PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



EXAM QUESTION PACK

SECTION 2: ELECTRICITY (PACK 2)

SCORE	PERCENTAGE
/183	%

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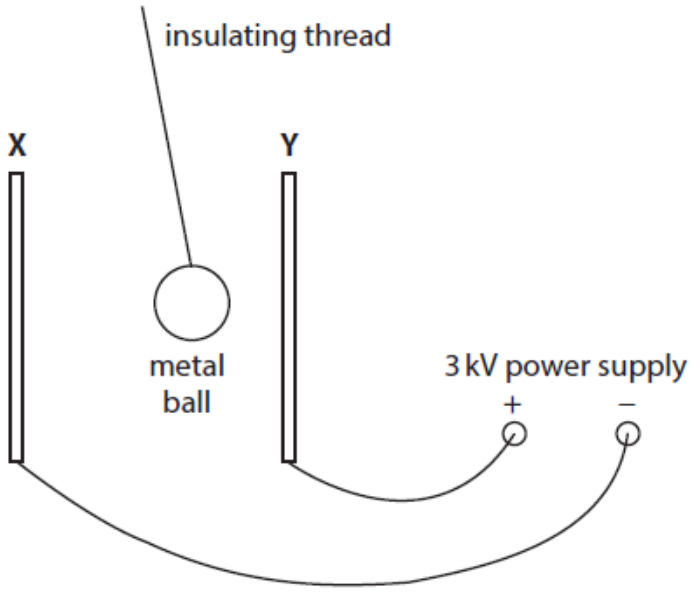
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Q1.

This question is about a demonstration to show the link between current and charge.

The diagram shows two metal plates, X and Y, with a metal ball moving between them.



(a) The two metal plates have no charge before the power supply is connected.

When plate Y is connected to the positive terminal of the power supply, the plate becomes positively charged.

Explain how plate Y gains a positive charge.

(2)

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(b) (i) The metal ball becomes positively charged when it touches plate Y.

The metal ball then moves away from plate Y towards plate X.

Explain why the metal ball moves away from plate Y.

(2)

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(ii) Give a reason why the ball is made of metal.

(1)

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(c) When the metal ball moves away from plate Y to plate X, a charge of 5.1×10^{-6} C is transferred.

(i) State the formula linking charge transferred, current and time taken.

(1)

(ii) Calculate the current if the metal ball takes 0.45 seconds to travel from plate Y to plate X.

(2)

current = ... A

(iii) Suggest why the current increases if the voltage of the power supply is increased.

(1)

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(iv) Give the name of the apparatus that can be used to measure current.

(1)

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(Total for question = 10 marks)

Q2.

This is a question about alpha particles.

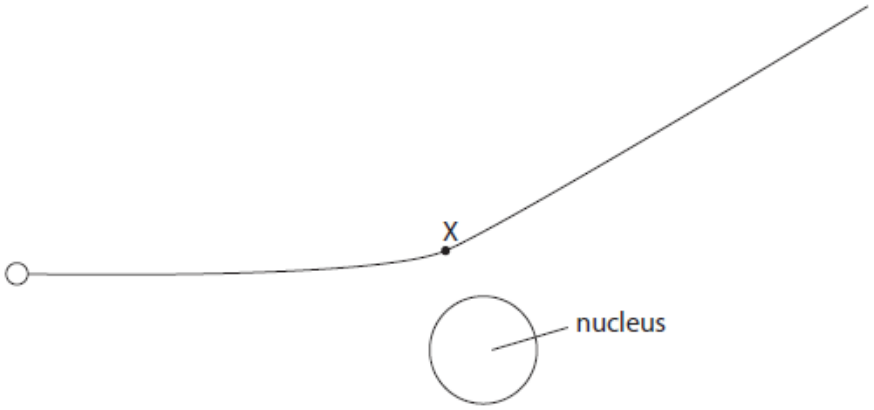
(a) Describe the nature of an alpha particle.

(1)

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(b) The diagram shows the path of an alpha particle as it passes close to a nucleus.



(i) Draw an arrow from point X to show the force on the alpha particle due to the nucleus.

Label this force Y.

(2)

(ii) Draw an arrow to show the force on the nucleus due to the alpha particle.

Label this force Z.

(2)

(iii) Explain how the path of the alpha particle shows whether the nucleus is positive, negative or neutral.

(3)

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(c) The alpha particle experiences a resultant force of 3.6 N and has a mass of 6.6×10^{-27} kg.

Calculate the acceleration of the alpha particle.

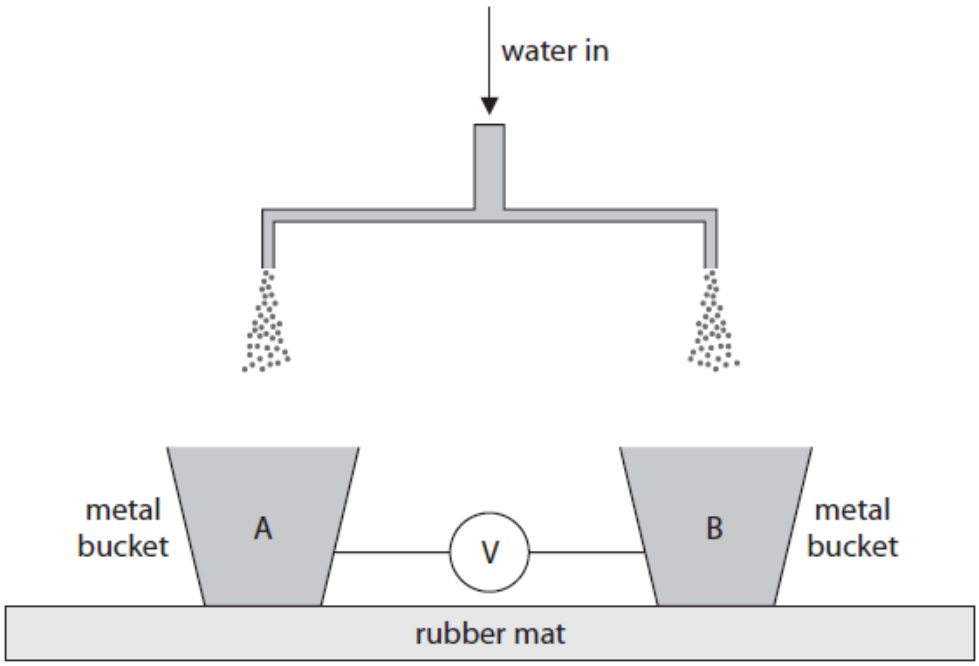
(3)

