SYDNEY BOYS HIGH SCHOOL

Physics

HSC TRIAL EXAMINATION

2012

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board- approved calculators may be used
- A data sheet, and formulae sheets Periodic Table are provided at the back of this paper
- Show all working

Total marks - 100

Section 1

75 marks
This section has two parts, Part A and Part B

Part A - 20 marks
- Attempt questions 1 – 20
- Allow about 35 minutes for this part

Part B - 55 marks
- Attempt Questions 21-30
- Allow about 1 hour and 40 minutes for this part

Section II

25 marks – Quanta to Quarks

- Allow about 45 minutes for this part

Use the separate multiple choice answer sheet.
Choose the most correct answer.

75 marks
Part A- Multiple Choice - 20 marks
Attempt Questions 1-20
Allow about 35 minutes for this part

Use the multiple choice answer sheet for Questions 1–20.
Choose the most correct answer.

1. Which of the following earth satellites will experience the greatest orbital decay?

(A) The Moon

(B) One of the 24 GPS satellites orbiting at 20000 km

(C) A satellite in a geostationary orbit

(D) The space station with an orbital period of 90 minutes.

2. A 500 gram object has a weight of 2 N on the surface of Planet Y.

What is the acceleration due to gravity on the surface of Planet Y?

(A) 4 ms^{-2}
(B) 1000 m s^{-2}
(C) 1 m s^{-2}
(D) 0.25 m s^{-2}

3. Intrinsic semiconductors have a lattice structure.

What part of the semiconductor's structure does the lattice represent?

(A) The location of the germanium or arsenic nuclei
(B) The location of the silicon and boron bonds
(C) The location of the silicon or germanium nuclei
(D) The location of the silicon and arsenic bonds.

4. Why are insulators poor conductors of electricity?

(A) Insulators have a full valence band and no conduction band
(B) The valence and conduction bands are separated by a large energy gap
(C) Insulators have a large energy band gap and an empty valence band
(D) Insulators have a small energy band gap and a partly filled conduction band.

5. Which law is most appropriate to explain the application of Lenz's Law?

(A) The Law of Conservation of Mass
(B) The Law of Conservation of Energy
(C) Ohm's Law
(D) The Law of Conservation of Momentum.

6. Faraday's Law could be used to explain which of the following?

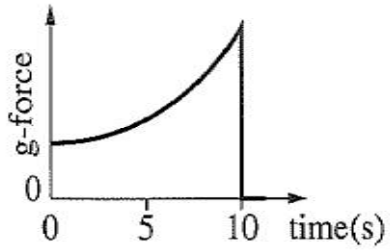
(A) Why current in a circuit is proportional to voltage
(B) Why a satellite can remain in a stable orbit around a planet
(C) Why the voltage output of a generator increases with generator speed
(D) Why magnetic field lines always form closed loops and electric field lines don't.

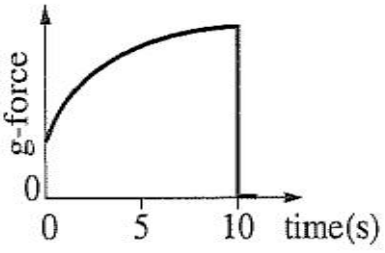
7. Two parallel plates are 2 nm apart and have a potential difference of 100 V between them. An electron is placed halfway between the plates.

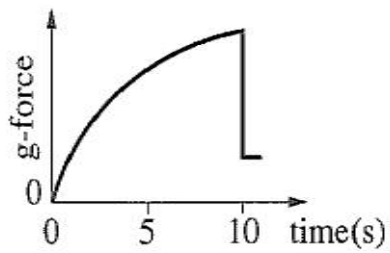
What is the magnitude of the force on the electron ?
(A) 5.0×10^{10} N
(B) 8.0×10^{-12} N
(C) 8.0×10^{-9} N
(D) 5.0×10^{8} N.

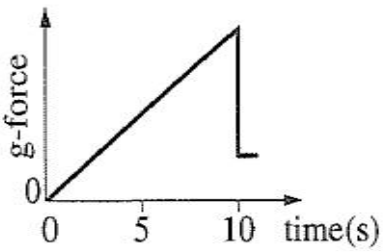
8. A rocket fires it's solid fuel engines in deep space. It produces thrust for 10 seconds and is then switched off.

Which graph best illustrates the g-force experienced by an astronaut in the rocket?

(A)


(B)


(C)


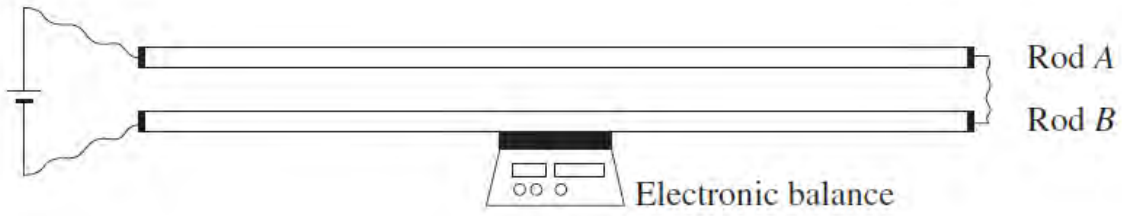
(D)


9. A spaceship is travelling away from Earth at 1.5×10^8 m/s. The time interval between consecutive ticks of a clock on board the spaceship is 1.0 s. Each time the clock ticks, a radio pulse is transmitted back to Earth.

What is the time interval between consecutive radio pulses as measured on Earth?

(A) 1.4 s
(B) 0.87 s
(C) 1.2 s
(D) 0.7 s

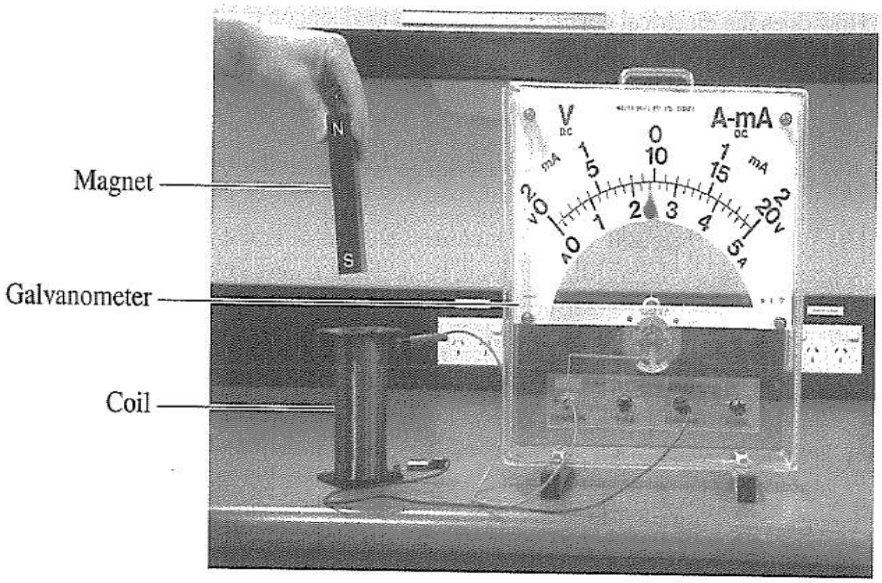
10. A student performed an experiment using two identical metal rods connected to a power supply. Rod A was placed at different distances from Rod *B*, and the measurements on the electronic balance were recorded.



Which alternative gives the dependent variable and a controlled variable?

(A) The length of the rods and the current in the rods
(B) The current in the rods and the mass recorded on the balance
(C) The mass recorded on the balance and the length of the rods
(D) The current in the rods and the distance between the two rods.

11. A student set up the equipment shown to carry out a first-hand investigation.



The magnet was pushed down into the coil. Which statement correctly describes what happens?

