Centre Number

Student Number

SCEGGS Darlinghurst

2004

Higher School Certificate
Trial Examination

Physics

This is a TRIAL PAPER only and does not necessarily reflect the content or format of the Higher School Certificate Examination for this subject.

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 Centre Number and Student Number at the top of this page, the Multiple Choice Answer Sheet, pages 8 and 16 and the first page of your bundle of answers for Section II.

Section I Pages 1-19

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 – 27
- Allow about 1 hour and 45 minutes for this part.

Section II Page 20

Total marks (**25**)

- Attempt Question 28
- 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.

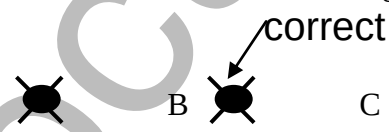
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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.



A ✕ B ✕ C ○ D ○

1. An 80 kg human was abducted by aliens and flown to the aliens' planet where the surface gravity is 2.5 times greater than on Earth. Which of the following would be true for the weight of the human on the surface of the alien planet?

   (A) The weight would still be 80 kg.

   (B) The weight would be 200 kg.

   (C) The weight would be (2.5 x 9.8 x 80) kg.

   (D) The weight would be 1960 N.

2. A satellite is in stable circular orbit at an altitude about 1000 km above the Earth's surface. When considering the velocity and acceleration of the satellite as it orbits, which of the following would be true?

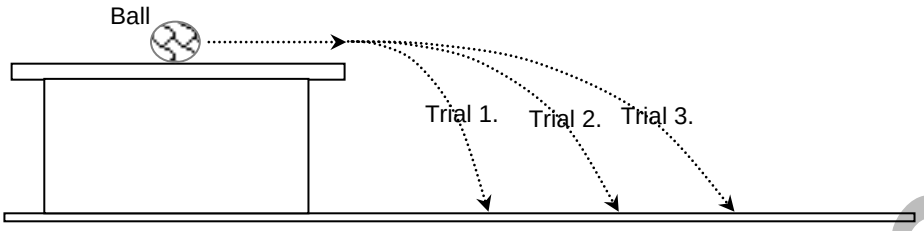
   (A) The acceleration remains constant.

   (B) Both the acceleration and velocity remain constant throughout the orbit.

   (C) Only the magnitude of the acceleration and velocity remain constant.

   (D) The magnitude of both the velocity and acceleration change continuously.

3. During an experiment, a ball was rolled across a horizontal table at different speeds and the distance it travelled before hitting the floor was measured. The path followed by the ball for three trials is shown in the following diagram.



Considering this information, which of the following statements would be true as the ball leaves the table and falls to the floor?

(A) The change in the velocity of the ball is the same in each trial.

(B) The ball will take different times to hit the floor in each trial.

(C) The ball only accelerates vertically down in each trial.

(D) The ball gains the same amount of kinetic energy in each trial.

4. During the first stage of a rocket launch, the rocket engine consumes fuel at a constant rate of 12 tonnes per second. As the rocket gains speed the rate at which the fuel is being consumed is reduced. Which of the following is best to describe what happens to the rocket while the fuel burns at a constant rate?

(A) The acceleration of the rocket steadily increases.

(B) The thrust from the engine increases as the total mass of the rocket decreases.

(C) The acceleration of the rocket is constant.

(D) The g-forces on passengers become smaller requiring the rate to be reduced.

5. A particle is to be used in a linear accelerator. Measured at rest relative to the laboratory, it has a half-life of 2.5 μs. When measured at constant speed by an observer in the laboratory, its half life increases to 10 μs. What is the speed of the particle relative to the laboratory?

