CRANBROOK SCHOOL

YEAR 12 TRIAL HSC EXAMINATION

PHYSICS
2 UNIT HSC COURSE
2001

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board of Studies 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 Pages 2 - 14

Total marks (75)
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 (60)
- Attempt Questions 16 - 28
- Allow about 1 hour and 45 minutes for this part

Section II Pages 15 - 17

Total marks (25)
- Attempt Questions 29 -31
- Allow about 45 minutes for this section

Section I
Total marks (75)

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 space.

1 The value of the gravitational field strength of a planet at a point distance, d, from the centre of the planet

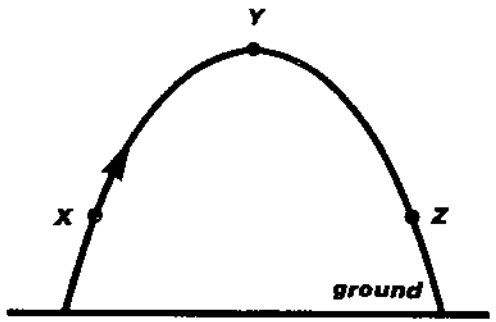
(A) depends on the mass of the object used to measure the field strength.

(B) is independent of the mass of the planet.

(C) is equivalent to the acceleration due to gravity of the planet at that point.

(D) is inversely proportional to the distance of that point from the centre of the planet.

2 An object is projected upwards from the ground and follows a path shown in the diagram below.



The magnitude of the object's acceleration is

(A) the same at points X and Y.

(B) less at point X than at point Z.

(C) greater at point Y than at point X.

(D) less at point Y than at point Z.

3. Which of the following is a correct statement?

(A) A net force cannot exist inside an inertial frame of reference.

(B) An observer inside an inertial frame of reference can detect the speed of the frame of reference.

(C) An accelerated frame of reference can be detected by an observer inside the frame of reference.

(D) An inertial frame of reference is indistinguishable from an accelerated frame of reference.

4. Galileo devised an experiment in which an object was dropped from the top of the mast of a sailing ship, moving at constant speed, down onto the deck of the ship.

The aim of this experiment was to:

(A) measure the acceleration due to gravity.

(B) demonstrate that the Earth was orbiting the Sun.

(C) show that the surface of Earth is curved.

(D) show that an observer on the ship will see a different path of the object's fall to that seen by an observer on land.

5. The aether was first proposed by:

(A) the ancients to explain the phases of the Moon.

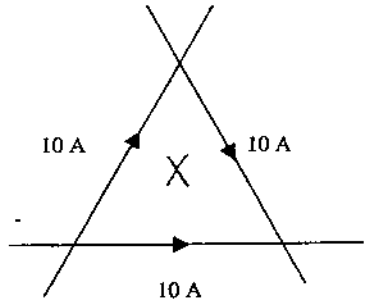
(B) nineteenth century scientists to explain the propagation of light from the Sun.

(C) Maxwell to explain the transmission of electromagnetic waves.

(D) ancient Greeks to explain the order and structure of the universe.

ext page

6. Three conducting wires each carrying a 10 A current cross each other, forming an equilateral triangle. The three wires are not electrically connected. Point X is at the centre of the triangle.



If the magnitude of the field at X with only one wire carrying a 10 A current is Y, then the magnitude of the resultant field at X due to the three current carrying conductors, and its direction is:

(A) 2Y, directed out of the page

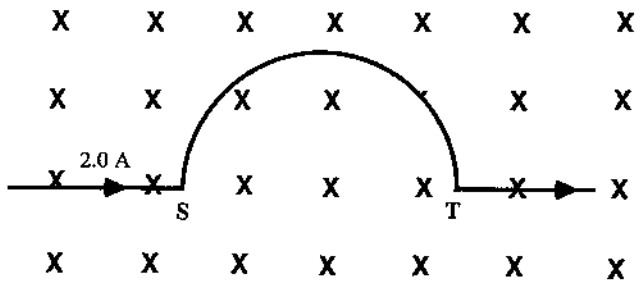
(B) Y, directed into the page

(C) 3Y, directed into the page

(D) zero

next page

7. A wire, bent as shown below, carries a current of 2.0 A and is located in a uniform magnetic field directed down into the page.



