SCEGGS Darlinghurst

Student Number

HSC Course
Trial Examination, 2002

PHYSICS

General Instructions

- Reading time - 5 minutes
- Working time – 3 hours
- Write using blue or black pen.
- Draw diagrams using pencil.
- Use Multiple Choice Answer Sheet provided.
- Board-approved calculators may be used.
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper.
- Write your Student Number at the top of pages 1 and 13.

Section I Pages 2 - 24

Total marks (**75**)

- This section has two parts, Part A and Part B

Part A

Marks (**15**)

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

Part B

Marks (**60**)

- Attempt Questions 16 – 26
- Allow about 1 hour and 45 minutes for this part.

Section II Page 25

Total marks (**25**)

- Attempt question 27
- Allow about 45 minutes for this section.

Section I
75 marks

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 oval completely.

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

A ○ B ● C ○ D ○

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

A ● B ✕ C ○ D ○

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.

correct

A ✕ B ✕ C ○ D ○

1. The gravitational acceleration at the surface of the Moon is 1.6 ms^{-2}. An astronaut wearing his spacesuit on Earth, where gravitational acceleration is 9.8 ms^{-2}, has a mass of 100 kg. When the astronaut was standing stationary on the surface of the Moon, which of the following would correctly represent the weight of the astronaut?

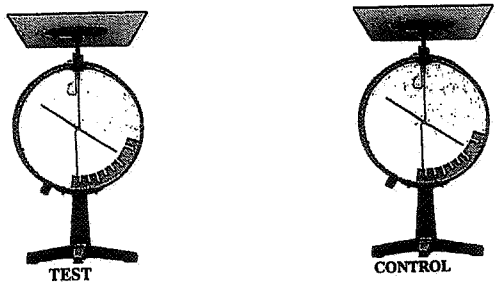
   (A) 100 kg

   (B) 16.3 kg

   (C) 980 N

   (D) 160 N

2. Single identical pieces of polished zinc metal plate are placed on the top of two negatively charged electroscopes as shown below.



It is observed that when ultraviolet light is shone on the zinc plate on the test electroscope, the electroscope loses its charge more rapidly than the control electroscope. The experiment is repeated and it is observed that the test electroscope discharges more rapidly than it did the first time. There is negligible difference in the results for the control electroscope.

Which of the following would best explain the second set of results?

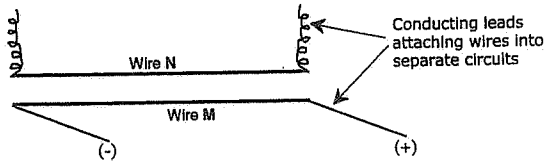
(A) Electromagnetic radiation of the same intensity but greater frequency was used.

(B) Electromagnetic radiation of the same frequency but greater intensity was used.

(C) Electromagnetic radiation of the same wavelength but greater frequency was used.

(D) Electromagnetic radiation of the same intensity but greater wavelength was used.

3. Two straight, rigid metal wires, both 200 mm long, are parallel and 10 mm apart. Wire M sits on a table while the second wire, N, is supported directly above, using two coiled conducting leads that behave in a similar fashion to springs as shown below.



The wires are attached into separate electric circuits with DC power supplies. When the power supplies are switched on, equal currents of 10.0 A flow through both wires. The wire N is observed to move up. Considering the electrical connections to wire M, (shown), when the circuits are both switched on, which of the following statements is correct?

(A) The current in wire N flows from left to right with the initial force acting on the wires equal to 2 x 10^{-3} N.

(B) The current in wire N flows from right to left with the initial force acting on the wires equal to 2 x 10^{-3} N.

(C) The current in wire N flows from left to right with the initial force acting on the wires equal to 4 x 10^{-4} N.

(D) The current in wire N flows from right to left with the initial force acting on the wires equal to 4 x 10^{-4} N.

4. Which of the following describes the reason why microwaves are preferred over other forms of electromagnetic radiation for communication with satellites?