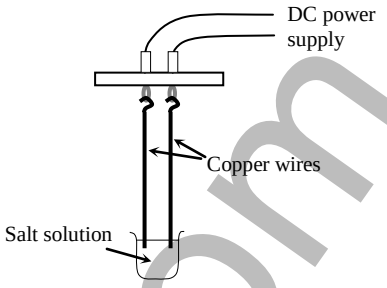
(A) 9.68×10^{-1} ms^{-1}

(B) 2.90×10^{-1} ms^{-1}

(C) 9.68×10^{7} ms^{-1}

(D) 2.90×10^{8} ms^{-1}

6. A student is conducting an investigation on the magnetic forces between current carrying wires. They have taken two equal, straight lengths of copper wire and suspended them from metal loops attached to a DC power supply, as shown in the diagram below.



When the power was switched on the student observed that the wires were weakly repelled from each other. The student then decided to try to modify the set-up so that the wires will now be attracted to each other and also to attempt to increase the size of the force acting.

Which of the following combinations of changes could the student make to the set-up to be sure they will achieve the desired result?

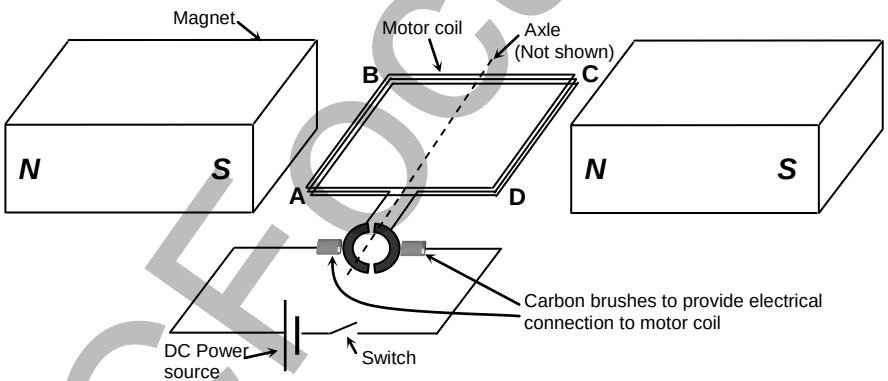
(A) Increase the length of the wires and reverse the connections to the DC power supply.

(B) Increase the length of the wires and increase the size of the current flowing.

(C) Reverse the direction of the current in one wire and use longer wires.

(D) Increase the current in the wires and reverse the connections to the DC power supply.

7. The diagram below represents a simple DC electric motor.



The magnets produce a field of 0.12 T in the region of the motor coil which consists of 10 square loops of 0.050 m side length. When the motor is switched on a current of 4.0 A flows into the motor coil. Which of the following alternatives correctly states the torque acting on the motor coil and the direction of the initial movement of the end of the motor coil AB?

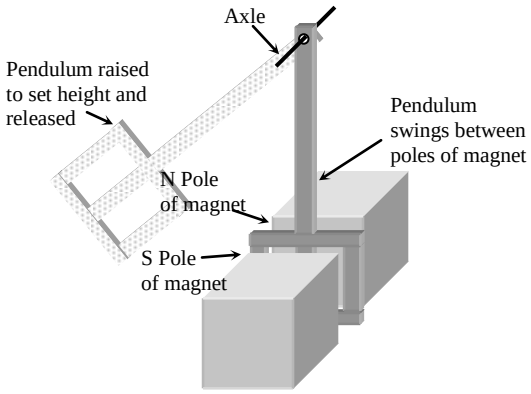
(A) Torque = 0.012 Nm, and end AB moves down

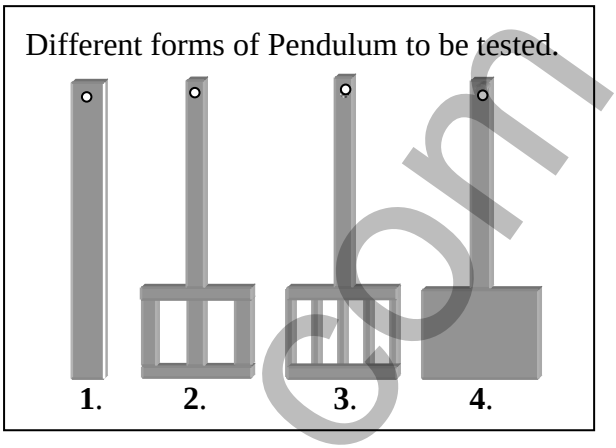
(B) Torque = 0.012 Nm, and end AB moves up

