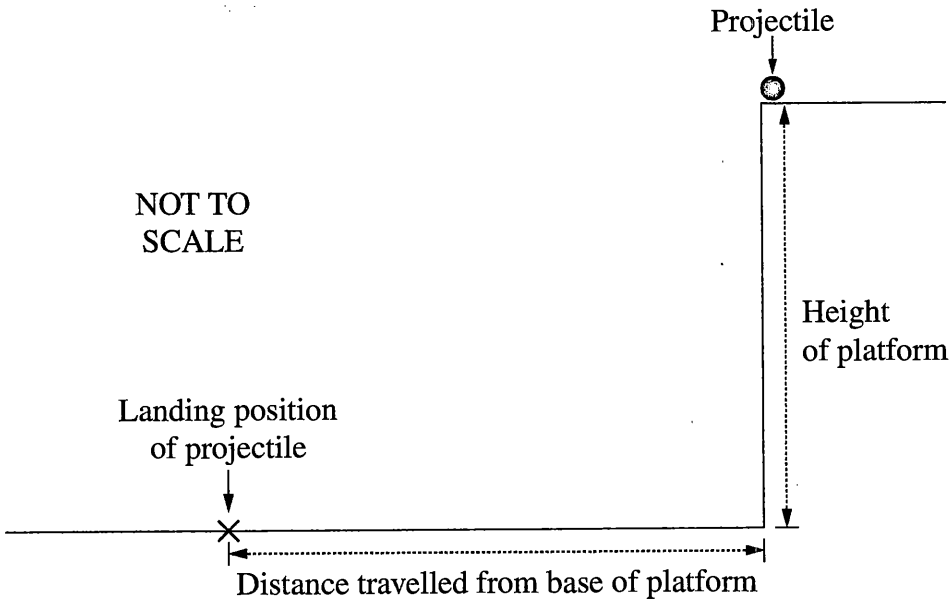
Question 21 (4 marks)

A projectile is fired horizontally from a platform.



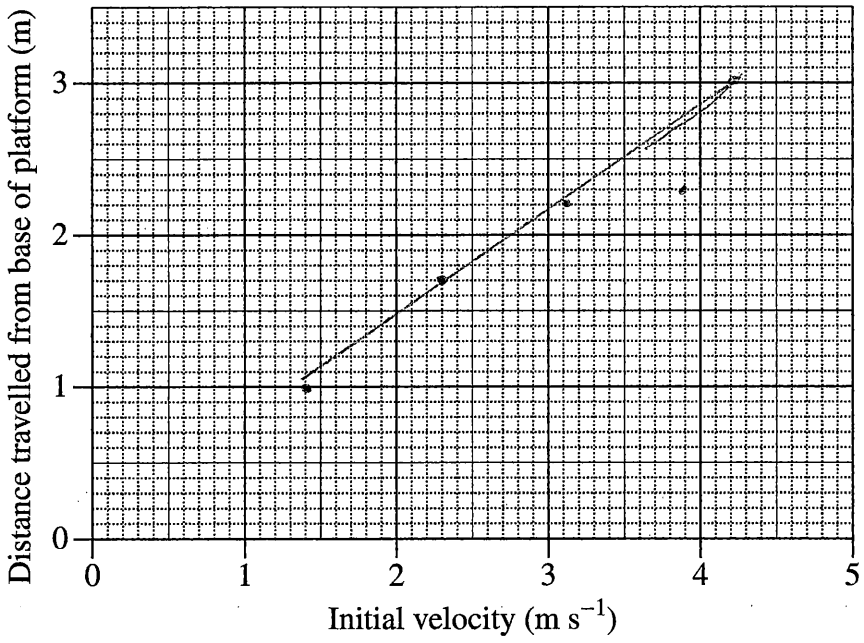
Measurements of the distance travelled by the projectile from the base of the platform are made for a range of initial velocities.

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**

$v_y^2 = u_y^2 + 2a_y\Delta y$

$\Delta y = \frac{v_y^2 - u_y^2}{2a}$

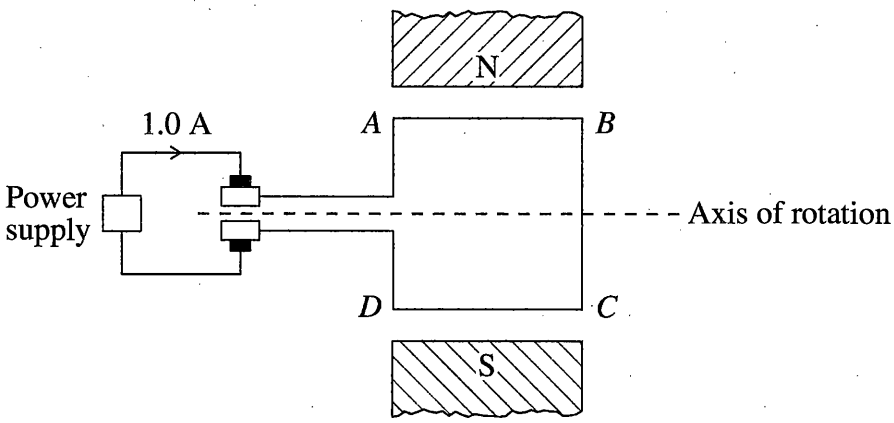
$= \frac{0 - 4.2^2}{-9.8 \times 2}$

$\Delta y = 0.9\text{m}$

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**

Section BC does not experience a force as it is parallel to the magnetic field.

