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

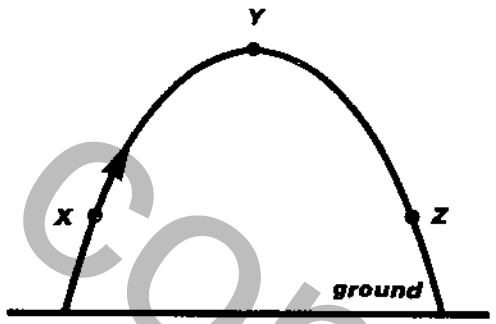
(A) depends on the mass of the object used to measure the field strength.

(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.

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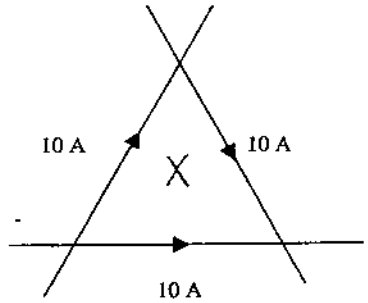
6. Three conducting wires each carrying a 10 A current cross each other, forming an equilateral triangle. The three wires are not electrically connected. Point X is at the centre of the triangle.



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

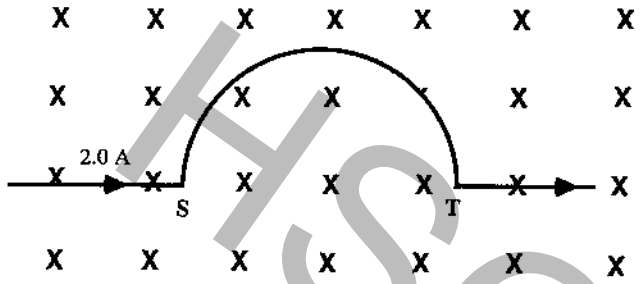
(B) Y, directed into the page

(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?

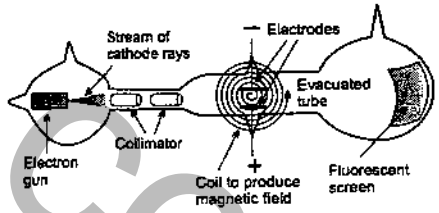
(A) electrons moving around the nucleus exist as standing waves in discrete energy states.

(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

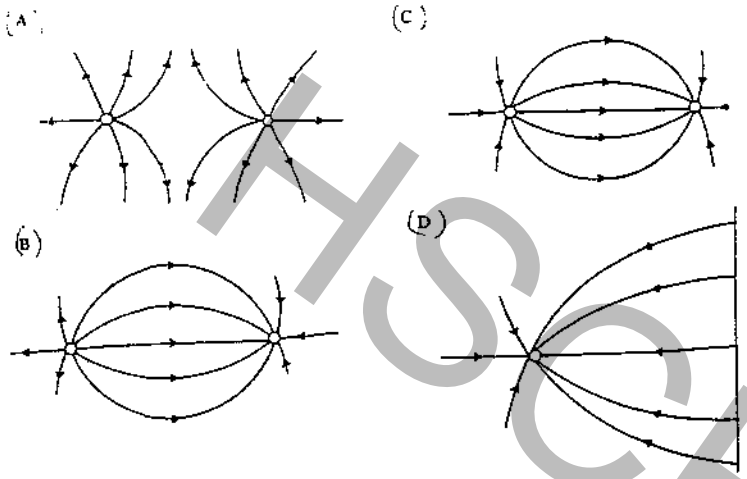
(A) electrons need to leave the electron gun at very high speeds.

(B) the magnetic field must be switched off.

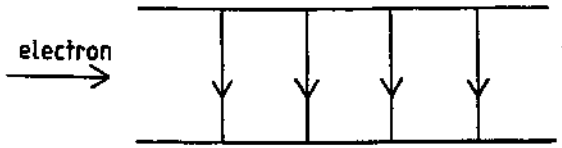
(C) The cathode rays must be moving at a specific speed according to the relative strengths of the electric and magnetic fields the rays pass through before hitting the screen.

(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

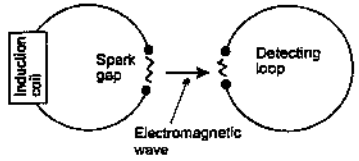
(A) up the page.

