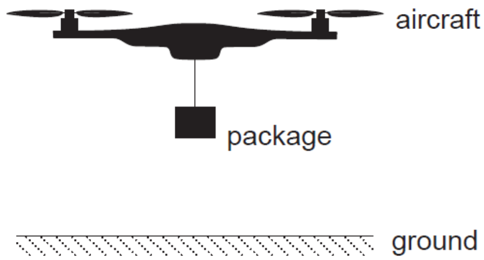
May 2022 Expected questions

[196 marks]

A company delivers packages to customers using a small unmanned aircraft. Rotating horizontal blades exert a force on the surrounding air. The air above the aircraft is initially stationary.



The air is propelled vertically downwards with speed v. The aircraft hovers motionless above the ground. A package is suspended from the aircraft on a string. The mass of the aircraft is $0.95\,\mathrm{kg}$ and the combined mass of the package and string is $0.45\ \mathrm{kg}$. The mass of air pushed downwards by the blades in one second is $1.7\ \mathrm{kg}$.

1a. State the value of the resultant force on the aircraft when hovering. *[1 mark]*

. . . .

. . . .

. . . .

1b. Outline, by reference to Newton's third law, how the upward lift force on the aircraft is achieved. *[2 marks]*

....

....

....

....

....

....

1c. Determine v. State your answer to an appropriate number of significant figures. *[3 marks]*

....

....

....

....

....

....

1d. Calculate the power transferred to the air by the aircraft. *[2 marks]*

....

....

....

....

....

....

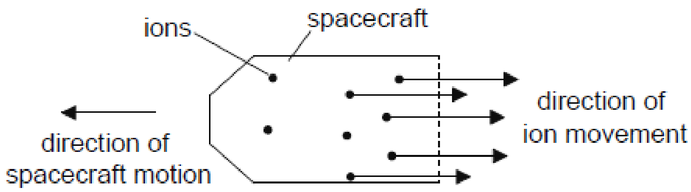
1e. The package and string are now released and fall to the ground. The lift force on the aircraft remains unchanged. Calculate the initial acceleration of the aircraft. *[2 marks]*

. . . .

. . . .

. . . .

Ion-thrust engines can power spacecraft. In this type of engine, ions are created in a chamber and expelled from the spacecraft. The spacecraft is in outer space when the propulsion system is turned on. The spacecraft starts from rest.



The mass of ions ejected each second is 6.6×10^{-6} kg and the speed of each ion is 5.2×10^{4} m s^{-1}. The initial total mass of the spacecraft and its fuel is 740 kg. Assume that the ions travel away from the spacecraft parallel to its direction of motion.

2a. Determine the initial acceleration of the spacecraft. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

An initial mass of 60 kg of fuel is in the spacecraft for a journey to a planet. Half of the fuel will be required to slow down the spacecraft before arrival at the destination planet.

2b. (i) Estimate the maximum speed of the spacecraft. *[3 marks]*

(ii) Outline why the answer to (i) is an estimate.

....

....

....

....

....

....

....

....

....

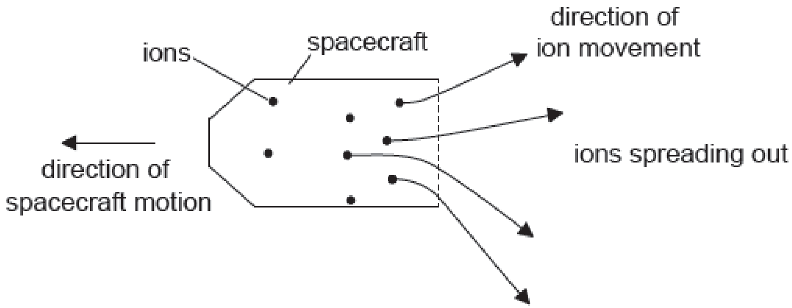
2c. Outline why scientists sometimes use estimates in making calculations. *[1 mark]*

....

....

....

In practice, the ions leave the spacecraft at a range of angles as shown.



2d. Outline why the ions are likely to spread out. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

2e. Explain what effect, if any, this spreading of the ions has on the acceleration of the spacecraft. *[2 marks]*

. . . .

. . . .

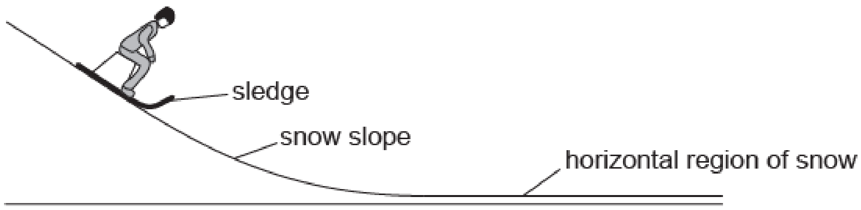
. . . .

. . . .

. . . .

. . . .

A girl on a sledge is moving down a snow slope at a uniform speed.



3a. Draw the free-body diagram for the sledge at the position shown on the snow slope. *[2 marks]*

3b. After leaving the snow slope, the girl on the sledge moves over a horizontal region of snow. Explain, with reference to the physical origin of the forces, why the vertical forces on the girl must be in equilibrium as she moves over the horizontal region. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

3c. When the sledge is moving on the horizontal region of the snow, the girl *[2 marks]*

jumps off the sledge. The girl has no horizontal velocity after the jump. The velocity of the sledge immediately after the girl jumps off is 4.2 m s^{-1}. The mass of the girl is 55 kg and the mass of the sledge is 5.5 kg. Calculate the speed of the sledge immediately before the girl jumps from it.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

3d. The girl chooses to jump so that she lands on loosely-packed snow rather than frozen ice. Outline why she chooses to land on the snow. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

The sledge, without the girl on it, now travels up a snow slope that makes an angle of 6.5° to the horizontal. At the start of the slope, the speed of the sledge is 4.2 m s^{-1}. The coefficient of dynamic friction of the sledge on the snow is 0.11.

3e. Show that the acceleration of the sledge is about –2 m s^{-2}. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

3f. Calculate the distance along the slope at which the sledge stops moving. Assume that the coefficient of dynamic friction is constant. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

3g. The coefficient of static friction between the sledge and the snow is 0.14. *[2 marks]*
Outline, with a calculation, the subsequent motion of the sledge.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

4a. Outline what is meant by the principle of superposition of waves. *[2 marks]*

. . . .

. . . .

. . . .

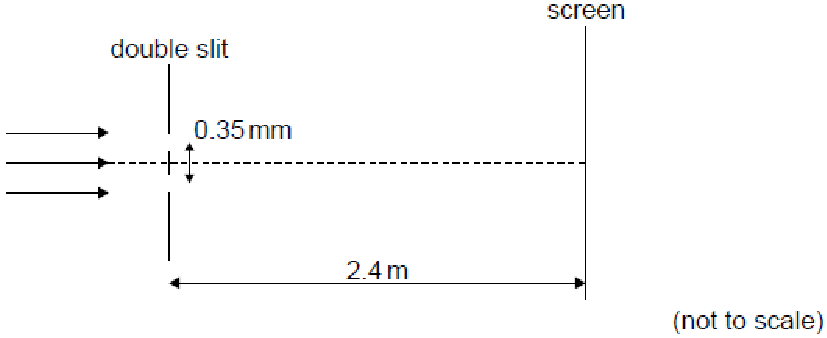
. . . .

