CRANBROOK SCHOOL

YEAR 12 TRIAL HSC EXAMINATION

2 UNIT HSC COURSE
2003

Physics

General Instructions

- Working time - 3 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Formulae Sheets are provided at the back of this paper
- Write your Student Number at the top of the pages indicated

Total marks - 100

Part A – 15 marks
- Attempt Questions 1 - 15
- Allow about 30 minutes for this part

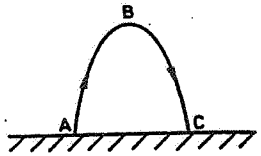
Part B – 85 marks
- Attempt Questions 16-31
- Allow about 2 hours and 30 minutes for this part

The content and format of this paper do not necessarily reflect the content and format of the HSC examination paper

Part A – 15 marks
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.

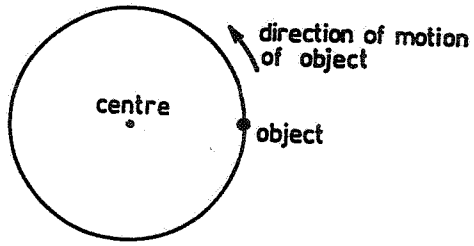
1. A projectile is fired from point A on a horizontal plane and takes the path ABC as shown.



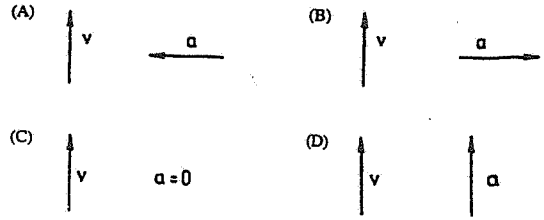
Which statement is true about point B?

(A) Both the velocity and the acceleration of the projectile are zero.
(B) The velocity of the projectile is not zero, but the acceleration is zero.
(C) The velocity of the projectile is zero, but the acceleration is not zero.
(D) Neither the velocity nor the acceleration of the projectile is zero.

2. An object is travelling around a circular track at a constant speed of 15 m/s as shown below.



Which is the best set of vectors for describing the velocity and acceleration at the position shown?



3. A ball dropped from rest, on Earth, impacts on the ground at 20 m/s. On another planet, where the acceleration due to gravity is four times that on Earth, the same ball is dropped from rest. If this ball falls through the same distance, what would be its velocity just before impact?

(A) 5 m/s
(B) 10 m/s
(C) 40 m/s
(D) 80 m/s

4. What centripetal force is needed to allow a 550 kg satellite to orbit at a speed of 7780 m/s, while at a distance of 6.58×10^6 m from the centre of the Earth?

(A) 5.49×10^{25} N
(B) 5059 N
(C) 0.65 N
(D) 8.3×10^{18} N

5. Consider a satellite in orbit around the Earth. Which statement is true?

(A) The greater the satellite's mass, the greater its speed for a given altitude.
(B) The greater the satellite's mass, the smaller its speed for a given altitude.
(C) The greater a satellite's mass, the greater the centripetal force on it at a given altitude.
(D) The greater a satellite's mass, the lower the centripetal force on it at a given altitude.

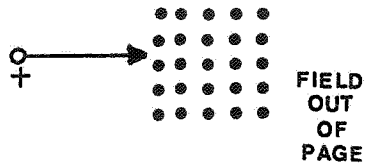
6. Consider a geostationary satellite that orbits the Earth in a direction from west to east in the equatorial plane. Which statement below describes its motion?

(A) It will hover over one spot on the Earth's surface.
(B) The satellite will have a period of 365 days.
(C) The satellite will continually move over different parts of the Earth's surface.
(D) It will be orbiting in the opposite direction to the Earth's rotation.

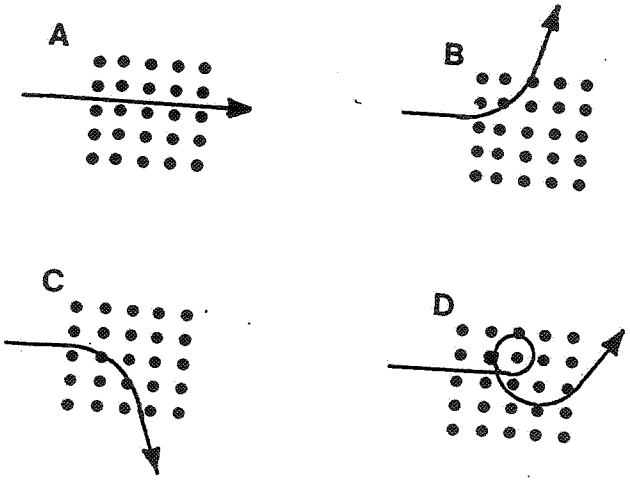
7. What is a major problem if a spacecraft re-enters the Earth's atmosphere at too shallow an angle?