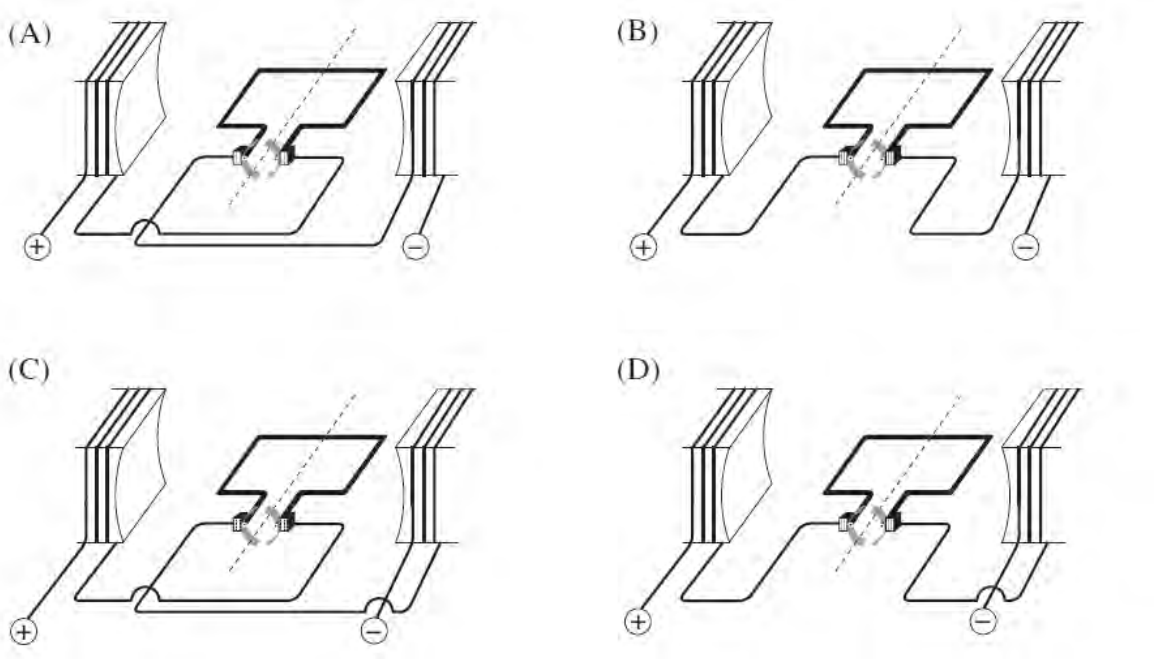
(A) The motor effect produces a clockwise current in the coil viewed from above

(B) The motor effect produces an anticlockwise current in the coil viewed from above

(C) Electromagnetic induction produces an anticlockwise current viewed from above

(D) Electromagnetic induction produces a clockwise current viewed from above.

12. The diagrams show possible ways to connect the coils and rotor of a DC motor to a DC power supply. In which circuit will the rotor turn in a clockwise direction.



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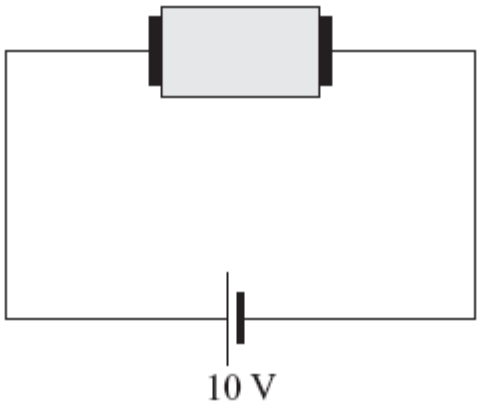
13. A block of silicon doped with arsenic is connected as shown in the diagram below.



What is the main way in which conduction occurs in the doped silicon block?

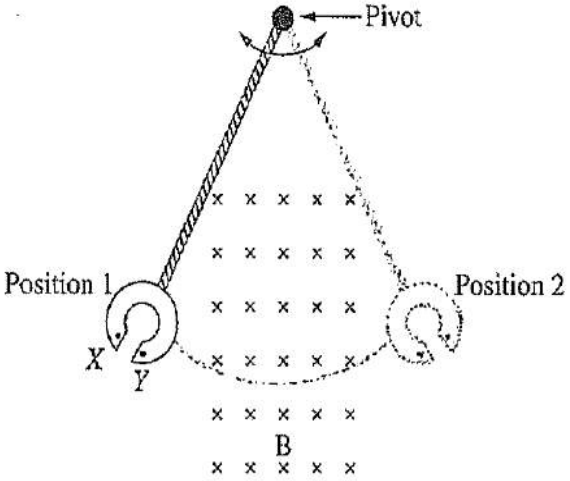
(A) Conduction band electrons move to the left

(B) Acceptor band holes move to the left

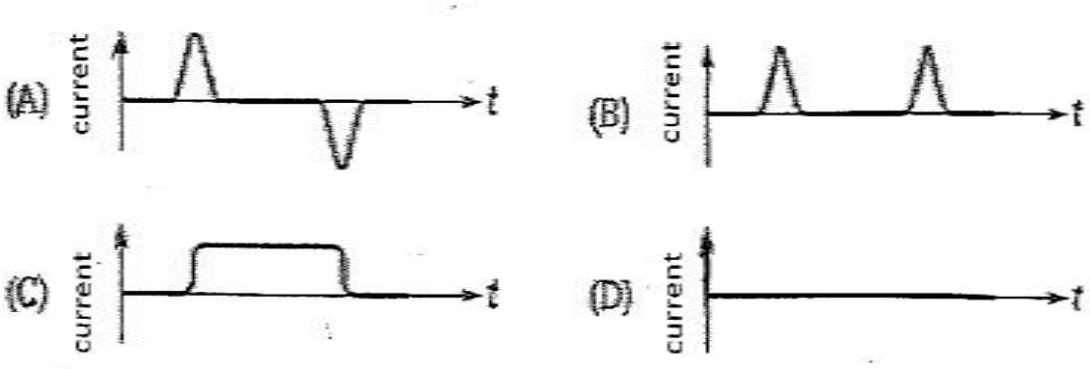
(C) Conduction band electrons move to the right

(D) Acceptor band holes move to the right.

14. A heavy copper split ring is attached by a light insulating rod to a pivot to form a pendulum. A region of uniform magnetic field B is present as shown. As the pendulum swings from Position 1 to Position 2, the induced current flowing from Y to X is measured.



Which graph best represents the measured current during the time that the pendulum swings from Position 1 to Position 2?



15. A volleyball rolls off a 1.0 m high horizontal table with initial velocity of 4.0 m s^{-1}.

The horizontal displacement of the volleyball during its flight is closest to:

(A) 4.0 m
(B) 0.45 m
(C) 1.8 m
(D) 5.1m

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16. An orbiting space ship in a stable orbit fires it's rockets resulting in an increase in it's orbital speed and radius. Which of the following statements is correct ?

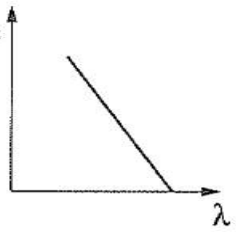
(A) The astronauts in the ship will observe time on their clocks slowing down

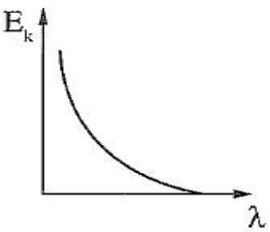
(B) The space ship's change in gravitational potential energy will be positive

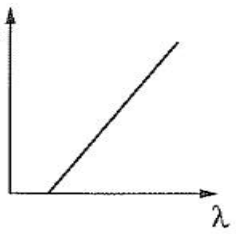
(C) The space ship's change in gravitational potential energy will be negative

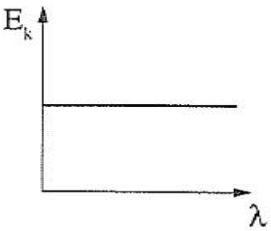
(D) The astronauts in the ship will observe their clocks running faster.