acceleration = ... m/s^2

(Total for question = 11 marks)

Q3.

The diagram shows part of a device used to demonstrate electrostatic charge.



(a) Negatively charged water droplets fall into bucket A.

Describe how bucket A becomes negatively charged.

(2)

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(b) Explain why the negatively charged droplets spread out as they fall.

(2)

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(c) (i) A droplet hits bucket A with a speed of 3.8 m/s.

Calculate the kinetic energy of the droplet when it hits bucket A.

[mass of droplet = 6.2×10^{-9} kg]

(3)

kinetic energy = ... J

(ii) The total charge stored in bucket A is -1.1×10^{-10} C.

This charge passes through the air between the buckets in 9.2×10^{-3} s, causing a spark between bucket A and bucket B.

Calculate the mean current between the buckets.

(3)

mean current = ... A

(iii) The spark transfers a charge of -1.1×10^{-10} C.

The mean voltage between the buckets is 1.7 kV.

Calculate the energy transferred by the spark.

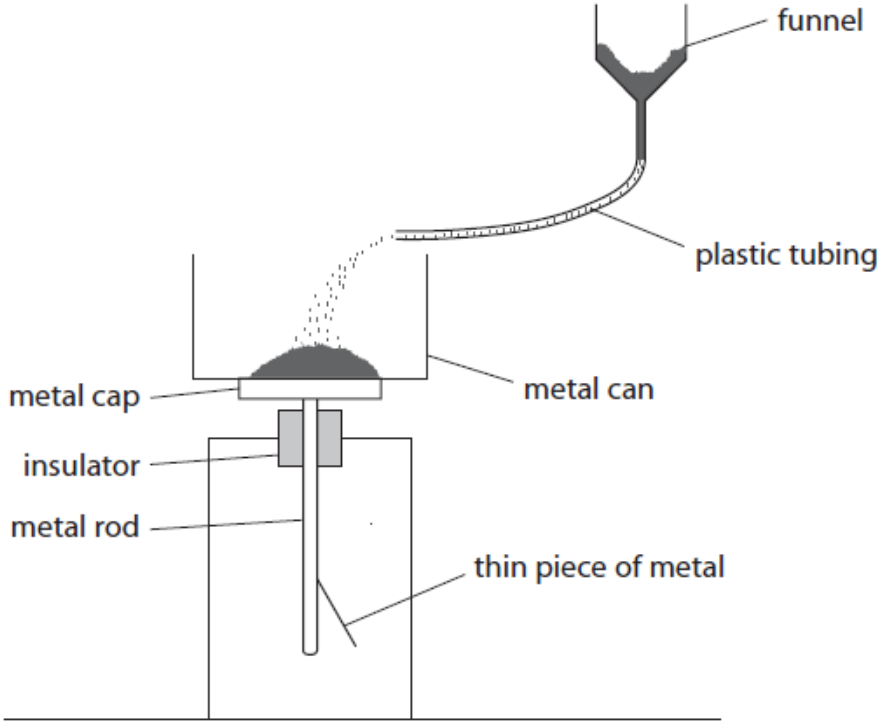
(3)

energy transferred = ... J

(Total for question = 13 marks)

Q4.

A student uses this apparatus to demonstrate the effect of electric charge.



He pours some fine powder into a funnel.

The fine powder moves through a length of plastic tubing and falls into a metal can.

The metal can rests on a metal cap.

The metal cap is connected to a thin piece of metal via a metal rod.

When the powder lands in the can, the thin piece of metal moves away from the metal rod.

(a) Explain why the thin piece of metal moves away from the metal rod.

(4)

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(b) A coulombmeter measures electric charge.

The student connects a coulombmeter to the metal can.

When all the powder has landed in the can, the coulombmeter shows a reading of -9.4×10^{-9} C.

(i) Which statement is true for the metal can?

(1)

☒ **A** it gains negatively charged electrons

☒ **B** it loses negatively charged electrons

☒ **C** it gains positively charged electrons

☒ **D** it loses positively charged electrons

(ii) State the formula linking charge, current and time.

(1)

(iii) It takes a time of 12 s from when the powder starts landing in the metal can until all the powder has landed in the can.