Force on section AB = $F = BIL\sin\theta$.

$F = 0.01 \times 1 \times 0.05 \times \sin 90$

$= 0.0005$ N.

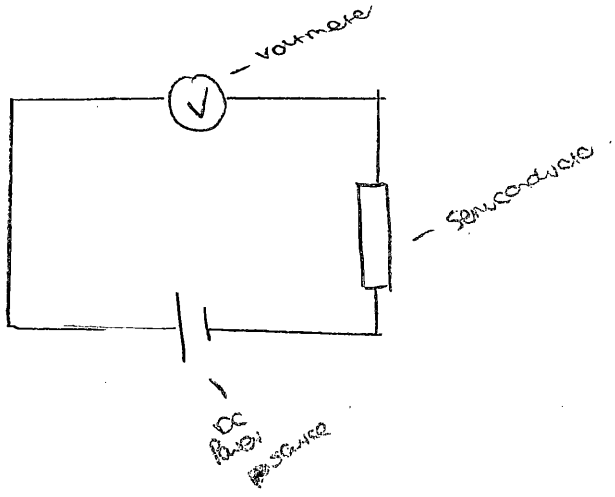
(b) How is the direction of the torque maintained as the loop rotates 360° from the position shown? **2**

Torque is maintained in DC motors using split ring commutators, which disconnect from the brushes every half cycle to create an alternating current.

Question 23 (5 marks)

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

Create a circuit set with a voltmeter, and a semiconductor (silicon), a power source. A high voltage will indicate high conductivity & a low meaning it acts as an insulator.



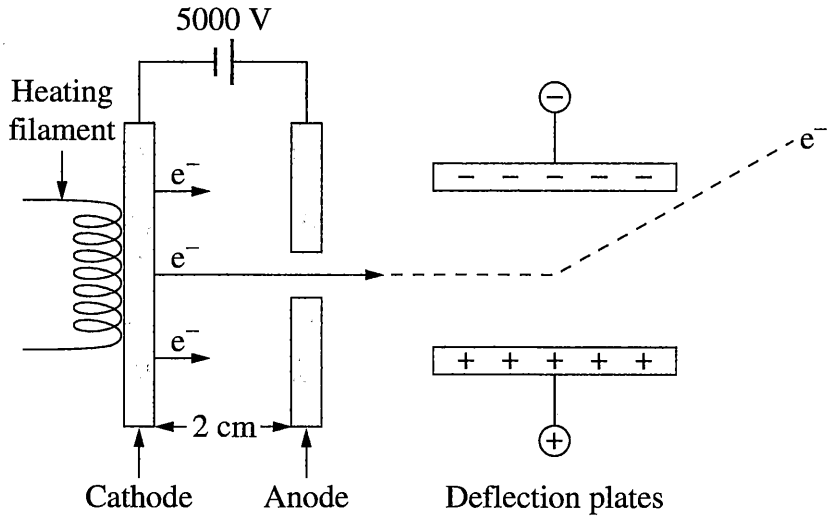
(b) Explain a limitation of the model outlined in part (a). **2**

The metal/element used may not be identified as a semiconductor. The semiconductor may have impurities that increase its resistance to electrical conduction.

?

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 electron has a negative charge, so when accelerated between plates, should be attracted towards the positive deflection plate & be repelled by the negative, due to their like charges & magnetic field lines interfering

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**

$E = \frac{V}{d}$ $F = E \times q$

$= 250000 \times -1.602 \times 10^{-19}$

$E = \frac{5000}{0.02}$ $= 4.005 \times 10^{-14}$ N.

$= 250000$

?

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

$F = BIL\sin\theta$

$B = F / IL\sin\theta$

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**

Electrical energy can be converted into heat energy, as used in heaters, ovens, heating water tanks.
It can also be converted into light energy, as used in lights, televisions, screens of appliances such as mobile phones & GPS's.

(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.

In an ideal transformer Power of the primary should = power of the secondary. Thus by law can be lost. is not the case as shown in this label:
$P = VI$
input $P = 240 \times 5 = 1200$ W.
output $P = 2000 \times 1 = 2000$ W.
Power has been gained, which defys the law of conservation. If anything, power should have been lost due to energy losses & transformation into other forms of energy, such as heat.

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**

Assumptions are made that the value of g is constant on Earth, however this is not the case.

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

The value of g, Earths acceleration due to gravity, varies slightly, depending on location.

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**

$F = m \times a$ $F = \frac{mv^2}{r}$

$= 300 \times 9.8$

$= 2940$ $\sqrt{\frac{Fr}{m}} = v$

$\sqrt{\frac{2940 \times 6.58 \times 10^6 + 200000}{300}}$

??

