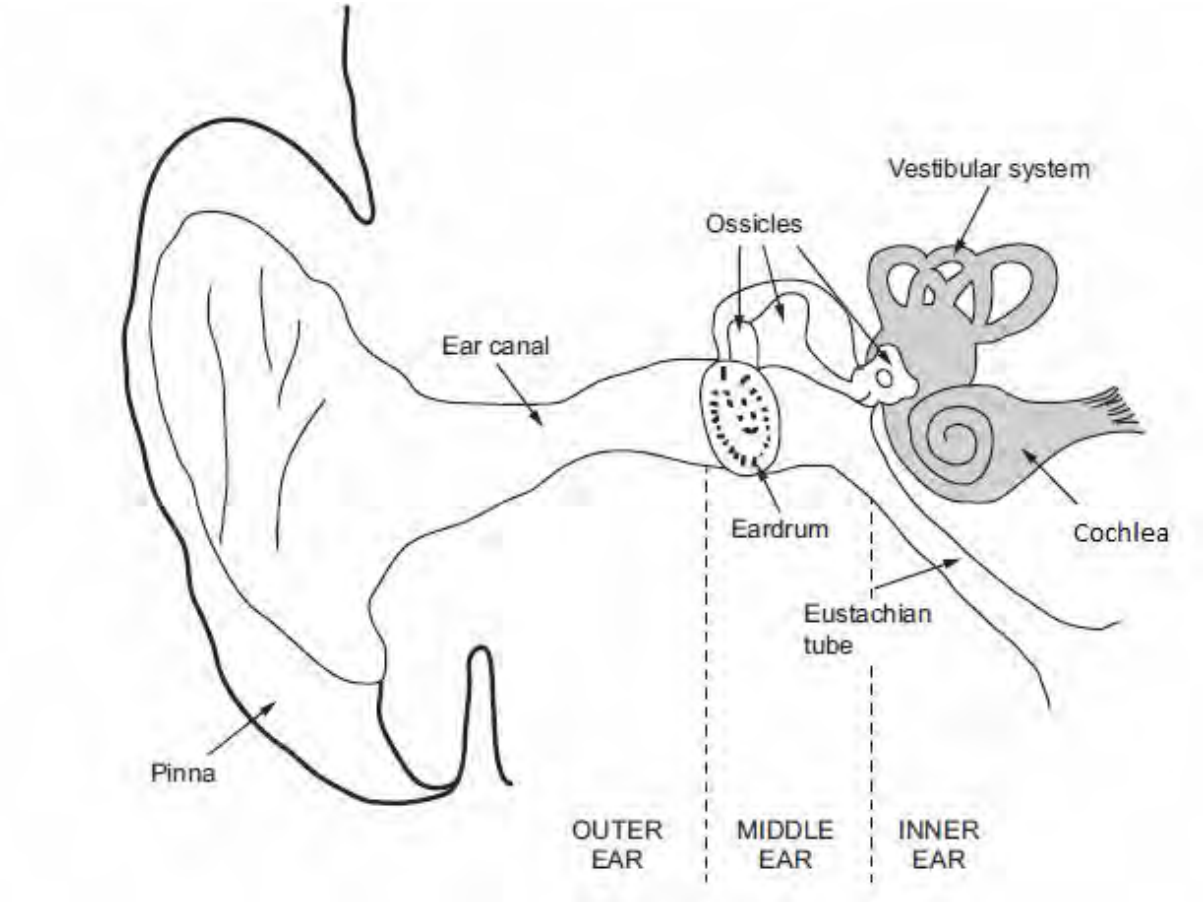
The diagram below shows the human ear.



(ii) Use the diagram to describe how the human ear works. [4]

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(iii) Explain why the range of hearing of the human ear is limited at the upper end. [2]