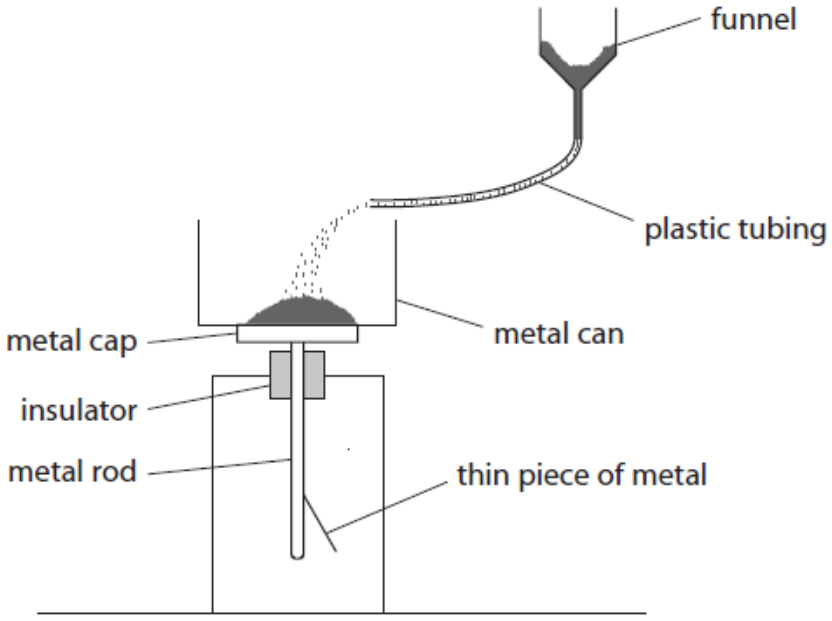
Calculate the mean charging current.

(3)

current = ... A

(c) The student suggests that this demonstration is similar to refuelling an aircraft.

The powder represents the fuel and the metal can represents the fuel tank in the aircraft.



Explain how the student should modify this apparatus to demonstrate how to minimise the dangers when refuelling an aircraft.

You may add to the diagram to help your answer.

(3)

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(Total for question = 12 marks)

Q5.

A racing car uses an engine and an electric motor to power its wheels.



(Source: Jens Mommens/Shutterstock)

(a) The electric motor can only operate at maximum power for part of each lap of the race.

The electric motor has a maximum power output of 1.2×10^5 W.

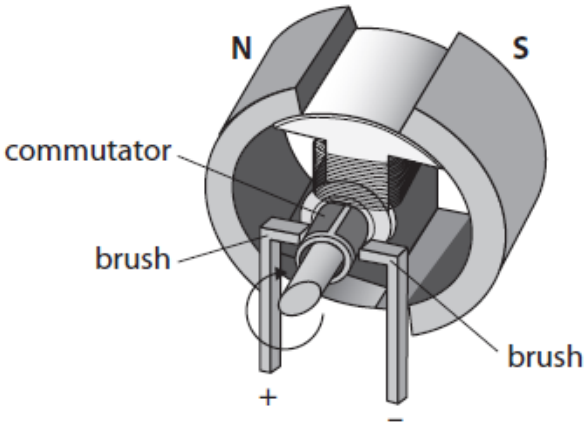
The electric motor transfers 4.0×10^6 J of energy when it operates at maximum power.

Calculate the amount of time the electric motor can operate at maximum power.

(3)

time = ... s

(b) The diagram shows a simplified view of a direct current (d.c.) electric motor.



(i) State what is meant by the term **direct current**.

(1)

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(ii) Explain the purpose of the brushes and the commutator in the d.c. motor.

(3)

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(c) The electric motor in the racing car can also be used as a generator to charge a battery pack. It is known as a motor generator unit (MGU).

The rotating wheels of the car cause the magnets in the MGU to spin near a coil of wire.

This induces a current in the coil when the coil is connected to the battery pack.

(i) Name the energy store of the battery pack that increases when the battery pack is being charged.

(1)

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(ii) Explain why the kinetic energy store of the car must decrease when the MGU charges the battery pack.

(3)

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(Total for question = 11 marks)

Q6.

Lightning strikes the Earth frequently and often starts in rain clouds.

Inside the clouds, powerful winds move ice particles and tiny water droplets.

The bottom of the clouds becomes negatively charged and the top becomes positively charged.

(a) Give a reason why the clouds become charged.

(1)

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(b) The ground below the cloud becomes positively charged.

Explain why the ground becomes charged.

You should use ideas about electron movement in your answer.

(2)

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(c) The build-up of charge in the cloud and in the ground causes the air to ionise.

This means that the air becomes a conductor, and a low resistance path from the cloud to the ground is formed.

(i) State what is meant by the term **ionise**.

(1)

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(ii) State the relationship between charge, current and time.

(1)

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(iii) During one lightning strike, the mean current is 32 kA and the mean charge transferred is 15 C.

Calculate the mean time duration of a lightning strike.

(2)

mean time = ... s

(iv) The mean energy transferred during the lightning strike is 510×10^6 J.

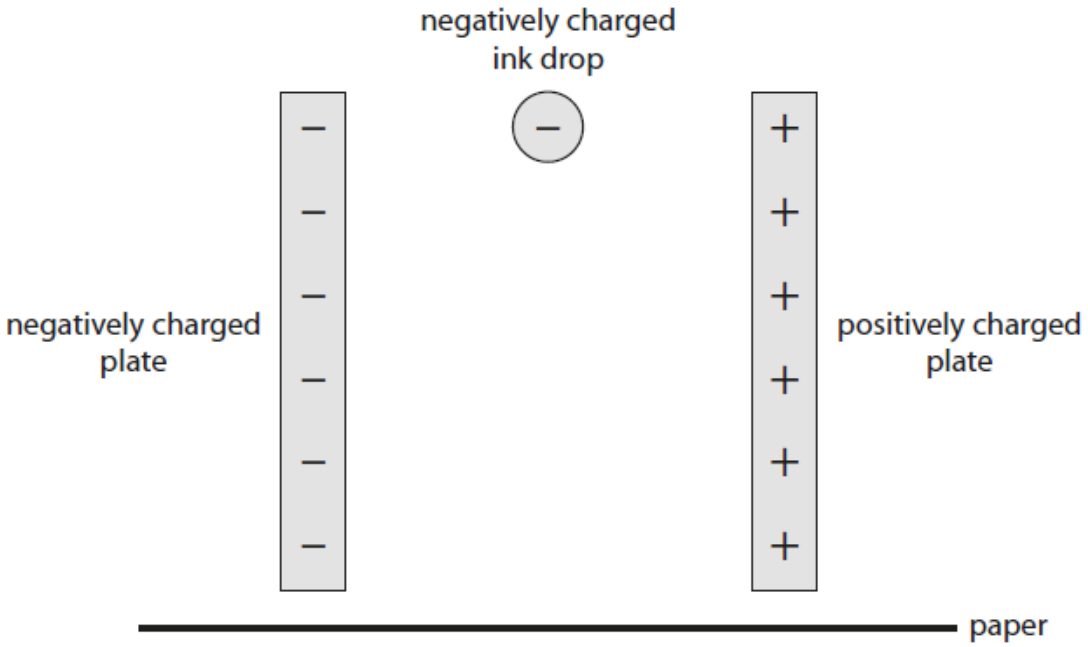
Show that the resistance of the air is approximately 1000 Ω.