. . . .

. . . .

4b. Red laser light is incident on a double slit with a slit separation of 0.35 mm. *[3 marks]*

A double-slit interference pattern is observed on a screen 2.4 m from the slits.
The distance between successive maxima on the screen is 4.7 mm.



Calculate the wavelength of the light. Give your answer to an appropriate number of significant figures.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

4c. Explain the change to the appearance of the interference pattern when the red-light laser is replaced by one that emits green light. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

4d. One of the slits is now covered. *[2 marks]*

Describe the appearance of the pattern on the screen.

. . . .

. . . .

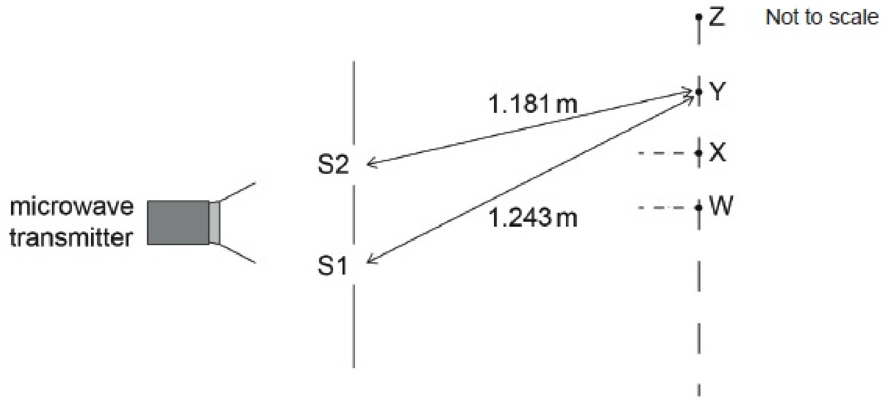
. . . .

. . . .

. . . .

. . . .

A beam of microwaves is incident normally on a pair of identical narrow slits S1 and S2.



When a microwave receiver is initially placed at W which is equidistant from the slits, a maximum in intensity is observed. The receiver is then moved towards Z along a line parallel to the slits. Intensity maxima are observed at X and Y with one minimum between them. W, X and Y are consecutive maxima.

5a. Explain why intensity maxima are observed at X and Y. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

5b. The distance from S1 to Y is 1.243 m and the distance from S2 to Y is 1.181 m. *[3 marks]*

Determine the frequency of the microwaves.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

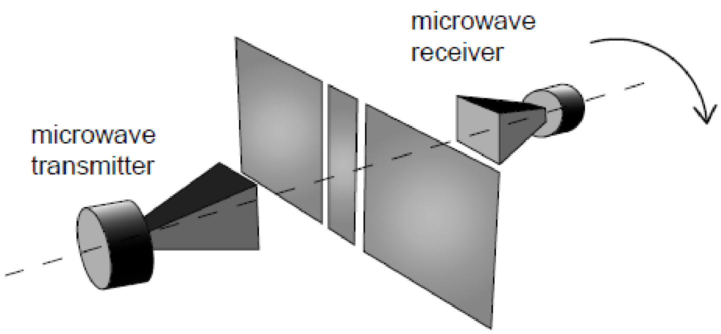
5c. Outline **one** reason why the maxima observed at W, X and Y will have different intensities from each other. *[1 mark]*

. . . .

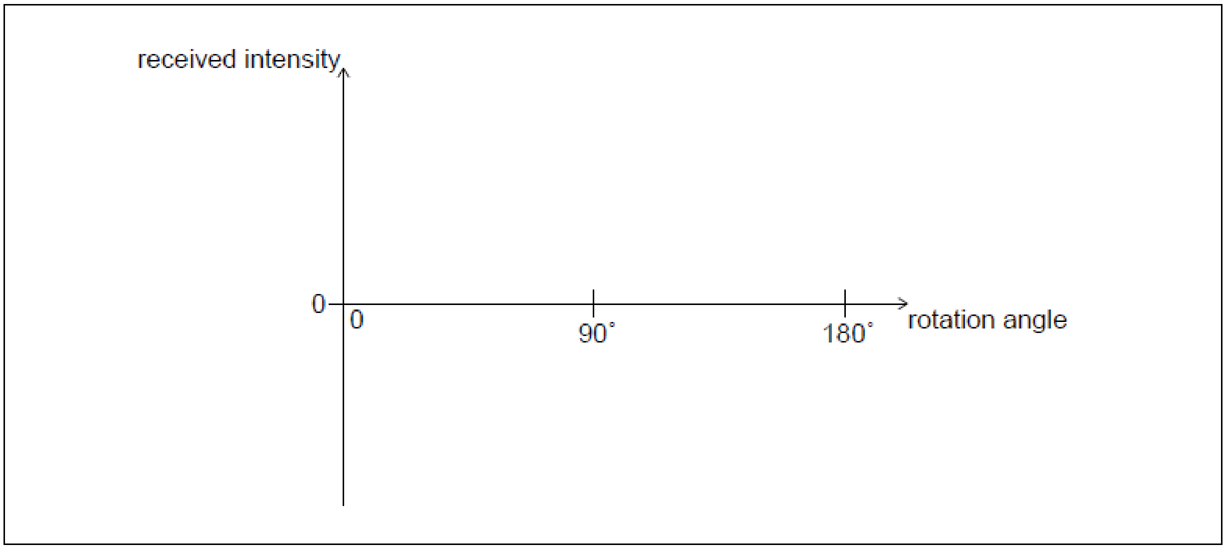
. . . .

. . . .

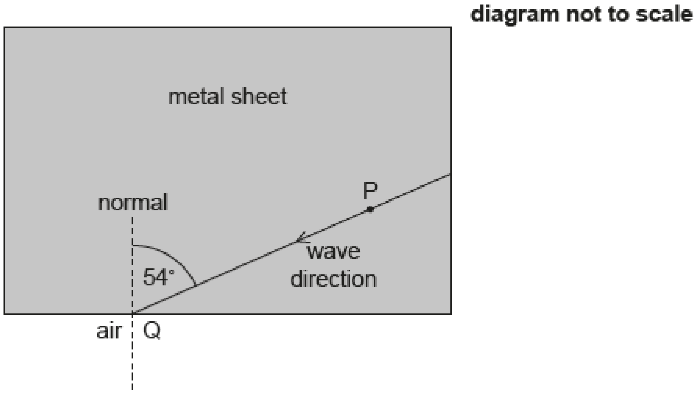
5d. The microwaves emitted by the transmitter are horizontally polarized. The microwave receiver contains a polarizing filter. When the receiver is at position W it detects a maximum intensity. *[2 marks]*



The receiver is then rotated through 180° about the horizontal dotted line passing through the microwave transmitter. Sketch a graph on the axes provided to show the variation of received intensity with rotation angle.



The diagram shows the direction of a sound wave travelling in a metal sheet.



6a. Particle P in the metal sheet performs simple harmonic oscillations. When the displacement of P is 3.2 μm the magnitude of its acceleration is 7.9 m s^{-2}. Calculate the magnitude of the acceleration of P when its displacement is 2.3 μm. *[2 marks]*

. . . .