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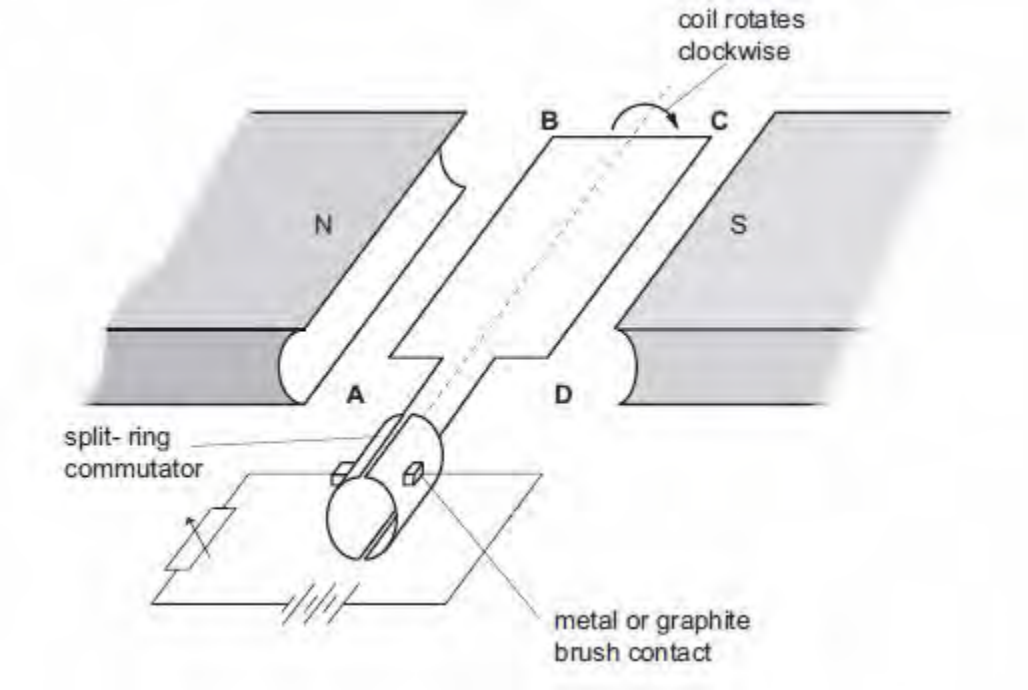
5. A student investigates the behaviour of a simple electric motor.



(a) (i) The student makes the following changes to the circuit. Predict the effect on the rotation of the coil. [3]

Adjusting the variable resistor to a lower resistance

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Doubling the number of turns of wire on the coil

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Reversing the magnetic field

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(ii) In the diagram above, the force on side **AB** of the coil is 9×10^{-2} N. The coil consists of 40 turns of wire. The current through the coil is 1.5 A and the magnetic field strength is 30 mT.

Use an equation from page 2 to calculate the length of side **AB** in the magnetic field.

[4]

length = ... m

(b) The variable resistor is adjusted and the power supplied to the motor is measured to be 10 W. The resistance of the motor is 40 Ω. Calculate the current in the motor using the equation: [4]

$$\text{power} = (\text{current})^2 \times \text{resistance, or } P = I^2R$$

current = ……

11

6. (a) (i) Velocity is a vector quantity and speed is a scalar quantity. Explain the difference between scalar and vector **quantities**. [1]

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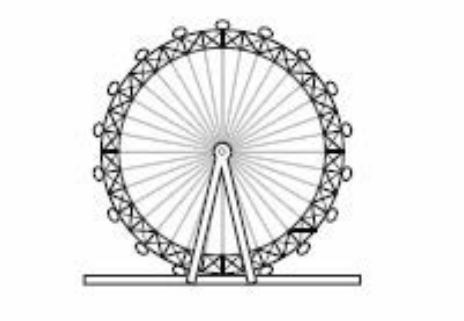

(ii) The London eye ride rotates at a constant speed of 0.24 m/s. Explain what happens to the velocity of the cars on the ride as it rotates. [2]

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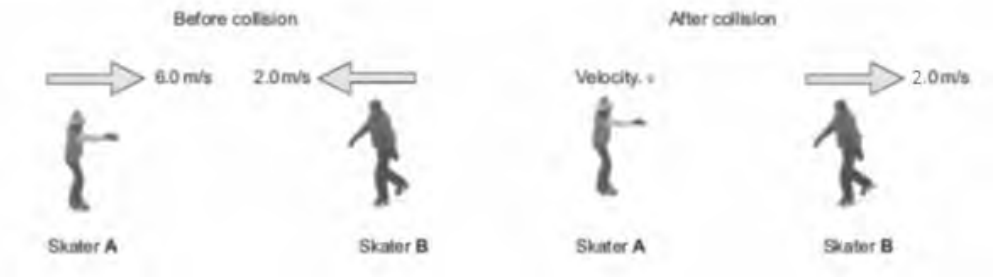
(iii) One rotation of the London eye takes about 30 minutes. Calculate the approximate circumference of the London eye. [3]

circumference = ……. m

(b) (i) Momentum is another vector quantity. When objects collide with each other momentum is conserved. Two ice skaters, A and B, each of mass 50 kg, collide as shown.



Calculate the velocity of ice skater **A** after the collision. [4]

velocity = ... m/s

(ii) A squash ball of mass 25 g and a tennis ball of mass 50 g both have the same momentum. What conclusion can you make about how their velocities compare? [2]

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(c) The game of squash uses a small hollow rubber ball. A measure of the bounciness of a squash ball is given by the ratio, R.

$$R = \frac{\text{height of bounce}}{\text{height from which the ball is dropped}}$$

To obtain standard values squash balls are dropped from a height of 254 cm.

The value of *R* of a competition squash ball at 23 °C and 45 °C are given in the table below.

Temperature of ball (°C)	***R***
23	0.12
45	0.25-0.30

During a game of squash the ball bounces further for the same stroke and the game becomes faster.