(C) Torque= 0.240 Nm, and end AB moves down

(D) Torque = 0.240 Nm, and end AB moves up

8. An apparatus has been constructed to investigate eddy currents. It consists of a large, very strong permanent magnet and several pendulum structures made of aluminium plate. The pendulums can be hung from an axle to allow them to swing between the poles of the large magnet. An example is represented in the following diagram.





Each of the FOUR different pendulums was tested. It was observed that the motion of each pendulum was slowed as it passed between the poles of the magnet.

Considering the shape of the FOUR pendulums, which of the following is most likely?

(A) Each of the four pendulums will come to rest at the same rate.

(B) The pendulum No. 1. will come to rest quicker than the others.

(C) The pendulum No. 3 will come to rest quicker than the others.

(D) The pendulum No. 4 will come to rest quicker than the others.

9. An ideal transformer is used to convert the 240 V AC power supply to 12 V DC to operate a slot car set. The transformer has 100 loops in the secondary coil and the power used by the slot cars when operating is 60 watts.

Which of the following correctly states the number of loops in the primary coil and the current flowing through them when the slot cars are operating?

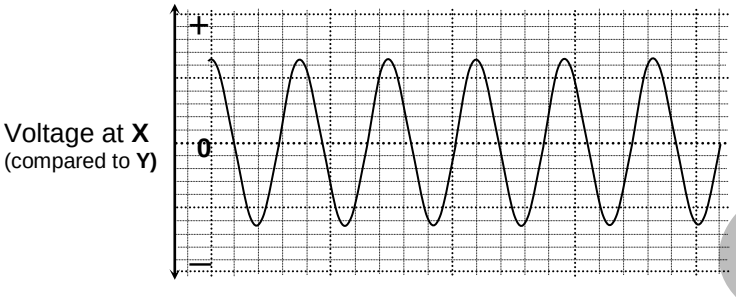
(A) 2000 loops and 0.25 A

(B) 5 loops and 5.0 A

(C) 2000 loops and 5.0 A

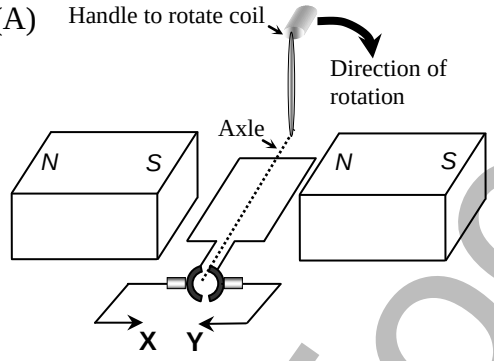
(D) 5 loops and 0.25 A

10. During an experiment, TWO forms of simple generator were each attached to a cathode ray oscilloscope. The handle of the generator was rotated at a steady rate and a plot of the voltage produced at the contact X, compared to Y, was recorded for each of the generators. The following graph shows the result for one of the generators tested.

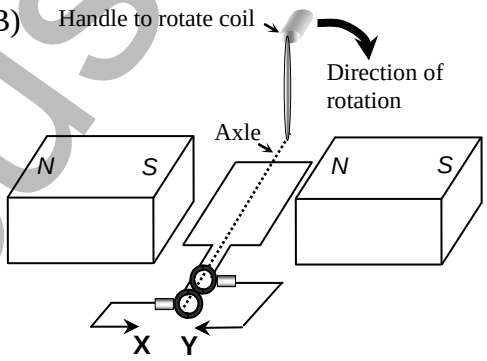


Considering the graph starts with the generators in the positions shown, which of the following alternatives would correctly represent the direction of rotation and form of generator that produced the plot shown.