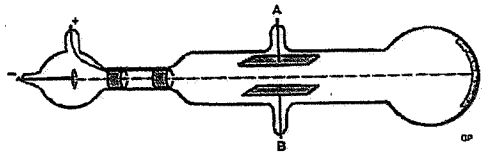
   (A) The atmosphere and Van Allen belts tend to be more transparent to microwaves than to other electromagnetic radiation.

   (B) Other types of electromagnetic radiation experience significant interference because they have higher frequencies than microwaves.

   (C) Microwaves have a higher frequency and so scatter much more than other electromagnetic radiation allowing much larger areas to be covered.

   (D) More than one of the above answers is correct.

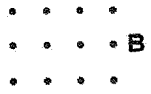
5. J.J. Thomson carried out an experiment to determine the charge to mass ratio of electrons. The following diagram shows the apparatus he used and the path of an undeflected cathode ray in the tube.

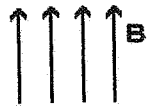


An electric field is produced by applying a voltage across the plates **AB**, with **A** being positive, causing the cathode ray to be deflected. Which of the following diagrams represents the direction of a magnetic field, applied in the region of the charged plates, that would cause the cathode ray to pass through the tube undeflected?

(A) 

(B) 

(C) 

(D) 

6. A student is rapidly turning the handle of a small generator. Another student attaches an electrical lead directly between the two output terminals of the generator. The student turning the handle notices that there is now a noticeable drag acting on the handle. Which of the following best explains this observation?

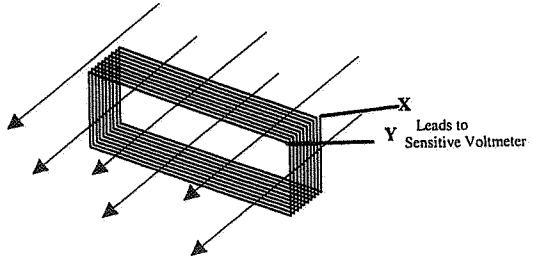
(A) The second student had created a short circuit in the generator.

(B) It is the result of the Law of Conservation of Energy.

(C) When the wire is connected a back emf is produced.

(D) It is the result of Faraday's Law.

7. A continuous length of conducting wire is wound into 10 loops, forming a rectangular coil of area 0.05 m^2. The ends of the coil are attached to a sensitive voltmeter by the conducting leads **X** and **Y** (see diagram). At $t = 0$ seconds, the coil sits in a region of uniform magnetic field of 100 mT, perpendicular to the plane of the coil, represented by the arrows in the diagram below.



The magnetic field reduces uniformly to zero over a period of 0.10 seconds. During the time from $t = 0$ to $t = 0.10$ s, which of the following would be true?

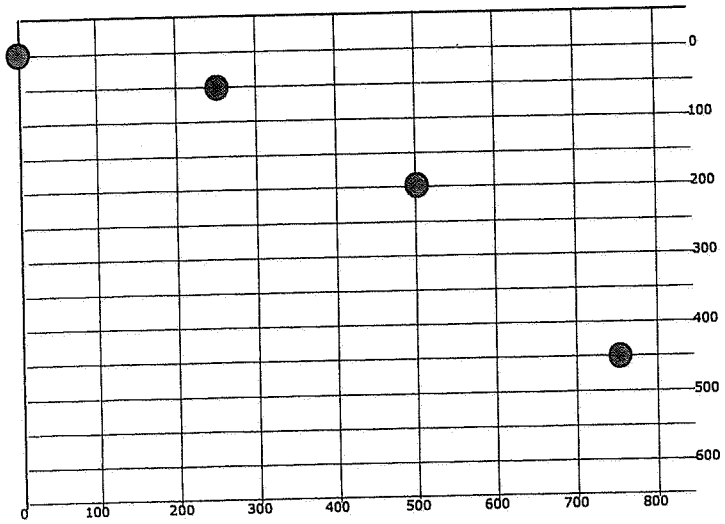
(A) The voltmeter will read 0.5 V with the lead X having a positive potential.