(4)

(Total for question = 11 marks)

Q7.

The diagram shows a simplified view of part of an inkjet printer.



A negatively charged ink drop falls vertically between a pair of charged plates.

(a) The ink drop experiences a horizontal electrostatic force as it falls.

Explain the direction of the electrostatic force exerted on the ink drop by the charged plates.

(2)

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(b) On the diagram, draw the path of the ink drop as it falls between the charged plates until it hits the paper.

(2)

(c) (i) The ink drop experiences a horizontal force of 8.5×10^{-7} N when it is between the charged plates.

The mass of the ink drop is 1.1×10^{-10} kg.

Calculate the horizontal acceleration of the ink drop when it is between the charged plates.

(3)

acceleration = ... m/s^2

(ii) The ink drop has no initial horizontal velocity before it passes between the charged plates.

After passing between the charged plates, the horizontal velocity of the ink drop is 3.9 m/s.

Calculate the horizontal distance travelled by the ink drop as it passes between the charged plates.

Give your answer in mm.

(4)

distance = ... mm

(d) Explain how another ink drop could be deflected in the opposite direction by a greater distance using the charged plates in the inkjet printer.

(2)

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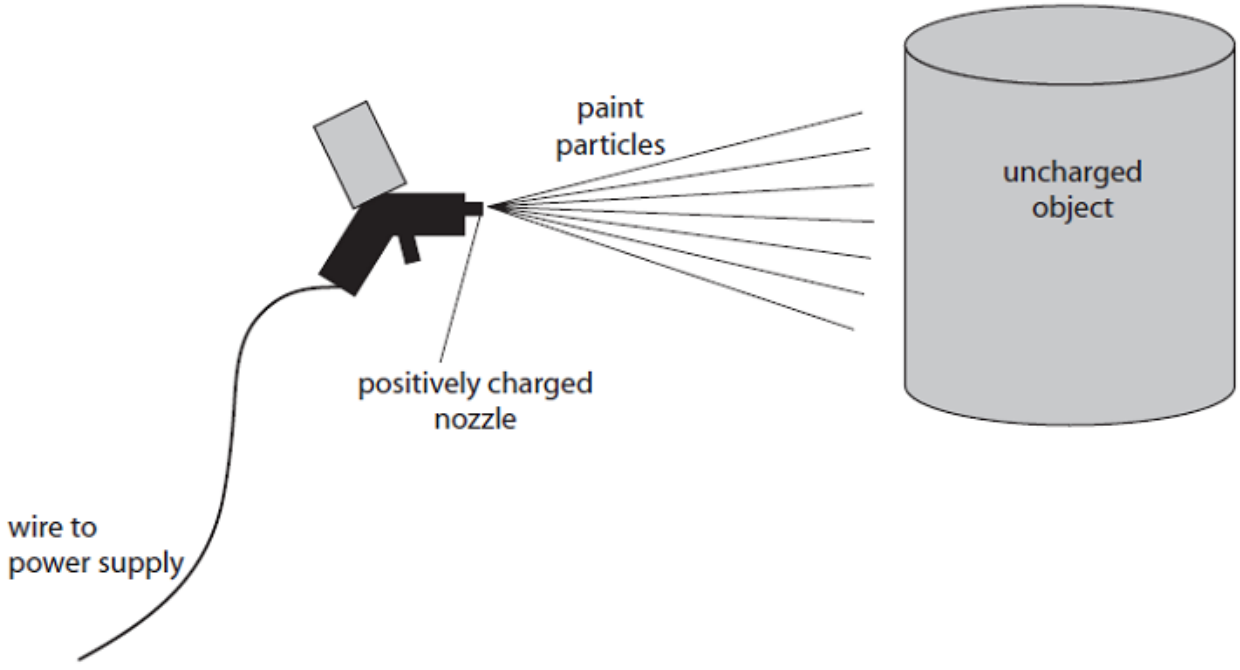
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(Total for question = 13 marks)

Q8.

An electrostatic paint sprayer is used to paint an object.



(a) The nozzle of the paint sprayer is positively charged.

Explain the advantage of using a charged nozzle.

(3)

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(b) The object is an electrical conductor and is initially uncharged.

Explain why the painting process would be more effective if the object were earthed.

(3)

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(Total for question = 6 marks)

Q9.

Diagram 1 shows a machine used for demonstrating electrostatics.