. . . .

. . . .

6b. The wave is incident at point Q on the metal–air boundary. The wave makes an angle of 54° with the normal at Q. The speed of sound in the metal is 6010 m s^{-1} and the speed of sound in air is 340 m s^{-1}. Calculate the angle between the normal at Q and the direction of the wave in air. *[2 marks]*

. . . .

. . . .

. . . .

The frequency of the sound wave in the metal is 250 Hz.

6c. State the frequency of the wave in air. *[1 mark]*

. . . .

. . . .

. . . .

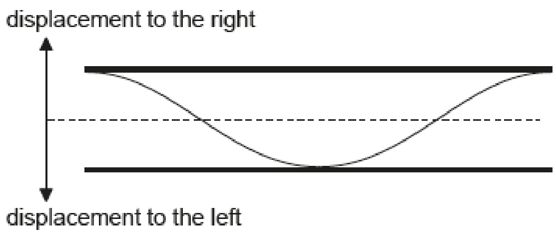
6d. Determine the wavelength of the wave in air. *[1 mark]*

. . . .

. . . .

. . . .

6e. The sound wave in air in (c) enters a pipe that is open at both ends. The diagram shows the displacement, at a particular time *T*, of the standing wave that is set up in the pipe. *[1 mark]*



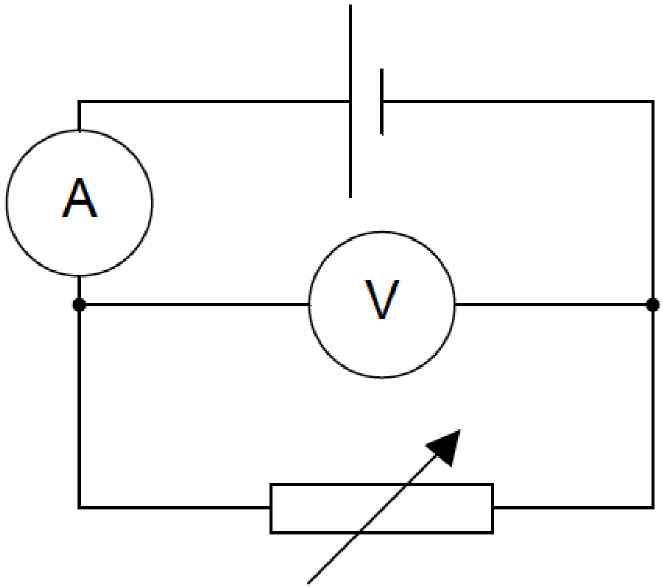
On the diagram, at time *T*, label with the letter C a point in the pipe that is at the centre of a compression.

. . . .

. . . .

. . . .

In an experiment a student constructs the circuit shown in the diagram. The ammeter and the voltmeter are assumed to be ideal.



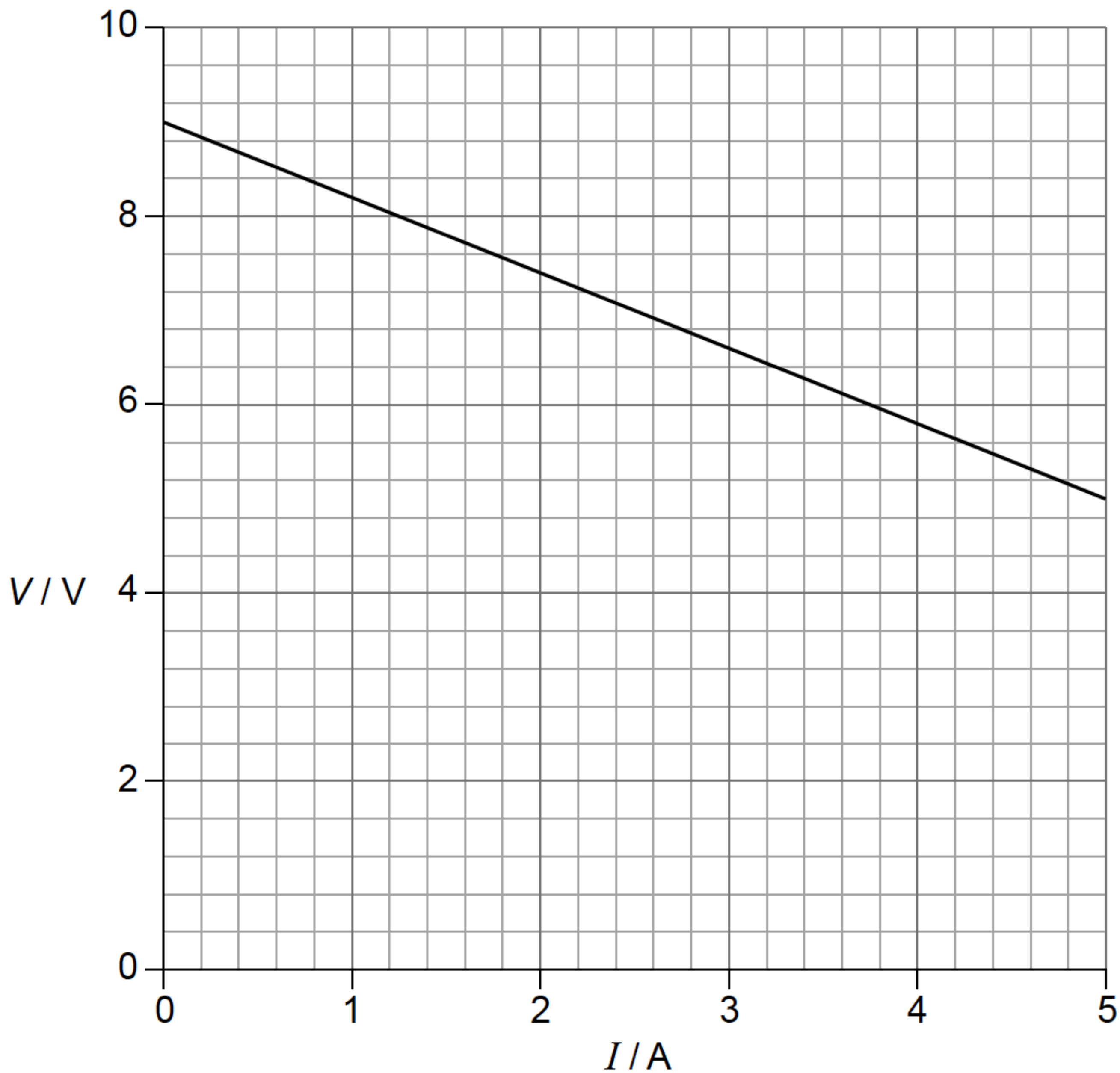
7a. State what is meant by an ideal voltmeter. *[1 mark]*

. . . .

. . . .

. . . .

7b. The student adjusts the variable resistor and takes readings from the ammeter and voltmeter. The graph shows the variation of the voltmeter reading V with the ammeter reading I. *[3 marks]*



Use the graph to determine

(i) the electromotive force (emf) of the cell.

(ii) the internal resistance of the cell.

....

....

....

....

....

....