(B) The voltmeter will read 0.5 V with the lead X having a negative potential.

(C) The voltmeter will read 0.05 V with the lead X having a positive potential.

(D) The voltmeter will read 0.05 V with the lead X having a negative potential.

8. The graphic below is of a strobe photo taken during an experiment performed in a large jet aeroplane. The strobe light flashed at 12.25 Hz. The first image was recorded at $t = 0$ s, triggered by the release of the ball in a horizontal direction. The units shown in the photo are in **millimetres**.



Based on the evidence from the photograph, which of the following would be a correct interpretation?

(A) The ball was released at about 3 ms^{-1} while the plane accelerated vertically down.

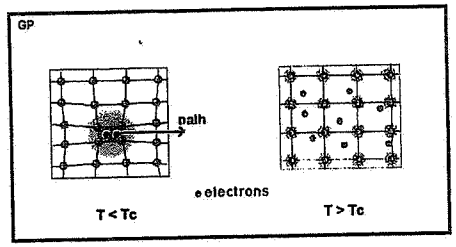
(B) The ball was released at about 3 ms^{-1} while the plane accelerated vertically up.

(C) The ball was released at about 6 ms^{-1} while the plane accelerated vertically down.

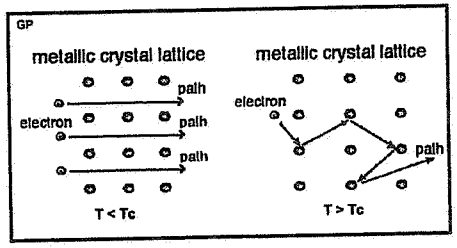
(D) The ball was released at about 6 ms^{-1} while the plane accelerated vertically up.

9. Which of the following diagrams **most accurately** represents the model used to explain the conduction of electric current through a superconducting metal at temperatures above and below the temperature, **Tc**, at which the material becomes superconducting?

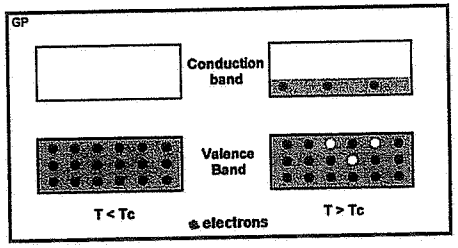
(A)



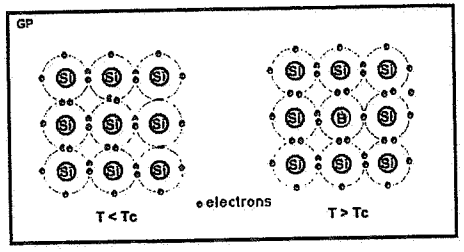
(B)



(C)

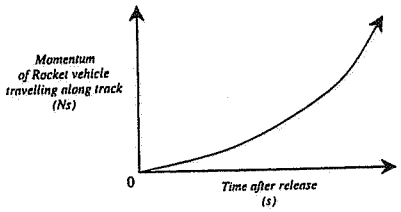


(D)

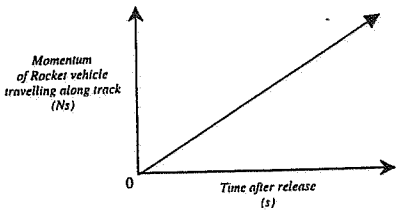


10. A test rocket firing is performed on a rocket engine that consumes fuel at a uniform rate as it operates. The rocket vehicle starts at rest, being propelled along a very long, straight, horizontal track. The fuel initially contributes about 67% of the total mass of the rocket vehicle. Which of the following graphs best represents the momentum of the rocket vehicle as it travels down the track?

