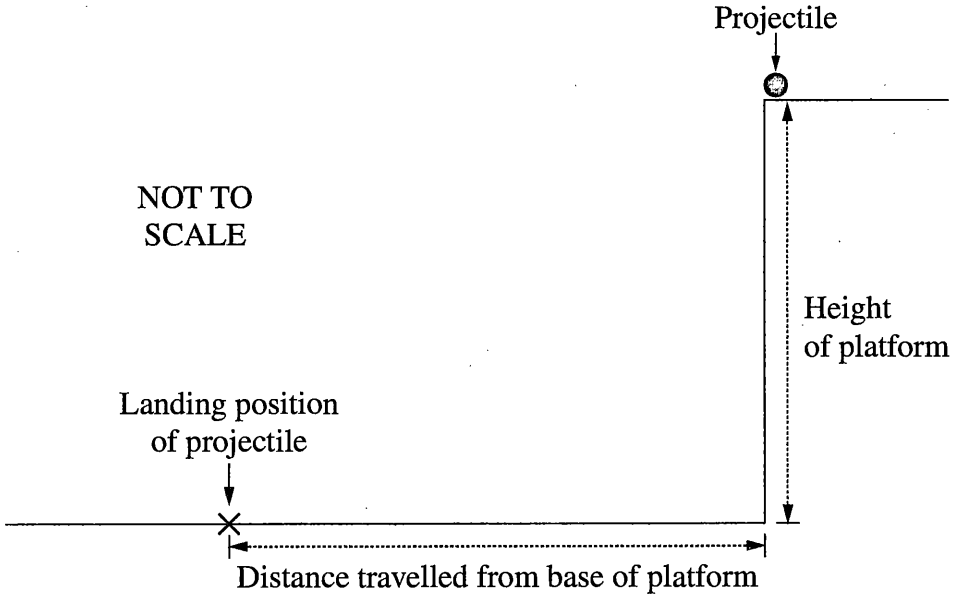
Question 21 (4 marks)

A projectile is fired horizontally from a platform.



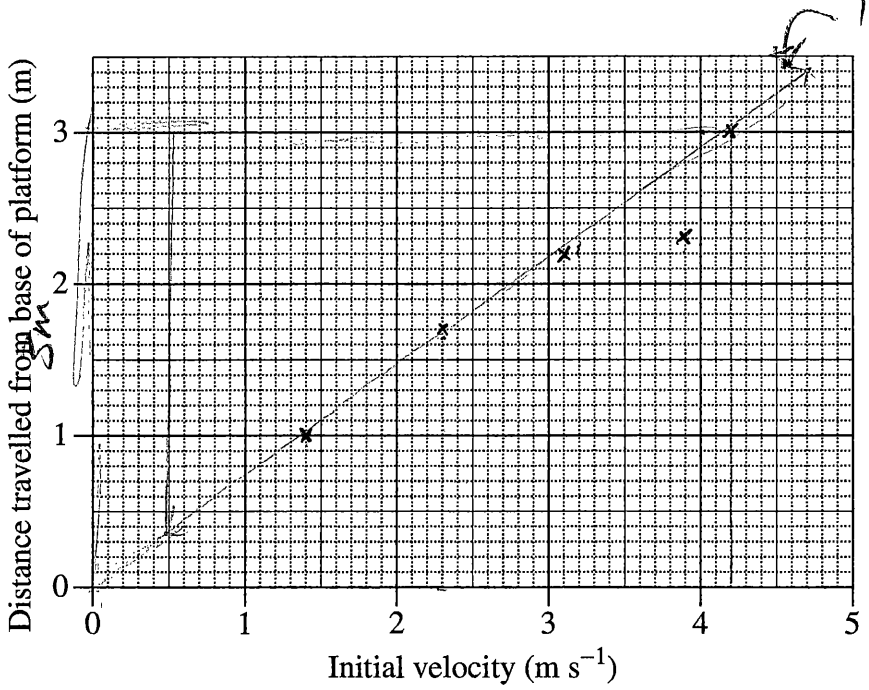
Measurements of the distance travelled by the projectile from the base of the platform are made for a range of initial velocities.

