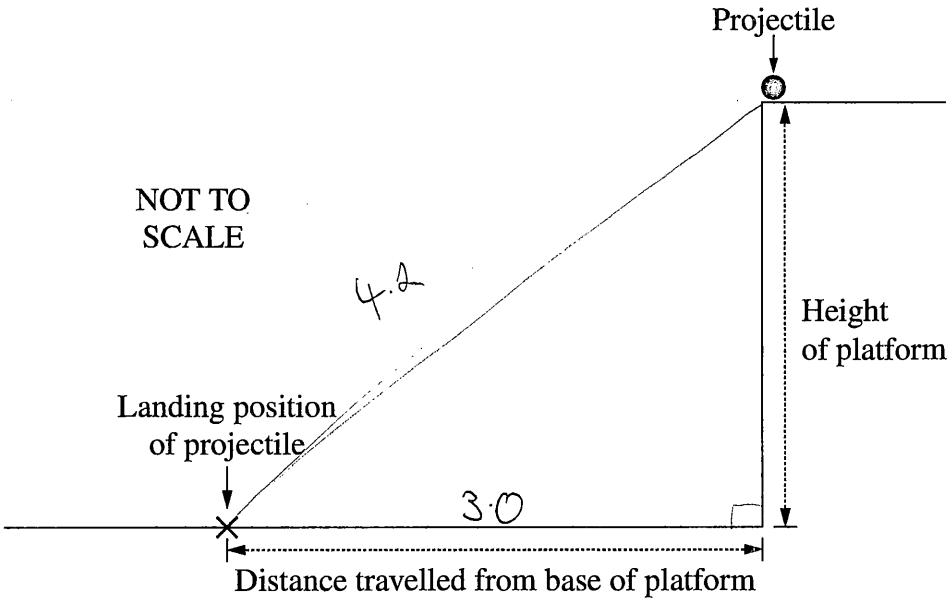
Question 21 (4 marks)

A projectile is fired horizontally from a platform.



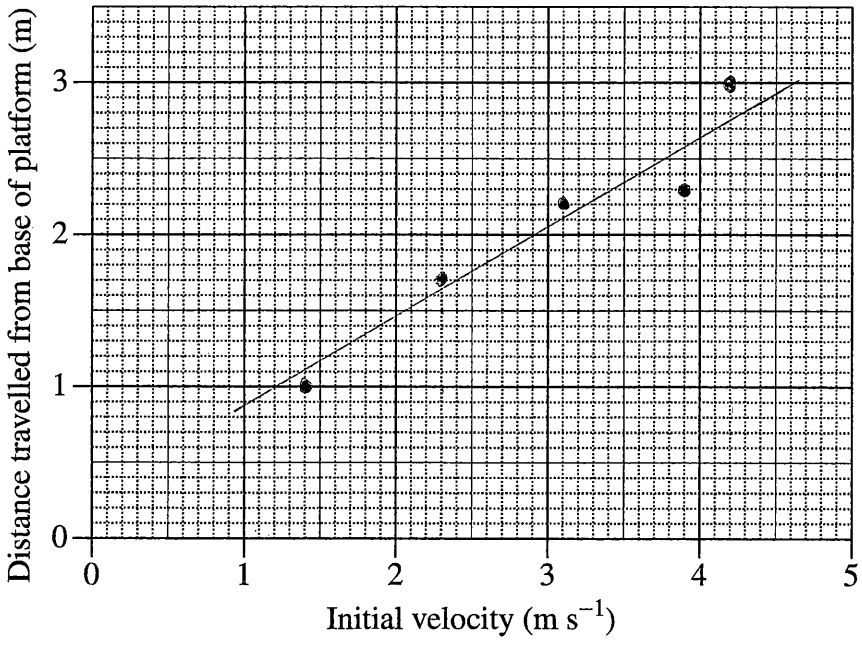
Measurements of the distance travelled by the projectile from the base of the platform are made for a range of initial velocities.

Initial velocity of projectile ($m\ s^{-1}$)	*Distance travelled from base of platform* (m)
1.4	1.0
2.3	1.7
3.1	2.2
3.9	2.3
4.2	3.0

Question 21 continues on page 15

Question 21 (continued)

(a) Graph the data on the grid provided and draw the line of best fit. **2**



(b) Calculate the height of the platform. **2**

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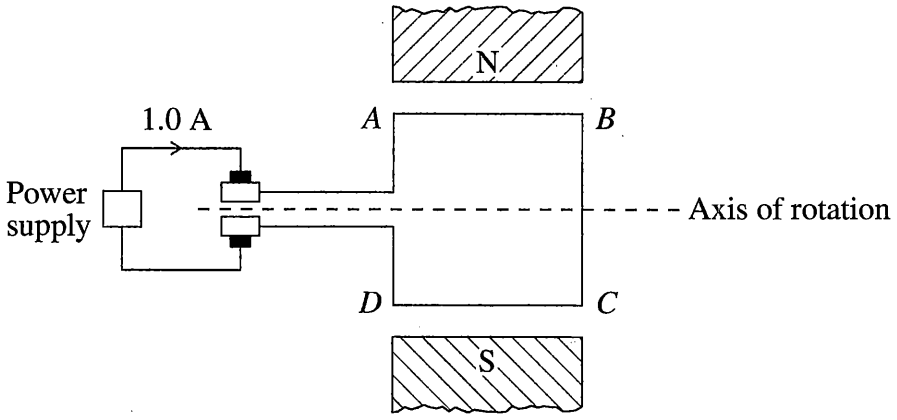
End of Question 21

Question 22 (5 marks)

The diagram represents a simple DC motor. A current of 1.0 A flows through a square loop *ABCD* with 5 cm sides in a magnetic field of 0.01 T.



