# Glenwood High School

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Please write your 4/5 digit **STUDENT NUMBER** neatly in the boxes.

# Physics

**2009**

**TRIAL HSC EXAMINATION**

## General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table and Formulae Sheets are provided at the back of this paper.

**Section I**

Total marks **(85)**

This section has two parts, Part A and Part B

Part A

Total marks **(15)**

- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B

Total marks **(70)**

- Attempt Questions 16-28
- Allow about 2 hours for this part

**Section I is presented in TWO parts:**

- **Part A** – Questions 1-15
- **Part B** – Questions 16-28

**Section II**

Total marks **(15)**

- Attempt question 31
- Allow about 30 minutes for this section

# Section I

**Total marks (85)**

## Part A

**Total marks (15)**

**Attempt Questions 1-15**

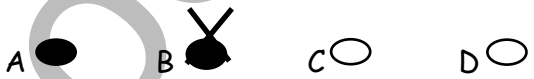
**Allow about 30 minutes for this part**

Use the multiple-choice answer sheet.

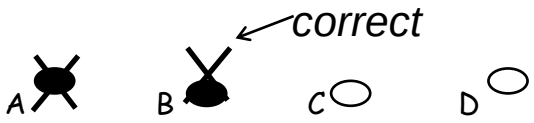
Select the alternative A, B, C or D that best answers the question. Fill in the response circle completely.

**Sample:** 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9


If you think you made a mistake, put a cross through the incorrect answer and fill in the new answer.




If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows:



**1.** Use the data in the table below to answer the following question

| **Planet** | **Acceleration due to gravity** |
|---|---|
| Earth | $9.8ms^{-2}$ |
| Mars | $3.7ms^{-2}$ |

A person stood on scales that were calibrated for Earth whilst on Mars. The scale gave a reading of 50kg. What is the actual mass of the person?

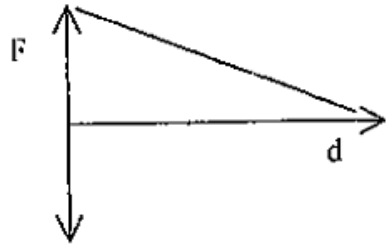
A. 50kg
B. 18.9kg
C. 132.4kg
D. 1297N

**2.** Which statement correctly describes the period of a satellite in Low Earth Orbit?

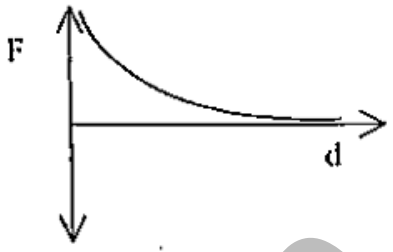
A. A satellite in low earth orbit has a period equal to that of a geostationary satellite
B. A satellite in low earth orbit has a period greater than that of a geostationary satellite
C. A satellite in low earth orbit has a period less than that of a geostationary satellite
D. The larger the radius of orbit, the faster the orbit period

**3.** Which graph best depicts the variation of the gravitational force *F*, with distance *d*, from the centre of the Earth?

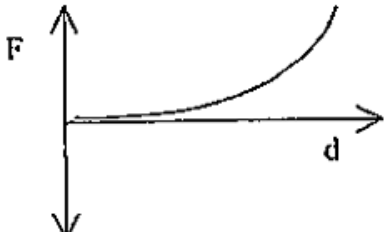
(A)



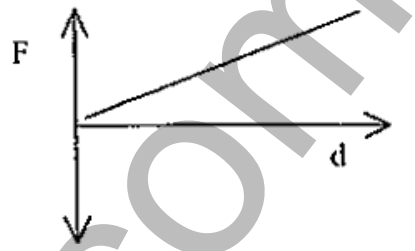

(B)




(C)




(D)




**4.** Michelson & Morley performed an experiment in which they tried to demonstrate the existence of the aether. What was the reason put forward by scientists at that time to justify the existence of the aether?