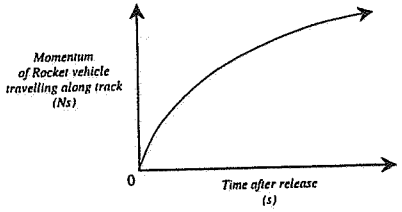
(A)



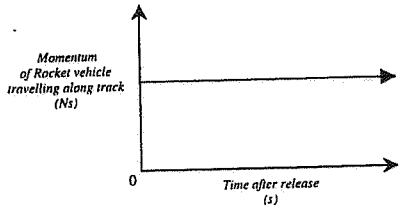
(B)



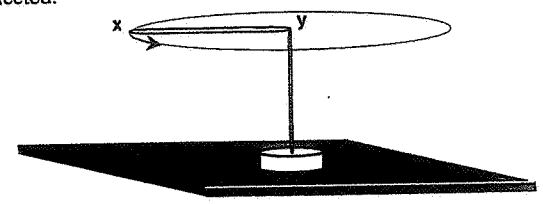
(C)



(D)

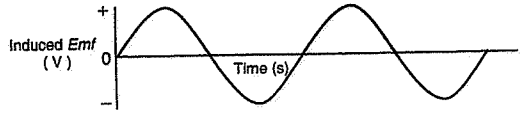


11. A metal rod, **xy**, is attached to a frictionless pivot that is mounted in a heavy stand sitting on a table. A force (not shown) is applied to the rod causing it to rotate in a horizontal circular path at a constant speed. All effects due to friction can be neglected.

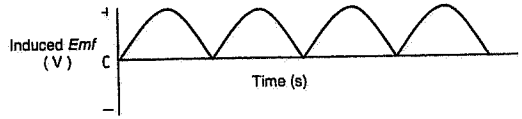


A uniform magnetic field acts vertically out of the table. If at $t = 0$ s, the rod is in the position shown in the diagram, which of the following graphs would best represent the emf, measured from **x** to **y**, induced over the rod as it rotates?

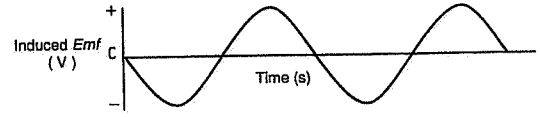
(A)



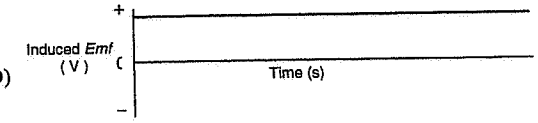
(B)



(C)



(D)



12. Which of the following best describes an immediate advantage provided when the de Broglie hypothesis was applied to examine electron orbits?

(A) It could explain conduction of current in high temperature superconductors.

(B) It explained the production of x-ray diffraction patterns by metals.

(C) It explained the mobility of outer electrons in metallic conductors.

(D) It provided an explanation for the discrete nature of allowable electron orbits.

13. Two identical satellites, **X** and **Y**, are in stable, near circular orbits well above the Earth's atmosphere. Satellite **X** has an orbit of radius **R** m, with the period of its orbit equal to **T** seconds. Considering that satellite **Y** has a radius of orbit equal to **4R** m, which of the following statements is correct?

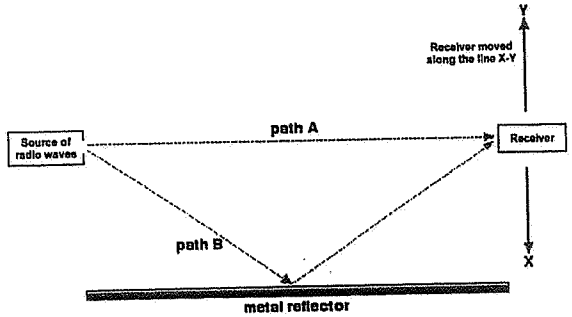
(A) Satellite Y orbits with a period of 64T seconds.

(B) Satellite Y orbits with a period of 16T seconds.

(C) Satellite Y orbits with a period of 8T seconds.

(D) Satellite Y orbits with a period of 4T seconds.

14. This question refers to the following diagram showing the arrangement of apparatus used to investigate a property of radio waves.



Which of the following correctly describes the wave property being explored?