(a) Determine the force acting on section *AB* and the force acting on section *BC* due to the magnetic field, when the loop is in the position shown. **3**

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(b) How is the direction of the torque maintained as the loop rotates 360° from the position shown? **2**

As the coil rotates, the opposite side passes the North and south point, producing a force that will keep the coil spinning in the same direction.

Question 23 (5 marks)

(a) Outline a procedure that could be used to model electrical conduction in a semiconductor. **3**

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(b) Explain a limitation of the model outlined in part (a). **2**

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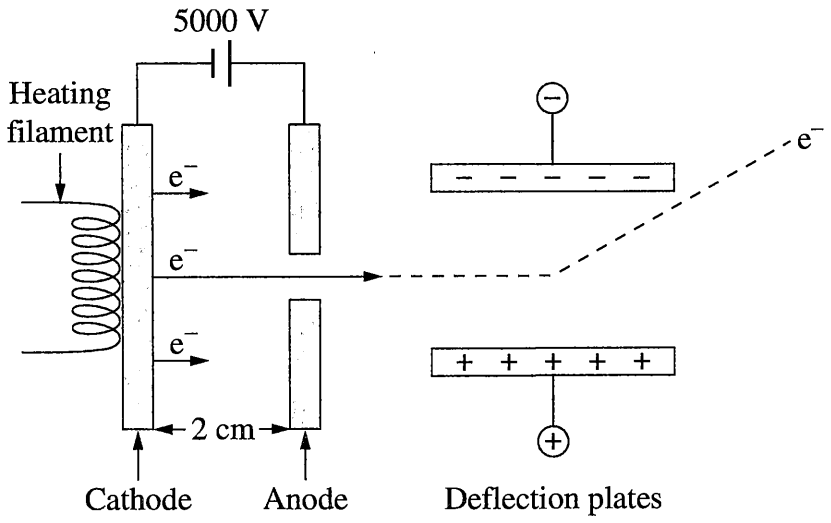
Question 24 (7 marks)

A part of a cathode ray oscilloscope was represented on a website as shown.



Electrons leave the cathode and are accelerated towards the anode.

(a) Explain why the representation of the path of the electron between the deflection plates is inaccurate. **3**

Because opposites attract. The electron would be pulled to the positive deflection plate as the electron has a negative charge, therefor the negative plate would repel the electron.

Question 24 continues on page 19

Question 24 (continued)

(b) Calculate the force on an electron due to the electric field between the cathode and the anode. **2**

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(c) Calculate the velocity of an electron as it reaches the anode. **2**

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End of Question 24

Question 25 (6 marks)

(a) Outline the conversion of electrical energy by devices in the home into TWO other forms of energy. **3**

Hotplates – ~~electricity~~ electricity is used to produce eddy currents producing heat energy.
Electricity is also used to run light globes producing light.

(b) The diagram shows a label on a transformer used in an appliance. **3**

Input:	240 V AC	5.0 A
Output:	2 kV AC	1.0 A

Explain why the information provided on the label is not correct. Support your answer with calculations.

As the ~~volt~~ Voltage decreases, the amps would increase

Question 26 (6 marks)

Consider the following two models used to calculate the work done when a 300 kg satellite is taken from Earth's surface to an altitude of 200 km.

You may assume that the calculations are correct.

Model X	*Model Y*
Data: $g = 9.8 \text{ m s}^{-2}$ $m = 300 \text{ kg}$ $\Delta h = 200 \text{ km}$ $W = Fs$ $= mg\Delta h$ $= 3 \times 10^2 \times 9.8 \times 2.0 \times 10^5$ $= 5.9 \times 10^8 \text{ J}$	Data: $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ $r_{\text{Earth}} = 6.38 \times 10^6 \text{ m}$ $r_{\text{orbit}} = 6.58 \times 10^6 \text{ m}$ $M = 6.0 \times 10^{24} \text{ kg}$ $m = 300 \text{ kg}$ $W = \Delta E_P$ $\Delta E_p = E_{p \text{ final}} - E_{p \text{ initial}}$ $= -\frac{GMm}{r_{\text{orbit}}} - \left(\frac{GMm}{r_{\text{Earth}}}\right)$ $= -1.824 \times 10^{10} - \left(-1.881 \times 10^{10}\right)$ $= 5.7 \times 10^8 \text{ J}$

(a) What assumptions are made about Earth's gravitational field in models *X* and *Y* that lead to the different results shown? **2**

That as you move further away from Earth, the gravitational field decreases.