(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)

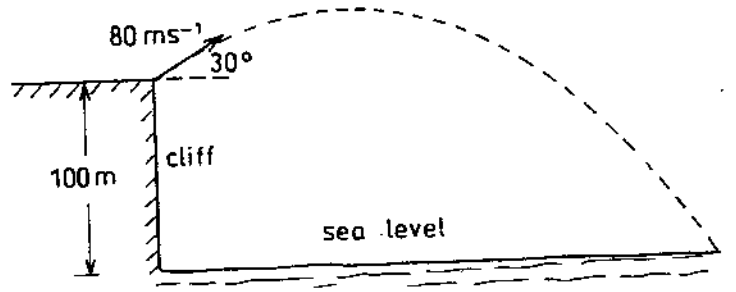
next page

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)

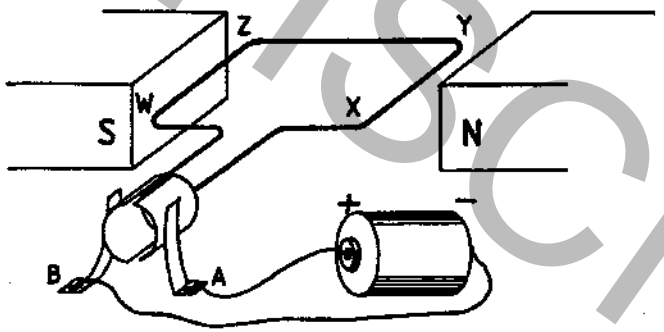
(d) the total time of flight of the projectile. (1 mark)

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.

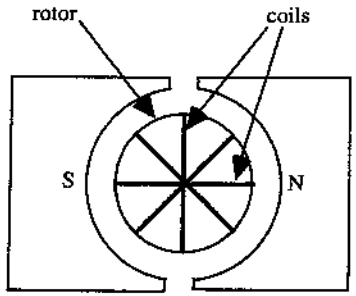
'or simplicity the diagram below only shows one loop of wire and the rotor and bearings have been
mitted.



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.

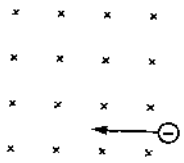
(a) In an experiment to study the photoelectric effect, radiation of frequency 7.0×10^{14} Hz is incident on a metal surface causing electrons to be ejected with a maximum kinetic energy of 1.3×10^{-19} J. Find the work function and the threshold frequency of the metal. (2 marks)

(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 <u>both</u> 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)

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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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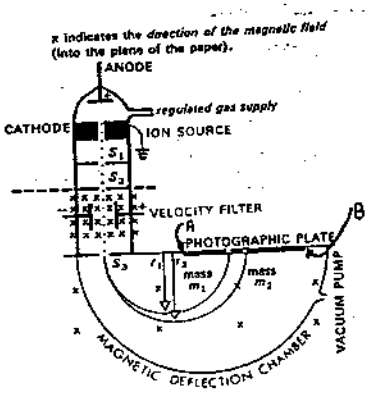
uestion 29 (7 marks)

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

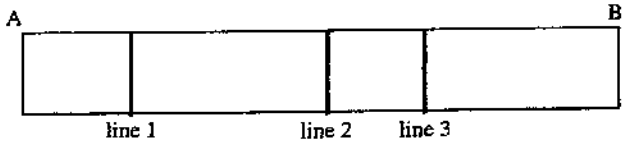
(c) In a separate experiment three different types of lithium ions enter the magnetic deflection chamber.

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)

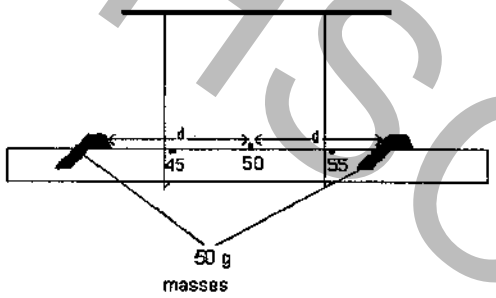
(ii) What observations were made when this experiment was performed? (1 mark)

(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 $(\text{Period})^2$, T^2 and $(\text{distance})^2$, 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)