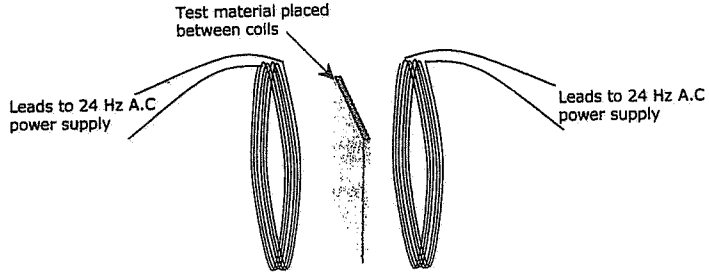
(A) The wavelength of radio waves using diffraction.

(B) The intensity of radio waves using reflection.

(C) The speed of radio waves using interference.

(D) The energy of radio waves using photoelectric emission.

15. An experiment was performed to examine the heating effects on metal sheets placed between two current carrying coils. The sheets were all of identical size and shape. Each sheet was mounted, in turn, between two large coils of wire, (see diagram below). The power supply was switched on for 5.0 min in each test. During this time an A.C current of 20 A flowed in each coil. The temperature of each test metal was recorded before, and immediately after, the 5.0 min between the coils. The metals tested were iron and aluminium.



Based on the information about the experiment, which of the following would be the **best** explanation for any heating of the sheets during the tests?

(A) The sheets would have mainly been heated due to the coils becoming very hot as the charges in the 20 A current lost their electrical energy.

(B) The iron sheet would have ended up much hotter as the magnetic fields produced by the coils would have affected it, but the aluminium is not attracted by magnetic fields, and would not have been heated as efficiently.

(C) The heating is due to the eddy currents induced in the metal sheets.

(D) Eddy currents are induced in the metal sheets because of the changing magnetic fields produced by the coils.

Student Number

Section I (continued)

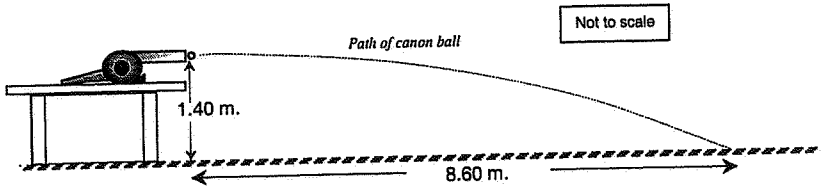
Part B – 60 marks
Attempt Questions 16 – 28
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (4 marks) **Marks**

A toy canon has standard charges supplied with it designed to propel the small canon balls of mass 100 g. The canon was set up on a heavy table with the barrel horizontal. The canon was then fired and the distance travelled by the canon ball was measured. The following diagram is a sketch of the result.



This result was collected by a student attempting to solve the problem: *"How much of the energy stored in a standard charge, as supplied by the manufacturers of the canon, is transferred to the canon ball when fired?"*

(a) Outline the basic physics that must be applied to enable the student to obtain an answer to the problem. Suggest a possible technique that might allow the student to be more sure of their result. **2**

Question 16 (continued) **Marks**

(b) Using the students' sketch of their results, calculate the velocity of the canon ball when it left the barrel of the canon. **2**

Question 17 (5 marks)

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

(a) Given that the average radius of the Earth is 6360 km, calculate the gravitational potential energy of the satellite. **2**

Question 17 (continued) **Marks**

(b) Compare the orbit of this satellite with a similar mass satellite in a geostationary orbit at an average distance of 35,890 km above the surface of the Earth. **3**

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Question 18 (6 marks)

The development of Einstein's Special Theory of Relativity, published in 1905, was based on the constancy of the speed of light. The ideas were initially considered very unusual but there was already indirect experimental support for Einstein's claim.