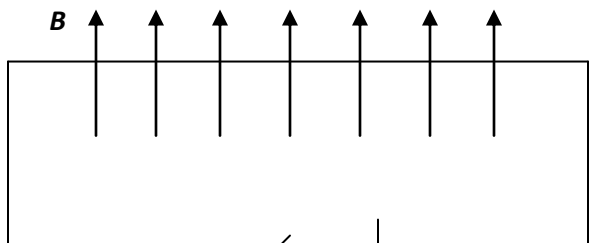
A. Light waves needed a medium through which to travel.
B. The speed of light is the same in all directions.
C. The speed of light is independent of the motion of the source and observer.
D. Time dilation could not occur if there was no aether.

**5.** A projectile is fired from ground level with an initial velocity of $35ms^{-1}$ at an angle of 40° above the horizontal.

Which of the following represents the maximum height and time of flight for this projectile?

| | **Maximum height (m)** | **Time of flight (s)** |
|---|---|---|
| A | 25.8 | 2.3 |
| B | 25.8 | 4.6 |
| C | 36.6 | 2.7 |
| D | 36.6 | 5.4 |

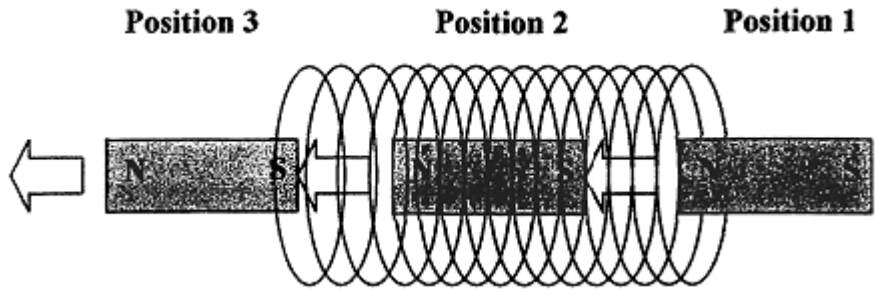
**6.** A conductor, which is in a magnetic field, is connected to a power source through a switch as shown below



When the switch is closed, what will be the direction of the force on the conductor?

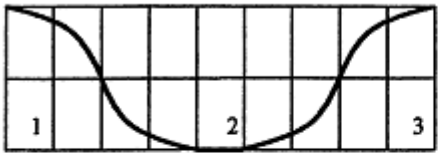
A. Up the page
B. Down the page
C. Into the page
D. Out of the page

**7.** A bar magnet is moved at a constant speed into, all the way through, and out the other side of a solenoid

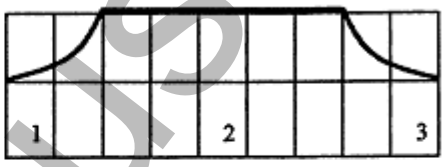



Which of the following graphs best represents how the EMF generated in the coil changes as the bar magnet moves from position 1, through 2, to 3?

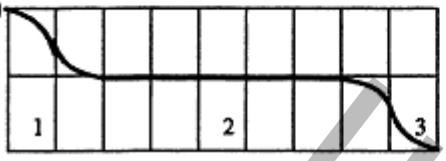
(A)



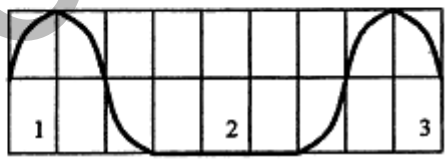

(B)



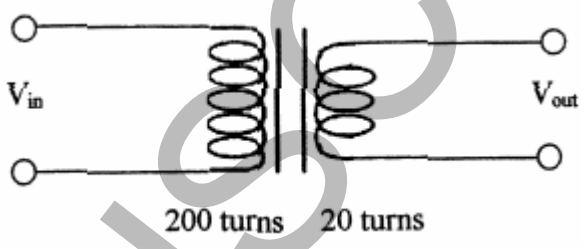

(C)




(D)



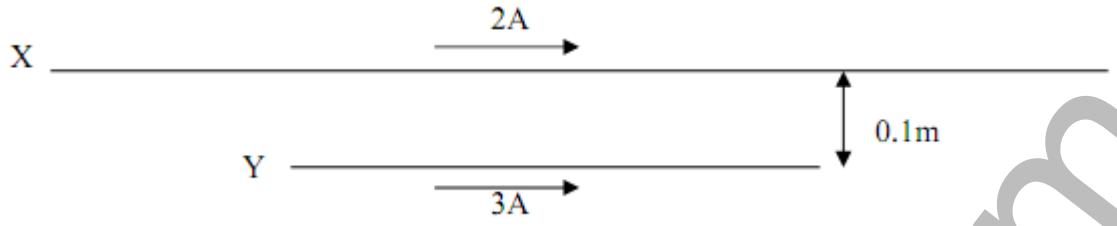

**8.** This question refers to the diagram below




The above transformer is being used in a circuit where the input voltage is 240V, with a current of 0.2A. Which combination of output voltage and current is supplied by the secondary coil?