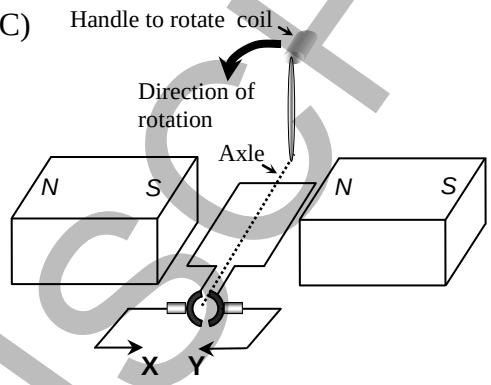
(A)



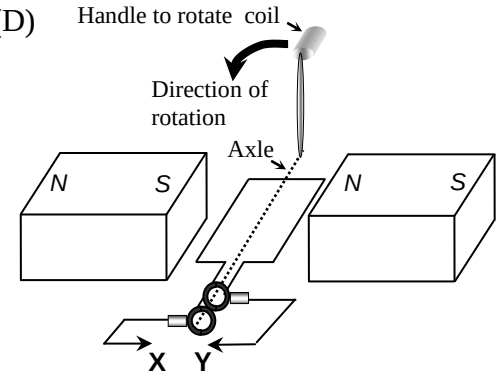
(B)



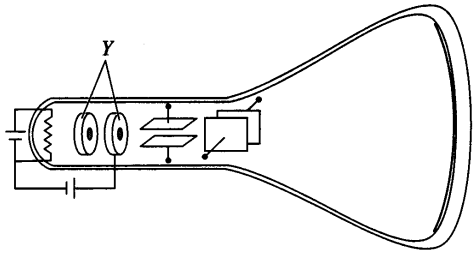
(C)



(D)



11. The following diagram shows a simple cathode ray tube from an oscilloscope.



The parts labelled Y have the function of:

(A) producing electrons.

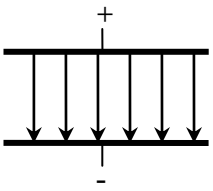
(B) accelerating the electrons.

(C) deflecting the beam horizontally.

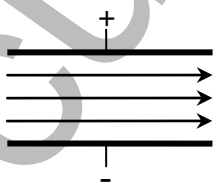
(D) indicating the path of the beam.

12. Which of the diagrams below is the best to represent the electric field between two charged, parallel metal plates?

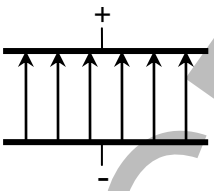
(A)



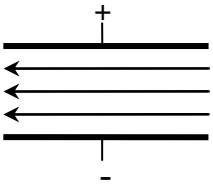
(B)



(C)



(D)



13. Which area of physics knowledge was used by the Braggs in their experimental work?

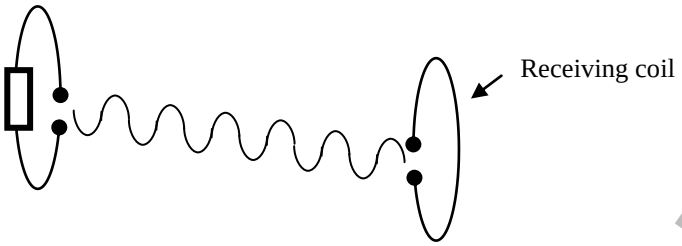
(A) particle nature of light

(B) law of refraction

(C) interference of waves

(D) forces on charged particles

14. Hertz used a high voltage source to generate a spark and realised that when another spark was produced at a receiving coil, energy must have been transferred somehow.



Early in his experiments Hertz made a chance observation when he found he could increase the strength of the spark in the receiving coil. Which of the following correctly describes what Hertz had done that led to this observation?

(A) He shone a source of ultraviolet light on the receiving coil.

(B) He slightly increased the gap between the terminals of the receiving coil.