(A) It may become too hot for the astronauts to survive.
(B) It may decelerate too quickly, and cause excessive g forces on the astronauts.
(C) It may bounce off the atmosphere and back into space.
(D) It may descend too fast and be unable to be controlled.

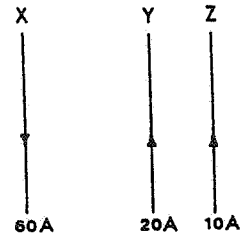
8. A positively charged particle enters the uniform magnetic field shown below.



Which diagram below best indicates the path of the particle through the region of the field?



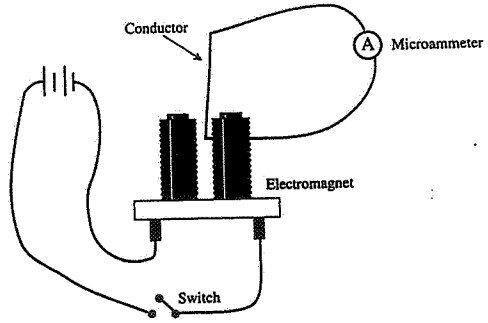
9. Consider the three parallel current carrying wires below.



What is the direction of the resultant force on Y?

(A) To the left.
(B) To the right.
(C) Into the plane of the page.
(D) Up the plane of the page.

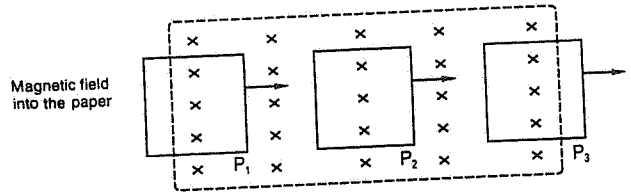
10. During a classroom experiment a student held a metal conductor attached to a micro-ammeter, between the poles of an electromagnet. He kept the conductor stationary, and ensured that it was not in contact with the electromagnet.



At the moment that the electromagnet was switched on, which of the following would have been observed?

(A) No current was detected on the micro-ammeter.
(B) A brief pulse of current was detected on the micro-ammeter when the electromagnet was switched on.
(C) No current flowed because there was no relative movement between the conductor and the magnetic field of the electromagnet.
(D) A current flowed through the micro-ammeter while the electromagnet was kept switched on.

11. A square metallic loop is moved at constant velocity through a uniform magnetic field. The loop, which is at all times perpendicular to the magnetic field, is shown at positions P_1, P_2, and P_3.



Which statement is TRUE?

(A) The induced current at all three positions is clockwise.
(B) The only induced current occurs at position P_2
(C) The induced current is clockwise at P_1, zero at P_2, and anti-clockwise at P_3.
(D) The induced current is anti-clockwise at P_1, zero at P_2, and clockwise at P_3.

12. A transmission line delivers power at a potential difference of 220 000 V to a transformer designed to step down to 2200 volts. If the primary coil has 9000 turns, how many turns are in the secondary coil? (assume 100% efficiency).

(A) 90
(B) 900
(C) 900 000
(D) 9 000

13. An atom of a hot object emits a quantum of red light of wavelength 6.6×10^{-7} m. What is the order of magnitude of the energy carried by this red photon.

(A) 10^{-19} J
(B) 10^{-32} J
(C) 10^{-40} J
(D) 10^{8} J

14. Cathode rays were discovered around the middle of the nineteenth century. There was considerable debate as to the true nature of these cathode rays. Which of the following was evidence <u>against</u> the hypothesis that cathode rays were a form of light?

(A) They travelled in straight lines.
(B) They could initiate chemical reactions.
(C) They were affected by magnetic fields.
(D) They could travel through almost a complete vacuum.

