
Student Number

SCEGGS Darlinghurst

HSC Course
Trial Examination, 2003

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 the Multiple Choice Answer Sheet and pages 1 and 9.

Section I Pages 1 - 17

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 18

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 following information, for the weight of the same stationary object at different locations on the surface of the Earth, was obtained using an accurate measuring device.

Position	Weight (N)
1	9.810
2	9.821
3	9.796
4	9.814

Which of the following could explain the variation in the measurements?

(A) The measurements were made at different altitudes.

(B) The measurements were made at different latitudes.

(C) The measuring device was faulty.

(D) Both (A) and (B) could explain the results.

2. A bullet is fired into the air and followed a flight path, represented by the diagram below,

If all effects due to air friction are negligible while the bullet is in flight, which of the following statements is true?

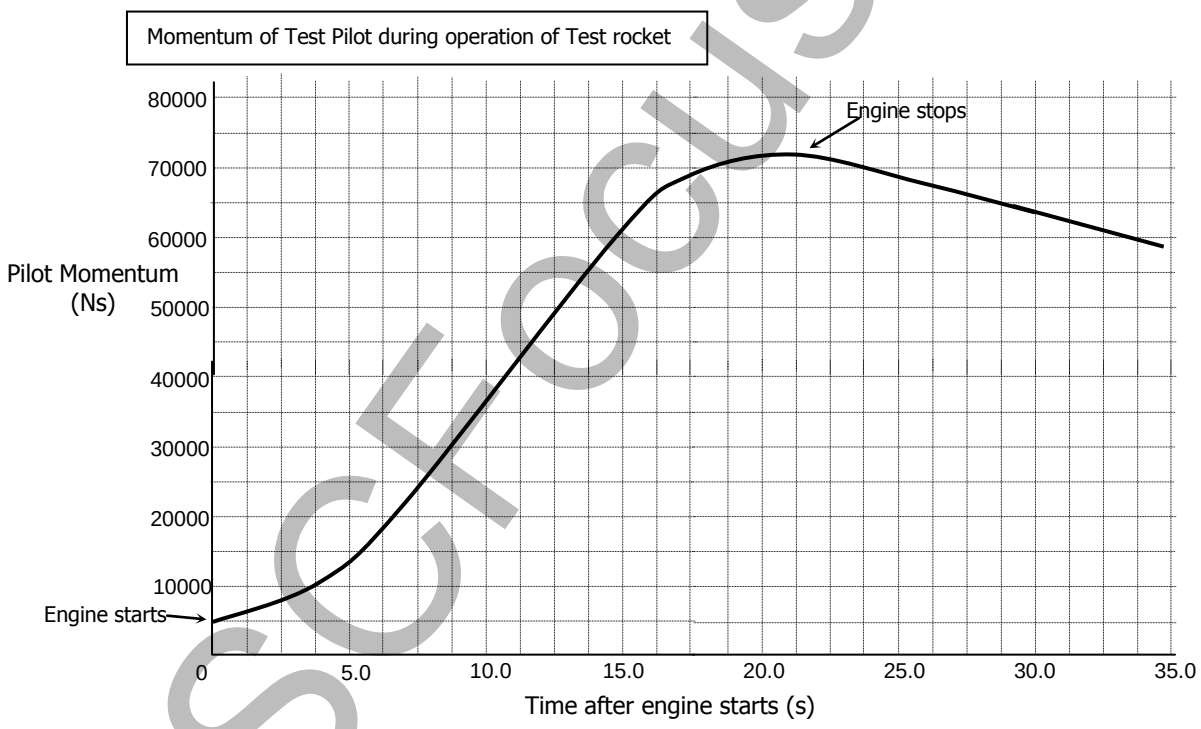
(A) The energy and acceleration of the bullet remain constant.

(B) The energy of the bullet varies while the acceleration remains constant.

(C) The energy of the bullet remains constant while the acceleration varies.

(D) Both the energy and acceleration of the bullet vary while in flight.