(C) He placed a glass panel between the transmitting coil and the receiving coil.

(D) He placed a flat metal sheet behind the transmitting coil which reflected energy to the receiving coil.

15. A small magnet can be made to hover above a superconducting material that is cooled below its critical temperature. Which of the following alternatives provides the best explanation for why this occurs?

(A) Below the critical temperature superconductors produce their own magnetic fields.

(B) The superconductor responds to the magnetic field of the small magnet by producing internal currents that produce magnetic fields to repel the small magnet.

(C) The magnetic field of the small magnet cannot enter the superconductor and is perfectly reflected from the surface of the superconductor causing the magnet to repel itself.

(D) Below the critical temperature all the electrons in the superconductor attract each other to form Cooper Pairs that repel magnetic fields.

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Section I (continued)

Part B – 60 marks

Attempt Questions 16 – 27
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 (3 marks) **Marks**

A satellite with a mass of 200 kg maintains its orbit at an altitude of 300 km above the surface of the Earth. Given that the Earth has a radius of 6.38×10^6 m, calculate the gravitational potential energy of the satellite at this altitude. **3**

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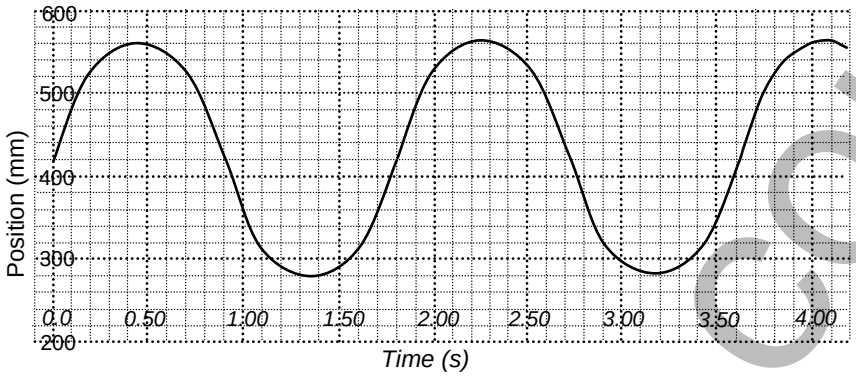
Question 17 (6 marks) **Marks**

A simple pendulum and motion sensor were used in an experiment to determine the size of acceleration due to gravity. The motion sensor was attached to a computer and set up to record the horizontal motion of the simple pendulum. The following graph shows the result for the 'Position' of the pendulum bob vs. 'Time', for a pendulum of length 0.800 m.



(a) Use the graph to determine the period and amplitude of the pendulum's motion. **3**

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(b) Based on the result from the graph and the length of the pendulum used, calculate the magnitude of acceleration due to gravity using the equation, $T = 2\pi\sqrt{L/g}$. **1**

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(c) Describe a possible technique that could be used with the same apparatus to improve the accuracy of the value of gravity calculated in part (b). **2**

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Question 18 (5 marks) **Marks**

At launch, a rocket and its payload have a total mass of 4.80×10^5 kg. The thrust produced by the rocket engines in the first second as the rocket begins to move is 1.43×10^7 N.

(a) Calculate the magnitude of the average acceleration of the rocket during the first second of launch. **2**

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(b) The rocket can be used to place a satellite into a stable circular orbit with a specific orbital velocity. Providing full detail, explain how the orbital speed can be used to calculate the altitude above Earth of the satellite's circular orbit. **3**