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**

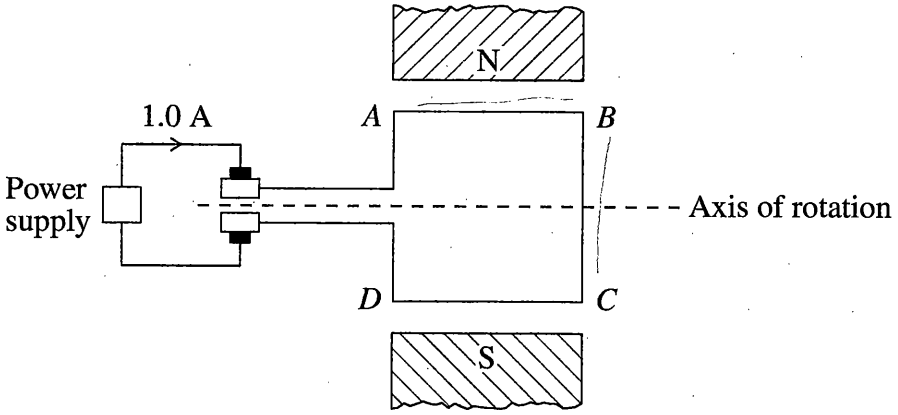
$\frac{\text{rise}}{\text{run}} = \frac{3}{4.2}$

$h = 0.714285714\,3\text{m}.$

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**

The forces acting on AB are the 0.01T as well as the forces found
The forces acting on AB are from the torque due to the current cutting magnetic field.
no force
whereas there is no force acting on BC due to the magnetic field direction.

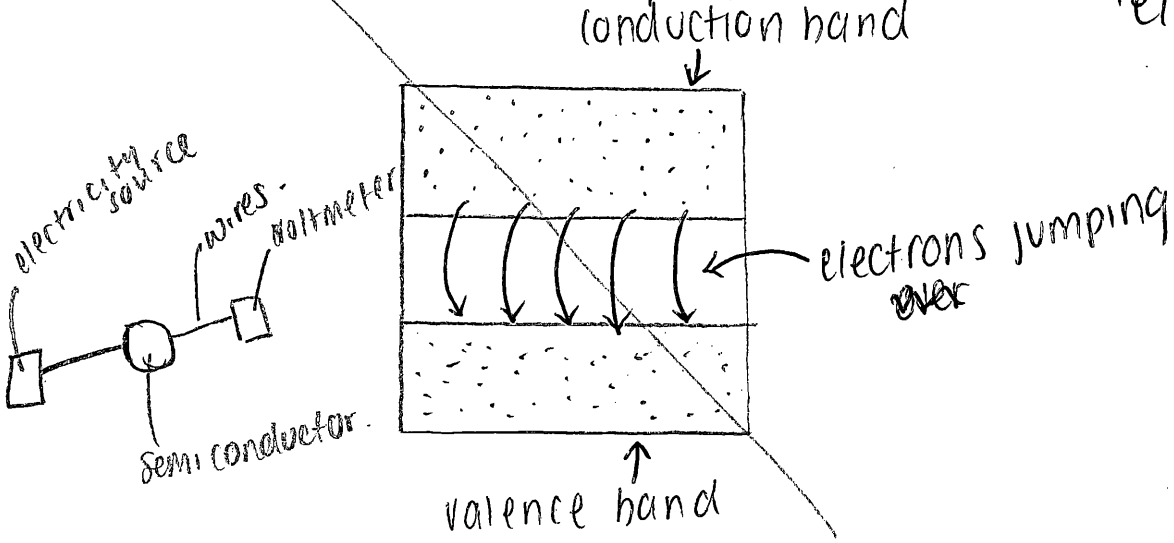
(b) How is the direction of the torque maintained as the loop rotates 360° from the position shown? **2**

The direction of the torque is maintained from the position shown due to the attraction forces of the magnetic field and the direction of the field and magnetic flux.

Question 23 (5 marks)

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

electrons in a semiconductor are able to jump over the 'gap' as the 'gap' is small enough in a semiconductor but the 'gap' in an insulator is too large for current flow of electrons.