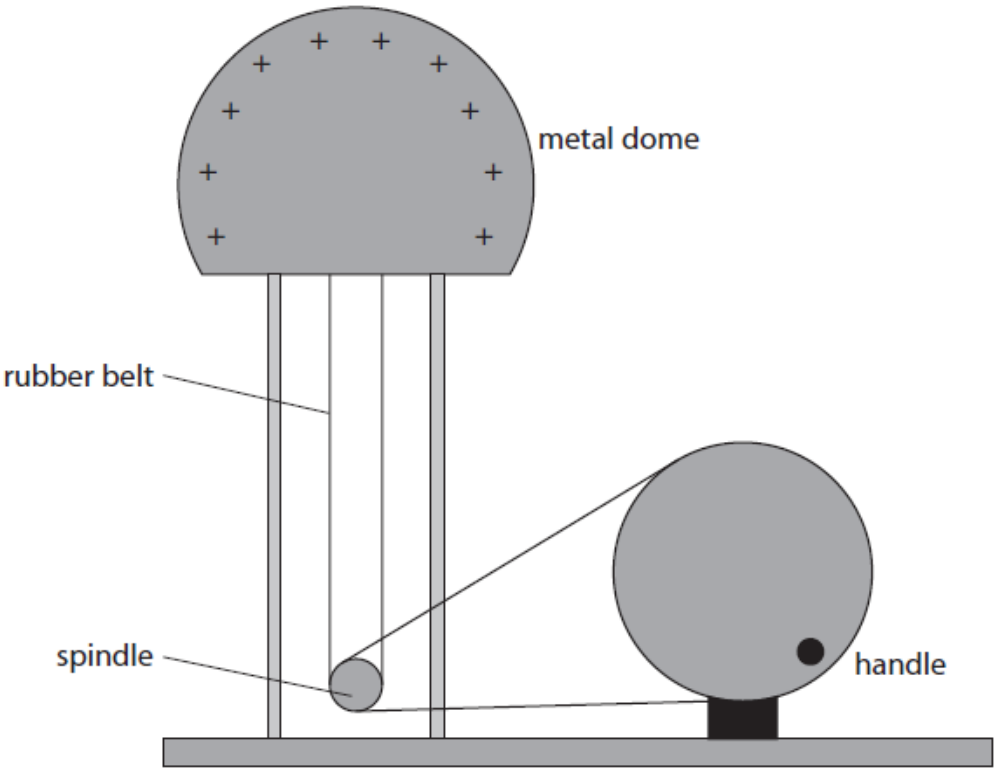


Diagram 1

(a) When the handle is turned, the dome becomes positively charged.

(i) In terms of electron movement, give a reason why the metal dome becomes positively charged.

(1)

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(ii) When the handle is turned for 15 s the dome gains 0.50 J of energy in its electrostatic store as it becomes charged.

The voltage between the dome and the earth is 120 kV.

Calculate the mean charging current during this time.

(3)

mean charging current = ... A

(b) The metal dome is discharged.

A thin metal case is then placed on top of the metal dome, as shown in Diagram 2.

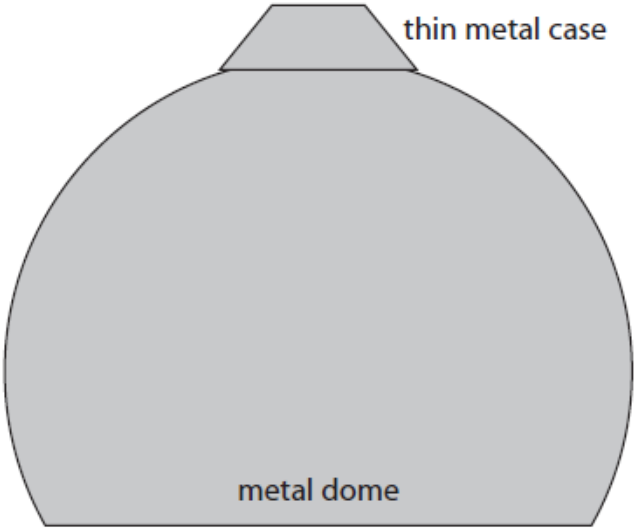


Diagram 2

(i) When the handle is turned, the thin metal case moves upwards away from the dome.

Explain why the thin metal case starts to move upwards.

(3)

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(ii) Explain why the metal case reaches a maximum height above the metal dome.

(4)

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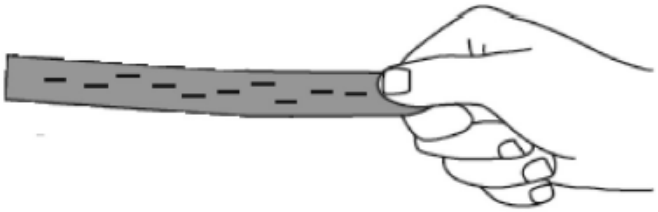
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(Total for question = 11 marks)

Q10.

This question is about electrostatics.

(a) A student uses a plastic rod to investigate electrostatics.



(i) Describe how the student could have charged the plastic rod.

(2)

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(ii) The student uses a meter to measure the amount of charge on the rod.

The meter displays a reading of –5.2 mC.

Which of these is the same as –5.2 mC?

(1)

☒ **A** –0.52 C

☒ **B** –0.052 C

☒ **C** –0.0052 C

☒ **D** –0.00052 C

(iii) The rod is negatively charged.

Which statement correctly explains why the rod is negatively charged?

(1)

☒ **A** the rod has gained negatively charged electrons

☒ **B** the rod has gained positively charged electrons

☒ **C** the rod has lost negatively charged electrons

☒ **D** the rod has lost positively charged electrons

(iv) Using a meter is one method of demonstrating that the rod is charged.

Describe another method of demonstrating that the rod is charged.

(2)

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(b) Electrostatic charges can be useful but they can also be dangerous.

(i) Give one use of electrostatic charges.