(b) Why do models *X* and *Y* produce results that, although different, are close in value? **1**

Satellite still has the same mass, the forces acting on it have slightly changed.

Question 26 continues on page 22

Question 26 (continued)

(c) Calculate the orbital velocity of the satellite in a circular orbit at the altitude of 200 km. **3**

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End of Question 26

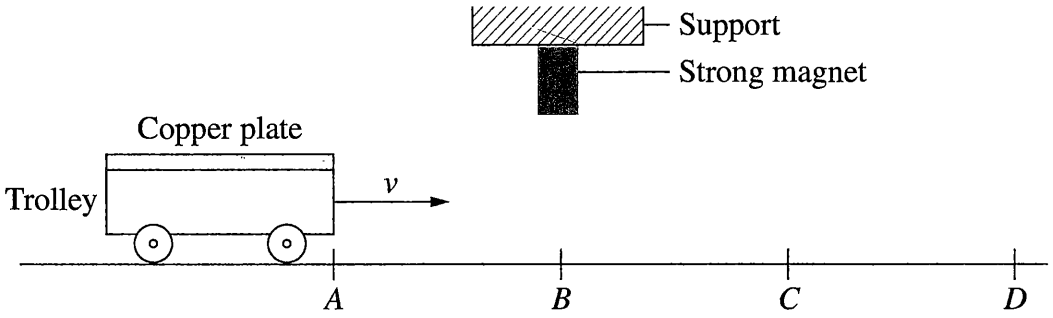
Question 27 (6 marks)

In 1865, James Clerk Maxwell developed the theory of electromagnetism. This theory explained the nature of light. It also predicted the existence of other electromagnetic waves. **6**

How did Hertz test and validate Maxwell's theory?

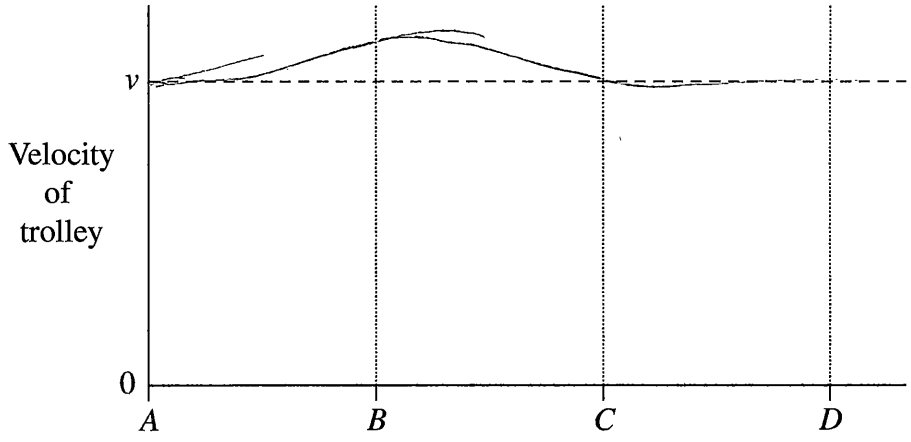
Question 28 (5 marks)

A copper plate is attached to a lightweight trolley. The trolley moves at an initial velocity, v, towards a strong magnet fixed to a support. **5**



The dashed line on the graph shows the velocity of the trolley when the magnet is not present.

On the axes, sketch the graph of the velocity of the trolley as it travels from A to D under the magnet, and justify your graph.



The trolley would ~~still~~ speed up as it reaches the magnet and then slow down again as it has passed the magnet.

Question 29 (5 marks)

In the Large Hadron Collider (LHC), protons travel in a circular path at a speed greater than 0.9999 c.

(a) What are the advantages of using superconductors to produce the magnetic fields used to guide protons around the LHC? **2**

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(b) Discuss the application of special relativity to the protons in the LHC. **3**

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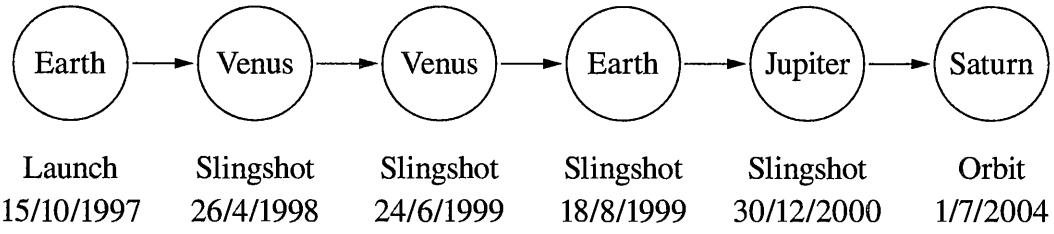
Question 30 (6 marks)

The following is a timeline for the Cassini space probe mission to Saturn. **6**



Explain how Newton's Laws of Motion and Universal Gravitation were applied to the Cassini mission.

Newtons Laws of Motion were used as the gravitational field of the planets were used to increase the velocity of the space probe. By entering the gravitational field the probe can gain momentum launching it to the next planet to do the same, the larger the planet, the larger the gravitational field, the more velocity the probe could gain