15. In a DC *generator*, what is the function of the split ring commutator?

(A) To ensure that the generator turns in one continuous direction.
(B) To carry away excess current that the motor generates due to back EMF.
(C) To provide the magnetic field needed for the coil to experience a torque.
(D) To turn the alternating current produced by the generator into direct current.

Student Number | | | | | | | | |

Part B – 85 marks
Attempt Questions 16 - 31
Allow about 2 hours and 30 minutes for this part

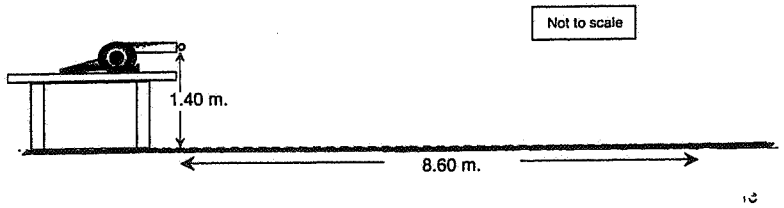
Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Marks

Question 16 (6 marks)

A model cannon propels cannon balls of mass 100 g. The cannon is resting on a horizontal table with its barrel horizontal. The barrel is 1.40 m vertically above the ground. When the cannon was fired, the cannon ball travelled a horizontal distance of 8.60 m.



(a) Sketch the trajectory of the cannon ball on the diagram above and state the name of the geometrical shape of this trajectory. **2**

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(b) From the measurements provided, calculate the velocity of the cannon ball as it left the barrel. **2**

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Question 16 continued next page

Marks

Question 16 (continued)

(c) The manufacturer of the model cannon specifies that the charge used to fire the cannon balls has 16 J of explosive energy. How much of the energy stored in the charge is transferred to the cannon ball when fired? In your answer outline the basic Physics principles used. **2**

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Question 17 (7 marks)

A satellite of mass 1200 kg orbits the Earth in a polar orbit at an average distance of 480 km above the surface.

(a) If the average radius of the Earth is 6380 km, calculate the gravitational potential energy of the satellite. **2**

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(b) Explain whether the magnitude of the work done required to lift this satellite into this orbit is equal to, less than or more than the value of the gravitational potential energy in part (a).

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Question 17 continued next page

Marks

Question 17 (continued)

(c) Compare features of the orbit of this satellite to a satellite of similar mass in a geostationary orbit at an average distance of 36000 km above the surface of the surface of the Earth. 3

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Question 18 (2 marks)

Einstein published his Special Theory of Relativity in 1905. Some years later he then published the General Theory of Relativity.

(a) Justify the use of the word 'special' in describing the Special Theory of Relativity. 1

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(b) State an important assumption made in Einstein's Special Theory of Relativity? 1

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Marks

Question 19 (4 marks)

(a) Show how Newton's Law of Universal Gravitation can be used to derive an equation for the orbital speed of a satellite at a given distance above the Earth. 2

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(b) Find the <u>period</u> of a satellite orbiting the Earth at an altitude of 580 km above the Earth's surface. (radius of Earth = 6380 km) 2

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Question 20 (3 marks)

(a) A proton of rest mass 1.67×10^{-27} kg, is accelerated to a speed of 2.0×10^{8} ms^{-1}. Determine the mass of the proton measured while it is moving. 2

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(b) Calculate the rest energy of the proton. 1

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Marks

Question 21 (4 marks)

Outline the reasons why the Special Theory of Relativity predicts that an object cannot move at the speed of light. 4

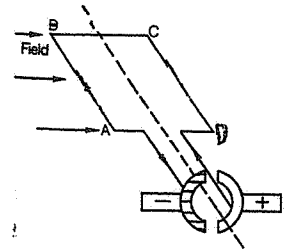
Question 22 (5 marks)

The transformer is an essential component in utilising electricity in modern life. Describe the general features of a transformer and the principles involved. Include the techniques developed to improve the efficiency of a transformer. 5

Marks

Question 23 (7 marks)

The diagram below is a simple diagram of the structural components of a direct current electric motor. The motor coil, ABCD, has an area of 1.70×10^{-3} m^2 and consists of 12 turns of wire. The magnetic field on the coil is equal to 0.22 T. When the coil is connected to a power supply and the current switched on, 3.10 A flow through the coil causing the coil to experience a torque and start to spin.