The direction of the resultant magnetic force on the semi-circular section of wire ST is:

(A) down the page

(B) up the page

(C) to the left

(D) to the right

8. Which of the following will NOT increase the size of the **maximum** torque on a coil as it rotates in a magnetic field?

(A) increase the number of turns on the coil

(B) place the coil in a radial field

(C) increase the size of the current through the coil

(D) use a wider coil in the magnetic field

9. If the density of electrons in a metal wire is increased (and all other factors remain the same), then it is true to say that any current in the wire will

(A) increase as there will be fewer electron collisions.

(B) increase as there are more free electrons available for conduction.

(C) decrease because the metal's resistance is increased.

(D) decrease because the drift velocity is inversely proportional to the electron density.

10. According to the BCS theory of superconductivity

(A) superconductivity occurs because the crystal lattice causes electron pairs to break up.

(B) distortions of the crystal lattice by electron movement causes superconductivity to cease.

(C) distortions of the crystal lattice allow electrons to pair up and flow unimpeded.

(D) superconductivity occurs because low temperatures cause the crystal lattice to stop vibrating and remain free from distortion.

11. Which statement about de Broglie's model of the atom is NOT true?

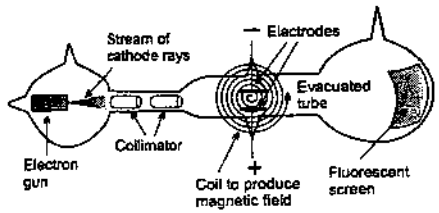
(A) electrons moving around the nucleus exist as standing waves in discrete energy states.

(B) electrons have both wave and particle properties.

(C) the nucleus is positively charged.

(D) electrons travel in definite orbits.

12. Consider the following diagram of the apparatus used in Thomson's q/m experiment.



For the cathode ray beam to travel through the system undeflected

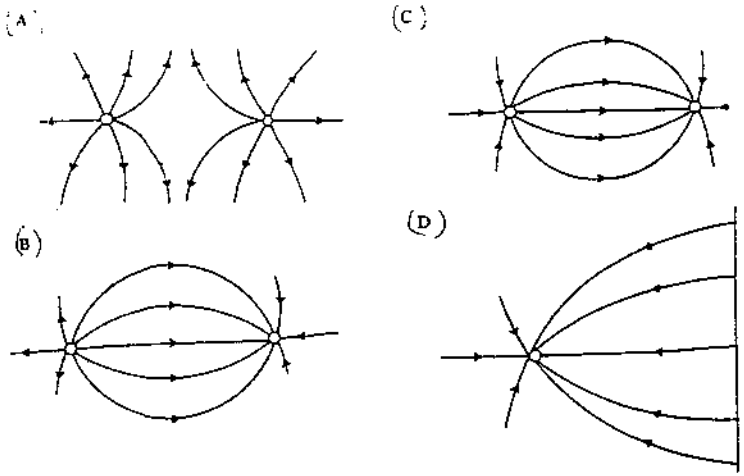
(A) electrons need to leave the electron gun at very high speeds.

(B) the magnetic field must be switched off.

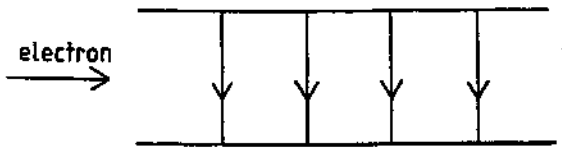
(C) The cathode rays must be moving at a specific speed according to the relative strengths of the electric and magnetic fields the rays pass through before hitting the screen.

(D) The value of **E** (electric field strength) must be equal to **B** (the magnetic field strength).

13. Which of the following electric field diagrams could NOT be correct?



14. The diagram below shows an electron entering a uniform electric field directed down the page.



The direction of the resultant force on the electron is

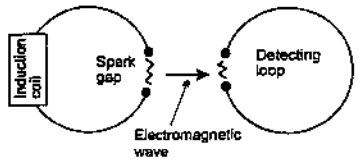
(A) up the page.

(B) into the page.

(C) into the page.

