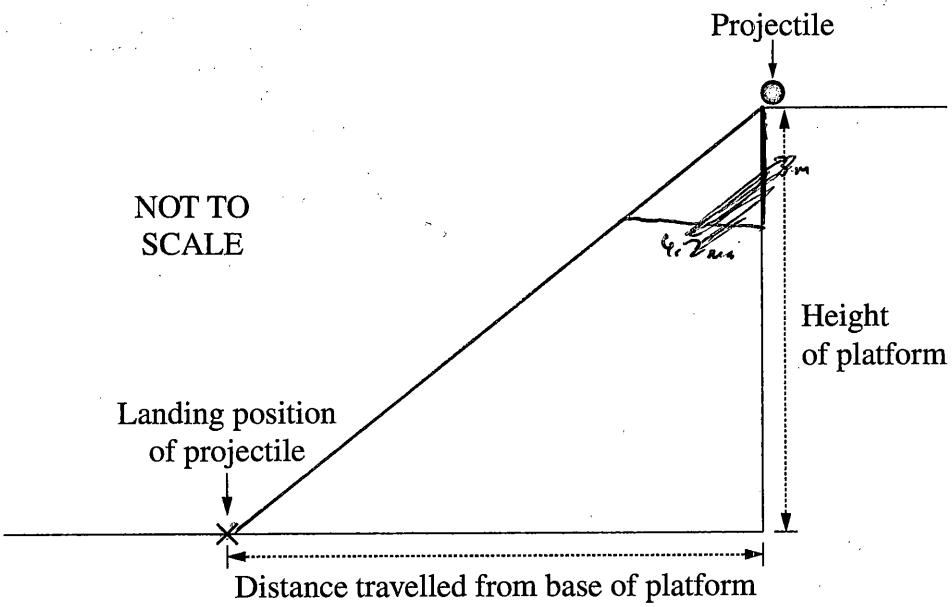
Question 21 (4 marks)