A. 24V, 0.02A
B. 24V, 2A
C. 2400V, 0.02A
D. 2400V, 2A

**9.** Two long parallel wires X and Y carry currents of 2A and 3A respectively in the same direction as shown in the diagram below.




Wire X is 3m long and is twice the length of wire Y. They are separated by 10cm. The force between the wires is:

A. $1.8 \times 10^{-5}$N attraction
B. $1.8 \times 10^{-5}$N repulsion
C. $3.6 \times 10^{-5}$N attraction
D. $3.6 \times 10^{-5}$N repulsion

**10.** Which of the following is NOT a method used to overcome heating difficulties in transformers?

A. The use of ferrites in the core
B. Oil cooling of large transformers
C. The use of a laminated iron core
D. Increasing the primary voltage in the transformer

**11.** Which of the following is an advantage of thermionic devices, compared to solid state devices?

A. Thermionic devices are cheaper to manufacture
B. Thermionic devices can be miniaturized easily
C. Thermionic devices operate with greater reliability
D. Thermionic devices operate at higher temperatures

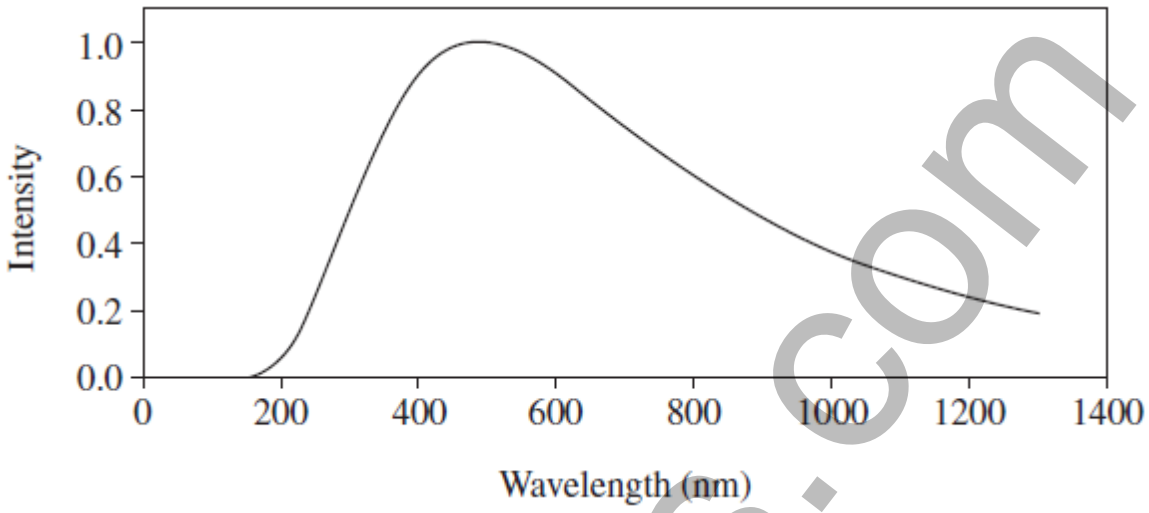
**12.** The debate as to whether cathode rays are charged particles or electromagnetic waves continued for many years.
Which observation of cathode rays resolved this debate?

