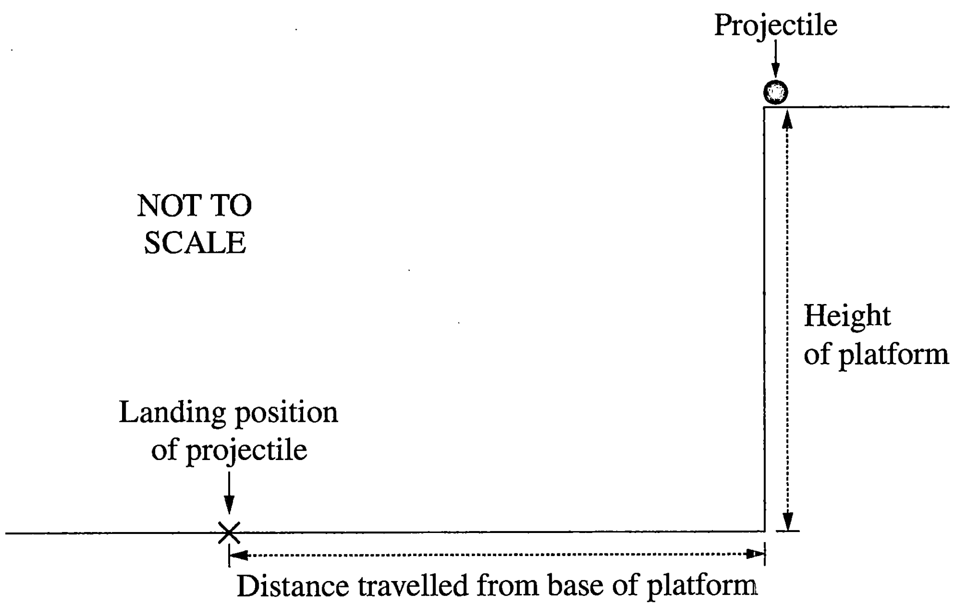
Question 21 (4 marks)

A projectile is fired horizontally from a platform.



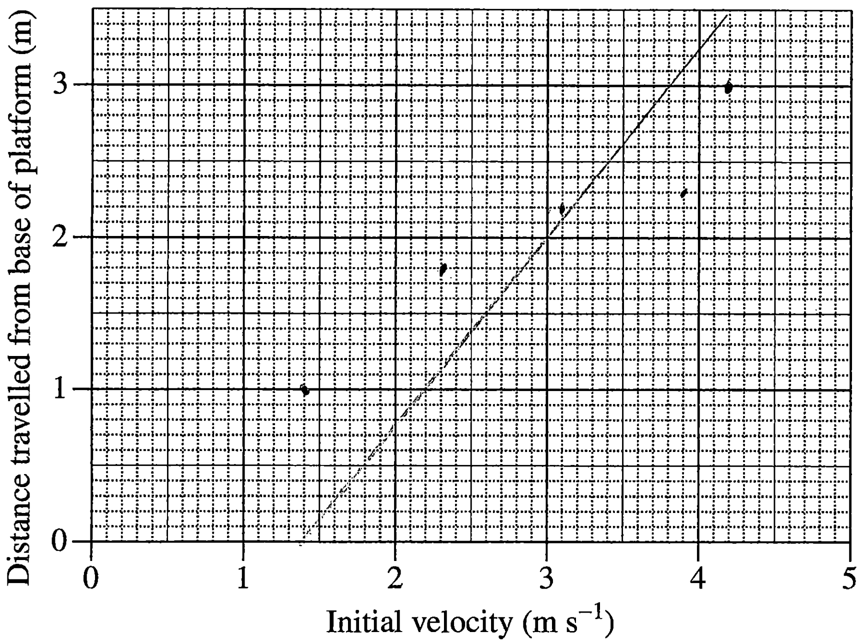
Measurements of the distance travelled by the projectile from the base of the platform are made for a range of initial velocities.