3. The following graph shows the way the momentum of a 100 kg test pilot changed during the trial of a new rocket engine.



Based on the evidence from the graph, which of the following statements is correct?

(A) The pilot experienced maximum g-force just before the engine stopped.

(B) The maximum acceleration produced by the rocket was close to 40 ms^{-2}.

(C) The pilot was travelling at 50 ms^{-1} when the rocket started, experiencing a maximum of about 3.6*g* before the engine stopped.

(D) The pilot reached a speed of about 720 ms^{-1}, experiencing a maximum of about 5g.

4. In the future, a spacecraft leaves Earth for a trip to examine a nearby star, a distance 9.0 light years from Earth. Before the launch, an atomic clock on the spacecraft is synchronised with a second atomic clock that remains on Earth. The spacecraft flies to the star, completes a single orbit, and then returns directly to Earth. The spacecraft has an average speed of 0.81c. for the trip. On returning to Earth, which of the following is most likely to correctly describe the observed results?

   (A) Both the clock on Earth and the clock on the spacecraft would record the same time for the trip.

   (B) The clock on Earth would record about 22.2 years have elapsed while the clock on the spacecraft will have registered a shorter time for the trip.

   (C) The clock on Earth would record about 11.1 years have elapsed while the clock on the spacecraft will have registered a shorter time for the trip.

   (D) The clock on Earth would record about 22.2 years have elapsed while the clock on the spacecraft will have registered a longer time for the trip.

5. In the launch of a particular satellite, the satellite was released from a rocket such that it moved into a stable orbit around the Earth. After the satellite had completed a number of orbits of Earth, each taking 90 minutes, rockets on board were used to propel the satellite into a much more distant stable orbit, with a radius 10 times larger than the original. Based on this information, which of the following would be closest to the orbital period of the satellite in the final more distant orbit?

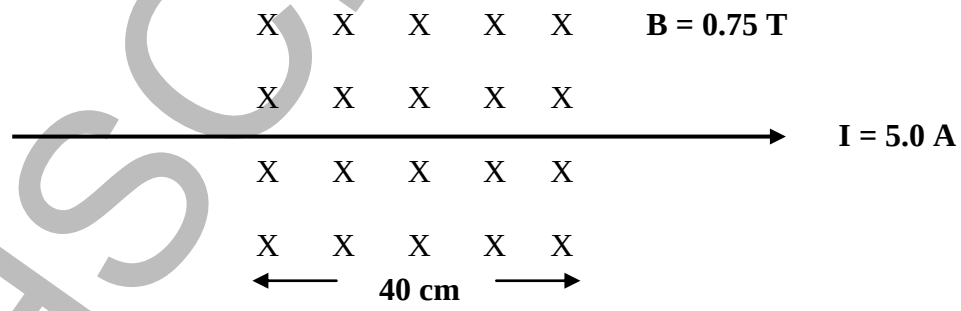
   (A) 47.4 hours

   (B) 38.7 hours

   (C) 22.5 hours

   (D) 15 hours

6. A conductor carries a current through a region of uniform magnetic field as shown below.



   Which of the following would be closest to the force acting on the wire?