Use data from the table to help explain this observation. [4]

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16

7. (a) In answer to an exam question, a student defined density as follows: "Density is the mass of its volume". The answer earned no marks. Identify what is wrong with this statement and write it correctly. [2]

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(b) Some information about an iceberg and its environment is given in the table.

Density of sea water	1 024 kg/m^3
Density of ice	920 kg/m^3
Density of air	1.28 kg/m^3
Atmospheric pressure at sea level	101 kPa
Volume of the iceberg above the surface	5 000 m^3
Pressure of water at bottom of iceberg	205 kPa
Mass of iceberg	46 Mkg
Gravitational field strength, g	10 N/kg

(i) Select an equation from page 2 and use it to calculate the depth of the water at the bottom of the iceberg. [3]

depth = ... m

(ii) Explain why the iceberg experiences an upwards force from the water. [2]

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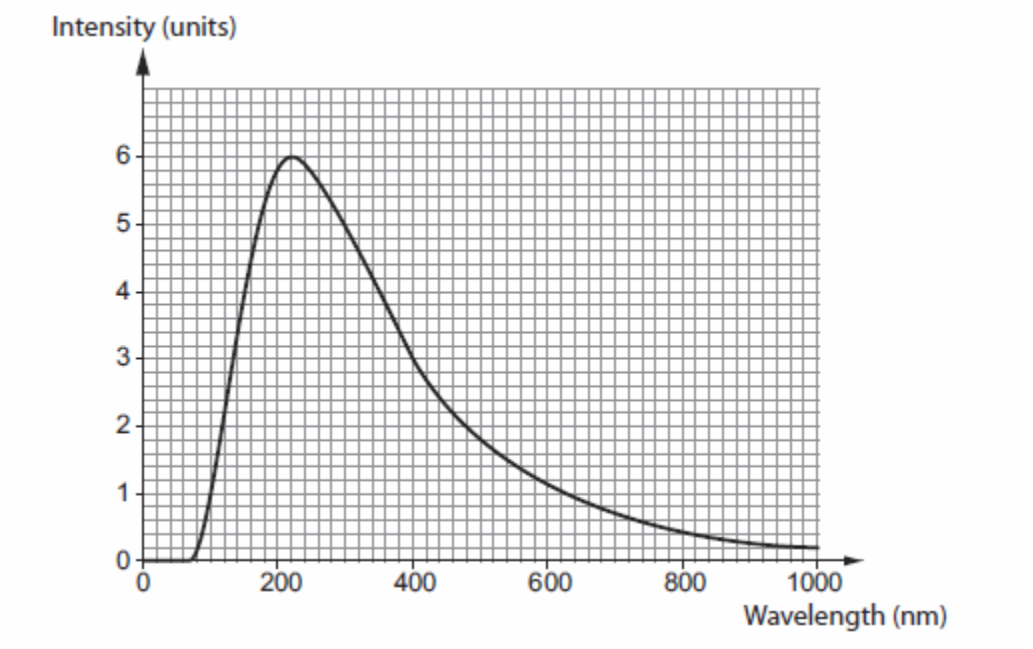
(iii) Use the information in the table to calculate the percentage of the iceberg's volume that is submerged. [2]

percentage = ...

9

8. Stars emit radiation and can be treated as black bodies. The following graph shows the distribution of wavelengths of radiation emitted by a hot star.



(a) (i) Calculate the frequency of the most intense radiation from this star. (Speed of light, c = 3.00 × 10^8 m/s) [5]

frequency = ... Hz

(ii) Visible light has a wavelength of between 0.4 μm and 0.7 μm. Explain which region of the electromagnetic spectrum the wavelength of maximum intensity is in showing your reasoning in full. [2]

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(b) (i) **Draw on the graph** opposite, the curve that you would expect for a cooler star of the same size. [3]

(ii) Stars give out radiation due to the nuclear fusion of hydrogen. Explain how fusion allows the star to maintain a stable size. [2]

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(c) (i) The accident that caused the meltdown of a Russian nuclear reactor in Chernobyl in 1986 was due to a design fault in Russian reactors. The fault led to uncontrolled nuclear reactions that caused the reactor to explode.
By referring to the reaction below explain how an uncontrolled series of nuclear reactions can occur. [2]

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{92}_{36}\mathrm{Kr} + {}^{141}_{56}\mathrm{Ba} + 3\ {}^{1}_{0}\mathrm{n}$$

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(ii) The element californium ($^{248}_{98}\mathrm{Cm}$) is unstable and decays in two steps, in which either an alpha or beta particle is emitted, into the element plutonium ($^{240}_{94}\mathrm{Pu}$). [2]

Use this information to determine the number of alpha and beta particles that are emitted to form this isotope. Show your reasoning.

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9. Discuss the information that spectra lines from distant galaxies can provide about the origin of the universe. [6 QER]

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