A. Cathode rays can penetrate thin metal foils, but not thick metal foils
B. A magnetic field can deflect cathode rays
C. Cathode rays turn a paddle wheel
D. An electric field can deflect cathode rays

**13.** Which of the following statements is true?

A. N-type semiconductors are generally more efficient due to the greater mobility of holes compared to electrons
B. P-type semiconductors are generally more efficient due to the greater mobility of holes compared to electrons
C. N-type semiconductors are generally more efficient due to the greater mobility of electrons compared to holes
D. P-type semiconductors are generally more efficient due to the greater mobility of electrons compared to holes

**14.** The graph shown below shows the intensity-wavelength relationship of electromagnetic radiation emitted from a black body cavity

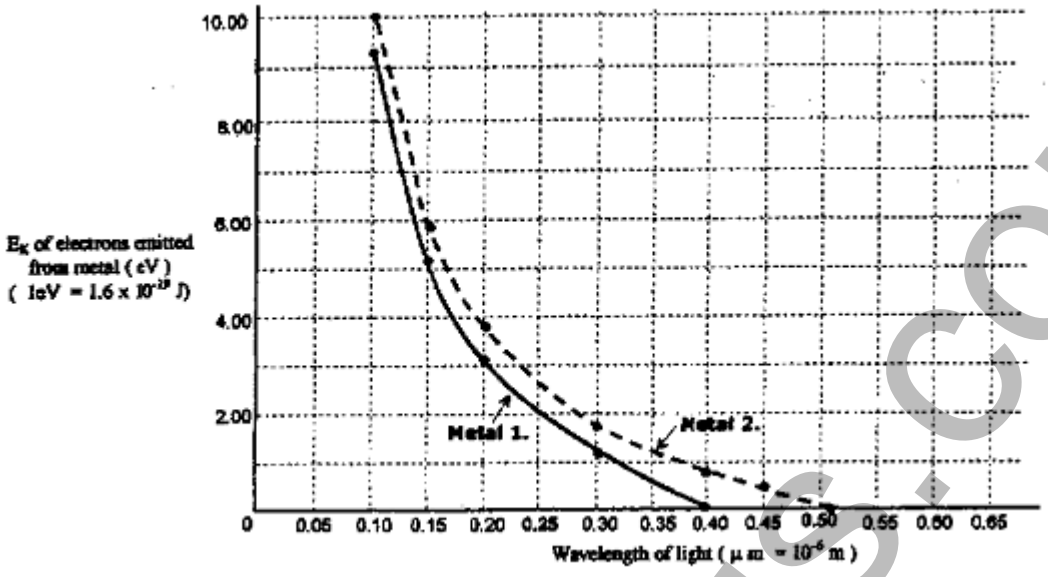



In 1900, Planck proposed a mathematical formula that predicted an intensity-wavelength relationship consistent with the experimental data.

The success of this formula depended on which of the following hypotheses?

A. The intensity of light is dependent on the wavelength
B. Light is quantised, with the energy of the light quanta depending on the frequency
C. Light is a wave whose intensity is readily expressed using mathematical formulae
D. Light is quantised, with the energy of the light quanta depending on the size of the cavity from which it is emitted

**15.** The following graph shows results collected on the kinetic energy of electrons that were emitted from TWO metals as the wavelength of the light source was changed




Considering the graph above, which of the following statements is correct?

A. The threshold frequency for Metal 1 is greater than for Metal 2
B. The greater the kinetic energy of the electrons, the shorter their wavelength
C. The intensity of the light used for Metal 2 was greater than that used for Metal 1
D. The work function for Metal 2 is greater than for Metal 1

# Section I (continued)

Please write your 4/5 digit **STUDENT NUMBER** neatly in the boxes.

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## Part B - 75 marks

**Attempt Questions 16-30**

**Allow about 2 hours for this part**

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

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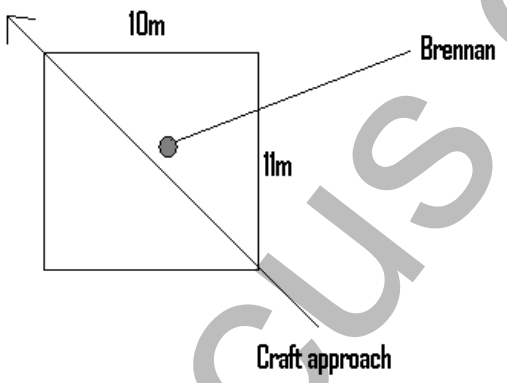
**Question 16** (3 marks)

It was Isaac Newton who first described the idea of an "escape velocity" required to launch an object so that it could break free of Earth's gravity. Describe the method Newton used that allowed him to show how the "escape velocity" for Earth could be calculated and calculate the escape velocity for the Earth's surface. **3**