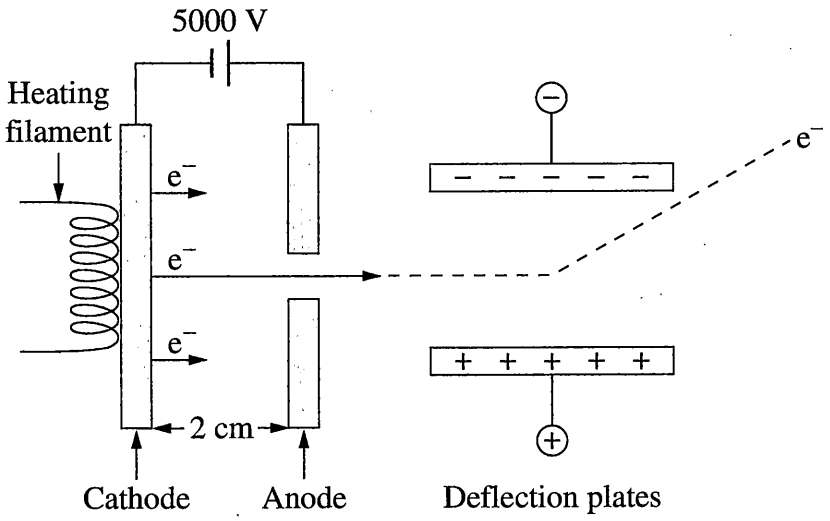


(b) Explain a limitation of the model outlined in part (a). **2**

voltage could be lost through resistance in wires therefore a 100% accurate result ~~is~~ cannot be taken.

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**

The representation of the path of the electron is inaccurate as electrons are attracted to the positive magnetic therefore the direction of electrons should be down not up.

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**

$\frac{V}{d} = hf \therefore f = \frac{\frac{V}{d}}{h}$

$f = \frac{5000}{2}$

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

$E = \frac{5000}{2}$

$E = 2500$

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**

The conversion of electrical energy into heat energy through microwave particles is shown in a microwave. The conversion of electrical energy into mechanical energy is shown in a ~~hair dryer~~ fan.

(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.

The information is incorrect as the ~~ohms~~ law of conservation of energy does not work with this information.

$\frac{V_{out}}{V_{in}} = -\frac{R_f}{R_i}$

$\frac{2000}{240} = -\frac{1}{5}$

$\frac{2000}{240} \times 5$ does not $= -1$ ∴ information incorrect.

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**

- there is no resistance
- Gravitational constand and acceleration.

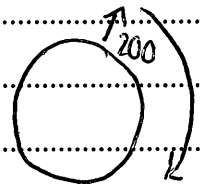
(b) Why do models *X* and *Y* produce results that, although different, are close in value? **1**

Because the values used are not exact are rounded up and the different formulas use different constants.