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**

~~$y = u_y t + \frac{1}{2} a_y t^2$~~ 1.4 $u_y = 1.4$ $x = 3$ $y = ?$

$a_x = 9.8$

$y = u_y t + \frac{1}{2} a_y t^2$

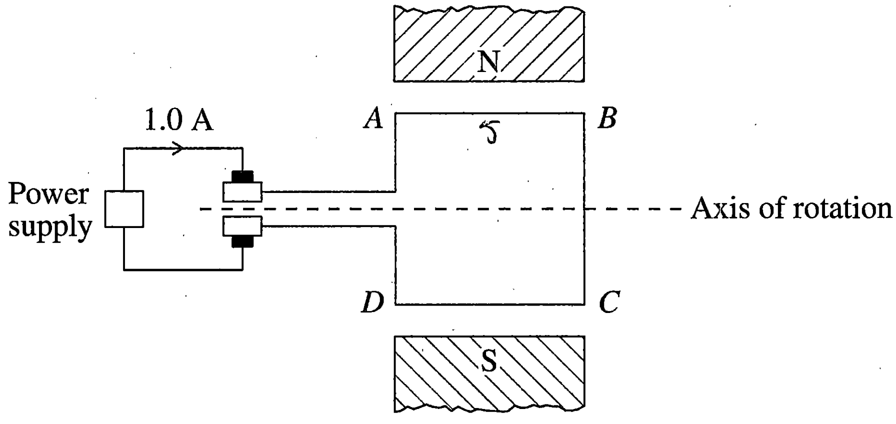
$y = 1.4 \times 4.2 + \frac{1}{2} \times 4.2 \times 4.2^2$

$y = 42.924$

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**

F= BIL

F= 0.01 x 1 x 5

F= 0.05

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

Because the lengths and the current are the same.

Question 23 (5 marks)

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

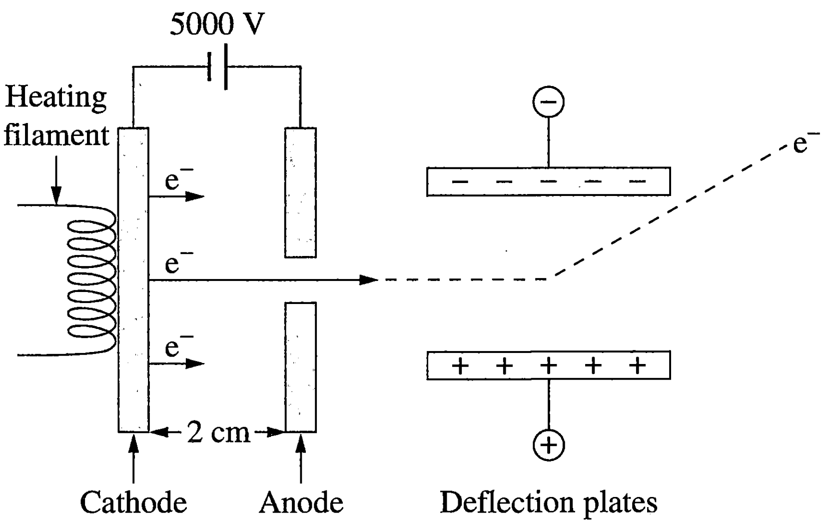
silicon can be used as a electrical conduction.

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

A limitation of using silicon is that it is very brittle and wears down easy. Causing it to be changed frequently.

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 the electron is negatively charged so it would go towards the positive plate.

Question 24 continues on page 19

Office Use Only – Do NOT write anything, or make any marks below this line.

Question 24 (continued)

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

$\frac{F}{l} = \frac{k I_1 I_2}{d}$

$= 2.0 \times 10^{-7} \frac{5000 \times 5000}{2}$

$= 2.5$

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

N/A

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 speakers of a radio transfers electrical into sound and heat

(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.

It is incorrect because the resistance is higher in the ~~[illegible]~~ output.

$R = \frac{V}{I}$ Input = $R = \frac{240}{5}$

$R = 48$

Output = $R = \frac{2000}{1}$

$R = 2000$

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**

model Y didn't use the altitude of the satellite.

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

Because they used the corret formulas just ~~did~~ different values.

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**

$F = \frac{Gm_1 m_2}{d^2}$ $F = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 300}{200^2}$

$F = 3.0015 \times 10^{12}$

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?