(1)

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(ii) Explain why electrostatic charges can be dangerous when fuelling an aeroplane.

(2)

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(Total for question = 9 marks)

Q11.

Magnetic Resonance Imaging (MRI) machines can take scans of the inside of a patient.

(a) There is an electromagnet inside the MRI machine.

Describe the construction of an electromagnet.

You may draw a diagram to help your answer.

(4)

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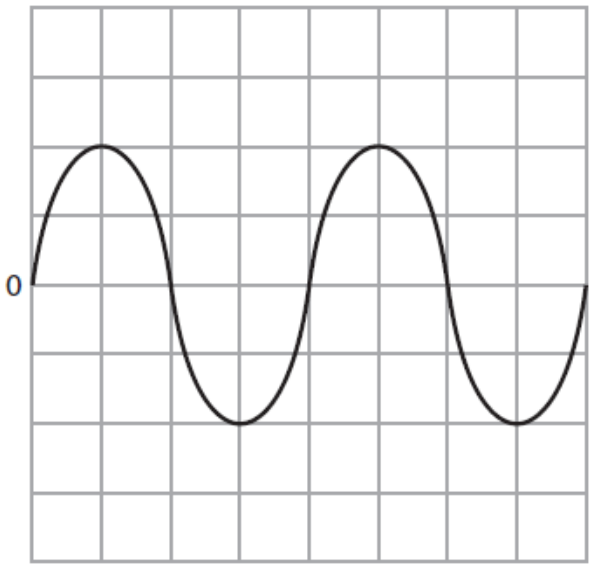
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(b) During the scan, music can be played through a loudspeaker to the patient.

The oscilloscope trace in the diagram represents a sound played to the patient.



Oscilloscope settings:

y direction: 1 square = 0.5 V

x direction: 1 square = 0.5 ms

(i) Determine the period of the sound wave.

(3)

period = ... s

(ii) Calculate the frequency of the sound wave.

(2)

frequency = ... Hz

(iii) Deduce whether humans can hear the sound wave.

(2)

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(iv) The current in the loudspeaker is alternating current (a.c.).

Give the evidence from the oscilloscope trace to support this statement.

(2)

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(v) Draw the circuit symbol for an a.c. power supply.

(1)

(Total for question = 14 marks)

Q12.

Nuclear fusion is a process that occurs in the core of stars.

(a) Which is the best description of nuclear fusion?

(1)

☒ **A** large nucleus splitting into two smaller nuclei

☒ **B** nucleus emitting an electromagnetic wave

☒ **C** nucleus releasing a beta particle

☒ **D** two smaller nuclei joining together to form a larger nucleus

(b) Two nuclei are close together and stationary.

Explain why these nuclei will move apart.

(2)

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(c) Describe the conditions needed for fusion to occur in the core of a star.

(2)

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(Total for question = 5 marks)

Q13.

The SPS is a particle accelerator in Geneva.

The SPS can accelerate sulfur particles to speeds almost as fast as the speed of light.

(a) Neutral sulfur particles can become positively charged sulfur particles.

Describe the difference between a neutral sulfur particle and a positively charged sulfur particle.

(2)

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(b) Diagram 1 shows a section of the SPS.

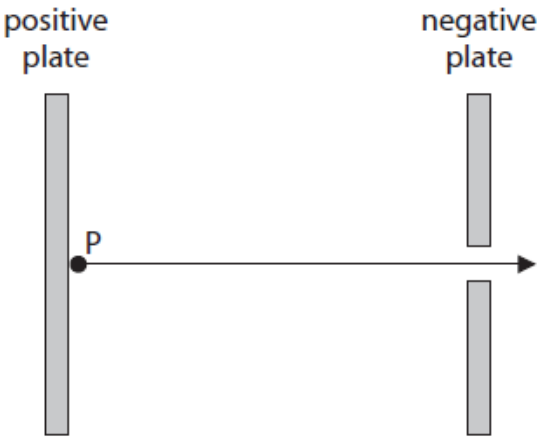


Diagram 1

Positively charged sulfur particles are introduced at point P and accelerate to the right.

Explain why the positively charged sulfur particles accelerate.

(2)

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(c) The sulfur particles enter a large tube and complete a circular orbit.

Diagram 2 shows a sulfur particle, travelling with velocity v, in the tube.

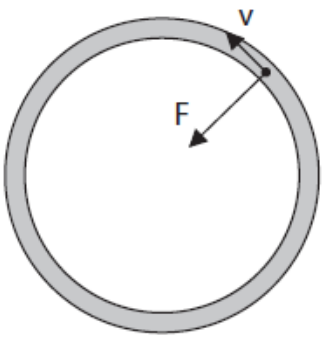


Diagram 2

(i) A magnetic force acts on the positively charged sulfur particle.

This force makes the particle travel in a circle.

The force is labelled F.

Use the left-hand rule to determine the direction of the applied magnetic field.

(1)

- ☒ **A** ↘ opposite to the direction of the velocity
- ☒ **B** ↙ along direction of force
- ☒ **C** ⊙ out of the page
- ☒ **D** ⊗ into the page

(ii) The tube has a radius of 1.1 km and the sulfur particle has an orbital speed of 2.9×10^8 m/s.

Calculate the orbital period of the sulfur particle.

(3)

orbital period = ... s

(Total for question = 8 marks)

Q14.

This question is about magnetic fields.

(a) Diagram 1 shows a positively charged proton moving downwards in a uniform magnetic field.