17. When photons strike a metal surface, photoelectrons may be emitted.
Which of the following graphs shows the relationship between the maximum kinetic energy of these electrons (E_k) and the wavelength of the photons (λ)?

(A) 

(B) 

(C) 

(D) 

18. An electric motor is constructed using a circular coil in a uniform magnetic field of strength 0.45 T. The coil has 3 turns and a diameter of 10 cm. A current of 0.5 A flows through the coil.

What is the maximum torque experienced by the coil as it rotates?

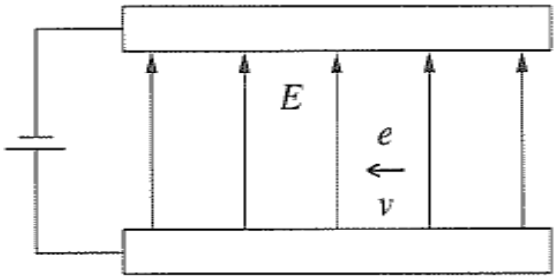
(A) 5.3×10^{-3} N m

(B) 6.7×10^{-3} N m

(C) 1.7×10^{-3} N m

(D) 10.6×10^{-3} N m .

19. An electron, *e*, travelling with velocity, *v*, passes through an electric field, *E*, between two parallel plates.



A magnetic field is then applied in the same region as the electric field shown to produce a net force of zero on the electron. The direction of the magnetic field would be

(A) To the right of page

(B) To the left of page

(C) Out of the page

(D) Into the page.

20. A satellite, initially in a low Earth orbit, is moved to a new orbit where the gravitational force acting on it is one quarter of its original value.

The satellite's period in its new orbit is closest to -

(A) 2.8 times initial period

(B) 4 times initial period

(C) 0.28 times initial period

(D) 0.5 times initial period .

Section I (continued)

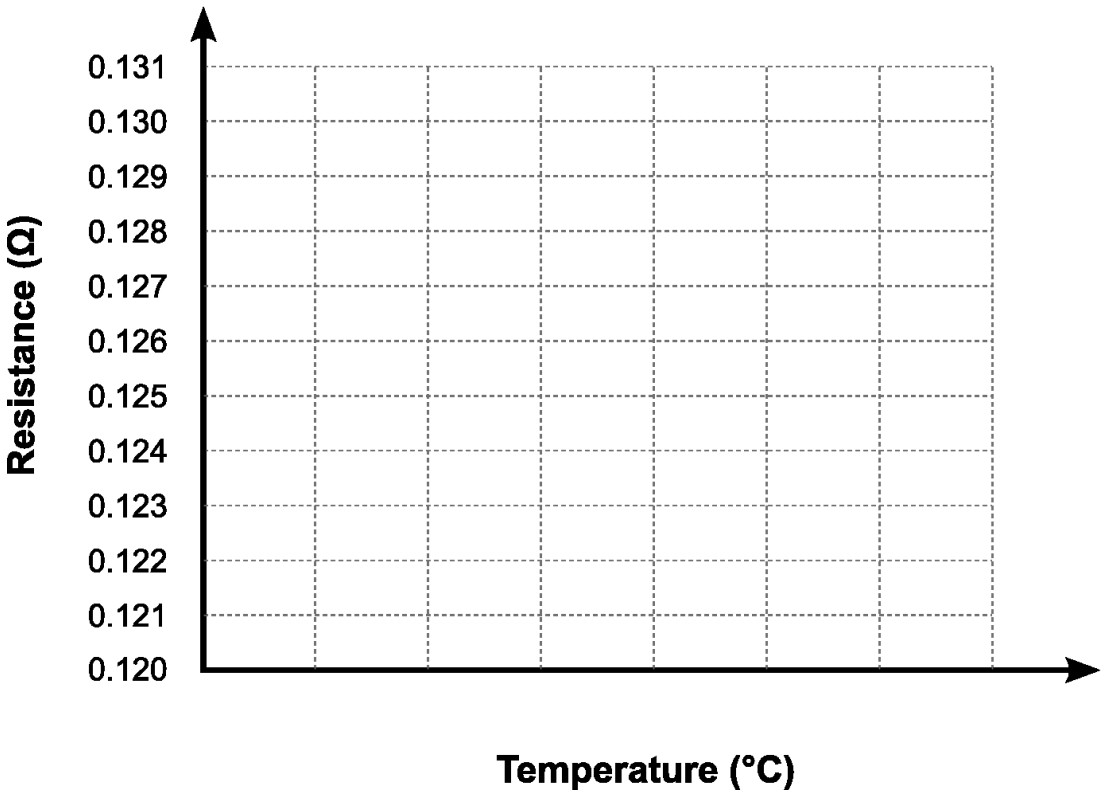
Part B – 55 marks
Attempt Questions 21-30
Allow about 1 hour and 40 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions that require calculations.

Question 21 (4 marks) **Marks**

The electrical resistance, *R*, of a piece of wire was measured at different temperatures, *T*. Near room temperature, the resistance of the wire can be modelled by the equation $R = mT + b$.

Temperature (°C)	Resistance (ohms)
12.5	0.122
16.4	0.124
32.6	0.130
36.5	0.131



(a) Plot the data points on the graph provided. Draw a line of best fit on the graph and use it to estimate the electrical resistance of wire at 30^{o} C. **2**

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(b) Assess the validity of using the data from this experiment to estimate the electrical resistance at 120 ^{o}C. **2**

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Question 22 (6 marks) **Marks**

(a) Einstein's Theory of Special Relativity was published 18 years after Michelson and Morley conducted their famous experiment to determine the relative speed of the earth through the aether in 1887. If Einstein's theory had been published in 1887, Michelson and Morley may not have attempted their experiment. Discuss this statement. **3**

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(b) Draw a labelled diagram that outlines how the experiment was performed. **3**

Physics

Section I (continued)

Question 23 (7 marks) **Marks**

A rocket launches a satellite into orbit 355 km above Earth's surface. The weight of the satellite is 14.0 kN at launch.

(Radius of Earth = 6380 km, mass of earth = 5.97 x 10^{24} kg)

(a) Calculate the gravitational field strength 355 km above the earth's surface. **2**

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(b) Calculate the orbital velocity of this satellite. **2**

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(c) Calculate the work done to move the satellite from the launch pad to the orbit altitude. **3**

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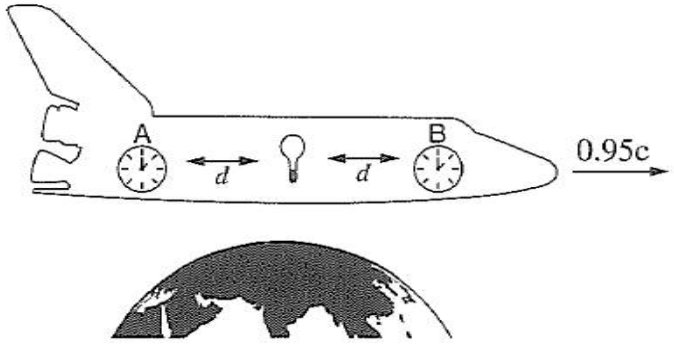
Question 24 (4 marks) **Marks**

Consider the following 'thought experiment'. **4**

A scientist on board a spaceship wishes to synchronise two clocks. To achieve this, beams of light from a source placed midway between the clocks activate photocells, turning on both clocks.