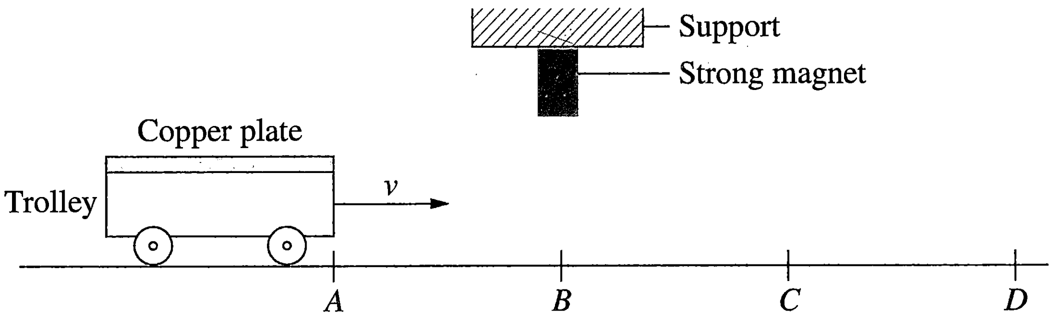
Hertz fired electromagnetic waves at materials and watched them bounce off. This discovered radio waves. It validated Maxwell's theory because it proved it and showed the existance of other electromagnetic waves.

He came up with a formula to calculate the energy bouncing off the material

$E = hf$ & $c = f\lambda$

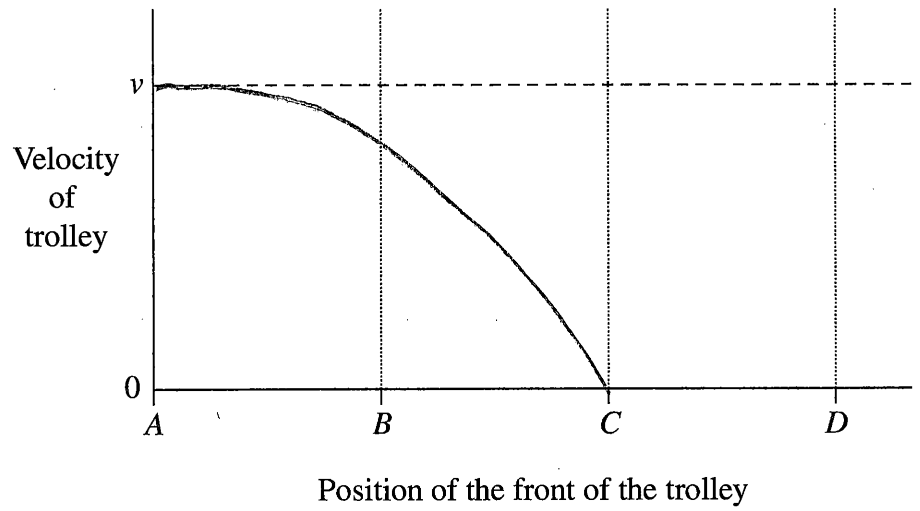
Question 28 (5 marks)

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 come to a stop at C because the magnet won't be able to completely bring it to a halt but slow it down.

Office Use Only – Do NOT write anything, or make any marks below this line.

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**

• can't reach abosolute 0°

• safe

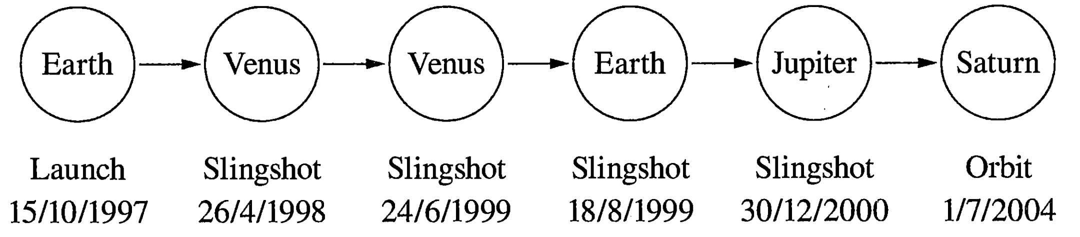
(b) Discuss the application of special relativity to the protons in the LHC. **3**

The application of special relativity has to be taken into account because the proton is traveling at such a fast speed, there will be different observers and thus resulting in different results.

Office Use Only – Do NOT write anything, or make any marks below this line.

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 applied through that an object will stay in motion until acted upon by an equal or opposite reaction. This means that the satellite will stay moving until something stops it. they were able to combine this with the universal Gravitation to use the slingshot effect on different planets to keep moving.