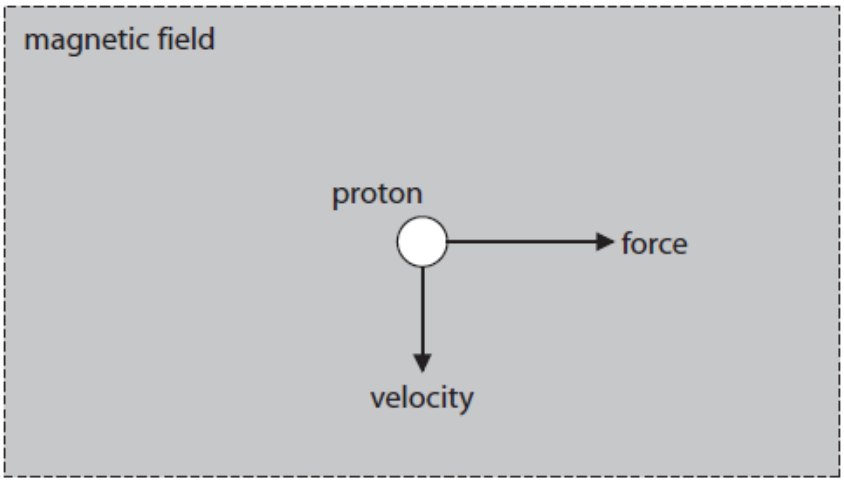


Diagram 1

The proton experiences a force to the right.

What is the direction of the magnetic field?

(1)

- ☒ **A** into the page
- ☒ **B** left
- ☒ **C** out of the page
- ☒ **D** upward

(b) When a current passes through a flat circular coil, a magnetic field is produced.

Complete diagram 2 by drawing the magnetic field of the flat circular coil.

(3)



Diagram 2

(c) A wireless charging base uses a magnetic field to charge the battery of a mobile phone.



© BeeBright/Shutterstock

There is an alternating current in a coil of wire in the charging base.

There is another coil of wire connected to the battery in the mobile phone.

(i) Explain how the wireless charging base charges the battery of the mobile phone.

(3)

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(ii) Discuss the advantages and disadvantages of using a high current in the wireless charging base.

(2)

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(Total for question = 9 marks)

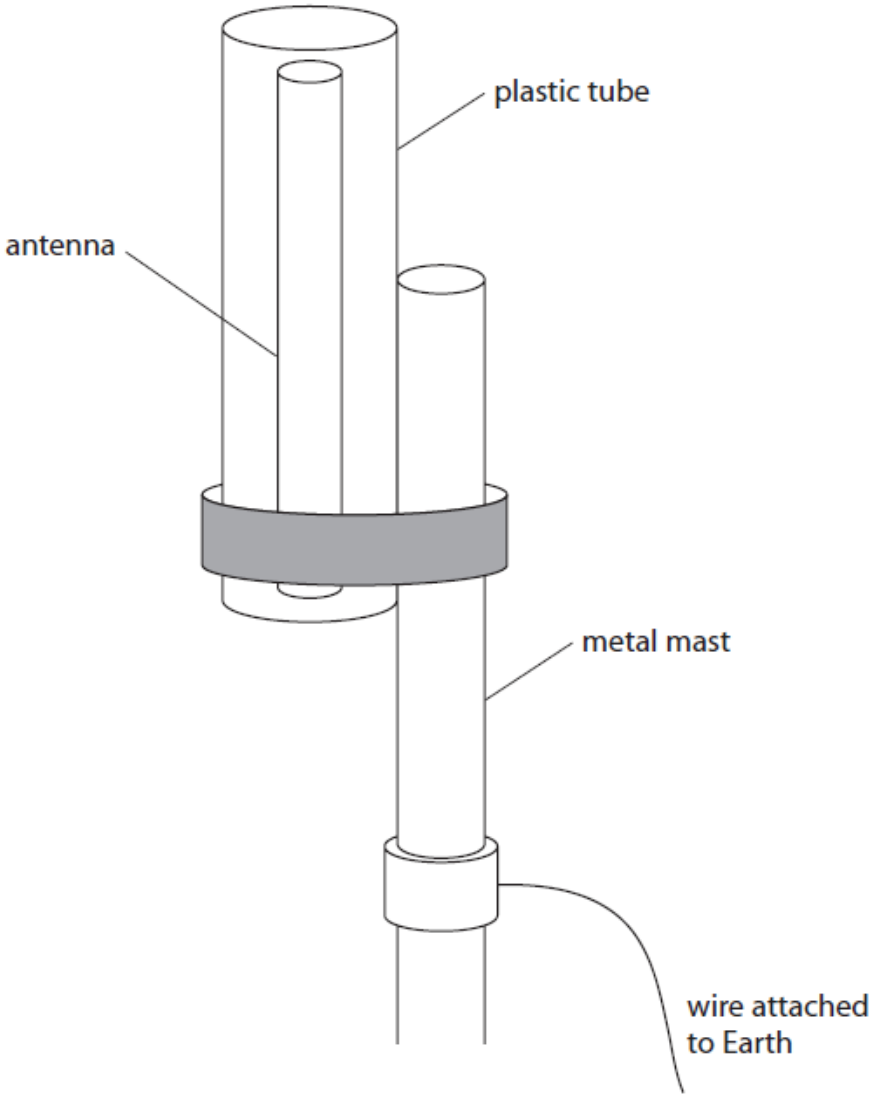
Q15.

The diagram shows part of a radio antenna.

The plastic tube protects the radio antenna from bad weather.

Dust particles carried by the wind rub against the plastic tube.

After some time, the dust particles cause the tube to become positively charged.



(a) State the property of plastic that allows it to become electrostatically charged.

(1)

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(b) Explain how the plastic tube becomes positively charged.

(2)

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(c) The plastic tube is attached to a metal mast.

This would cause the metal mast to become positively charged.

Explain why there is a wire connecting the metal mast to the Earth.

(3)

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(d) The plastic tube gains a charge of 4.3 mC.