(D) out of the page.

15. The diagram below is a simplified outline of Hertz's experiment on the production of radio waves.



One reason it is an important experiment is because it

(A) it disproved the existence of the aether.

(B) the waves were found to travel at the same speed as visible light, thus suggesting that light was also an electromagnetic wave.

(C) it explained how the photoelectric effect occurred.

(D) it showed that air could be a conductor if a sufficiently high voltage source was used.

Section I

PART B
Total marks (60)
Attempt Questions 16 - 28
Allow about 1 hour and 45 minutes for this part

Answer Questions 16 - 22 in the Part B1 Answer Booklet.
Answer Questions 23 - 28 in the Part B2 Answer Booklet.

Show all relevant working in questions involving calculations.

Question 16 (7 marks)

(a) Discuss in point form

(i) two postulates/assumptions in Special Relativity. (2 marks)

(ii) the conclusions that the theory reaches regarding length and time and the view point from which the Special Relativity effects of these three quantities are observed. (3 marks)

(b) The velocity of a muon is 0.99 c. The half life of the muon from the point of view of the muon is 2.2×10^{-6} s. How far does the muon appear to travel, before decaying, to an external observer? (2 marks)

Question 17 (6 marks)

(a) The moon Phobos circles Mars in 7 hours and 39 minutes at a distance of 9.5×10^{3} km measured from their centres. Calculate the mass of Mars. (2 marks)

(b) Discuss <u>two</u> problems associated with satellites in low Earth orbits. (2 marks)

(c) Calculate the orbital radius of a satellite in a geostationary orbit, measured from the centre of the Earth. (2 marks)

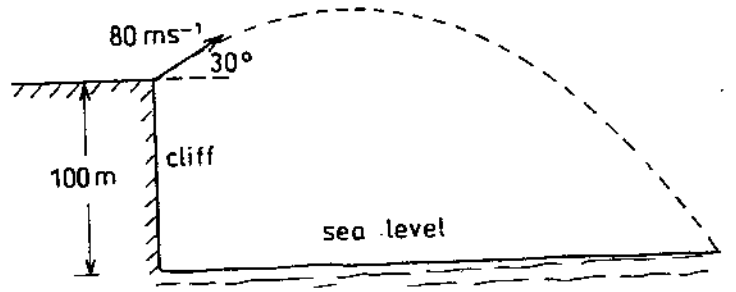
next page

Question 18 (3 marks)

Discuss three issues that need to be solved before interplanetary travel becomes feasible. Each issue should include a reasonable assessment of the problem.

Question 19 (4 marks)

A projectile is fired from the edge of the top of a cliff with a velocity of 80 m/s at an angle of 30° to the horizontal as shown in the diagram below. The cliff is 100 m above sea level.



Ignoring air resistance calculate:

(a) the time taken for the projectile to reach its maximum height, (1 mark)

(b) the maximum height above sea level reached by the projectile, (1 mark)

(c) the speed of the projectile at its maximum height, (1 mark)

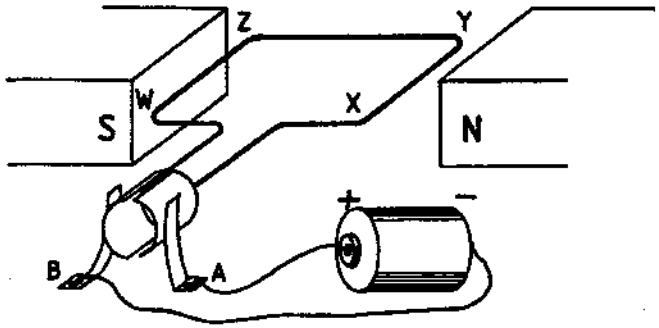
(d) the total time of flight of the projectile. (1 mark)

next page

)uestion 20. (7 marks)

, simple DC electric motor comprises a coil of 20 turns of wire set on bearings so that is free to rotate ı a magnetic field of strength 0.32 T. The coil has a width YZ of 0.20 m and a length XY of 0.40 m. 'he long side of the coil is set perpendicular to the field. A current of 9.0 A flows in the coil.