**Question 17** (4 marks)

Having been working for the FBU (Federal Bureau of Unintelligence) for nearly 2 years, Agent Ryan Barfoot has the opportunity to pilot a 6m radius circular flying saucer over the Bermuda triangle. As usual, ignoring his superior officers' instructions, he pilots the craft to Glenwood, Australia to visit his mate, Brennan. Brennan now being a multi-millionaire country and western singer has his own helipad. His helipad is a 10mx11m rectangle. Remembering some of his awesome, inspirational physics lessons from year 12, he tells Ryan to approach from the bottom right hand corner towards the top left hand corner and he will observe whether the craft can fit on the helipad.




(a) Name the effect Brennan is trying to measure **1**

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(b) Determine the minimum velocity which Ryan has to fly the craft in order for Brennan to judge that it can fit on the helipad and calculate the dimensions of the craft as judged by Brennan at this velocity. **3**

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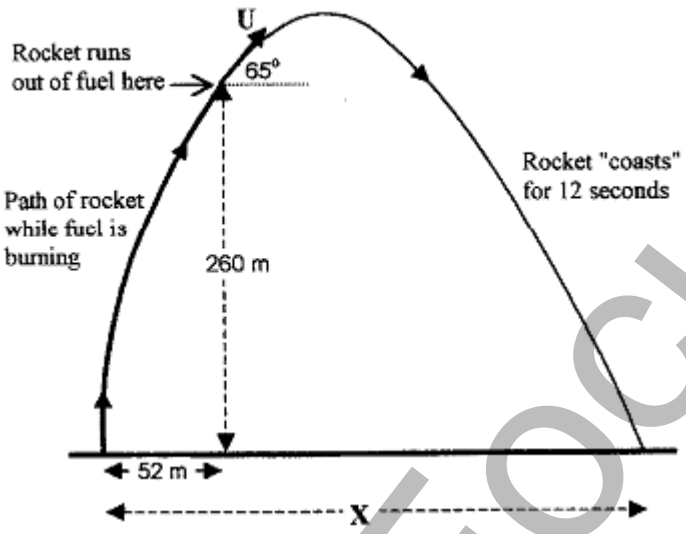
**Question 18** (6 marks)

A group of students build a small rocket under the guidance of an expert (Mr. Williams), and take it out to a large field to test it. It takes off vertically, but does not quite go straight, as shown in the diagram.

At a height of 260m it runs out of fuel. At that point it is travelling at an angle of 65° to the horizontal, as shown. It then coasts on, following the path as shown, hitting the ground 12 seconds after it ran out of fuel.

Note that the diagram is **NOT** to scale.




For the following parts (a) and (b), assume that air friction on the rocket is not significant

(a) What was the speed U (see diagram) of the rocket at the point where it ran out of fuel? **2**

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(b) What is the distance X (see diagram) from the launch point to where it hits the ground? **2**

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(c) Explain why the approach that you used to calculate speed and distance could not be used for a rocket that went to a height of 100km before running out of fuel, even if air friction was negligible. **1**

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(d) Sites for launching satellites are generally close to the equator. When a low earth orbit satellite with an orbit close to the equator is launched from such a site, the rocket carrying it will initially climb vertically upwards, but will then be steered towards the East. Explain why this is the preferred direction, rather than towards the West. **1**

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**Question 19** (3 marks)

Explain the idea of the relativity of simultaneity, giving an example to support your answer. **3**