$= 470.617 \text{ m/s}$

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**

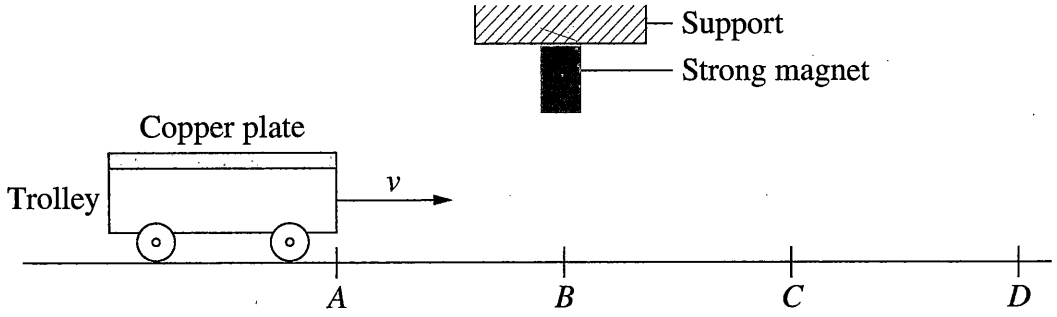
How did Hertz test and validate Maxwell's theory?

Light was thought to be a particle & a wave. This caused scientists for many years. Light was concluded to be a wave, that did not need a medium to travel, & was on a spectrum along with many other electromagnetic waves, that all travelled at the speed of light, 3.0×10^8.

The photoelectric effect was the experiment that proved the nature of light. When two pieces of metal were close enough & light was shined, the spark could jump across the gap, as more energy was given to the photons. ??

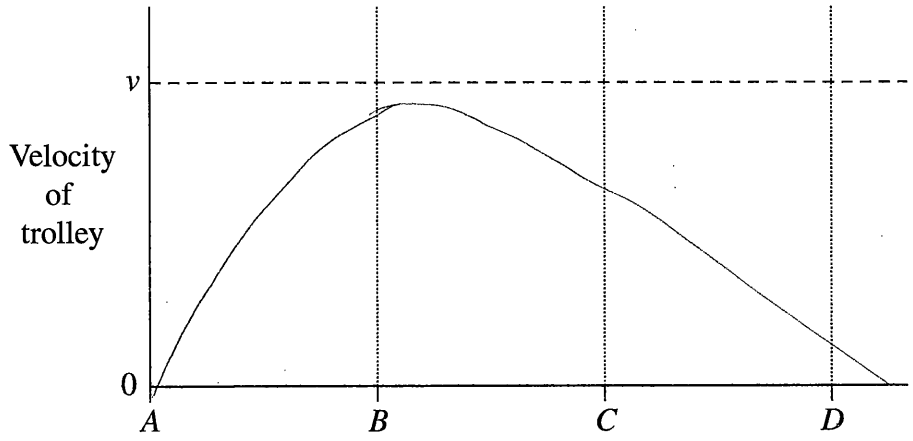
Question 28 (5 marks)

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.



As the trolley approaches the magnet, it will be attracted towards it, thus increasing the velocity of the trolley from positions A – B. When moving away from the magnet it will be harder for the trolley to gain velocity, as it is still attracted towards the magnet as seen in the graph by the declining velocity from B – C – D.

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**

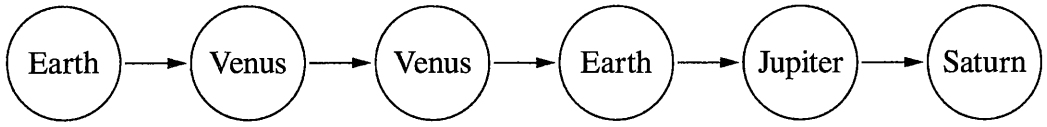
Below their critical temperature, super-conductors do not allow external magnetic fields to penetrate it, so create their own, which causes magnets (or protons) to levitate above the surface due to the repelling forces of the magnetic field. This allows little to no resistance & is very efficient at reaching great speeds.

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

Special relativity states that units (time, energy, mass, length, etc.) are all relative to each other & must be observed from a non-inertial frame of reference to see this.

Question 30 (6 marks)

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



Launch	Slingshot	Slingshot	Slingshot	Slingshot	Orbit
15/10/1997	26/4/1998	24/6/1999	18/8/1999	30/12/2000	1/7/2004

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

Newton created 3 Laws of motion:

1. Inertia - a bodys resistance to move

2: force is proportional to the product of mass & acceleration.

3: every action will have an equal but opposite reaction.

The Law of Universal Gravitation states, simply, that every object in the universe experiences attraction to eachother.

This has allowed scientists to discover how to build space craft, send them into space, & do this efficiently by utilising the nature of space. — knowing discovering the sling shot effect, using the gravitational orbit around the sun to gain velocity when traveling to further planets & stars.