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

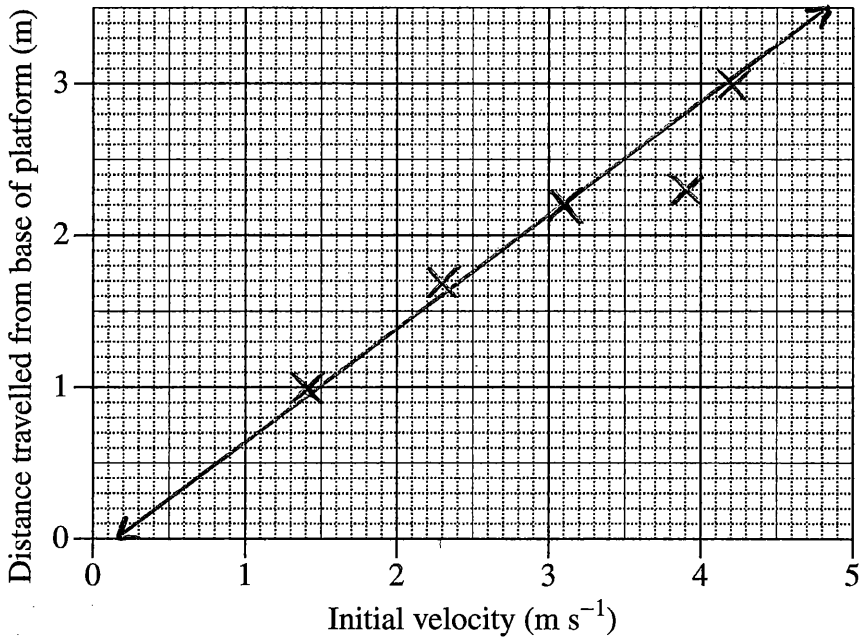
$\Delta y = 3$

$v^2 = 4.2^2$

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**

$V^2 = U^2 + 2ay$

$= 4.2^2 + 2 \times 9.8 \times 3$

$= 76.44$

$V = \sqrt{76.44}$

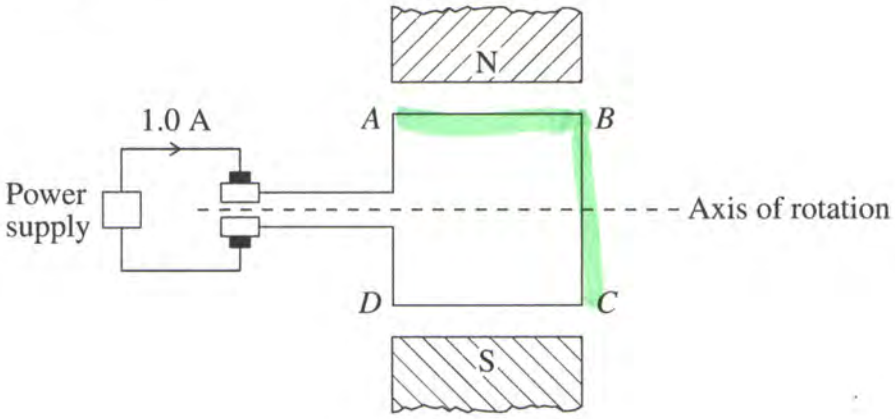
$= 8.74\text{ m}$

Height $= 8.74\text{ m}$

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**

$F = BIL\sin\theta$

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

$= 0.005\,N$

$AB = 0.005\,N$

$F = BIL\sin\theta$

$= 0.01 \times 1 \times 0.05 \times \sin 0$

$= 0N$

$DC = 0N$ of force going through it as it is perpendicular to the magnetic field

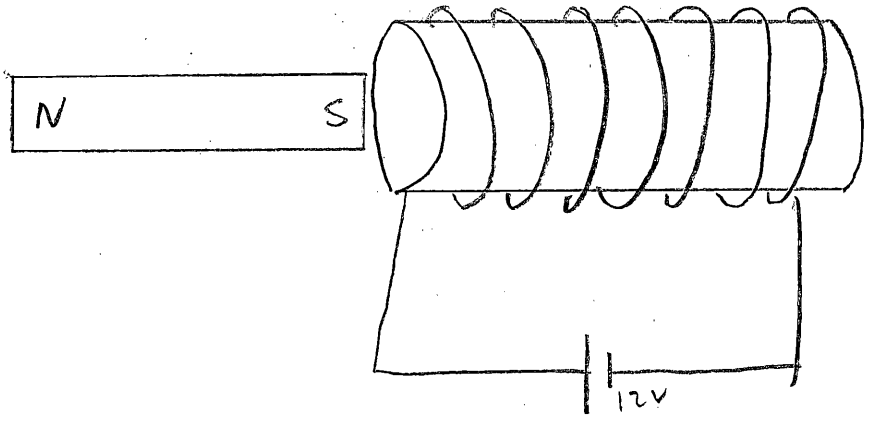
(b) How is the direction of the torque maintained as the loop rotates 360° from the position shown? **2**

Torque is maintained through out the 360° rotation as slip rings are always in contact with the ~~ca~~ wire giving it constant Force as it rotates past and around the magnets. Therefore being always in ~~contact~~ side the magnetic field

Question 23 (5 marks)

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

Electricle conduction can be ~~used~~ developed in a semiconductor through placing voltage between two terminals and placing a magnet through. This increase electrical conduction ~~not~~ on the semiconductor.

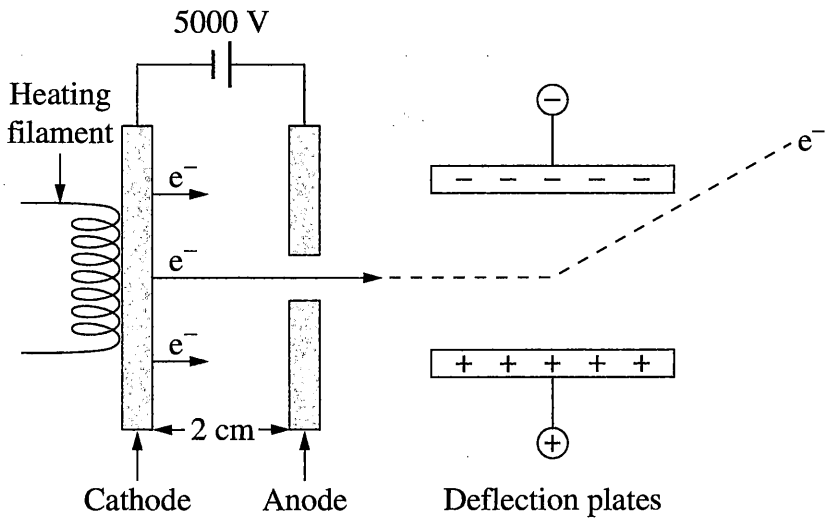


(b) Explain a limitation of the model outlined in part (a). **2**

A limitations it that it is hard to achieve a constant flow of electrons creating the design to need ~~at~~ replacement and constant changes to produce electrical conductions.