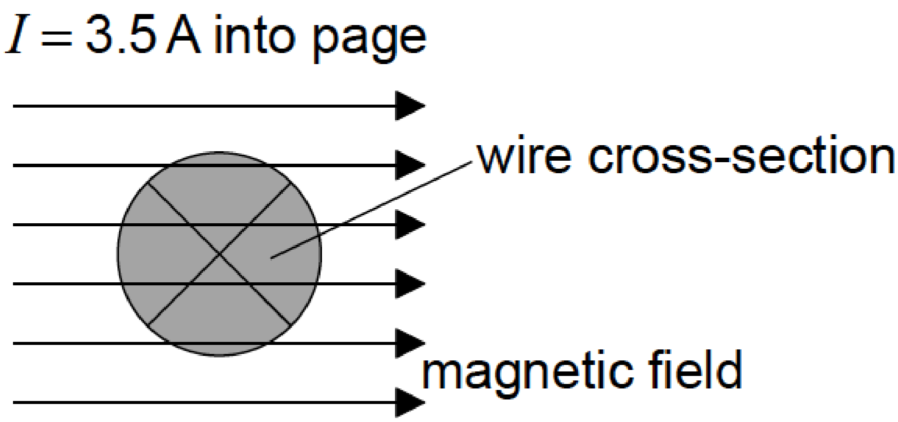
7c. A connecting wire in the circuit has a radius of 1.2mm and the current in it is 3.5A. The number of electrons per unit volume of the wire is $2.4\times10^{28}m^{-3}$. Show that the drift speed of the electrons in the wire is $2.0\times10^{-4}ms^{-1}$. *[1 mark]*

. . . .

. . . .

. . . .

7d. The diagram shows a cross-sectional view of the connecting wire in (c). *[2 marks]*



The wire which carries a current of 3.5A into the page, is placed in a region of uniform magnetic field of flux density 0.25T. The field is directed at right angles to the wire.

Determine the magnitude **and** direction of the magnetic force on one of the charge carriers in the wire.

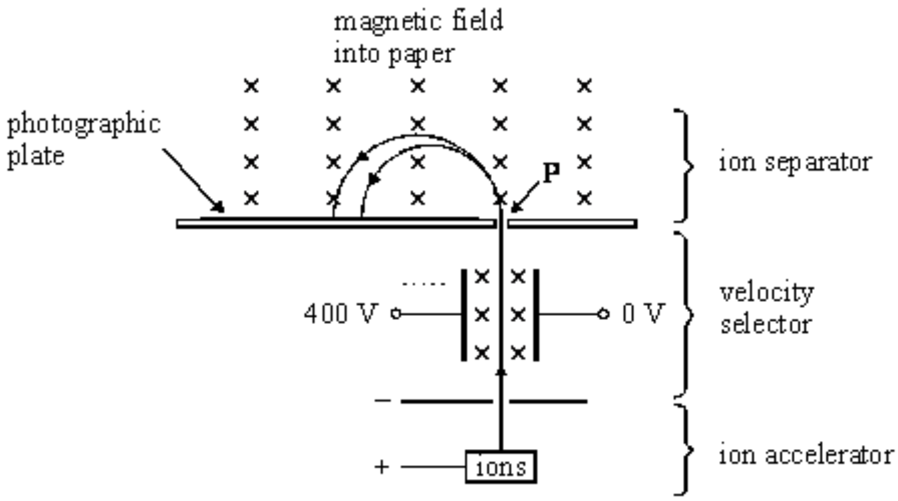
. . . .

. . . .

. . . .

Extra Topic 6 Questions

The diagram below shows a diagram of a mass spectrometer.



(a) The magnetic field strength in the velocity selector is 0.14 T and the electric field strength is 20 000 V m^{-1}.

(i) Define the unit for magnetic flux density, the tesla.

____

____

(2)

(ii) Show that the velocity selected is independent of the charge on an ion.

(2)

(iii) Show that the velocity selected is about 140 km s^{-1}.

(1)

(b) A sample of nickel is analysed in the spectrometer. The two most abundant isotopes of nickel are $^{58}_{28}Ni$ and $^{60}_{28}Ni$. Each ion carries a single charge of $+1.6 \times 10^{-19}$ C.

mass of a proton or neutron = 1.7×10^{-27} kg

The $^{58}_{28}Ni$ ion strikes the photographic plate 0.28 m from the point **P** at which the ion beam enters the ion separator.

Calculate:

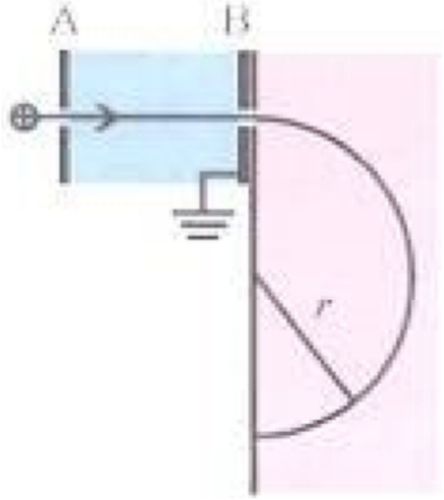
(i) the magnetic flux density of the field in the ion separator;

(3)

(ii) the separation of the positions where the two isotopes hit the photographic plate.

(2)
(Total 10 marks)

$^{12}C^+$ ions from an accelerator are accelerated to an energy of 65 keV. They are then directed in between two plates A and B, between which they are slowed down to a particular speed so that as the ions enter a magnetic field ($B = 0.146\ T$) the radius, r, of the path is 48 cm.



i) In the diagram above, draw the direction of the electric field and the magnetic field

[2 marks]

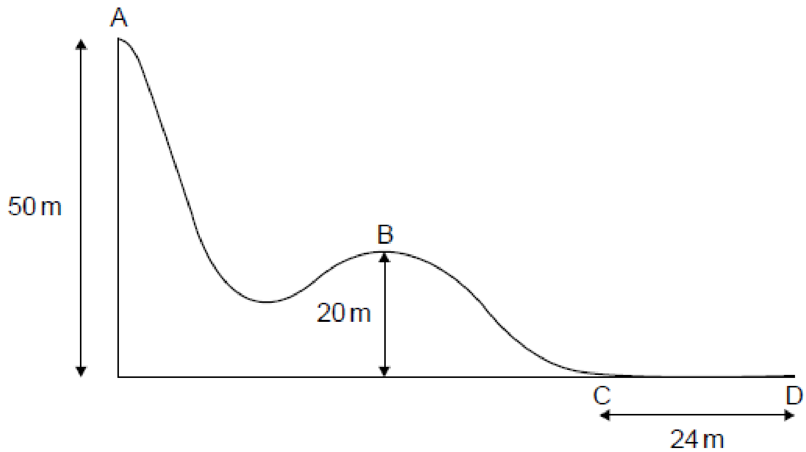
ii) Find the speed of the ions as they are traveling in the magnetic field

[2 marks]

iii) Given that plate B is grounded (has a potential = 0), find the magnitude of the electric potential of plate A

[4 marks]

The diagram below shows part of a downhill ski course which starts at point A, 50 m above level ground. Point B is 20 m above level ground.



A skier of mass 65 kg starts from rest at point A and during the ski course some of the gravitational potential energy transferred to kinetic energy.