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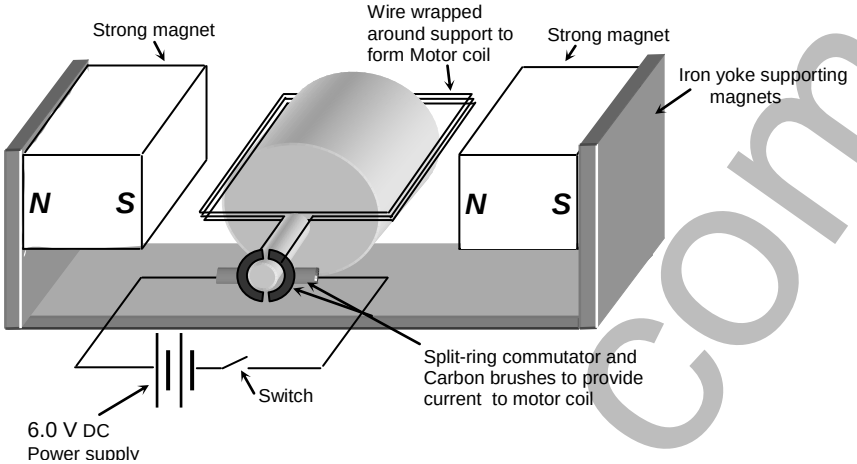
Question 19 (6 marks) **Marks**

The experiments carried out by Albert Michelson and Edward Morley won Michelson a U.S national prize in Physics in 1888 for, as it was described, "Not only for what he has established but also for what he has unsettled." With detail on the basis for the Michelson-Morley, experiment discuss what was shown by the experiments and what was unsettled. **6**

Question 20 (4 marks) **Marks**

As part of their studies a group of students successfully constructed a simple D.C electric motor, represented in the diagram below. **4**



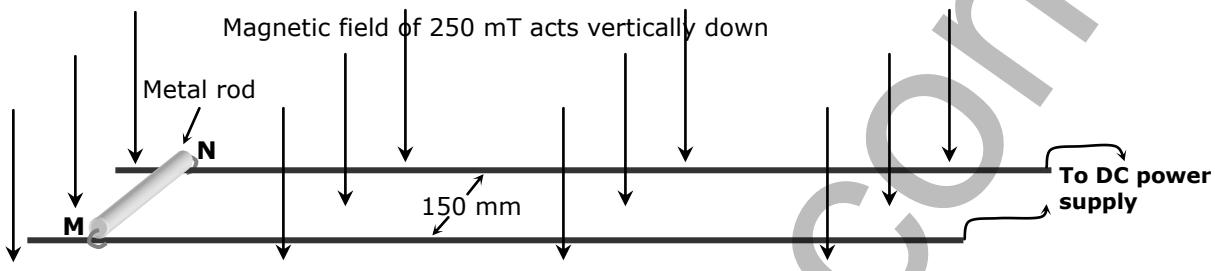
The students conducted tests on the motor and found that it operated best using a 6.0 V power supply, with the motor coil rotating at a frequency of about 3 Hz. Considering when the switch is closed the motor begins at the position shown in the diagram, explain how the torque acting on the motor coil will vary as the coil begins to rotate and reaches its full speed.

Question 21 (4 marks) **Marks**

With reference to an "ideal" situation, describe the requirements to change the voltage of a source of electrical energy to a different value to operate a second circuit. **4**

Question 22 (5 marks) **Marks**

In a demonstration device a light metal rod, MN, sits loosely attached with hooks on two parallel metal rails of negligible electrical resistance, a distance 150 mm apart. A uniform magnetic field of 250 mT acts vertically down as shown. When a DC power supply attached to the ends of the metal rails is switched on, a current of 8.40 A flows through the rails and rod. This results in a magnetic force acting on the rod and it is observed to move to the right, sliding easily along the horizontal rails.



(a) State the direction of current flow through the metal rod and calculate the magnitude of the magnetic force that acts on the rod when the power is first switched on. **2**

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(b) With reference to the physical principles involved, explain how the motion of the rod will affect the magnetic force that is pushing it along the rails. **3**

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Question 23 (7 marks) **Marks**

The early quest to provide "large scale electrical power" to consumers saw Westinghouse and Edison pitted in a very expensive battle to try to convince others of the suitability of their own system when compared to the others. Discuss reasons why the Westinghouse system was eventually to win and how the development of large scale electrical power supply has affected society and the environment. **7**

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Question 24 (4 marks) **Marks**

A student studying the photoelectric effect has a weak UV light source and a laser that produces red light of wavelength 6.35×10^{-7} m. The student placed a polished zinc sheet on the surface of an electroscope and then charged the electroscope negatively. They then tested each light source, one at a time, by directing the beam onto the zinc sheet on top of the charged electroscope.