(a) Justify Einstein's use of the word "*special*" in describing his Special Theory of Relativity. **1**

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Question 18 continues on page 16

Question 18 (continued) **Marks**

(b) A futuristic spacecraft, just before take-off on Earth, is measured and found to be 120 m long. The spacecraft takes off and completes several fly-bys of the Earth to allow observations and accurate measurements to be collected by scientists on the Earth. During one of these fly-bys the spacecraft flew parallel to the ground at a constant velocity and the scientists recorded a length of 80 m for the spacecraft. Using Einstein's theory, calculate the velocity of the spacecraft. **2**

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(c) Although it was not the purpose of the experiment, and not part of Einstein's reasoning as he developed his Special Theory, describe the experimental evidence that had already been collected to support Einstein's ideas on the speed of light. **3**

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Question 19 (5 marks) **Marks**

Manned missions to space must carefully consider the way that they return to Earth. Discuss the issues involved with re-entry and achieving the safe return of the human occupants to the surface of the Earth. **5**

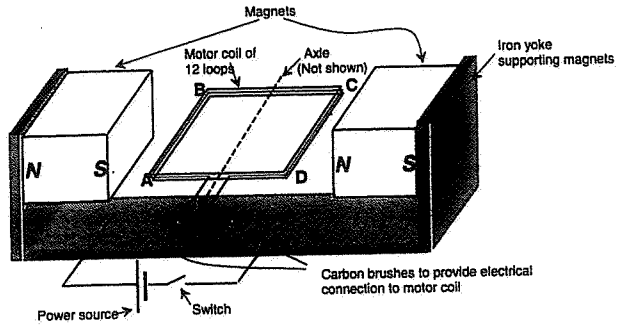
Question 20 (4 marks) **Marks**

The transformer is essential to allow humans in a modern city to exploit the valuable resource that electricity provides. The earliest transformers were not terribly efficient but improvements in design have overcome many of the original problems. Describe the general features of a transformer, including information on the requirements for their operation, and the techniques that have been developed to improve their efficiency. **4**

Marks

Question 21 (5 marks)

The diagram below shows some of the structural components of a simple electric motor.



The motor coil, ABCD, has an area of 1.70×10^{-3} m^2 and is made from a continuous length of insulated wire wound into 12 loops. The magnitude of the magnetic field in the region of the coil is 0.22 T. When the switch is closed a current of 3.10 A begins to flow into the motor coil causing the coil to experience a torque and start to spin. When the motor coil has achieved full speed it is measured to rotate at 5.0 Hz.

(a) Describe the force that acts on the side of the coil **AB** when the motor is first switched on. **1**

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

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(c) Giving support for your answer, describe how the torque acting on the coil would change as the motor is switched on, then begins to rotate, and then finally reaches the point where it is rotating at 5.0 Hz. **3**

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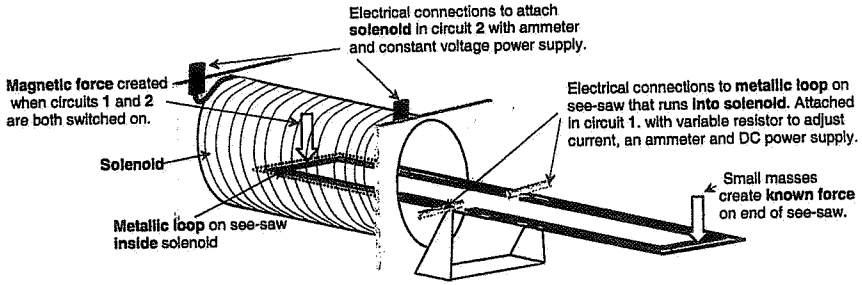
Marks

Question 22 (6 marks)

During a class experiment a current balance was used to determine the magnetic field inside a solenoid. The apparatus, without electrical components, is shown below.