8a. From A to B, 24 % of the gravitational potential energy transferred to kinetic energy. Show that the velocity at B is 12 m s^{-1}. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

8b. Some of the gravitational potential energy transferred into internal energy of the skis, slightly increasing their temperature. Distinguish between internal energy and temperature. *[2 marks]*

. . . .

. . . .

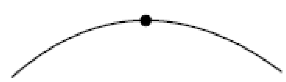
. . . .

. . . .

. . . .

. . . .

8c. The dot on the following diagram represents the skier as she passes point B. *[2 marks]*
Draw and label the vertical forces acting on the skier.



8d. The hill at point B has a circular shape with a radius of 20 m. Determine whether the skier will lose contact with the ground at point B. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

8e. The skier reaches point C with a speed of 8.2 m s^{-1}. She stops after a distance of 24 m at point D. *[3 marks]*

Determine the coefficient of dynamic friction between the base of the skis and the snow. Assume that the frictional force is constant and that air resistance can be neglected.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

At the side of the course flexible safety nets are used. Another skier of mass 76 kg falls normally into the safety net with speed 9.6 m s^{-1}.

8f. Calculate the impulse required from the net to stop the skier and state an appropriate unit for your answer. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

8g. Explain, with reference to change in momentum, why a flexible safety net is less likely to harm the skier than a rigid barrier. *[2 marks]*

. . . .

. . . .

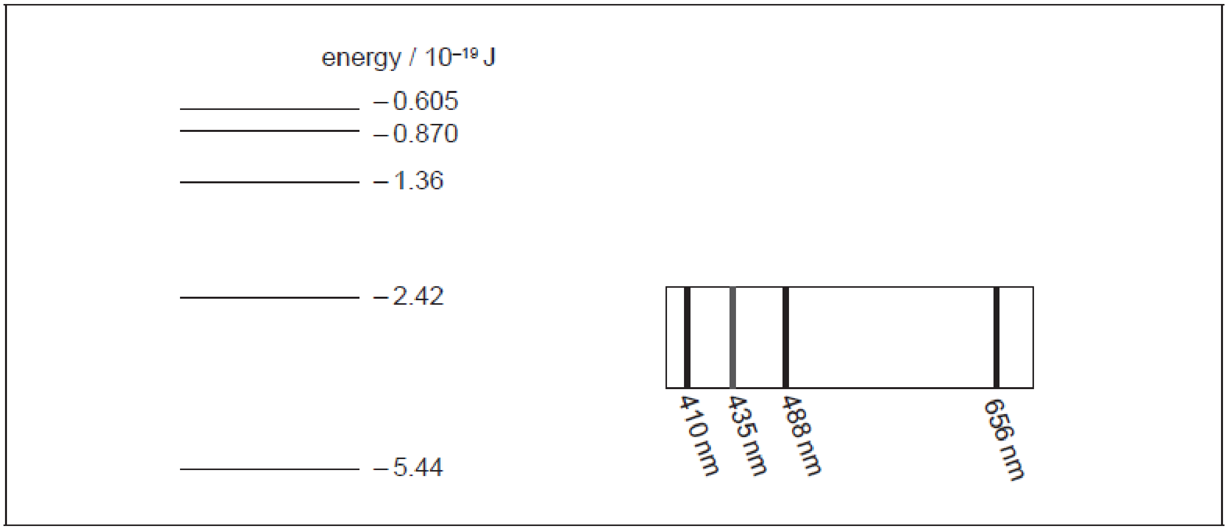
. . . .

. . . .

. . . .

. . . .

The diagram shows the position of the principal lines in the visible spectrum of atomic hydrogen and some of the corresponding energy levels of the hydrogen atom.



9a. Determine the energy of a photon of blue light (435nm) emitted in the hydrogen spectrum. *[3 marks]*

....

....

....

....

....

....

9b. Identify, with an arrow labelled B on the diagram, the transition in the hydrogen spectrum that gives rise to the photon with the energy in (a). *[1 mark]*

9c. Explain your answer to (b). *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Silicon-30 $\left({}^{30}_{14}\mathrm{Si}\right)$ can be formed from phosphorus-30 $\left({}^{30}_{15}\mathrm{P}\right)$ by a process of beta-plus decay.

10a. Write down the nuclear equation that represents this reaction. *[2 marks]*

. . . .

. . . .

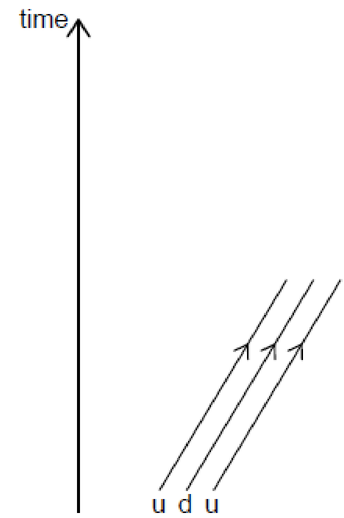
. . . .

. . . .

. . . .

. . . .

10b. Sketch the Feynman diagram that represents this reaction. The diagram has been started for you. *[3 marks]*



. . . .

10c. Energy is transferred to a hadron in an attempt to separate its quarks. *[2 marks]*
Describe the implications of quark confinement for this situation.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

10d. The Standard Model was accepted by many scientists before the observation of the Higgs boson was made. *[1 mark]*

Outline why it is important to continue research into a topic once a scientific model has been accepted by the scientific community.

. . . .

. . . .

. . . .

11a. Rutherford constructed a model of the atom based on the results of the alpha particle scattering experiment. Describe this model. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

Rhodium-106 ($^{106}_{45}\mathrm{Rh}$) decays into palladium-106 ($^{106}_{46}\mathrm{Pd}$) by beta minus (β^-) decay.

The binding energy per nucleon of rhodium is 8.521 MeV and that of palladium is 8.550 MeV.

11b. State what is meant by the binding energy of a nucleus. *[1 mark]*

. . . .

. . . .

. . . .

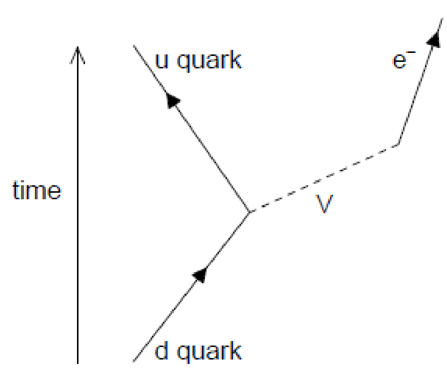
11c. Show that the energy released in the β^- decay of rhodium is about 3 MeV. *[1 mark]*

. . . .

. . . .

. . . .

β^- decay is described by the following incomplete Feynman diagram.



11d. Draw a labelled arrow to complete the Feynman diagram. *[1 mark]*

11e. Identify particle V. *[1 mark]*

. . . .

. . . .

. . . .

Wind is incident on the blades of a wind turbine. The radius of the blades is 12 m. The following data are available for the air immediately before and after impact with the blades.