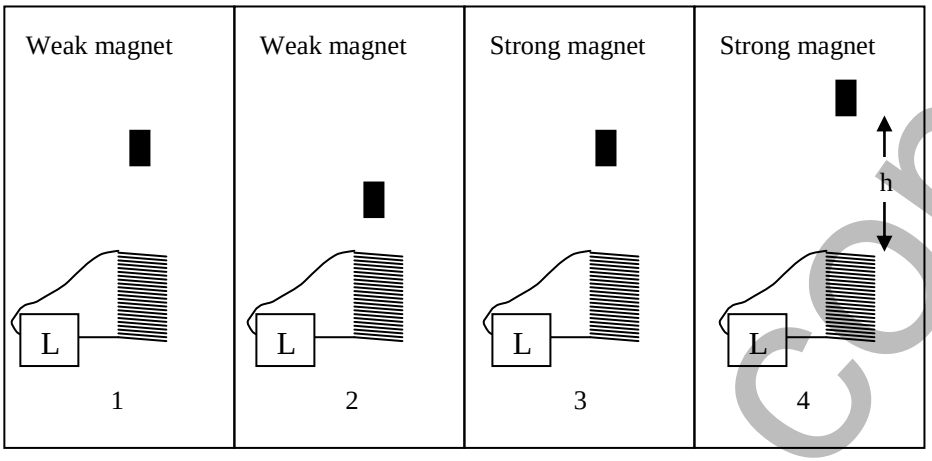
   (A) 150 N into the page

   (B) 150 N up the page

   (C) 1.5 N up the page

   (D) 1.5 N down the page

7. A student performed an experiment in which two magnets were dropped through a coil from different heights (h), shown in the diagram below. The coil was connected to a data-logger (L) that measured the potential difference across the coil each time a magnet was dropped through it.



Which of the following correctly ranks the experiments in order of *increasing* maximum potential difference that would have been recorded by the data-logger?

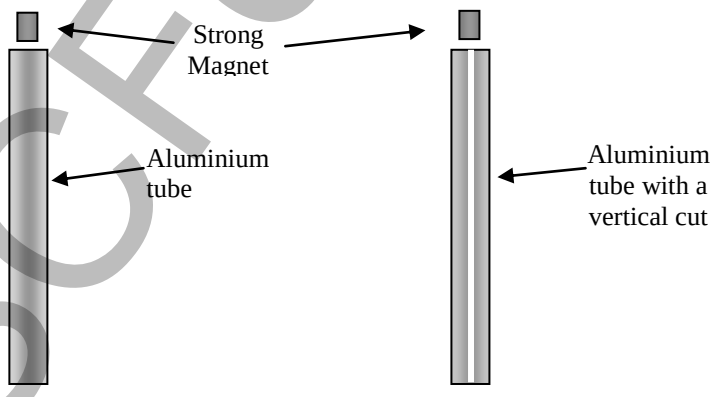
(A) 4, 3, 2, 1

(B) 4, 3, 1, 2

(C) 1, 3, 2, 4

(D) 2, 1, 3, 4

8. A student dropped a small but very strong magnet down through two aluminium tubes as shown below. One of the tubes had a vertical cut down one side.



After repeating the experiment several times, the student noted that the magnet seemed to float slowly down through the complete tube and fell much faster through the tube with the vertical cut.

Which of the following is a reasonable conclusion from these results?

(A) The magnet lost its magnetic field when it was inside the tube with the vertical cut.

(B) Larger magnetic forces produced inside the complete tube slowed the magnet's progress.

(C) There were no magnetic forces slowing the magnet's progress through the cut tube.

(D) Aluminium is a magnetic metal that is only attracted to strong magnets.

9. A transformer has 200 turns of wire on its primary coil and 1500 turns on its secondary coil. If 50 V AC was connected to the primary coil, and there were no energy losses, which of the following would be closest to the output voltage provided from the secondary coil?

(A) 75 000 V

(B) 6 000 V

(C) 375 V

(D) 6.7 V

10. Which of the following correctly describes the function of the split-ring commutator in a DC generator?

(A) It ensures that the current to the external circuit always flows in the same direction.

(B) It changes the current direction in the generator coils so that it is always flows through them in the same direction.

(C) It changes the direct current produced by the rotating coil into alternating current for use in the external circuit.

(D) It ensures that the torque on the generator coil is always in the same direction so that it continues rotating in the same direction.

11. After the discovery of cathode rays, study of the rays produced debate as to whether they were electromagnetic waves or streams of particles. The experiment that collected convincing evidence to resolve this debate was performed by which of the following scientists?