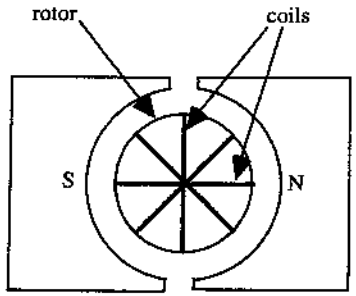
'or simplicity the diagram below only shows one loop of wire and the rotor and bearings have been mitted.



ı) On the diagram in your answer book label the commutator and brushes and explain how each contributes to the operation of this motor. (2 marks)

ɔ) Calculate the maximum torque produced by this motor. (2 marks)

Most electric motors actually have a number of coils set at different angles around a laminated rotor and ıe magnets surrounding this have curved faces. The diagram below shows a simplified end view of a ıotor.



) Give a reason why (3 marks)

(i) there is more than one coil in the rotor.

(ii) the magnets have curved faces.

(iii) the rotor is laminated.

Question 21 (2 marks)

The galvanometer is a sensitive current measuring device. Describe, giving a reason, one important similarity and one important difference between an electric motor's structure and a galvanometer's structure.

Question 22 (2 marks)

Some electric motors require large resistances to be placed in series with the armature windings of an electric motor to prevent the armature windings from burning out when the motor is turning slowly. Once the motor picks up speed these resistors can be removed.

Explain why the resistors can be removed once the motor has picked up speed.

Question 23 (6 marks)

Transformers allow for the conversion of high voltages to low voltages and vice versa. Power stations generate electricity at 25 000 volts before large transformers step this up to 500 000 volts.

(a) Explain why power stations transfer electrical energy at very high voltages. (2 marks)

(b) In the above step up transformer, what is the ratio of the number of turns in the secondary coil to the number of turns in the primary coil? (1 mark)

(c) If power stations generate electricity with current of 1000 amperes, calculate the current after the voltage has been stepped up to 500 000 volts. (2 marks)

(d) Outline how energy losses within the transformer itself are reduced to a minimum. (1 mark)

next page

Question 24 (8 marks)

This question deals with the photoelectric effect.

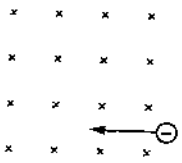
(a) In an experiment to study the photoelectric effect, radiation of frequency 7.0×10^{14} Hz is incident on a metal surface causing electrons to be ejected with a maximum kinetic energy of 1.3×10^{-19} J. Find the work function and the threshold frequency of the metal. (2 marks)

(b) Two possible variables affecting the photoelectric current and the kinetic energy of the emitted electrons are the frequency and intensity of the incident light. Explain the effect of intensity and frequency on both the photoelectric current and kinetic energy of the electrons. (4 marks)

(c) In what ways did classical wave theories of light prove inadequate in explaining these observations? (2 marks)

Question 25 (4 marks)

An electron is shot perpendicularly into a uniform magnetic field of flux density 0.1T with a speed of 1.0×10^5 m/s.



The magnetic field is directed perpendicularly into the plane of the paper

a) What is the size and direction of the force experienced by the electron? (2 marks)

b) Find the initial acceleration of the electron in the magnetic field. (1mark)

c) What is the size of the electric field needed to balance the effect of the magnetic field on the electron? (1 mark)

ext page

Question 26 (4 marks)

(a) Explain why there would be a significant advantage in using superconductors in electricity transmission wires? (2 marks)

(b) Superconductors have not yet achieved the widespread use that was originally anticipated. Outline TWO limitations of the ceramic materials (non-metals) currently used as Type II superconductors. (2 marks)

Question 27 (4 marks)

(a) It has been observed that increasing the temperature of a metal increases its resistance but increasing the temperature of a semiconductor decreases its resistance. Explain these observations. (2 marks)

(b) Define the term thermionic emission and identify one reason why thermionic devices were replaced by solid state devices. (2 marks)

Question 28 (3 marks)

In a television what is the function of each of the following?

(a) the anodes in the electron gun.

(b) the magnetic steering coils.

(c) The fluorescent coating on the screen.

ection II – Options

otal marks (25)
ttempt all questions from this section
llow about 45 minutes for this section

OTE: This section is in lieu of the whole HSC option which still has to be covered.

nswer the questions in the relevant writing booklets provided.