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**



$9.8 ms^{-1}$

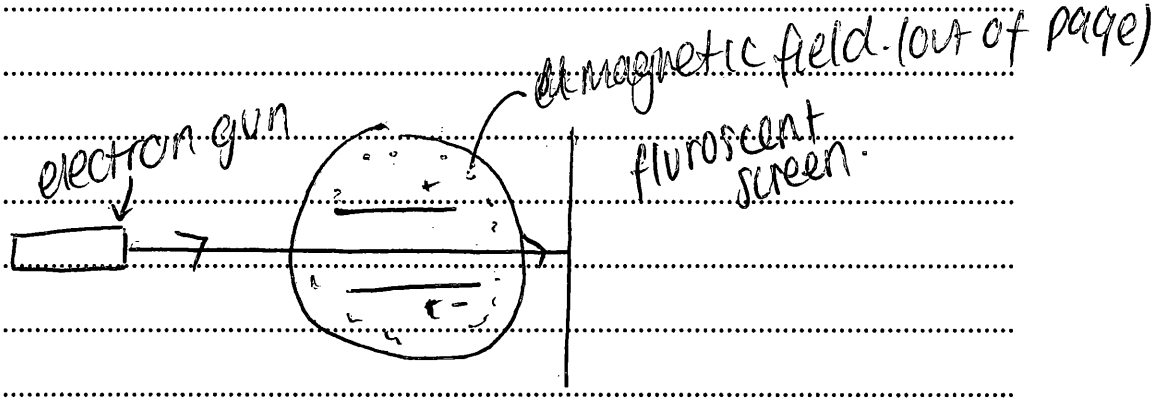
End of Question 26

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**

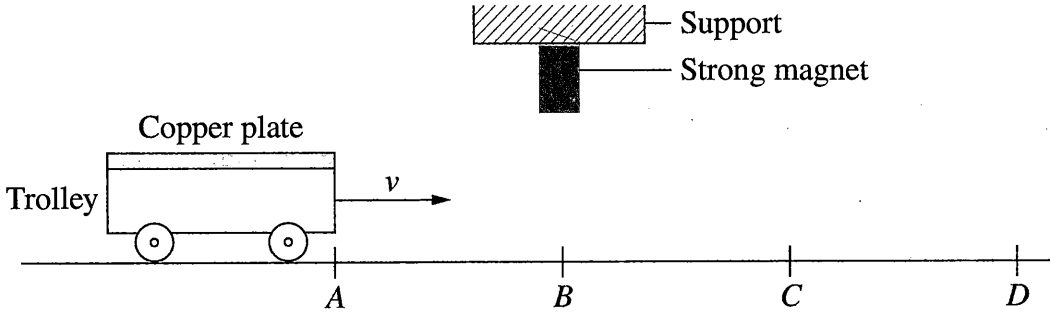
How did Hertz test and validate Maxwell's theory?

~~Hertz tested light with~~
Hertz tested light through magnetic field and observed the result of the light hitting the fluorescent screen to determine the electromagnetism of light.



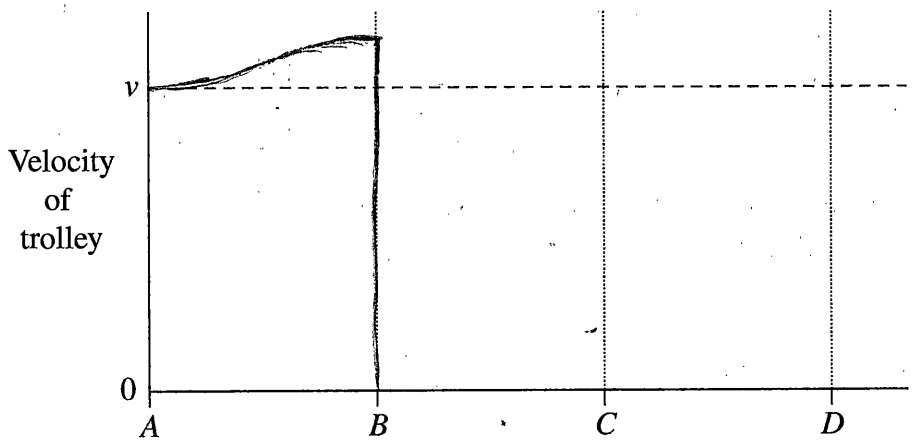
Question 28 (5 marks)

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 will be pulled by magnet but the magnet is strong enough to keep the trolley in place and stop the trolley once the copper has been attracted to 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**

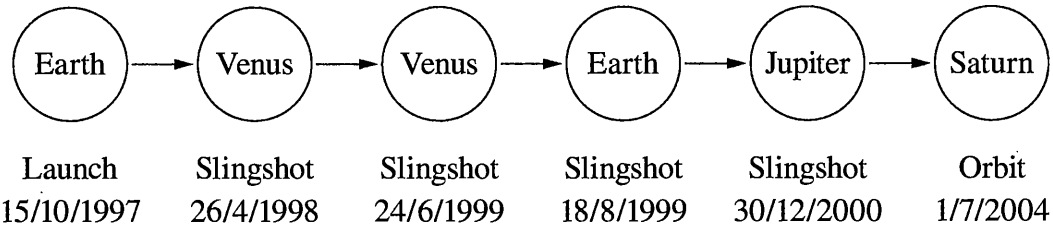
- No resistance
- high density.

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

The protons cannot reach the speed of light therefore cannot be I.C. The protons would become heavier and time would slow down from ~~the~~ an inferial frame of reference. relative to the outside surroundings.

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 and the Universal Gravitation of planets allowed for precise calculations to be made on the speed and angle of the probe launch to to enable the probe to be slingshot from 4 different planets at the precise angle for to not get caught in the gravitational pull of the planets and to conserve fuel. The probe is then slingshot from Jupiter at the an angle ~~direction~~ direction that corresponds with the rotation of the planet and an angle that puts them into geostationary orbit of the planet.