(a) What is the direction in which the coil rotates when the motor is first switched on. 1

(b) Calculate the maximum torque on the coil after the motor is switched on. 1

(c) When the current is first switched on the coil starts to spin. When the motor coil has achieved full speed it revolves at a constant rate of 5 Hz.
Explain how the torque acting on the coil would change as the motor is switched on, begins to rotate, and then finally achieves a maximum rate of rotation. Assume that the coil starts from position of maximum torque. 3

Question 23 continued next page

Marks

Question 23 (continued)

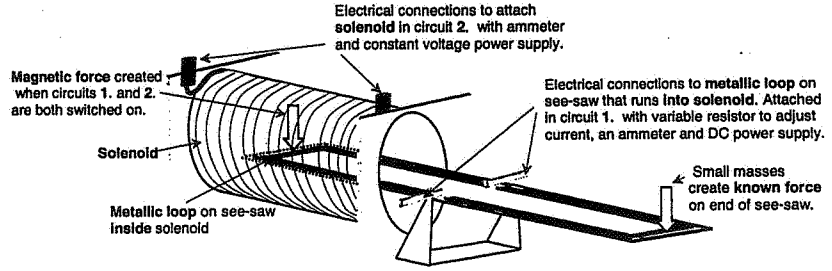
(d) Sketch a graph of torque vs position of coil (angle) for the rotation of the coil from the start of its rotation to when it is rotating at a constant frequency. (Assume that the coil starts from a position of maximum torque). 2

Question 24 next page

Marks

Question 24 (6 marks)

In an experiment a current balance was used to determine the magnetic field inside a solenoid. The apparatus is shown below.

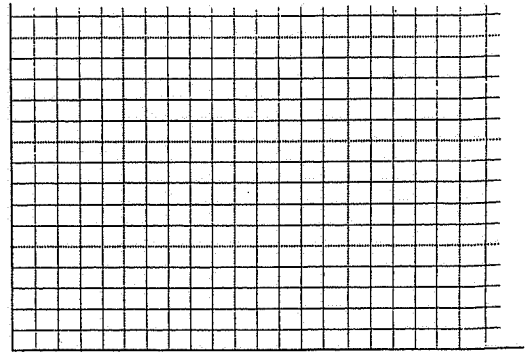


The see-saw is initially balanced. A small mass was placed at the end of the see-saw outside the solenoid to create a known force. With both circuits on, the current flowing into circuit 1 was adjusted till the magnetic force on the see-saw, created on the current carrying metallic loop inside the solenoid, balanced the force created by the mass at the other end. The current through the solenoid in circuit 2 remained constant throughout the experiment. The following data was collected:

length of metallic loop inside solenoid affected by the magnetic field of the solenoid = 0.032 m
constant current in solenoid (circuit 2) = 4.20 A

known force on see-saw created by mass (10^{-3} N)	current in circuit 1 to balance see-saw (A)
0.98	1.25
1.18	1.51
1.76	2.26
2.35	3.01
2.84	3.76

(a) Plot a graph of the results shown on the table in the grid below. 2



Question 24 continued next page

Marks

Question 24 (continued)

(b) Outline one important consideration in conducting this experiment if the results are to be valid and reliable. 1

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(c) Use the graph to calculate the magnetic field inside the solenoid. Show all working. 3

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Question 25 next page

Student Number | | | | | | | | |

Part B (continued)

Marks

Question 25 (6 marks)

In your course, you observed the results of experimental demonstrations that identified the properties of cathode rays using gas discharge tubes. Outline the experiments and describe how the experimental results of these demonstrations showed that:

(a) cathode rays travel in straight lines. **2**

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(b) cathode rays transfer energy. **2**

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(c) cathode rays are negatively charged. **2**

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Marks

Question 26 (6 marks)

Thomson attempted to measure the charge on the cathode ray particles but he did not get consistent results. He was, however, successful in obtaining consistent results of the charge to mass ratio of cathode ray particles.

(a) Outline the experimental method that Thomson carried out to measure the charge to mass ratio of cathode ray particles. Your answer should include the measurements he had to obtain. **5**

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(b) State the conclusions that could be drawn from the value of the charge to mass ratio obtained? **1**

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Question 27 next page

Marks

Question 27 (4 marks)

The electric plates in a cathode ray tube are 0.008 m apart and have a potential difference of 620 V across them.