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how all relevant working in questions involving calculations.

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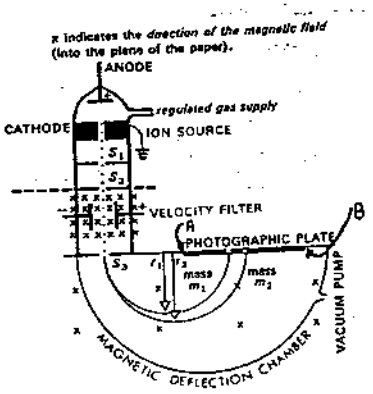
uestion 29 (7 marks)

he Bainbridge mass spectrograph is illustrated below.



, S_2 and S_3 are slits to orm a narrow ion beam

) Describe, using the relevant equation/s, how the velocity filter (selector), consisting of magnetic and electric fields at right angles to each other, produces a beam of ions which all travel at the same speed in a straight line. (2 marks)

) In the diagram above, two ions of the same charge are admitted to the magnetic deflection chamber. One has a mass m_1 and the other mass m_2. Which of these has the greater mass? EXPLAIN. (2 marks)

uestion 29 continued next page

Question 29 continued

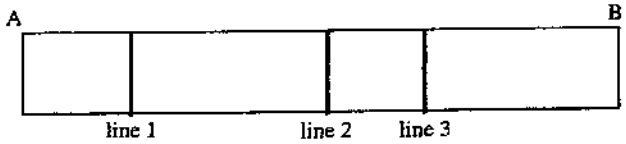
(c) In a separate experiment three different types of lithium ions enter the magnetic deflection chamber.

These ions are:

$${}^{6}_{3}Li^{+} \qquad {}^{7}_{3}Li^{+} \qquad {}^{6}_{3}Li^{2+}$$

where ${}^{A}_{Z}X$ A is the mass number and Z is the atomic number (number of protons)

It is found that the processed photographic plate AB contains three lines, one for each of the above ions, as shown below.



Which line corresponds to which ion? Justify your answers by appropriate working. (3 marks)

Question 30 (7 marks)

(a) Describe or draw a labelled diagram to illustrate the features of Thomson's model of the atom. (1 mark)

(b) Outline an experimental investigation that led to the rejection of the Thomson model. (2 marks)

(c)

(i) What result/s were be expected from this experiment using Thomson's model? (1 mark)

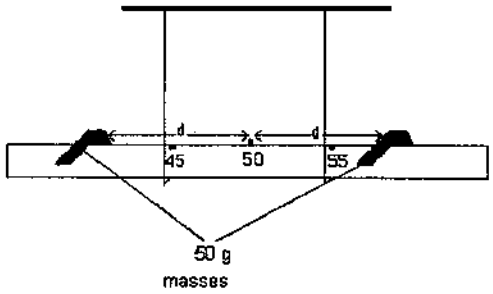
(ii) What observations were made when this experiment was performed? (1 mark)

(iii) Explain Rutherford's interpretation of these experimental results. (2 marks)

next page

Question 31 (11 marks)

In an experiment, a metre ruler was suspended by two vertical strings of equal length, as shown in the diagram below. The strings were 10 cm apart. Two 50 g masses (the dark slots on the diagram) were placed on the metre ruler at equal distances, d, from the centre of the ruler and on opposite sides of the centre of the ruler.



The ruler was set oscillating so that it swings in a horizontal plane. The period, T, of oscillation was determined experimentally for various values of the distance, d, the distance of **each** mass from the centre of the ruler. The table in your Option Answer Booklet Two records the period, T, and the distance, d for different values of d.

(a) Complete the table in your answer booklet for values of (Period)^2, T^2 and (distance)^2, d^2. (2 marks)

(b) Plot a graph, on the graph sheet provided, of T^2 against d^2. (3 marks)

(c) The relationship between T and d is given by:

$$T^2 = A + B\,d^2$$

Use your graph to obtain values of A and B in the expression. SHOW how you obtain these values. State their units. (4 marks)

(d) What aspect of the ruler's motion does quantity A physically represent and explain how it can be measured experimentally. (2 marks)

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Answers

DIRECTIONS TO CANDIDATES:

- Write your Student Number at the top right hand corner of this page.