	Before	**After**
Density of air	$1.20\,\text{kg}\,\text{m}^{-3}$	$1.32\,\text{kg}\,\text{m}^{-3}$
Wind speed	$8.0\,\text{m}\,\text{s}^{-1}$	$4.0\,\text{m}\,\text{s}^{-1}$

12a. Determine the maximum power that can be extracted from the wind by this turbine. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

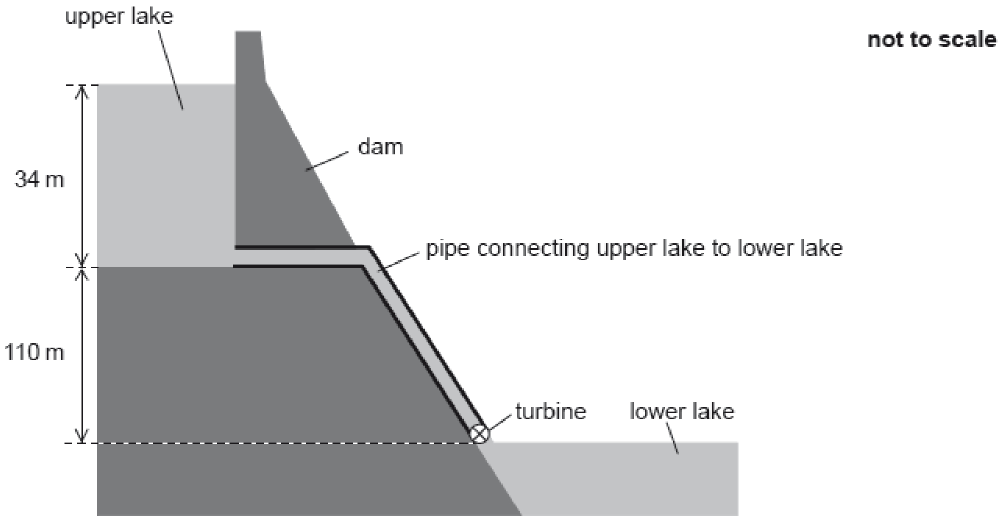
12b. Suggest why the answer in (a) is a maximum. *[1 mark]*

. . . .

. . . .

. . . .

In a pumped storage hydroelectric system, water is stored in a dam of depth 34 m.



The water leaving the upper lake descends a vertical distance of 110 m and turns the turbine of a generator before exiting into the lower lake.

Water flows out of the upper lake at a rate of 1.2×10^5 m^3 per minute. The density of water is 1.0×10^3 kg m^{-3}.

13a. Estimate the specific energy of water in this storage system, giving an appropriate unit for your answer. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

13b. Show that the average rate at which the gravitational potential energy of the water decreases is 2.5 GW. *[3 marks]*

....

....

....

....

....

....

13c. The storage system produces 1.8 GW of electrical power. Determine the overall efficiency of the storage system. *[1 mark]*

....

....

....

13d. After the upper lake is emptied it must be refilled with water from the lower lake and this requires energy. Suggest how the operators of this storage system can still make a profit. *[1 mark]*

....

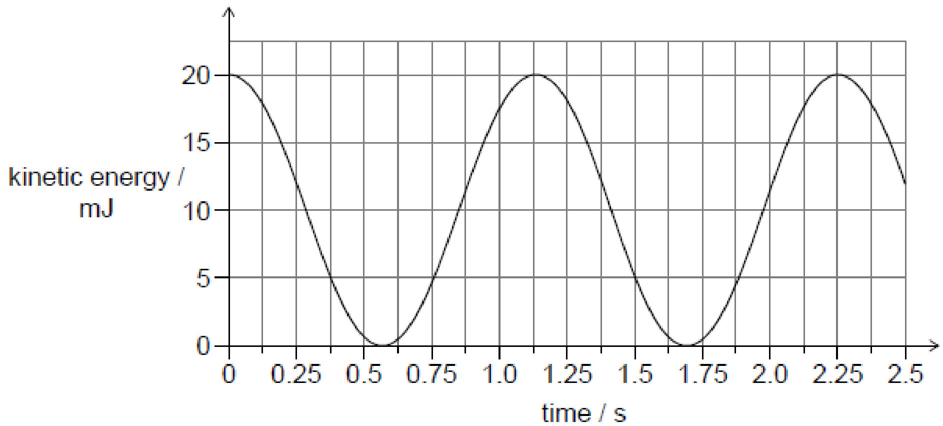
....

....

A small metal pendulum bob is suspended at rest from a fixed point with a length of thread of negligible mass. Air resistance is negligible.

The pendulum begins to oscillate. Assume that the motion of the system is simple harmonic, and in one vertical plane.

The graph shows the variation of kinetic energy of the pendulum bob with time.



14a. Calculate, in m, the length of the thread. State your answer to an appropriate number of significant figures. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

14b. Label on the graph with the letter X a point where the speed of the pendulum is half that of its initial speed. *[1 mark]*

. . . .

. . . .

. . . .

14c. The mass of the pendulum bob is 75 g. Show that the maximum speed of the bob is about 0.7 m s^{-1}. *[2 marks]*

. . . .

. . . .

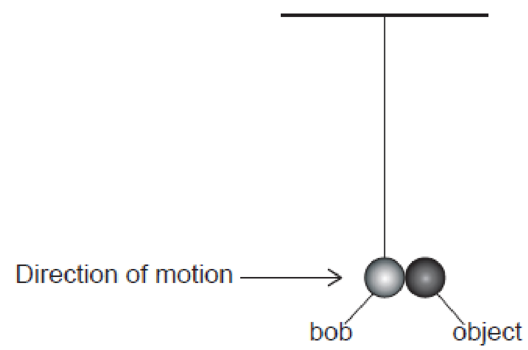
. . . .

. . . .

. . . .

. . . .

When the 75 g bob is moving horizontally at 0.80 m s^{-1}, it collides with a small stationary object also of mass 75 g. The object and the bob stick together.



14d. Calculate the speed of the combined masses immediately after the collision. *[1 mark]*

. . . .

. . . .

. . . .

14e. Show that the collision is inelastic. *[3 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

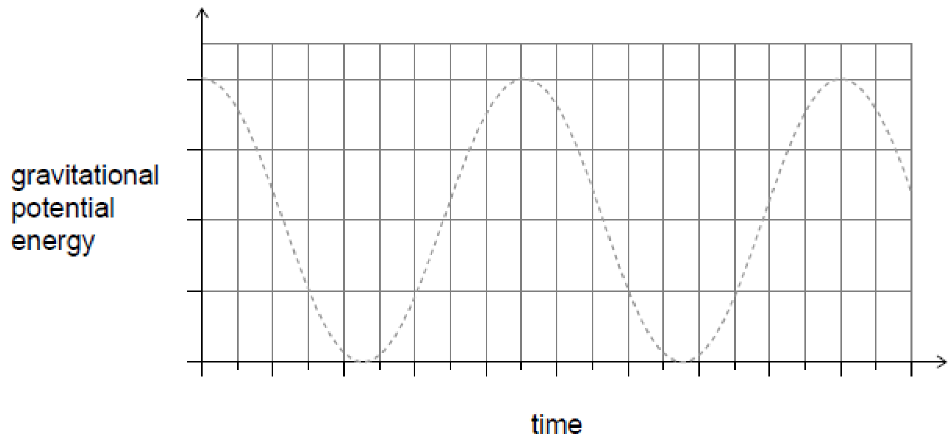
. . . .

. . . .