The scientist observed the synchronisation of the clocks as the rocket flies past Earth at 0.95c. A person on Earth observes that the clocks are not synchronised. Account for these observations.

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Question 25 (4 marks) **Marks**

(a) Explain why transformer cores are laminated. **1**

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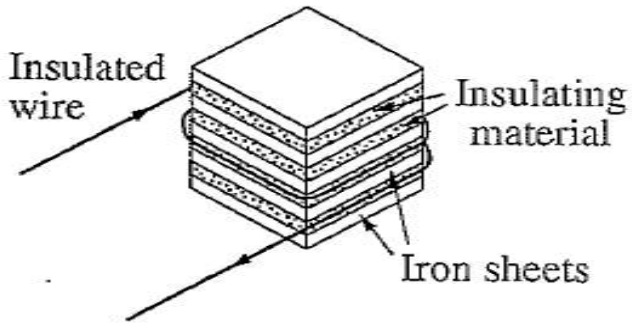
(b) A student designs a simple induction cooktop solenoid. He inserts a laminated iron core into the solenoid as shown below. Evaluate the impact this will have on the efficiency of the oven. **3**



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Question 26 (9 marks) **Marks**

(a) Use a flowchart to show how electrical energy is transferred from a power station to its point of use. **3**

Question 26 continues on the next page

Question 26 (continued) **Marks**

(b) Contrast the urban and rural environmental impacts of large scale electricity generation in Australia. **3**

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(c) The "War of the Currents" refers to the battle between Edison and Westinghouse to develop the dominant system for generation and transmission of electrical power. If cost effective superconducting technology had been available to Edison at the time, propose how this might have strengthened his campaign against Westinghouse. **3**

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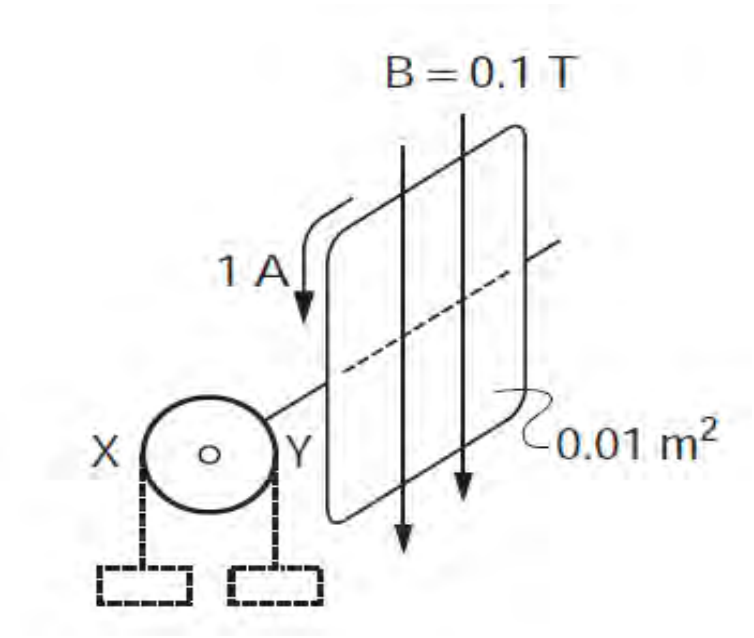
Question 27 (4 marks)

A simple motor consists of 200 coils positioned in a region of uniform magnetic field with a strength of 0.10 T. The plane of the coil is parallel to the magnetic field. The coil is a square with area $0.01m^2$, and carries a current of 1.0 A. The motor drives a pulley of diameter 20 cm.



(a) In order to prevent rotation should a weight be hung at X or Y ? **1**

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(b) What is the magnitude of the net torque acting on the pulley if a mass of 0.3 kg is hung at point X ? **2**

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(c) Explain how the use of a radial magnetic field would improve this motor ? **1**

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Question 28 (6 marks) **Marks**

(a) Describe an investigation that has been done in your school laboratory to demonstrate that cathode rays behave like charged particles. List all necessary equipment and safety precautions. **4**

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(b) Draw a labelled diagram of the vacuum tube used by Thomson to calculate the q/m ratio of electrons. **3**

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Question 29 (5 marks) **Marks**

(a) Calculate the number of photons, $\lambda = 4.5 \times 10^{-4}$ mm, which are required to transfer 2.0 MeV of energy. **2**

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(b) Watts per square meter (W/m^2) is a measure of light intensity.

With reference to the particle model of light, contrast a beam of red light and a beam of blue light, both of the same intensity. **2**

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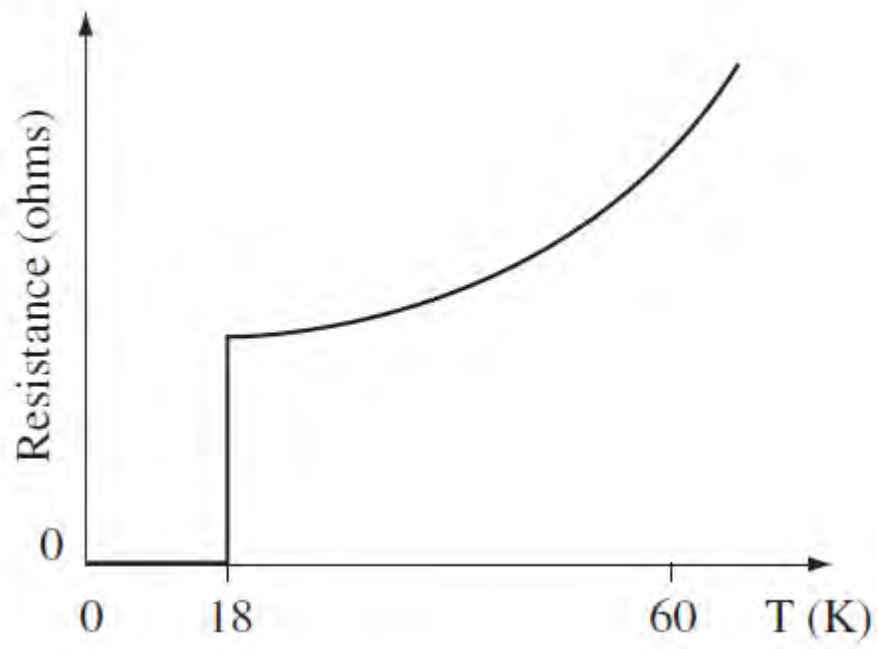
Question 30 (6 marks) **Marks**

The graph shows the relationship between the resistance of a metal alloy sample and its temperature.