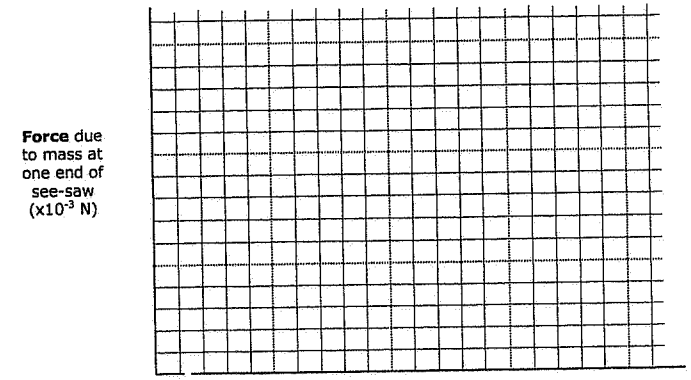


The see-saw was initially balanced. A small mass was placed on the end of the see-saw outside the solenoid to create a known force. With both circuits on, the current flowing into circuit 1 was adjusted until the magnetic force on the see-saw, created on the current carrying metallic loop inside the 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 lists the results collected.

Length of metallic loop inside solenoid affected by magnetic field of solenoid = 32.0 mm
Constant **current** in solenoid (Circuit 2) = 4.20 A

Known **Force** on see-saw created by mass (x 10^{-3} N)	**Current** required 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) Graph these results on the grid, including line of best fit **2**



Question 22 (continued) **Marks**

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

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(c) Explain how the graph you have drawn can be used to determine the strength of the magnetic field produced inside the solenoid during the experiment **and** calculate the experimental result. 3

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Question 23 (5 marks)

The AC induction motors has proved very versatile and 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 24 (8 marks) **Marks**

(a) Explain why silicon became the preferred material for use in transistors. 2

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(b) Contrast thermionic and solid state devices. Relate your answer to the dominance of one of these technologies in the modern electronics industry. 4

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(c) Explain the effect of changing the cross-sectional area of a conductor on drift velocity if the current through the wires of different diameters remains the same. 2

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Question 25 (5 marks) **Marks**

(a) Identify the energy transformation that occurs in a solar cell. **1**

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(b) Describe the application of the photoelectric effect in solar cells. **4**

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Question 26 (7 marks)

(a) In your studies, you carried out a first-hand investigation of the properties of cathode rays using a discharge tube containing a paddle wheel. With reference to relevant observations that you made, explain how this apparatus demonstrates an important property of cathode rays. **3**

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Question 26 continues on page 24

Question 26 (continued) **Marks**

(b) Assess the impact of the application of the cathode ray tube on society. **4**

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Section II

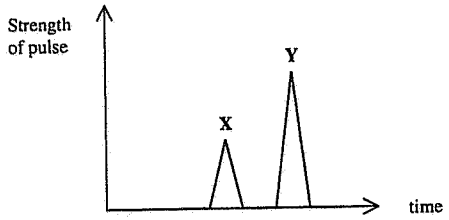
25 marks
Attempt Question 27 – Medical Physics
Allow about 45 minutes for this section

Answer the question on the writing paper provided. Write your student number at the top of each page and staple the bundle together when you have finished the option.

Show all relevant working in questions involving calculations.

Question 27 – Medical Physics (25 marks) **Marks**

(a) The following information was obtained by directing ultrasound at a patient's eye.



(i) What name is given to this type of scan? **1**

(ii) Outline the inferences that can be made from the spacing and height of the signals labelled X and Y. **2**

(b) (i) Describe a first-hand investigation that you carried out to observe the transfer of light by optical fibres. **2**

(ii) Explain how the results of your investigation can be applied to obtain a clear image of an internal body organ. **2**

(c) (i) Identify the function of the radio frequency oscillator in MRI equipment. **1**

(ii) Outline how the use of the radio frequency oscillator can help distinguish between grey and white matter in the brain. **3**

(d) Discuss the impact of the use of CAT scans on society. **6**

Question 27 continues on page 26

(e) The following PET scan shows a tumour in the upper leg bone of a patient.

Describe how this scan would have been obtained and explain why using PET might be preferable to using X-rays in this situation. **7**

END OF PAPER

Student Number

Multiple Choice Answer Sheet

PART A

Total Marks (15)
Attempt Questions 1 – 15
Allow about 30 minutes for this part

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

TOTAL PART A