. . . .

14f. Sketch, on the axes, a graph to show the variation of gravitational potential energy with time for the bob and the object after the collision. *[2 marks]*

The data from the graph used in (a) is shown as a dashed line for reference.



. . . .

. . . .

. . . .

. . . .

. . . .

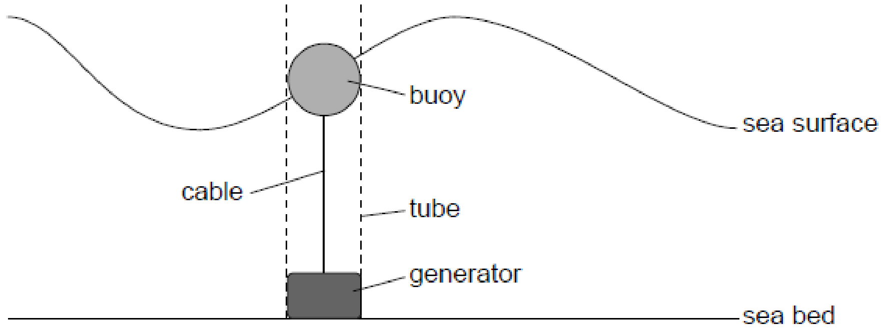
. . . .

14g. The speed after the collision of the bob and the object was measured using a sensor. This sensor emits a sound of frequency f and this sound is reflected from the moving bob. The sound is then detected by the sensor as frequency f'. *[3 marks]*

Explain why f and f' are different.

15a. Outline the conditions necessary for simple harmonic motion (SHM) to occur. *[2 marks]*

A buoy, floating in a vertical tube, generates energy from the movement of water waves on the surface of the sea. When the buoy moves up, a cable turns a generator on the sea bed producing power. When the buoy moves down, the cable is wound in by a mechanism in the generator and no power is produced.



The motion of the buoy can be assumed to be simple harmonic.

15b. A wave of amplitude 4.3 m and wavelength 35 m, moves with a speed of 3.4 m s^{-1}. Calculate the maximum vertical speed of the buoy. *[3 marks]*

....

....

....

....

....

....

....

....

....

15c. Sketch a graph to show the variation with time of the generator output power. Label the time axis with a suitable scale. *[2 marks]*

Water can be used in other ways to generate energy.

15d. Outline, with reference to energy changes, the operation of a pumped storage hydroelectric system. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

15e. The water in a particular pumped storage hydroelectric system falls a vertical distance of 270 m to the turbines. Calculate the speed at which water arrives at the turbines. Assume that there is no energy loss in the system. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

15f. The hydroelectric system has four 250 MW generators. Determine the maximum time for which the hydroelectric system can maintain full output when a mass of 1.5×10^{10} kg of water passes through the turbines. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

15g. Not all the stored energy can be retrieved because of energy losses in the system. Explain **two** such losses. *[2 marks]*

1. . . . .

. . . .

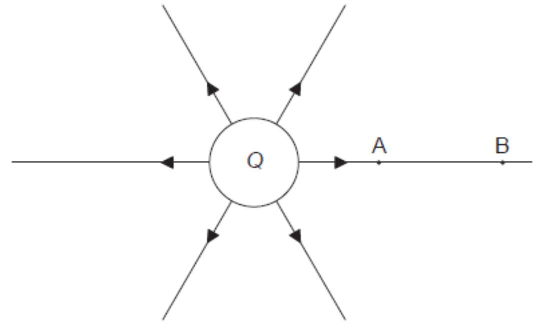
. . . .

2. . . . .

. . . .

. . . .

The diagram shows the electric field lines of a positively charged conducting sphere of radius R and charge Q.



Points A and B are located on the same field line.

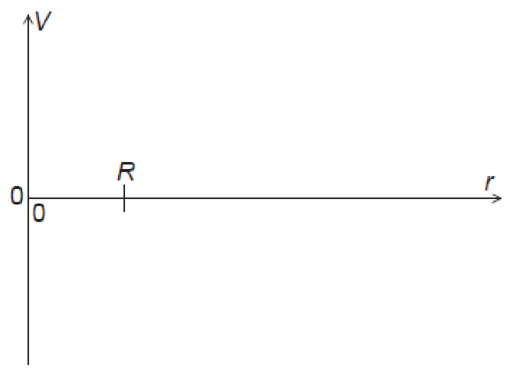
16a. Explain why the electric potential decreases from A to B. *[2 marks]*

. . . .

. . . .

. . . .

16b. Draw, on the axes, the variation of electric potential V with distance r from the centre of the sphere. *[2 marks]*



A proton is placed at A and released from rest. The magnitude of the work done by the electric field in moving the proton from A to B is 1.7×10^{-16} J. Point A is at a distance of 5.0×10^{-2} m from the centre of the sphere. Point B is at a distance of 1.0×10^{-1} m from the centre of the sphere.

16c. Calculate the electric potential difference between points A and B. *[1 mark]*

....

....

....

16d. Determine the charge Q of the sphere. *[2 marks]*

....

....

....

16e. The concept of potential is also used in the context of gravitational fields. Suggest why scientists developed a common terminology to describe different types of fields. *[1 mark]*

....

....

....

The primary coil of a transformer is connected to a 110 V alternating current (ac) supply. The secondary coil of the transformer is connected to a 15 V garden lighting system that consists of 8 lamps connected in parallel. Each lamp is rated at 35 W when working at its normal brightness. Root mean square (rms) values are used throughout this question.

17a. The primary coil has 3300 turns. Calculate the number of turns on the secondary coil. *[1 mark]*

....

....

....

17b. Determine the total resistance of the lamps when they are working normally. *[2 marks]*

....

....

....

....

....

....

17c. Calculate the current in the primary of the transformer assuming that it is ideal. *[2 marks]*

....

....

....

....

....

....

17d. Flux leakage is one reason why a transformer may not be ideal. Explain the effect of flux leakage on the transformer. *[2 marks]*

....

....

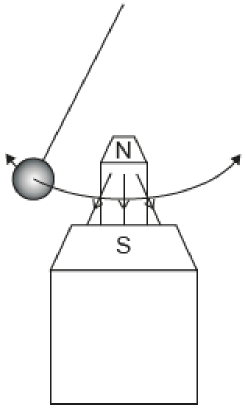
....

....

....

....

17e. A pendulum with a metal bob comes to rest after 200 swings. The same pendulum, released from the same position, now swings at 90° to the direction of a strong magnetic field and comes to rest after 20 swings. *[4 marks]*



Explain why the pendulum comes to rest after a smaller number of swings.

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

A capacitor consists of two parallel square plates separated by a vacuum. The plates are 2.5 cm × 2.5 cm squares. The capacitance of the capacitor is 4.3 pF.

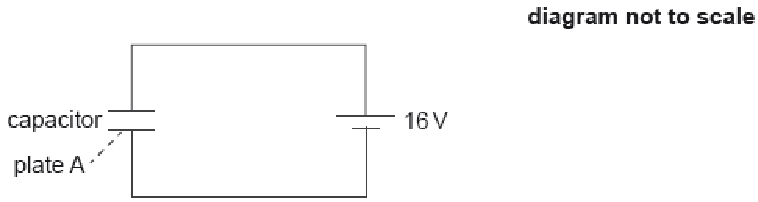
18a. Calculate the distance between the plates. *[1 mark]*

. . . .