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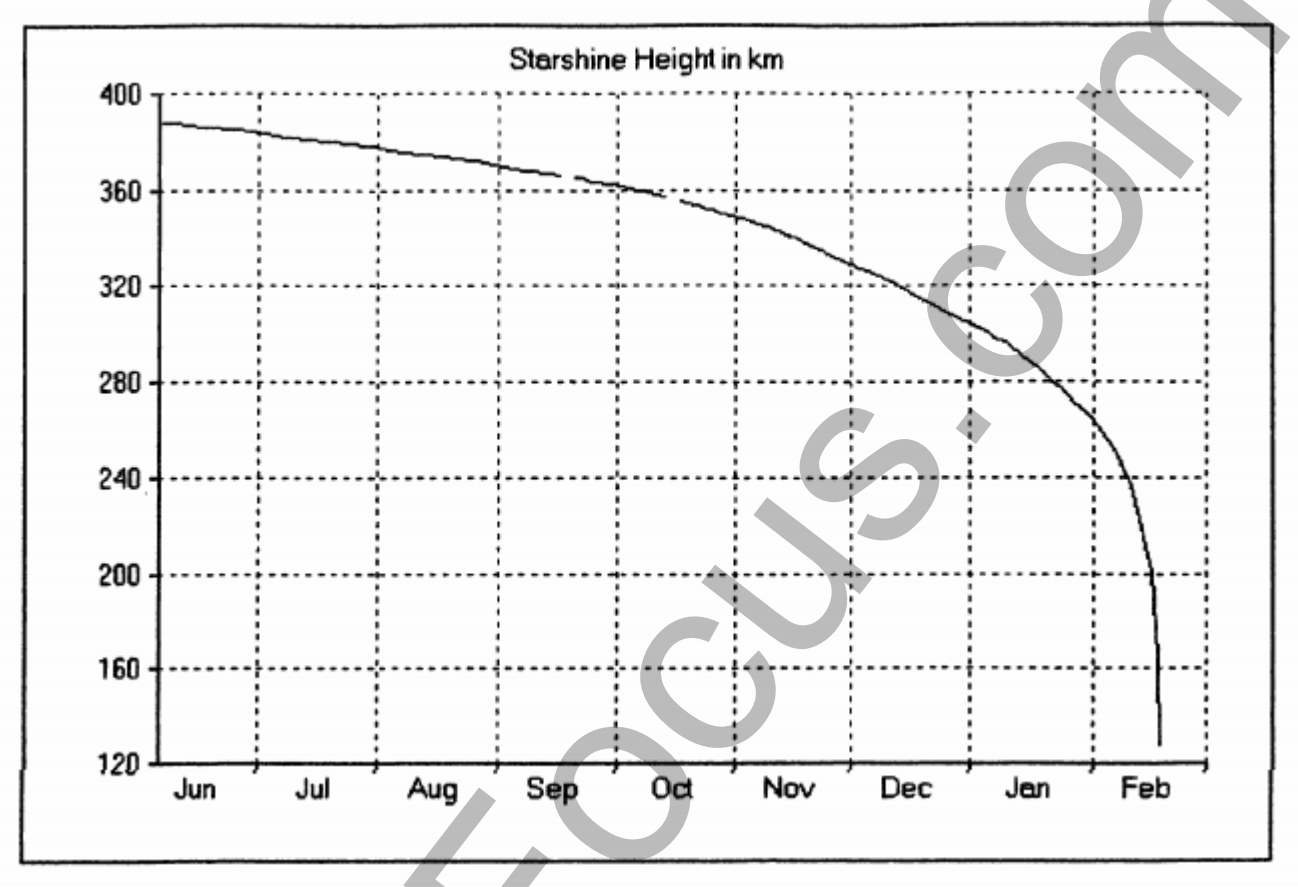
**Question 20** (3 marks)

The graph below shows the orbital decay of the satellite, Starshine. The height is plotted against the date. The altitude in early June was 385km above the Earths surface.




(a) Describe the term "orbital decay". **1**

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(b) Describe TWO factors causing the changing rate of orbital decay of Starshine from June to February. **2**

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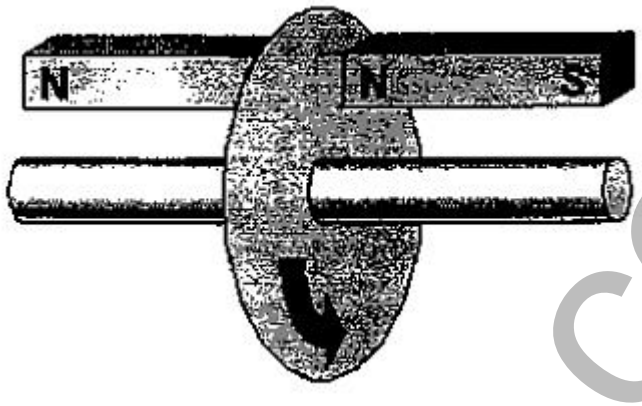
**Question 21** (3 marks)

One of the most dangerous parts of a space flight is the re-entry into the Earth's atmosphere. **3**

Identify the angle range at which the craft must enter through the atmosphere when landing and the consequences of not approaching within this angle range and outline one other issue associated with safe re-entry into the Earth's atmosphere.