(A) Heinrich Hertz

(B) J.J. Thomson

(C) William Crookes

(D) Max Planck

12. Which of the following would best describe the material composing a p-type semiconductor?

(A) extremely pure silicon with some of the silicon electrons removed leaving holes in the resulting crystal lattice

(B) extremely pure silicon with a certain number of extra electrons added leaving some free electrons in the resulting crystal lattice

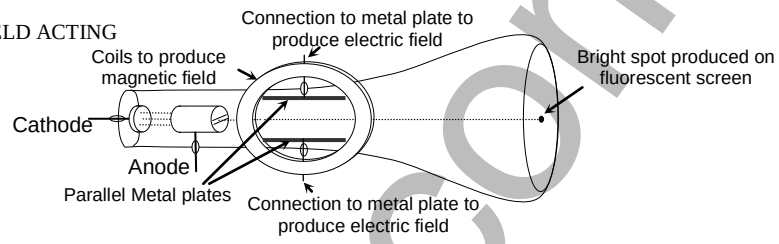
(C) pure silicon that has small amounts of an element, that has one fewer valence electron than a silicon atom, added to result in a crystal lattice where some of the silicon atoms in the lattice have a space for another electron

(D) pure silicon that has small amounts of an element, that has one more valence electron than a silicon atom, added to result in a crystal lattice with a number of extra electrons

13. During an experiment with cathode rays, a highly evacuated glass tube included a set of parallel metal plates inside the tube which could be attached to a source of potential difference, to allow an electric field to be set up inside the tube. The apparatus also included a set of coils that, when attached to a power supply and a current flows through them, produce a magnetic field in the same region where the parallel metal plates produce the electric field.

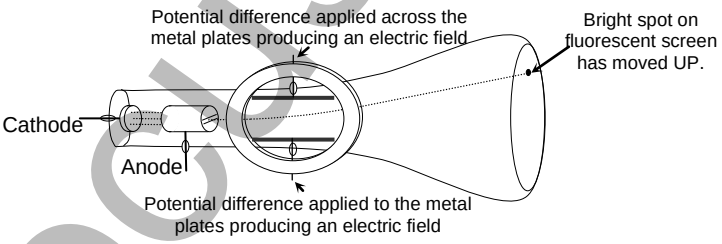
In Part 1 of the experiment, the magnetic and electric fields were NOT acting. The result produced is shown in the following diagram.

Part 1 Neither ELECTRIC or MAGNETIC FIELD ACTING



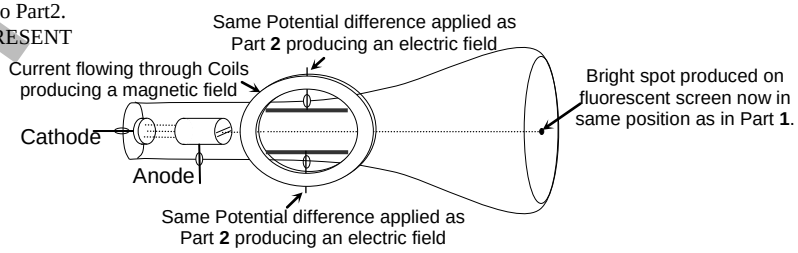
In the Part 2 of the experiment, an electric field was produced by applying a potential difference to the connections to the metal plates. The bright spot was observed to change its position on the fluorescent screen, as shown below.

Part 2 ONLY ELECTRIC FIELD ACTING



In the Part 3 of the experiment the electric field was left on, as in Part 2, but a DC current was now supplied to the coils to also produce a magnetic field. The strength of the magnetic field was adjusted, producing the result shown below.

Part 3 ELECTRIC FIELD ACTING identical to Part2.
BUT a MAGNETIC FIELD is ALSO PRESENT



Based on the results observed in the parts of the experiment, which of the following would correctly describe the direction of the magnetic field that was acting in Part 3?

(A) down the page

(B) into the page

(C) up the page

(D) out of the page

14. Which of the following changes is most likely to increase the resistance of particular wire?

(A) reducing the temperature of the wire

(B) increasing the diameter of the wire

(C) adding impurities to the metal that makes up the wire

(D) reducing the length of the wire

15. Which of the following would best describe the basic idea behind the BCS theory in its attempt to explain superconductivity?