Section I
PART A Multiple Choice

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

1.	Ⓐ	Ⓑ	●	Ⓓ
2.	●	Ⓑ	Ⓒ	Ⓓ
3.	Ⓐ	Ⓑ	●	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	●
5.	Ⓐ	Ⓑ	Ⓒ	●
6.	Ⓐ	●	Ⓒ	Ⓓ
7.	Ⓐ	●	Ⓒ	Ⓓ
8.	Ⓐ	●	Ⓒ	Ⓓ
9.	Ⓐ	●	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	●	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	●
12.	Ⓐ	Ⓑ	●	Ⓓ
13.	Ⓐ	Ⓑ	●	Ⓓ
14.	●	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	●	Ⓒ	Ⓓ

Write your answers in the spaces provided for each question.

Question 16 (7 marks)

Marks

(a) (i) • The speed of light is constant and independent of the motion of the observer
• All inertial frames of reference are equivalent i.e. laws of physics are the same in all inertial frames — 2

(ii) the length of an object appears to decrease to an external observer when the object is moving at speeds close to the speed of light.
• the time in a moving frame (close to the speed of light) appears to go slower to a stationary observer. — 3

(b) $t = \frac{t_0}{\sqrt{1-v^2/c^2}}$ t_0 = time observed by stationary observer

$t_0 = \frac{2 \cdot 2}{\sqrt{1-0 \cdot 99^2}} = \frac{2 \cdot 2}{0 \cdot 1410673} = 15 \cdot 6 \mu s$ ✓

distance observed = $15 \cdot 6 \times 10^{-6} \times 3 \times 10^8$ ✓ (speed of light)

$= 4680 m$ $(4 \cdot 7 km)$

4630m

(92. 2)

next page

Marks

Question 17 (6 marks)

(a) Using $r^3/T^2 = GM/4\pi^2$ where M = mass of mars

$T = 7\text{h } 39\text{m} = 2.754\times10^4\text{ s}$ $\therefore M = \frac{4\pi^2 r^3}{GT^2}$

$M = \frac{4\pi^2\times(9.5\times10^{6(3)})}{6.67\times10^{-11}\times(2.754\times10^4)^2} = 6.7\times10^{23}\text{ kg}$ ✓ 2

(b) • The satellites are hidden for part of their orbit around the Earth.

• Due to appreciable air resistance, they lose their orbital velocity and spiral down to Earth (may burn up on re-entry) greater 2

(c) $r^3/T^2 = GM/4\pi^2 \Rightarrow r^3 = \frac{GMT^2}{4\pi^2}$

$T = 24\text{ hours} = 24\times60\times60$ 2

$r = \sqrt[3]{\frac{6.67\times10^{-11}\times6\times10^{24}\times(24\times60\times60)^2}{4\pi^2}} = 4.23\times10^7\text{ m}$

Question 18 (3 marks)

Three issues discussed from one of the following:

• Distance and time of travel (one issue)
Speed required (linked to above — one issue)

• Fuel to be carried for manoeuvring and return flight.

• Communication difficulties (weak signal)

• Hazards from radiation + perhaps asteroids. 3

Marks

Question 19 (4 marks)

(a) v at max height $= 0$ $v = u + at$ $a = -9.8\text{ m/s}^2$

$0 = 80\sin30 + (-9.8)t$

$\therefore t = \frac{80\sin30}{9.8} = 4.1\text{ s}$

(b) $v^2 = u^2 + 2as \Rightarrow 0 = (80\sin30)^2 + 2(-9.8)s$

$s = \frac{40^2}{19.6} = 81.6\text{ m}$ (82 m)

$\therefore$ Total height above sea level $= 182$ m

(c) Speed at max height is horizontal component of initial velocity $= 80\cos30° = 69.3 = 69\text{ m/s}$