(a) Why is the resistance of the sample higher at 60 K than at 30 K? **2**

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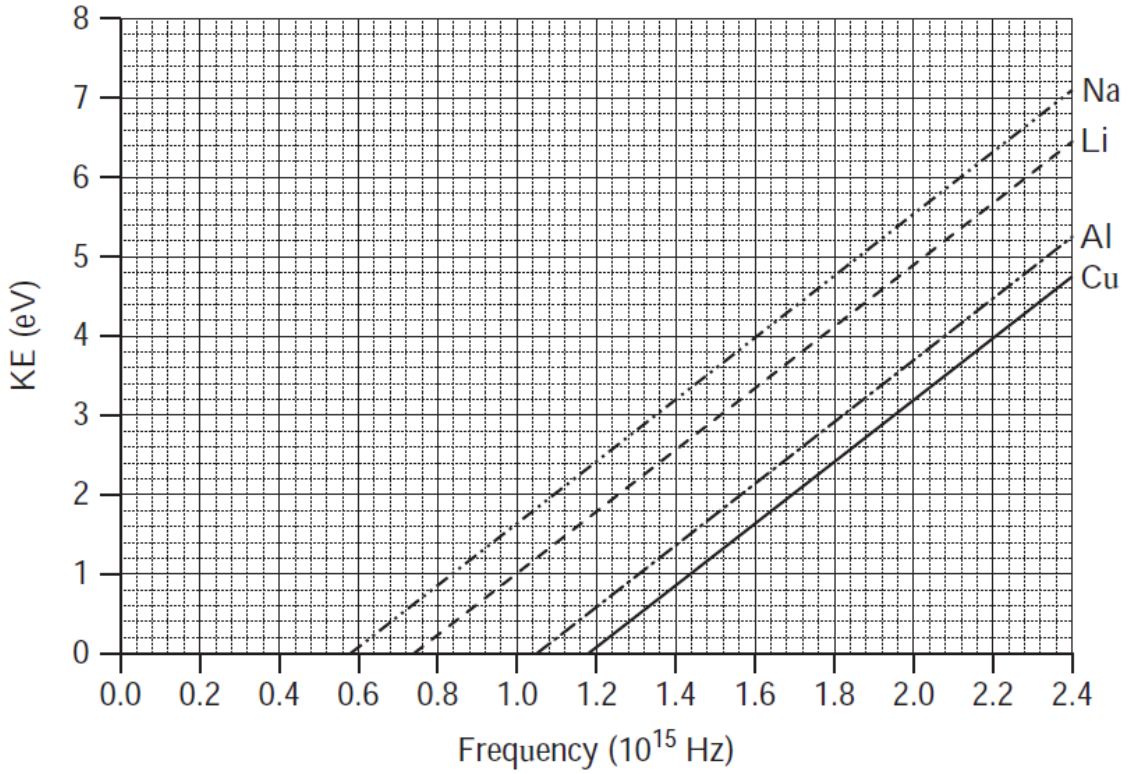
(b) The graph below shows the KE of photoelectron emitted from a range of metals for different incident frequencies.



(i) Which metal requires the least amount of energy to stimulate a photocurrent? Justify. **2**

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(ii) What would be the stopping (or cut off) voltage for a photoelectric copper cathode when incident light of frequency 2.2 x 10^{15} Hz is used? **2**

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Section II - OPTIONS **25 marks**

On this page in the HSC you will be asked to go to the page that has the Option you have studied at school. Your option is Quanta to Quarks.
(If you didn't know that we're in trouble already).
To save paper we've only listed questions for Quanta to Quarks.

Answers to the Option are written in the SEPARATE writing booklet provided.

Question 31 - Quanta to Quarks (25 marks)

(a) Draw a labelled diagram of the Rutherford atom. **3**

(b) With reference to specific evidence from the Geiger and Marsden experiment, justify 2 aspects of the Rutherford model you drew and labelled for part (a). **2**

(c) The success of the Bohr model of the Hydrogen atom is based on its ability to address two issues:

* the limitations of the Rutherford model and
* observations of the emission spectrum of the hydrogen atom.

Assess the validity of this statement. **6**

(d) Outline the main contributions of Heisenberg and Pauli to the development of atomic theory. **4**

(e) Harry hit a volleyball of mass 225 grams with a velocity of 50 km/h. Calculate it's De Broglie wavelength. **2**

(f) Early measurements of the kinetic energies of emitted beta particles were not consistent with predictions made using the conservation laws.

(i) Outline the problem with the aid of an appropriate graph. **2**

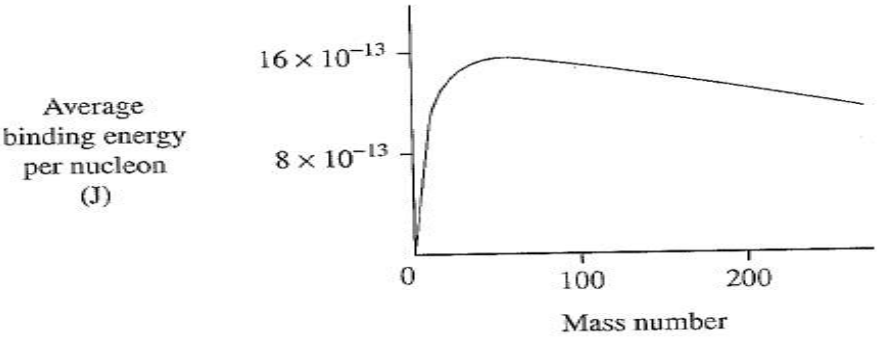
(ii) Explain Pauli's proposed solution to the problem. **2**

(g) Account for the need for the strong nuclear force and describe it's properties. **2**

(continued over page)

Quanta to Quarks (continued)

(h) The energy required to separate all the nucleons in a nucleus is called Binding Energy. The graph shows how average binding energy per nucleon varies with mass number.



Use the graph to contrast the stability of a nucleus of mass number 50 with one of mass number 10. **2**

END OF QUESTIONS.

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SYDNEY BOYS HIGH SCHOOL

Physics

HSC TRIAL EXAMINATION

2012

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Total marks - 100

Section 1

75 marks
This section has two parts, Part A and Part B

Part A - 20 marks
- Attempt questions 1 – 20
- Allow about 35 minutes for this part

Part B - 55 marks
- Attempt Questions 21-30
- Allow about 1 hour and 40 minutes for this part

Section II

25 marks – Quanta to Quarks

- Allow about 45 minutes for this part

Multiple choice answer sheet. Choose the most correct answer.
(You may remove this sheet if you wish)

Indicate your answer with an **X.**

	A	B	C	D
1				**x**
2	**x**			
3			**x**	
4		**x**		
5		**x**		
6			**x**	
7			**x**	
8	**x**			
9			**x**	
10			**x**	
11				**x**
12		**x**		
13	**x**			
14				**x**
15			**x**	
16		**x**		
17		**x**		
18	**x**			
19				**x**
20	**x**			

Section I (continued)

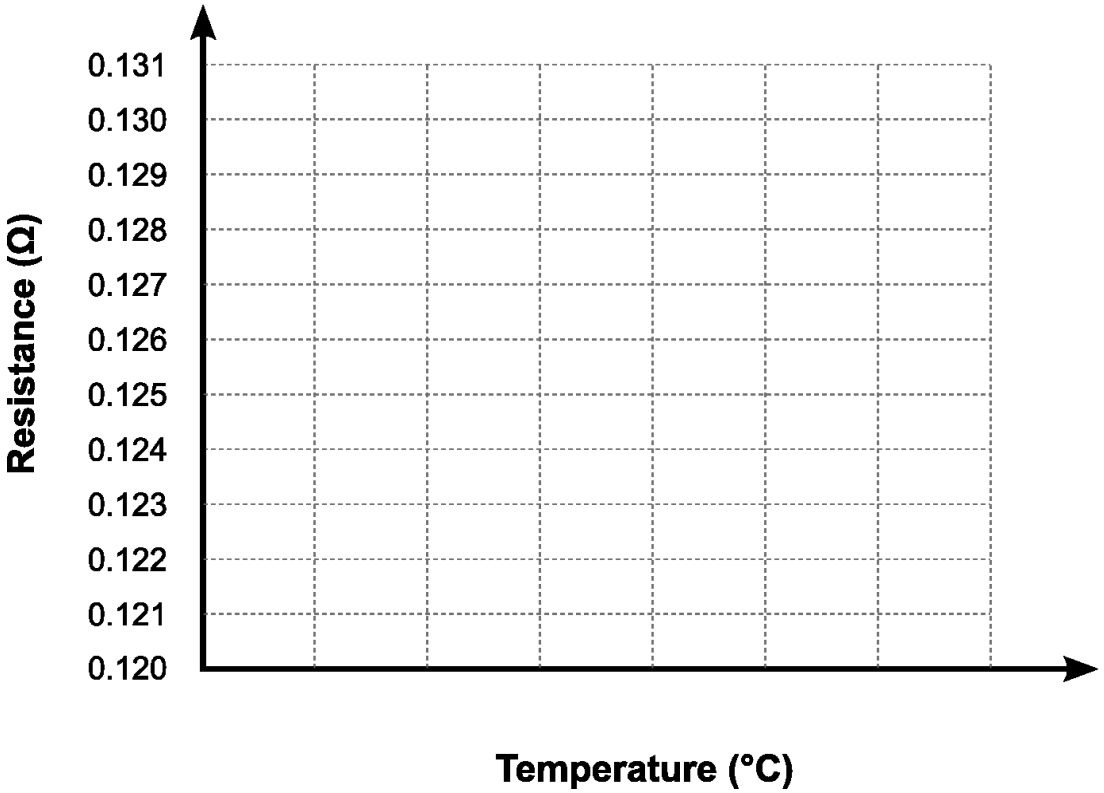
Part B – 55 marks
Attempt Questions 21-30
Allow about 1 hour and 40 minutes for this part

Answer the questions in the spaces provided.
Show all relevant working in questions that require calculations.