(A) Electrons come together in pairs that are able to travel through the lattice of the superconductor with no interactions at all with the nuclei in the lattice.

(B) Electron pairs interact with each other to produce magnetic fields that allow the paired electrons to travel through the lattice of the superconductor with no resistance.

(C) Groups of electrons interact with the nuclei to allow the electrons to combine and move through the lattice of the superconductor with no resistance to their motion.

(D) The nuclei and the electrons interact to allow pairs of electrons to move through the crystal lattice of the superconductor with no resistance to their motion.

Student Number

Section I (continued)

Part B – 60 marks

Attempt Questions 16 – 26
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 (5 marks) **Marks**

Three newly discovered planets all orbit a very distant star nicknamed "N-Chig".
The following data has been collected.

	Planet		
	A	**B**	**C**
diameter (km)	84 200	21 100	168 400
mass (kg)	2.99×10^{26}	2.87×10^{26}	3.71×10^{26}
orbital period	48 Earth days	284 Earth days	14 Earth years
rotational period (h)	200	46	20

(a) On which of the planets would you expect the gravitational acceleration at the surface to be the greatest? Justify your answer. **3**

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(b) Planet B is found to be orbiting a distance of 1.50×10^{11} m from the star N-Chig and to move with an orbital speed of $55.8\ kms^{-1}$. Calculate the gravitational force that N-Chig is exerting on planet B. **2**

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Question 17 (6 marks) **Marks**

A futuristic spacecraft arrives back to Earth having been on a successful mission into deep space testing a revolutionary propulsion system. The whole test spacecraft had ended up with a mass of only 2.54×10^6 kg after its construction on Earth. The spacecraft was propelled by a newly created anti-matter propulsion system that allows the engine to produce enormous thrust with only 50 kg of the fuel required for a 100 year mission. After leaving the Earth and entering space, the trial had involved propelling the spacecraft to its top speed of 0.92c, and then maintaining this speed while the spacecraft completed an enormous loop through deep space, to eventually return to Earth. A scientist on Earth notes, with the return of the spacecraft, it has been 2.0 years since the spacecraft had departed on the trial.

(a) An observer viewed the spacecraft from Earth with a powerful telescope, and watched it travelling at its top speed, just as the spacecraft reaches the point halfway through the mission. Explain any changes to the spacecraft that would have been observed. **2**

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(b) From the moment of launch, a sensor on board continually measured the mass of the spacecraft while it was on the mission. This information was automatically transmitted to Earth. What would have been observed by the scientist on Earth who was responsible for continually monitoring the data received on the mass from the spacecraft? Justify your answer. **2**

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(c) Outline the considerations for the spacecraft as it was approaching the Earth towards the end of its mission. **2**