(d) time down: $s = -182$ m from max height. $u = 0$ vertically

$s = ut + \frac{1}{2}at^2$

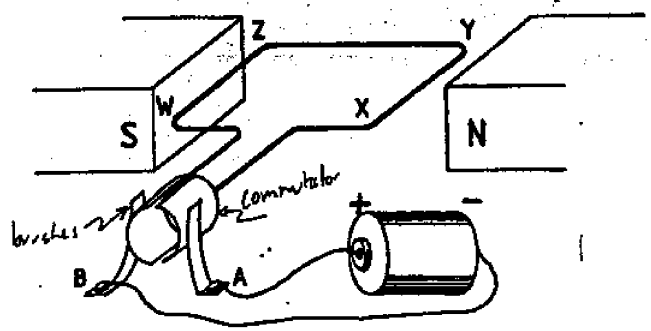
$-182 = 0 + \frac{1}{2}(-9.8)t^2 \Rightarrow t = \sqrt{\frac{182}{4.9}} = 6.1\text{ s}$

$\therefore$ Total time $= 6.1 + 4.1$ (time up) $= 10.2\text{ s}$

next page

Marks

Question 20 (7 marks)



(a) Commutator: allows the current in the coil to change direction every ½ revolution so coil travels in constant direction. 1

Brushes: allow current to conduct to coil without affecting the rotation of the coil

(b) $\tau_{max} = nIAB = 20 \times 9.0 \times 0.20 \times 0.40 \times 0.32$ 2

$= 4.6$ Nm

(c) (i) multiple coils ensure that active coil is always aligned to field lines for maximum torque. Allows smooth torque + maximum torque 1

(ii) curved faces provide a radial field so that coil is always aligned with field lines : smooth, strong torque 1

(iii) laminations reduce eddy current build up in rotor : reducing heating in rotor and energy loss 1

Marks

Question 21 (2 marks)

Similarity : both contain coils in magnetic fields, respond to a current causing movement of the coil

Difference : The galvanometer has hair springs to prevent it moving full circle (provide counter torque) as well as no commutator (doesn't need to move full circle)

Question 22 (2 marks)

Motors act as generators producing current in them as they turn in a magnetic field. The current opposes the change that caused it (Lenz's law) and leads to back emf. The nett current drops in the coil as it picks up speed & resistance can be removed as it is not likely to burn out the coil.

Marks

Question 23 (6 marks)

(a) High voltages produced by transformers are accompanied by lower currents. This reduces the current heating effects in wires and losses of efficiency (energy) in transmission. (2) 1 1

(b) $N_s : N_p = 500000 : 25000$

$= 20 : 1$ 1

(c) $V_p I_p = V_s I_s \quad \therefore I_s = \frac{V_p I_p}{V_s} = \frac{25000 \cdot 1000}{500000}$

$= 50A$ 1 1

(d) The transformer consists of a laminated core steel which wires are wound. This reduces eddy currents and so energy losses due to heating are reduced. 1 1 (2)

Question 24 (8 marks)

(a) $E_{max} = hf - \phi \qquad \phi$ = work function

$1.3 \times 10^{-19} = 6.626 \times 10^{-34} \times 7 \times 10^{14} - \phi$

$(4.6382 \times 10^{-19}) \qquad 3.34 \times 10^{-19}$

$\therefore \phi = 4.6382 \times 10^{-19} - 1.3 \times 10^{-19} = 3.3 \times 10^{-19}$ J 1

$\phi = h f_0 \qquad f_0$ = threshold frequency

$f_0 = \frac{\phi}{h} = \frac{3.34 \times 10^{-19}}{6.626 \times 10^{-34}} = 5.04 \times 10^{14}$ Hz 1

Question 24 continued next page

Marks

Question 24 continued

(b) Intensity : No effect on the maximum KE of electrons as max KE depends on the frequency

• increases the value of photoelectric current as more electrons are released. 1

Frequency : • Emission is frequency dependent, below the threshold frequency no emission occurred as the minimum energy depended on a min frequency 1

• No effect on the photoelectric current as frequency only determines the energy not the number. 1

(c) Classical theory predicted that emission is independent of frequency and that the KE of photoelectrons would increase with light intensity 1 1

Question 25 (4 marks)