(a) What is the strength of the uniform electric field between the two plates? 1

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(b) What is the force an electron would experience inside this electric field? 1

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(c) If a magnetic field was applied (in the appropriate direction), what magnetic field strength would be required to balance the electric force on the electron if the electron is travelling through the field at 2.2×10^5 ms^{-1}? 2

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Question 28 next page

Marks

Question 28 (5 marks)

The AC induction motor has proved very versatile and has been widely employed in many applications. Give reasons for the widespread use of AC induction motors and assess their impact on society and the environment. 5

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Question 29 next page

Marks

Question 29 (5 marks)

(a) Describe Hertz's observation of the effect of a radio wave on a receiver and the photoelectric effect he produced but failed to investigate. **3**

(b) Outline qualitatively Hertz's experiments to demonstrate how radio waves relate to light waves. **2**

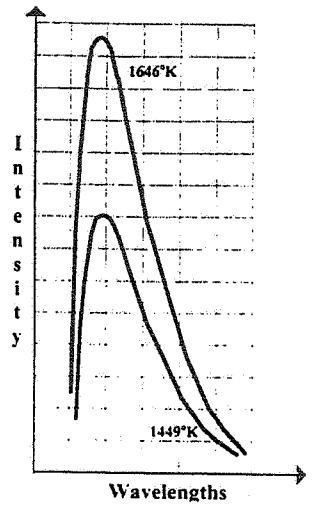
Question 30 next page

Marks

Question 30 (3 marks)

(a) Statewhat is meant by a 'black body'? **1**

(b)



The above diagram shows the shape of the curve for the intensity of thermal radiation from a black body plotted against the distribution of wavelengths at two different temperatures. Outline the contribution that Planck made in his efforts to explain the shape of these curves. **2**

Marks

Question 31 (12 marks)

(a) State what is meant by the photoelectric effect? 1

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(b) Classical Physics theories about the wave nature of light made several predictions about the photoelectric effect which turned out not to agree with experimental observations. State ONE of these predictions and outline the actual experimental observation/s. 2

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(c) Einstein developed the equation KE = h f – work function to describe the kinetic energy (KE) given to electrons in the photoelectric effect. What does the 'work function' refer to? 1

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(d) The data below show the outcome of a photoelectric effect experiment from a given metal surface. This data can be analysed using the equation in part (c) above.

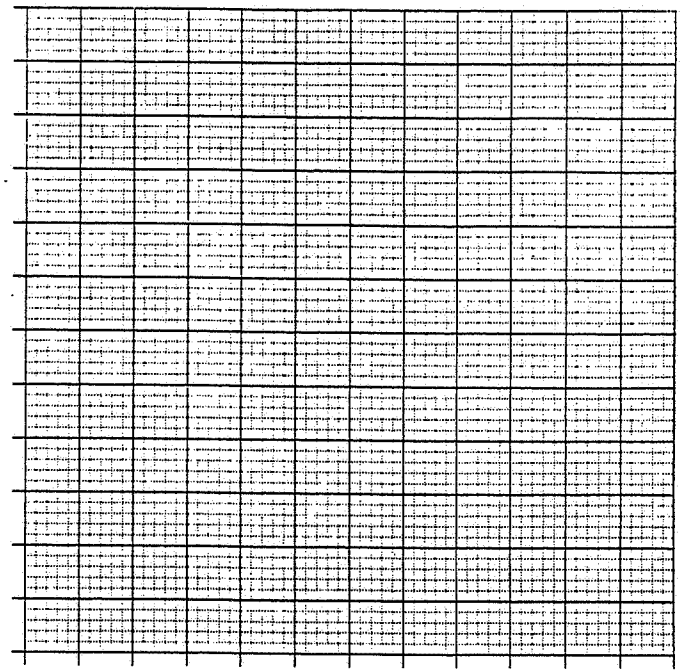
frequency of incident radiation (x 10^{14} Hz)	energy of photoelectrons (x 10^{-19} J)
6.9	1.22
8.2	1.70
9.1	2.50
9.9	3.05
10.6	3.38
11.8	3.91

Plot this data on the axis provided on the next page and draw the line of best fit. 3

Question 31 continued next page

Mark

Question 31 (continued)



(e) Find the gradient of the line and state its units.

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(f) State the quantity the gradient represents?

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(g) State what is meant by 'threshold frequency' in the photoelectric effect?

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(h) Determine the threshold frequency in this experiment.

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End of examination questions