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 dotted path is inaccurate because it does not take into account the strength of the magnetic field therefor the path of the electron is not correctly determined. Also the path would be more of a gradual curve rather than a sudden angle. An Electron is negative therefore it would be deflected away from the negative and towards the positive

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**

$F \propto \frac{1}{d}$

$F = 2\times10^{-7} \times \frac{1}{0.02}$

$\frac{5000}{-1.6\times10^{-19}} = -3.125\times10^{22}$

$F = qvB\sin\theta$

$= (-1.6\times10^{-19}) \times 5000 \times 0.02$

$= 1.6\times10^{-17}$ N

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

$V = \frac{F}{qB}$

$= \frac{1.6\times10^{-17}}{-1.6\times10^{-19} \times 0.02}$

$= 5000$ ms^{-1}

$E = \frac{V}{d}$

$= \frac{5000}{0.02}$

$= 250000$ J

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**

• Solar cell convert Potential energy into kinetic energy producing a AC current that passes through the system producing electricity.

• A heater converts AC current into DC to produce a constant force of heat without having any arcing or surging of 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
	2000V	

$V = IR$

$R = \frac{V}{I}$

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

The information provided is incorrect because the current passing through the output input is incorrect. $H = \frac{V_{out}}{V_{in}} = \frac{2000}{240} = 8.3\,A$. which The output valve is incorrect because there would be a short circuit overload with the increased amount of Voltage with limited current passing through. More current needs to pass through the output in order for the circuit not to be overloaded.

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**

In Model X the gravition value used is 9.8 which is not constant all around the world, the different values for different altitudes. Model Y uses the gravitational constant ($6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$) to determin the gravitational energy.

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

Both models are similar as they both derive each other and use the same known values to produce similar outcome with varying reliability.

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**

Circular orbit $= \sqrt{\frac{2GM}{r}}$

$= \sqrt{\frac{2 \times (6.67 \times 10^{-11}) \times 300}{200}}$

$= 0.000014 \text{ km/s}$

$= 0.000014 \times 1000$

$= 0.01445 \times 3600$

$= 50.92 \text{ ms}^{-1}$

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 used the same principle and Maxwell did using a Cathode tube. Instead Hertz placed an wheel into the tube. Using the same process as Maxwell, Hertz showed that the electron beam could turn a wheel. This development in electromagnetism proved that quantum physics could be used to develop and re-create the theory of electromagnetic waves. Hertz validated the experiment by showing the world the experiment showing that electromagnetic waves are able to turn an object and change its structure. Hertz was able to explain that light was produced by and act as quanta towards the form of electromagnetic waves providing and uncovered understanding in the perceptions of Maxwell original theory.

LOOK AT PAGE 27

Section I Part B extra writing space

If you use this space, clearly indicate which question you are answering.

Question 27

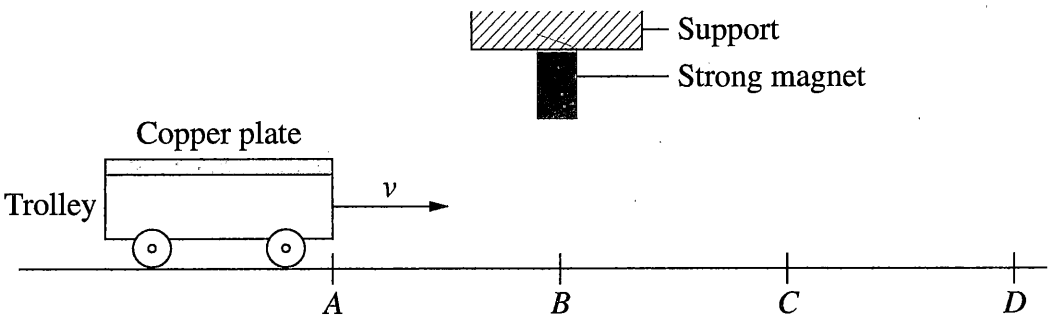
Hertz used maxwells experiment to show electrons moving from a cathode to an anode. This is proven by the

Question 27

Hertz devised an experiment involving a spark to jump across two terminal when current is produceed through a nearby loop of wire. The test relates to the existence of electromagnetic waves and the charge of electromagnatism. The test showed a spark to jump across the terminals proving that light can be in a wave form. The experiment was validated as Hertz could prove that it existed in all forms of a circuit and could be reproduceed showing the development of waves in electromagnetic devices. the theory of Hertz experiment allowed scientists to develop upon maxwells theory of light being in a wave form rather them a Particle form which was the previous belifs of physicists.