Question 21 (4 marks) **Marks**

The electrical resistance, *R*, of a piece of wire was measured at different temperatures, *T*. Near room temperature, the resistance of the wire can be modelled by the equation $R = mT + b$.

Temperature (°C)	Resistance (ohms)
12.5	0.122
16.4	0.124
32.6	0.130
36.5	0.131



(a) Plot the data points on the graph provided. Draw a line of best fit on the graph and use it to estimate the electrical resistance of wire at 30^{o} C. **2**

1 mark for graph(LOBF and SCALE),
1 mark for correct answer, units and 3 sig figs. R=0.129 Ohms.

(b) Assess the validity of using the data from this experiment to estimate the electrical resistance at 120 ^{o}C. **2**

1 mark for correct assessment ---- Validity is poor

1 mark for justification ---- extrapolation is valid if close(in range) to a reliable set of data but in this case there were only 4 data points and the extrapolation is too large. Plus, the linear relation was only said to apply to "near room temperature"

Question 22 (6 marks) **Marks**

(a) Einstein's Theory of Special Relativity was published 18 years after Michelson and Morley conducted their famous experiment to determine the relative speed of the earth through the aether in 1887. If Einstein's theory had been published in 1887, Michelson and Morley may not have attempted their experiment. Discuss this statement. **3**

Response must have points both FOR and AGAINST the statement.

Markers Notes: Most students only provided support for the statement. Many students didn't limit their discussion to the STATEMENT and hence lost focus and succinctness.

FOR. If M and M accepted that c was constant for all observers they would have known the interferometer interference pattern would never change and the experiment was invalid.

AGAINST. Einstein's theory re the constancy of the speed of light was not immediately accepted so M and M may have proceeded anyway. Or they may have conducted the experiment to verify Einstein's theory.

(b) Draw a labelled diagram that outlines how the experiment was performed. **3**

Required labels:

INTERFEROMETER	
Coherent monochromatic light source Or laser	**Path and direction of light rays**
Half silvered mirror	**Aether wind direction (or reference to)**
2 mirrors	**Ref to ROTATION of interferometer**
Telescope /viewing port/microscope Interference pattern	**Provides brief info about how the apparatus was used**

Physics

Section I (continued)

Question 23 (7 marks) **Marks**

A rocket launches a satellite into orbit 355 km above Earth's surface. The weight of the satellite is 14.0 kN at launch.

(Radius of Earth = 6380 km, mass of earth = 5.97 x 10^{24} kg)

(a) Calculate the gravitational field strength 355 km above the earth's surface. **2**

8.78 m/s^2 1 mark for correct number , 1 mark for correct unit

(b) Calculate the orbital velocity of this satellite. **2**

V= (Gm/r)^{½} 1 mark
= substitution line (no carry overs paid)
= **7690 m/s 1 mark for correct value and unit**

(c) Calculate the work done to move the satellite from the launch pad to the orbit altitude. **3**

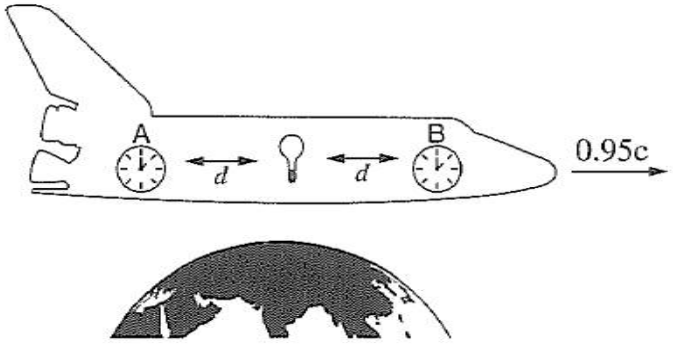
$W = E_{p\ final} - E_{p\ initial}$
= $-Gmm/r_f - -Gmm/r_i$ **1 mark**
= substitution line **1 mark for correct answer and unit.**
= 4.67 x10^9 J

.

Question 24 (4 marks) **Marks**

Consider the following 'thought experiment'. **4**

A scientist on board a spaceship wishes to synchronise two clocks. To achieve this, beams of light from a source placed midway between the clocks activate photocells, turning on both clocks.



The scientist observed the synchronisation of the clocks as the rocket flies past Earth at 0.95c. A person on Earth observes that the clocks are not synchronised. Account for these observations.

Markers Notes:

Some students incorrectly referred to TIME DILATION, to account for the lack of synchronisation. Ie This in not a valid argument when both clocks being observed are in the same inertial frame.

Correct meta language is necessary

4 Marks;

1. States that the scientist and earthling are both in INERTIAL FRAMES OF REFERENCE.

2. States that observations are explained by Einstein's Principle of SIMULTANEITY

3. Explains that due to the motion of the spaceship, measured from the Earth Frame, the distances from the light event to clocks A and B are different.

4. States that viewed from Earth, clock A turns on before clock B, since the distance is shorter and light travels at c for all observers.

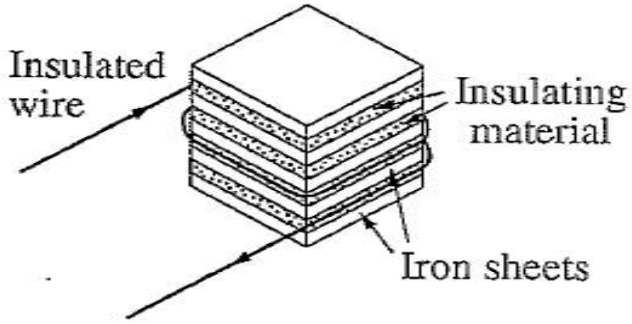
.

Question 25 (4 marks) **Marks**

(a) Explain why transformer cores are laminated. **1**

Answer must refer to improvements in EFFICIENCY through the reduction in size of induced eddy currents and ohmic heating losses.

(b) A student designs a simple induction cooktop solenoid. He inserts a laminated iron core into the solenoid as shown below. Evaluate the impact this will have on the efficiency of the oven. **3**



Markers Notes: Many students incorrectly stated (or implied) that the core is supposed to heat up in the normal operation of an induction cooktop.

3 Marks –

Identifies that lamination plane is incorrect. Eddy currents will not be minimised and energy will be lost in the form of heat.

_ States that the ferromagnetic (iron) core has better permeability that an air core, so B field will be stronger and assist eddy current formation in the saucepan.

- **Evaluates that the cooktop will work better with the core, but efficiency will be low due to induced eddy currents that will radiate heat.**

2 Marks –

Identifies that laminations are in the wrong plane to minimise eddy currents and that as a result efficiency will be low.

.