(a) $F = Bqv = 0.1 \times 1.602 \times 10^{-19} \times 1 \times 10^5$

1.6×10^{-15} N 1

Direction: up the page (in the same plane of page) 1

(b) $F = ma \quad \therefore a = \frac{F}{m} = \frac{1.6 \times 10^{-15}}{9.109 \times 10^{-31}} = 1.8 \times 10^{15}$ m/s^2 1

(c) $F_{mag} = F_{Elec} = qE \quad \therefore E = \frac{F}{q} = \frac{1.6 \times 10^{-15}}{1.602 \times 10^{-19}} = 9987.5$ N/C

1×10^4 N/C 1

NO

Question 26 (4 marks)

(a) Energy losses in wires due to resistance would be greatly reduced saving large amounts of energy which would be used as electrical energy and reducing costs and environmental problems. Also low power plants can be built very far from population centres. 1 1

(b) any 2
- Ceramic superconductors are too brittle and difficult to make into wires for transmission 1
- They are chemically unstable in some environments 1
- Costly and difficult to manufacture.

Question 27 (4 marks)

(a) In a metal the increase in temperature increases the increased vibrations of lattice ions increases the probability of collisions with conduction electrons. 1
In semiconductors the increase in temperature provides the energy to promote conduction electrons into the conduction band – jumping the forbidden gap thus lowering resistance 1

(b) Thermionic emission: emission of electrons from surfaces when a material (such as a metal) is heated. 1

- ~~Solid state devices are compact resulting in miniaturisation~~

OR They waste less energy in heating effects than thermionic devices 1

OR ~~cheaper to manufacture~~.

OR long start-up time while they heat up

Marks

Question 28 (3 marks)

(a) These are to charge and accelerate the electrons emitted by the cathode. 1

(b) Deflect the electron beam and have two sets of plates for vertical and horizontal deflection. 1

(c) The coating fluoresces (light up) as electrons strike the screen to give an image of the signal (picture). 1

Marks

Question 29 (7 marks)

(a) $\therefore F_{mag} = F_{elec}$ on charged particles — 1

$Bqv = qE$ — 1

$\therefore v = E/B$

(b) $F_{mag} = F_c$ — 1

$Bqv = mv^2/r \Rightarrow m = Bqr/v$ (or use momentum)

$\therefore m \propto r$ $\therefore m_2 > m_1$ — 1

(c) line 1 From (b) above $q = mv/Br$ and $m = Bqr/v$ — (1)

$\therefore q \propto \frac{1}{r}$ and $m \propto r$ — (1)

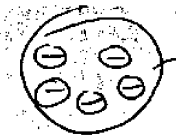
$\therefore$ small mass, large charge bends most

line 1: ${}^{6}_{3}Li^{+}$ ${}^{7}_{3}Li^{+}$

line 2 ${}^{6}_{3}Li^{+}$ — (1)

line 3 ${}^{7}_{3}Li^{+}$

next page



Marks

Question 30 (7 marks)

(a) A sphere of positive charge with electrons embedded in it. — 1

(b) Alpha particles were fired at gold foil and the deviation of the α-particles was detected by using a scintillating screen after passing through the gold foil — 1

(c)(i) The deviation of the α-particles after passing through the gold foil would be very small. — 1

(ii) Most of the α-particles passed through with small deviations but a small number showed large deviations (scattering) — 1

(iii) The +ve charge in the atom must be concentrated in a very small volume and that the atom was largely empty space. — 1

(the mass of the atom is concentrated in the nucleus as it was known that most of +ve charges [protons] is larger than that of electrons). — 1

Marks

(a)

d (cm)	Period, T (s)	d^2 (cm^2)	T^2 (s^2)
10	6.78	100	46.0
15	7.18	225	51.6
20	7.70	400	59.3
25	8.00	625	64.0
30	9.10	900	82.8
35	9.68	1225	93.7

(b) Graph paper

(c) A: "4" in except

$\therefore A = 42\ s^2$ ✓

B: Gradient $= \frac{96 - 44}{1300 - 50} = 0.042\ s^2 cm^{-2}$

(d) A represents the (period)^2 when the two masses are both at the 50 cm mark of the ruler (minimum (period)^2) ✓

Experimentally, it can be measured by placing the masses at the 50 cm mark. ✓