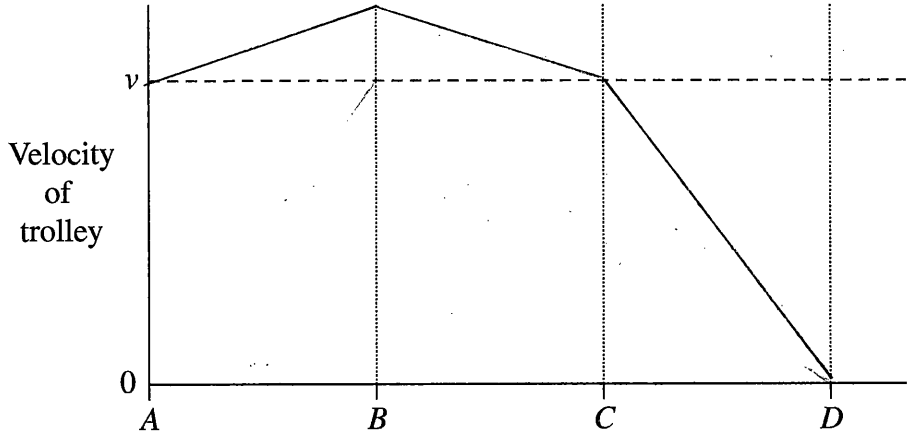
Question 28 (5 marks)

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 moves towards B from A it velocity will be increased as the copper plate is attracted to the strong magnet. As the trolley moves from B to C (returning to v) it will decelerate as it will be being pulled back towards the copper wire and magnets. The Trolley will decrease it initial velocity as it is being away because the magnet will have removed some of its energy

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**

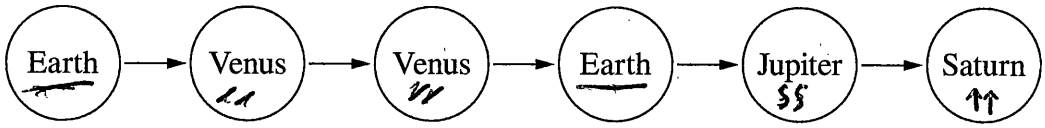
Superconductors allow for faster acceleration and ~~increased~~ Superconductors to produce a strong magnetic field which allow the proton to stay in a controlled area and increase it velocity while still allowing it to maintain ~~a strong~~ its shape.

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

Special relativity ~~to a proton~~ in the LHC is propitional towards the observer and proton. To the observer they could see the proton go past them ~~at~~ at 0.9999c. To the proton they ~~will~~ could ~~not~~ be able to see the send a light source ~~at~~ ~~infront~~ ahead of them. To the observer the would not see a light source move forward but merly ~~eliminate~~ the what is ~~infront~~ around them.

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 law of Motion ~~are~~ a is applied to all the plants as the slingshot. The slingshot is used to increase the velocity ~~and~~ while not using any fuel. Newton said that the motion could be manipulated to increase the speed of an object ~~while not~~ through Kinetic Energy. The probe will take some of the momentum from Venus, Earth and Jupiter to increase and marginally reduce the Kinetic energy of the planet. Universal Gravitation is applied in the orbit of ~~Earth~~ Saturn to determin where the probe can be placed in order to not fall back down ~~and~~ to the ground. ~~and~~ The probe would be placed in a G.E.O stationary orbit to not get sucked into the atmosphere and experience orbital decay. If the probe was placed close to Saturn it would need boosters attached, ~~to not~~ this would ~~even~~ not always last and the probe would fall out of ~~the~~ the sky after time. Both Newton law of motion and the Universal Gravitation are needed to deem make the cassini mission a ~~success~~ success.