Question 26 (9 marks) **Marks**

(a) Use a flowchart to show how electrical energy is transferred from a power station to its point of use. **3**

For 3 marks :

- **Needs to be a flow chart**
- **Starts from 23kV Power Station**
- **Goes to STEP UP TRANSFORMER 330kV to 500kV**
- **Shows high voltage TRANSMISSION WIRES**
- **Show STEP DOWN TRANSFORMER SUBSTATIONS bringing voltage down to 22 or 11kV**
- **Show local STEP DOWN TRANSFORMER – 240 V**
- **Show domestic use V=240V and factory use V=415V (3 phase)**

For 2 marks:

Correct flow chart as above but incomplete voltage values at each step.

Question 26 continues on the next page

Question 26 (continued) **Marks**

(b) Contrast the urban and rural environmental impacts of large scale electricity generation in Australia. **3**

Markers notes: many students simply listed urban and environmental impacts without explicitly CONTRASTING. Some used a table which is ok , but it needs to be set up correctly. The table has to present CONTRASTS rather than be a list.

Eg

Environmental Aspect	**Pre AC Generators**		**Post AC Generators**	
	Urban	**Rural**	**Urban**	**Rural**
Air quality	Polluted due to smoke in city form burning coal and firewood.	Good. Some chimney smoke	Improved. Less pollution, less coal and wood burning.	Worse off. Pollution increases due to coal fired power stations
Landscape	Dirty due to coal dust and the need to store fuel.	Good but some tree felling for fire wood.	Improved. Cleaner as no coal dust	Worse off. More land degradation due to construction of mines and power plants.

3 Marks: Response must EXPLICITLY CONTRAST an environmental and an urban impact due to the introduction of Coal fired AC Power Generation.

2 Marks: Lists environmental and urban impacts of COAL FIRED GENERATORS without explicitly CONTRASTING.

(c) The "War of the Currents" refers to the battle between Edison and Westinghouse to develop the dominant system for generation and transmission of electrical power. If cost effective superconducting technology had been available to Edison at the time, propose how this might have strengthened his campaign against Westinghouse.

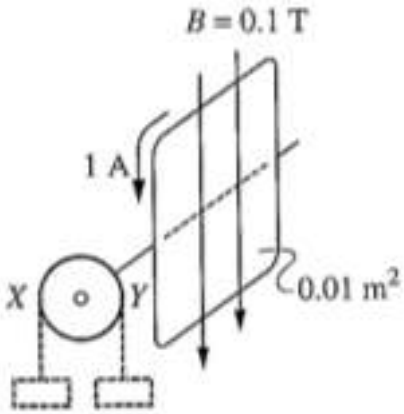
<u>3 Marks</u> :Identifies that Edison's DC system was inefficient because high currents led to energy loss in the FORM OF HEAT. This is called LINE LOSS.
$P_{loss} = I^2 R_{transmission\ lines}$ (Just writing $P=I^2R$ is not enough). Explains that zero R superconductors would solve Edison's LINE LOSS problem and also reduce the need for so many POWER STATIONS. Infrastructure costs would be reduced.Efficiency would be increased. Edison's case for DC would be strengthened.

2 marks:

Identifies that Edison's DC campaign would be strengthened because DC transmission efficiency would be improved. This is because power loss is given by $P=I^2R$. Superconductors have zero R there P loss would be close to zero.

Question 27 (4 marks)

A simple motor consists of 200 coils positioned in a region of uniform magnetic field with a strength of 0.10 T. The plane of the coil is parallel to the magnetic field. The coil is a square with area $0.01m^2$, and carries a current of 1.0 A. The motor drives a pulley of diameter 20 cm.



(a) In order to prevent rotation should a weight be hung at X or Y ? **1**

… **X**……

(b) What is the magnitude of the net torque acting on the pulley if a mass of 0.3 kg is hung at point X ? 2

$\tau = nBIA$ $= 200 \times 0.1 \times 1 \times 0.01$ $= 0.2$ Nm $= -0.2$ Nm (clockwise τ is negative)	$\tau_g = F \times d_\perp$ $= mg \times r$ $= 0.3 \times 9.8 \times 0.1$ $= 0.294$ Nm	$\tau_N = \tau_g + \tau_2$ $\therefore \tau_{NET} = 0.294 - 0.2$ $= 0.094$ Nm (anti-clockwise)
1 mark (must have both correct)		**1 mark (with units)**

(c) Explain how the use of a radial magnetic field would improve this motor ? **1**

Maximum or constant torque will be maintained at all angles of rotation - 1 mark

Question 28 (6 marks) **Marks**

(a) Describe an investigation that has been done in your school laboratory to demonstrate that cathode rays behave like charged particles. List all necessary equipment and safety precautions. **4**

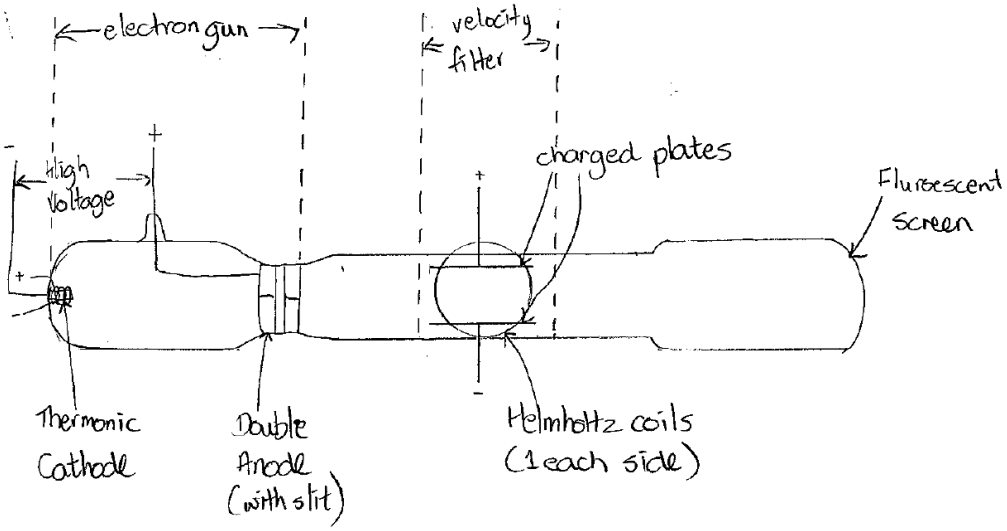
1 mark for each point	**Describes all equipment necessary – must have High Voltage Induction Coil. (may use a labelled diagram)**
	Safety precautions – must mention x-rays
	Describes particular cathode ray behaviour
	Links to why supports being a charged particle

Markers Notes: "radiation" or "EMR not good enough for X-ray, as not specific enough (and not all EMR is dangerous)

Paddle wheel alone doesn't show the particle is charged

(b) Draw a labelled diagram of the vacuum tube used by Thomson to calculate the q/m ratio of electrons. **3**

3 marks	**1 mark**	**Pencil and ruler used**
	2 marks ≥ 5 out of 7 points **1 mark = 4 out of 7 points** **0 marks ≤ 3 out of 7 points**	**Must have the following labels** • **Thermonic cathode** • **Electron gun** • **Anode(s)** • **Magnetic fields (or Holmholtz coil)** • **Electric field (or charged plates)** • **Velocity filter** • **Fluroscent screen**
OR		
1 mark		**Reasonable attempt with cathode and anode labelled**



Question 29 (5 marks) **Marks**

(a) Calculate the number of photons, $\lambda = 4.5 \times 10^{-4}$ mm, which are required to transfer 2.0 MeV of energy. **2**

$E = \frac{hc}{\lambda} = \frac{6.626\times10^{-34} \times 3\times10^{8}}{4.5\times10^{-7}} = 4.4173\times10^{-19}\ J$ $2\ MeV = 2\times10^{6} \times 1.6\times10^{-19}\ J = 3.2\times10^{-13}\ J$	1st mark
$\therefore$ No. photons $= \frac{3.2\times10^{-13}\ J}{4.4173\times10^{-19}\ J} = 7.2\times10^{5}$ photons	2nd mark

Markers Notes: must ensure that the units are the same before calculating the no. of photons.