(a) Calculate the energy for each photon of red light produced by the laser. **2**

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(b) With reasons for your answer, describe what the student is likely to have observed. **2**

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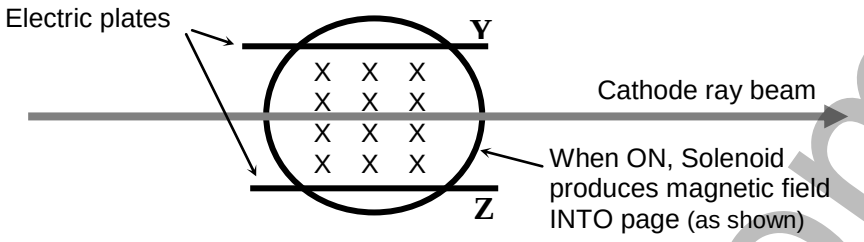
Question 25 (5 marks) **Marks**

A cathode ray beam was manipulated in a Thomson-like apparatus. Part of this apparatus is shown below with the beam shown indicating the path followed when NO fields are acting.



The speed of the particles in the cathode ray beam was known to be 2.0×10^5 ms^{-1}. The cathode ray beam was slightly deflected when the magnetic field was turned on. From the amount of deflection, the magnetic force on the particles in the cathode ray was determined to be 2.2×10^{-15} N.

(a) Calculate the magnitude of the magnetic field acting. **1**

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With the magnetic field still operating, it was found that when the electric field was turned on, the voltage applied to the plates could be adjusted so that the cathode ray beam went through without being deflected.

(b) State which of the electric plates (Y or Z) would be positively charged. **1**

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(c) The distance between the plates producing the required electric field is 2.00 cm. With reference to the physical principles involved, calculate the voltage that must be applied to the plates so the beam is not deflected. **3**

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Question 26 (5 marks) **Marks**

Assess Einstein's contribution to quantum theory and its relation to black body radiation. **5**

Question 27 (6 marks) **Marks**

Discuss how superconductors and the effects of magnetic fields have been applied to develop a Maglev train. **6**

Section II
25 marks

Attempt Question 28 – 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 28 – Medical Physics (25 marks) **Marks**

(a) The endoscope used in medical procedures contains two bundles of optical fibres to allow the surgeon to view internal structures.

(i) Name the physical principle employed in an endoscope. **1**

(ii) Contrast the role of the coherent bundle of optical fibres with that of the incoherent bundle. **2**

(b) The table below gives values for the density and speed of sound in a variety of body tissues.

Tissue	Density (kgm^{-3})	Speed of sound (ms^{-1})
heart muscle	1080	1580
fat	950	1450
blood	1025	1570

(i) Calculate the acoustic impedance of heart muscle and blood. **2**

(ii) Some of an ultrasound pulse is reflected when it passes from heart muscle into a blood-filled chamber. Calculate the percentage intensity reflected. **2**

(c) Certain radioactive isotopes are commonly used to obtain scans of organs. Identify ONE specific radioactive isotope used to obtain scans and outline the properties that enable it to be useful. **3**

(d) Compare the situations in which phase and sector scans would be used. **2**

(e) The images produced by a PET scan can be very useful to assist in diagnosing certain medical problems.

(i) Outline one advantage and one disadvantage of PET scans. **2**

(ii) Describe how PET scans are produced. **4**

(f) Compare the techniques employed to produce a CAT scan with those of a MRI scan including information on the possible effects of each technique on the patient. **7**

End of Paper

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Multiple Choice Answer Sheet

PART A
Total Marks (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 =