The energy stored on the tube is 3.7 J.

Calculate the voltage between the plastic tube and the metal mast.

(3)

voltage = ... V

(e) An engineer is working on the radio antenna.

Describe the hazard to the engineer if there is no earth wire.

(2)

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(Total for question = 11 marks)

Q16.

The photograph shows a solar power farm.



© Alessandro Pierpaoli/Shutterstock

(a) Discuss the advantages and disadvantages of using solar power rather than fossil fuels to generate electricity.

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(b) Solar panels produce direct current (d.c.).

The National Grid in many countries operates on alternating current (a.c.).

Describe the difference between direct current (d.c.) and alternating current (a.c.).

(2)

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(Total for question = 6 marks)

Q17.

Mobile phone charger X contains a transformer and is used to charge the phone's battery.

Diagram 1 shows the information on charger X.

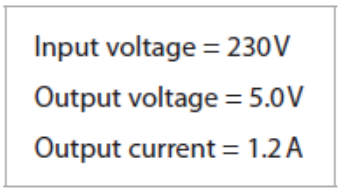


Diagram 1

(a) (i) The power of the charger can be calculated using the formula

power = current × voltage

Calculate the output power of charger X.

(2)

output power = ... W

(ii) Calculate the input current to charger X.

Assume that charger X is 100% efficient.

(3)

input current = ... A

(b) Charger X transfers a charge of 10 500 C to the mobile phone battery.

(i) State the formula linking charge, current and time.

(1)

(ii) Calculate the time in minutes to transfer a charge of 10 500 C to the battery.

(3)

time = ... minutes

(iii) Charger Y can also be used to charge the mobile phone battery.

Diagram 2 shows the information label for charger Y.

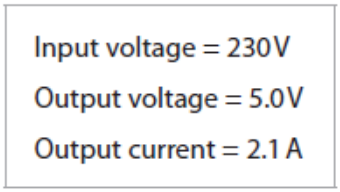


Diagram 2

Explain how the time taken to transfer the same amount of charge to the mobile phone battery will be affected when charger Y is used instead of charger X.

(2)

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(c) Both chargers contain step-down transformers.

Explain how a step-down transformer works.

You may include a diagram to support your answer.

(4)

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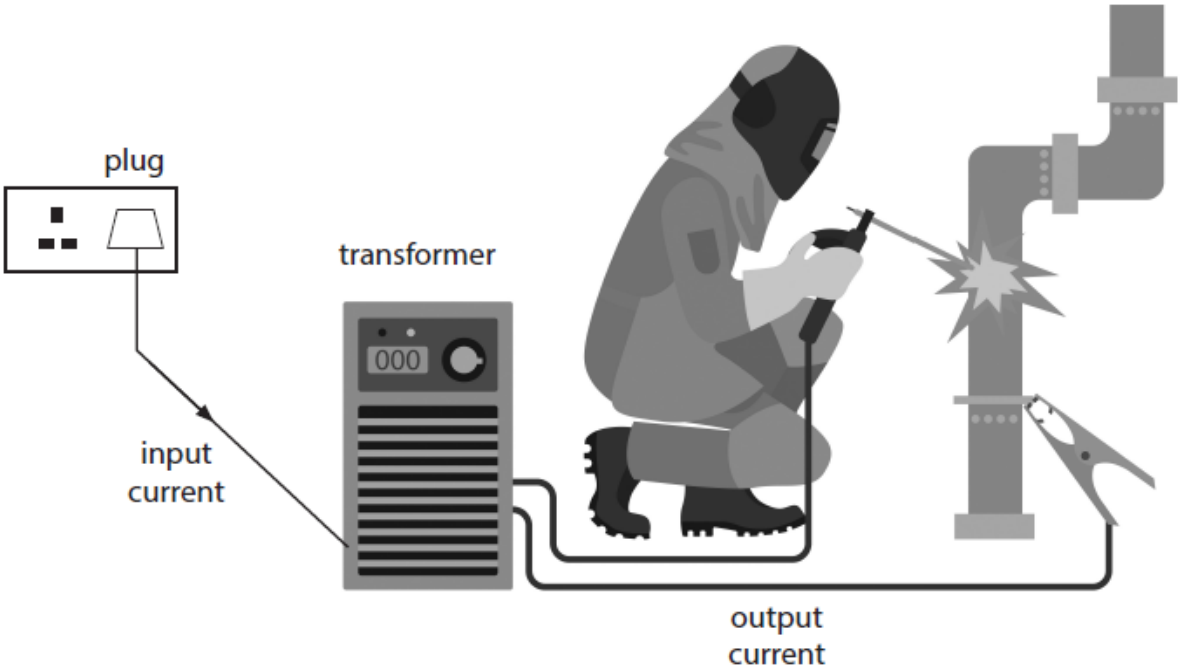
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(Total for question = 15 marks)

Q18.

Welding is a process where pieces of metal are melted and then joined together.

The diagram shows apparatus used for welding.



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The welding apparatus uses the transformer to decrease the voltage from 230 V.

(a) State the name of this type of transformer.

(1)

.....

(b) State the formula linking the turns ratio, the input voltage and the output voltage for a transformer.

(1)

(c) The table gives some information about the transformer.

input voltage in V	230
number of turns on input coil	16
number of turns on output coil	4
input current in A	11

(i) Use information from the table to calculate the output current of the transformer.

Assume that the transformer is 100% efficient.

(5)

current = ... A

(ii) A fuse is installed in the plug which supplies the input current.

Which fuse should be used in this plug?

(1)

☒ **A** 3 A

☒ **B** 5 A

☒ **C** 10 A

☒ **D** 13 A

(Total for question = 8 marks)