(b) Watts per square meter (W/m^2) is a measure of light intensity.

With reference to the particle model of light, contrast a beam of red light and a beam of blue light, both of the same intensity. **2**

Blue Photons have more energy per photon than red photons, therefore need more red photons than blue photons if the intensity is the same.

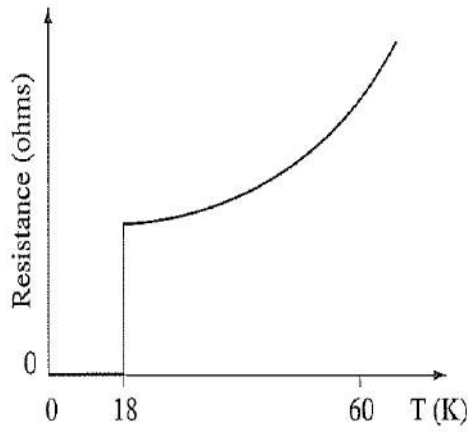
$$\frac{W}{m^2} = \frac{\frac{\Delta E}{seconds}}{m^2}$$

Markers Notes: Key word is contrast. Must show how blue photons differ from red photons to get mark. Need 2 contrasts. (ie, different energy and different numbers.

Must refer to photons, not light as specifically asks to refer to particle model ie, photons.

Question 30 (6 marks) **Marks**

The graph shows the relationship between the resistance of a metal alloy sample and its temperature.



(a) Why is the resistance of the sample higher at 60 K than at 30 K? **2**

The lattice vibrations of the metal ally are higher at 60K than at 30k. Increased lattice vibrations increase the rate of collisions between the lattice and the electrons, increasing resistance.

1 mark for increased lattice vibrations

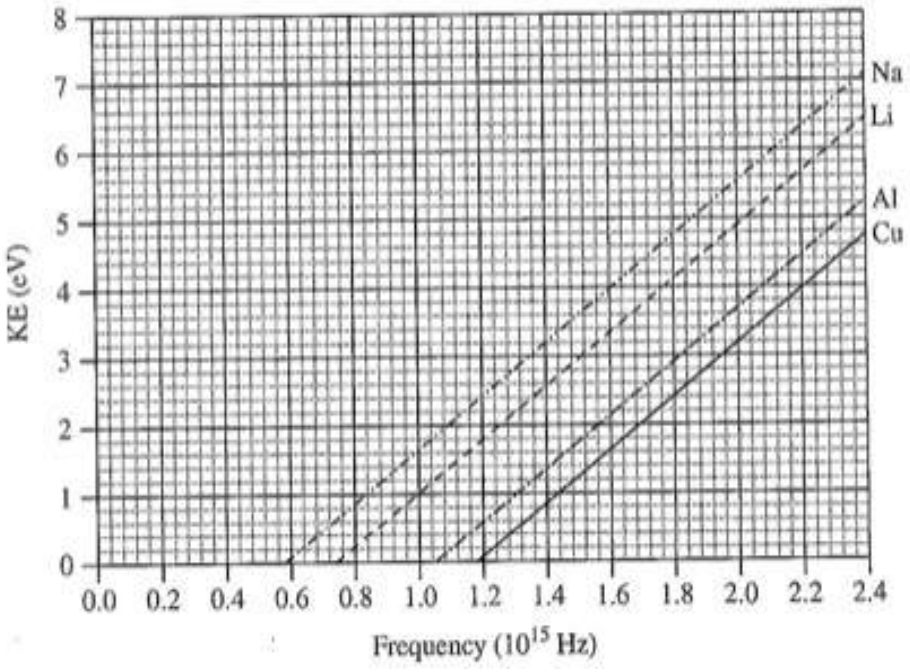
1 mark for this then increases the rate of collision.

Markers Notes: this is not a superconductor question. It doesn't become a superconductor until temp is below 18K.

Must state how lattice vibrations change and how rate of collision change.

Can't get mark for increased rate of collisions without talking about increased lattice vibrations.

(b) The graph below shows the KE of photoelectron emitted from a range of metals for different incident frequencies.



(i) Which metal requires the least amount of energy to stimulate a photocurrent? Justify. **2**

Na. Has the lowest threshold freq. and since E is proportional to f, this corresponds to the lowest energy.

1 mark for correct metal, 1 mark for correct explanation

(ii) What would be the stopping (or cut off) voltage for a photoelectric copper cathode when incident light of frequency 2.2 x 10^{15} Hz is used? **2**

at 2.2×10^{15} Hz, KE = 4 eV = 6.4×10^{-19} J = qV_s

$\therefore V_s = \frac{6.4 \times 10^{-19}}{1.6 \times 10^{-19}} = 4$ Volts

4 volts = 2 marks

4 eV = 1 mark

Anything else = 0 marks

Markers notes: $E_k = hf - W_o$ is the work function, Ek needed to be read straight off the graph.

Section II - OPTIONS **25 marks**

On this page in the HSC you will be asked to go to the page that has the Option you have studied at school. Your option is Quanta to Quarks.
(If you didn't know that we're in trouble already).
To save paper we've only listed questions for Quanta to Quarks.

Answers to the Option are written in the SEPARATE writing booklet provided.

Question 31 - Quanta to Quarks (25 marks)

(a) Draw a labelled diagram of the Rutherford atom. **3**

(b) With reference to specific evidence from the Geiger and Marsden experiment, justify 2 aspects of the Rutherford model you drew and labelled for part (a). **2**

(c) The success of the Bohr model of the Hydrogen atom is based on its ability to address two issues:

* the limitations of the Rutherford model and
* observations of the emission spectrum of the hydrogen atom.

Assess the validity of this statement. **6**

(d) Outline the main contributions of Heisenberg and Pauli to the development of atomic theory. **4**

(e) Harry hit a volleyball of mass 225 grams with a velocity of 50 km/h. Calculate it's De Broglie wavelength. **2**

(f) Early measurements of the kinetic energies of emitted beta particles were not consistent with predictions made using the conservation laws.

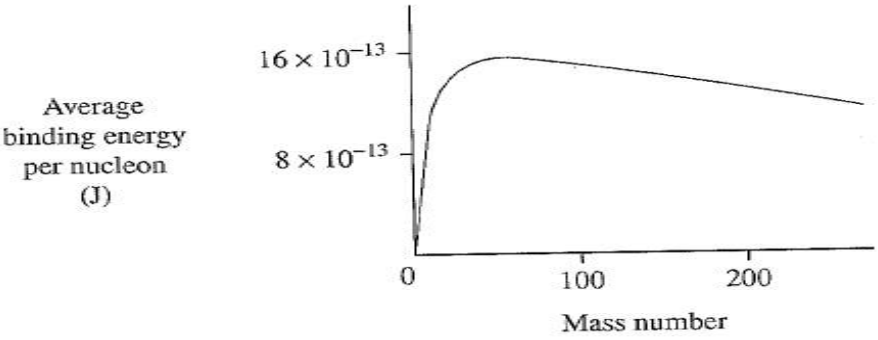
(a) Outline the problem with the aid of an appropriate graph. **2**
(b) Explain Pauli's proposed solution to the problem. **2**

(g) Account for the need for the strong nuclear force and describe it's properties. **2**

(continued over page)

Quanta to Quarks (continued)

(h) The energy required to separate all the nucleons in a nucleus is called Binding Energy. The graph shows how average binding energy per nucleon varies with mass number.



Use the graph to contrast the stability of a nucleus of mass number 50 with one of mass number 100. **2**

END OF QUESTIONS.