**Question 22** (4 marks)

Two magnets are brought near to a spinning aluminium disc, as shown in the diagram below




(a) Describe what happens when the magnets are brought near **2**

(b) Explain how this effect could be reduced **2**

**Question 23** (6 marks)

(a) Outline the differences between a step-up and a step-down transformer. **2**

(b) In a transformer, the primary and secondary coils are not electrically connected to each other. Describe how the voltage is produced in the secondary coil. **2**

(c) Describe ONE benefit for modern society arising from the development of transformers. **2**

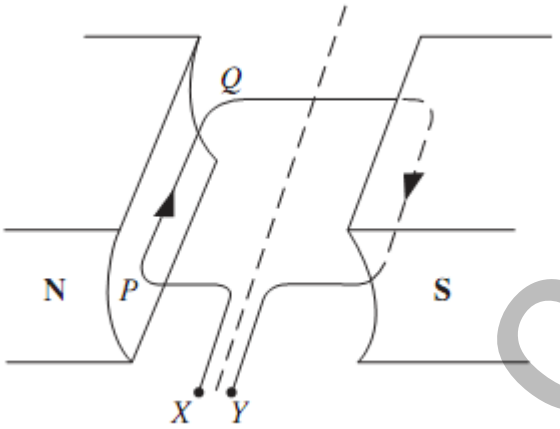
**Question 24** (4 marks)

The majority of modern motors are AC induction motors. **4**

Describe the principles by which an AC induction motor operates and outline a reason why they have become the most common motors in general use.

**Question 25** (4 marks)

The diagram shows a coil in a magnetic field. The coil can rotate freely.




The coil is connected to a power supply and at the instant shown, terminal X is positive.

(a) In which direction will the side PQ initially move? **1**

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(b) When the coil starts rotating, the potential difference experienced by the electrons in the wire is less than that supplied by the power supply. Describe the origin of this effect. **3**

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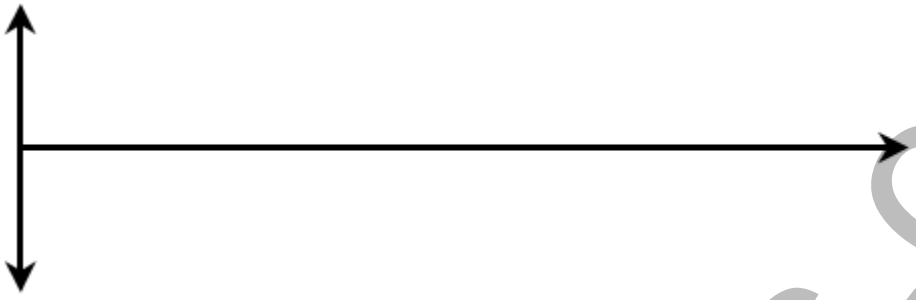
**Question 26** (3 marks)

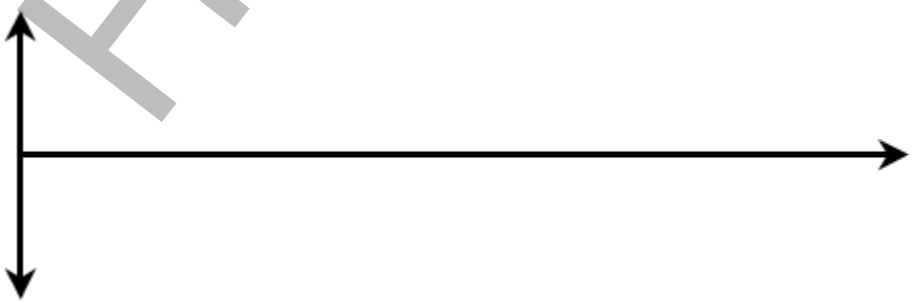
Sketch the output of the following generators:

(i) D.C Generator **1**



(ii) A.C Generator with a single coil **1**

(iii) A.C Generator with three coils spaced equally apart **1**



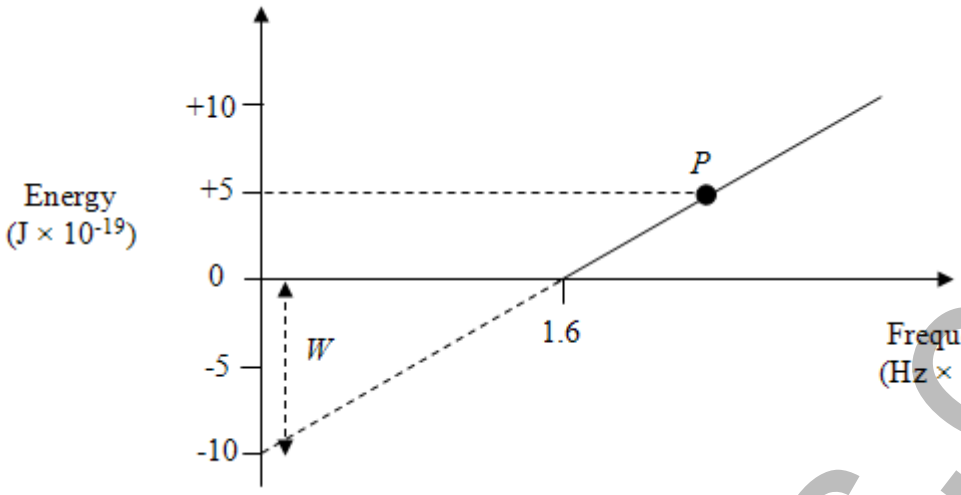
**Question 27** (6 marks)

Scientists are only human. They come to their work with ideas that extend beyond the objectivity of the scientific research process. Einstein and Planck were the two most important developers of the early quantum theory yet their individual belief in the practical validity of the theory differed. So too did their views on the relationship of science, society and politics. **6**

Discuss the opposing views of Einstein and Planck on these issues

**Question 28** (8 marks)

The following graph demonstrates the photoelectric effect in the metallic element platinum.




(a) *Explain* the significance of the frequency value $1.6 \times 10^{15}$ Hz. **2**

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(b) The valence electrons of zinc atoms conduct more easily than the valence electrons of platinum atoms. **2**
On the graph above, *construct* a suitable corresponding graph line for zinc atoms.

(c) *Explain* the meaning of the energy difference marked *W* on the y axis of the graph above. **2**

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(d) *Deduce* the kinetic energy of a photocurrent electron with the energy marked at point *P* on the graph line for platinum. **2**

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**Question 29** (9 marks)

(a) Using labeled diagrams and text, Discuss the BCS Theory of superconductivity **5**

(b) Discuss two possible applications of superconductivity and identify two limitations to the applications of superconductors. **4**

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**Question 30** (4 marks)

Metals have a regular crystal structure.

(a) Outline the method used by the Braggs to determine crystal structure **2**

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(b) Sketch a diagram showing a model of a metal, and use it to describe how metals conduct electricity **2**

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# Section II

**Total marks (15)**
**Attempt Question 31**
**Allow about 30 minutes for this section**

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

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**Question 31 – From Quanta To Quarks** (15 marks)

(a) Describe a first-hand investigation used to observe the visible spectrum of the hydrogen atom. **2**

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(b) Calculate the ionization energy of an electron in Hydrogen from its ground state. Express your answer in eV. **3**

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(c) Identify ONE example of a radio isotope used in Medicine and how it is used **2**

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(d) In 1909, Rutherford, Geiger and Marsden conducted experiments in which a-particles were used to bombard thin metal foils.

i. Summarize the observations from the experiment and describe Rutherford's explanation of these observations. **2**

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ii. Explain why Rutherford's description of electrons occupying fixed spherical orbits around the nucleus cast doubt on aspects of his atomic model **2**

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(e) State De Broglies hypothesis, and calculate the wavelength of the electron in the first stationary state if its speed is $2.188 \times 10^6 ms^{-1}$ **2**

(f) Use Bohrs' postulates to determine the radius of the orbit of the above electron, express your answer in Angstroms (Å) [10Å = 1nm] **2**