. . . .

. . . .

18b. The capacitor is connected to a 16 V cell as shown. *[2 marks]*



Calculate the magnitude and the sign of the charge on plate A when the capacitor is fully charged.

....

....

....

....

....

....

18c. The capacitor is fully charged and the space between the plates is then filled with a dielectric of permittivity $\varepsilon = 3.0\varepsilon_0$. *[2 marks]*

Explain whether the magnitude of the charge on plate A increases, decreases or stays constant.

....

....

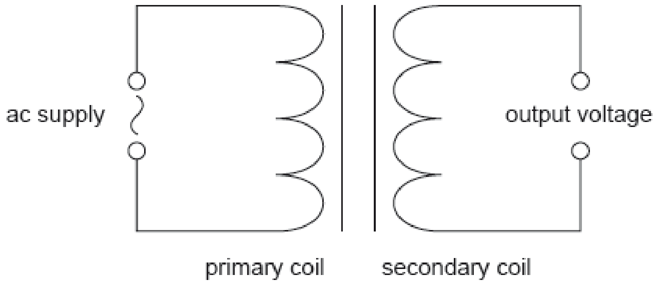
....

....

....

....

18d. In a different circuit, a transformer is connected to an alternating current (ac) supply. *[3 marks]*



The transformer has 100 turns in the primary coil and 1200 turns in the secondary coil. The peak value of the voltage of the ac supply is 220 V. Determine the root mean square (rms) value of the output voltage.

....

....

....

....

....

....

18e. Describe the use of transformers in electrical power distribution. *[3 marks]*

....

....

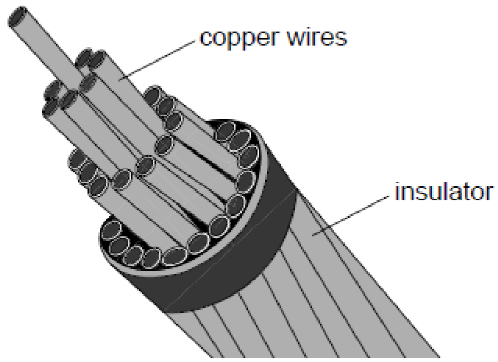
....

....

....

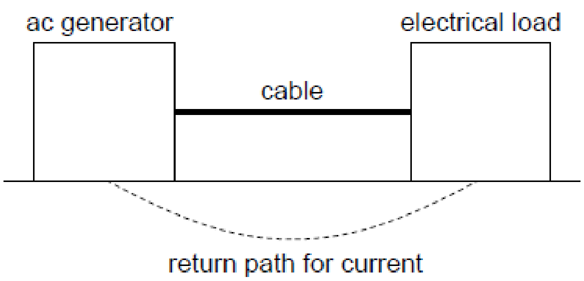
....

A cable consisting of many copper wires is used to transfer electrical energy from an alternating current (ac) generator to an electrical load. The copper wires are protected by an insulator.



The cable consists of 32 copper wires each of length 35 km. Each wire has a resistance of 64 Ω. The cable is connected to the ac generator which has an output power of 110 MW when the peak potential difference is 150 kV. The resistivity of copper is 1.7×10^{-8} Ω m.

output power = 110 MW



19a. Calculate the radius of each **wire**. *[2 marks]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

19b. Calculate the peak current in the **cable**. *[1 mark]*

. . . .

. . . .

. . . .

19c. Determine the power dissipated in the cable per unit length. *[3 marks]*

. . . .

. . . .

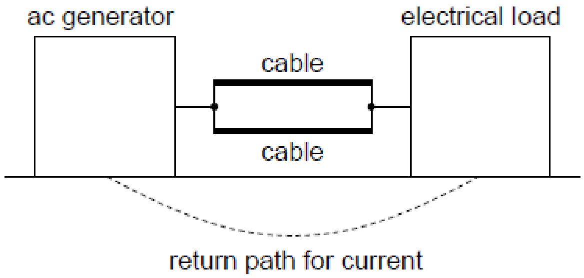
. . . .

. . . .

. . . .

. . . .

To ensure that the power supply cannot be interrupted, two identical cables are connected in parallel.



19d. Calculate the root mean square (rms) current in each cable. *[1 mark]*

. . . .

. . . .

. . . .

19e. The two cables in part (c) are suspended a constant distance apart. *[2 marks]*
Explain how the magnetic forces acting between the cables vary during the course of one cycle of the alternating current (ac).

....

....

....

....

....

....

The energy output of the ac generator is at a much lower voltage than the 150 kV used for transmission. A step-up transformer is used between the generator and the cables.

19f. Suggest the advantage of using a step-up transformer in this way. *[2 marks]*

....

....

....

....

....

....

19g. The use of alternating current (ac) in a transformer gives rise to energy losses. State how eddy current loss is minimized in the transformer. *[1 mark]*

....

....

....

Monochromatic light of very low intensity is incident on a metal surface. The light causes the emission of electrons almost instantaneously. Explain how this observation

20a. does not support the wave nature of light. *[2 marks]*

. . . .

. . . .

. . . .

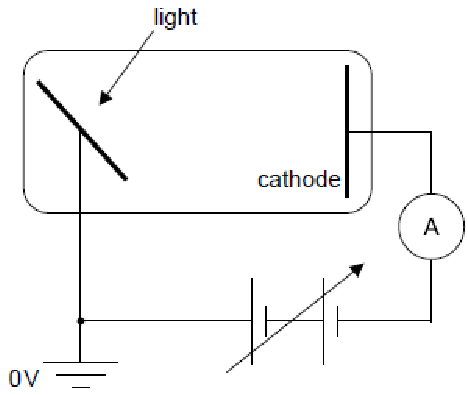
20b. does support the photon nature of light. *[2 marks]*

. . . .

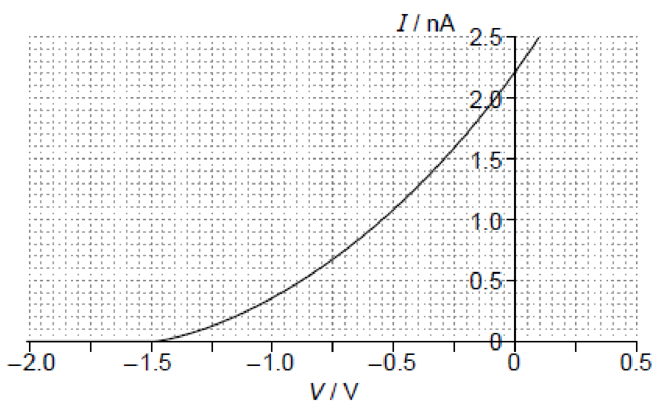
. . . .

. . . .

In an experiment to demonstrate the photoelectric effect, light of wavelength 480 nm is incident on a metal surface.



The graph shows the variation of the current I in the ammeter with the potential V of the cathode.



20c. Calculate, in eV, the work function of the metal surface. *[3 marks]*

....

....

....

....

....

....

20d. The intensity of the light incident on the surface is reduced by half without changing the wavelength. Draw, on the graph, the variation of the current I with potential V after this change. *[2 marks]*