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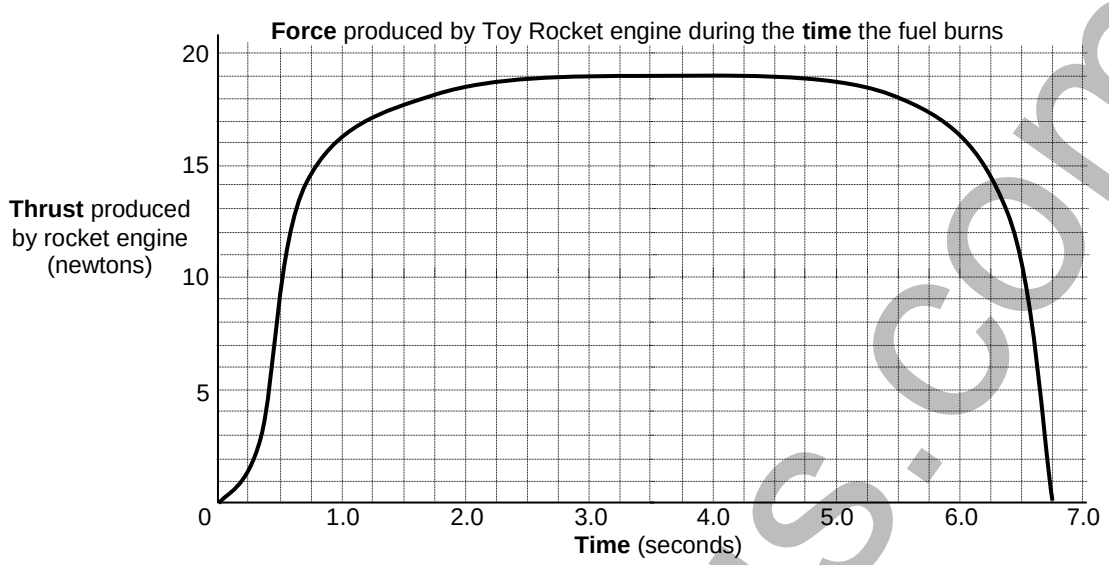
Question 18 (4 marks) **Marks**

The following graph shows the experimental results collected by a group of students where a toy rocket engine was tested using a force sensor and computer. A rocket engine was positioned in a mounting attached to the force sensor, the sensor triggered, and then the rocket engine fired. This allowed the thrust (force) produced by the rocket engine to be recorded over the time the fuel burnt.



As part of the experiment, an identical rocket engine was mounted in position in an actual rocket, resulting in the rocket to be launched having a total mass of 435 g. The rocket was carefully set up so that when the engine was ignited, the rocket was launched vertically up and, after reaching a maximum height, fell back to the ground landing in the spot where it had been launched. The students then compared the measured maximum height of the rocket with the value they had predicted based on their analysis of the graph.

(a) Describe how the students could use information from the graph to determine the expected maximum acceleration of the final toy rocket. **2**

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(b) Explain how the students might have used the information from the graph to predict the maximum speed their rocket would reach when launched. **2**

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Question 19 (5 marks) **Marks**

Discuss the aether, including reasons for its proposal and any significant contributions to resolve whether it existed. **5**

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Question 20 (5 marks)

Two conductors 3.0 m in length were hung beside each other, as shown below. The conductors were parallel and separated by a distance of 50 mm. When a switch in a circuit with the conductors was closed and a current flowed, the conductors were observed to move towards each other.

(a) If the wires each carry a current of 5.0 A, calculate the magnitude of the force between the wires. **2**

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Question 20 (continued) **Marks**

(b) Explain why the wires moved towards each other when the switch was closed. **3**

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Question 21 (6 marks)

(a) Outline the difference between a step-up and a step-down transformer. **2**

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(b) In a transformer, the primary and secondary coils are not electrically connected to each other. Describe how the voltage is produced in the secondary coil. **2**

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(c) Describe ONE benefit for modern society arising from the development of transformers. **2**

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Question 22 (5 marks) **Marks**

You carried out a first-hand investigation to examine the principles involved in an AC induction motor. Explain how the principles of an AC induction motor were demonstrated in your investigation. You should include appropriate diagrams and relevant information on the procedure used. **5**

Question 23 (4 marks) **Marks**

Discuss the energy losses that occur in the transmission of electrical energy produced by a large generator at a power station to supply the electrical energy for use by consumers a distance away. **4**

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Question 24 (8 marks) **Marks**

A certain substance has a work function of 2.2 eV. It is lit with two separate beams of light, blue light of wavelength 450 nm and orange light of wavelength 650 nm.

(a) Explain the concept of a "threshold frequency" as it applies to the photoelectric effect. **2**

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(b) Calculate the frequency of a photon of orange light. **2**

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Question 24 (continued) **Marks**

(c) Which of the two colours of the beams of light is more likely to cause photoelectrons to be emitted from the surface of the substance? Justify your choice *without* making calculations. **4**

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Question 25 (5 marks)

Cathode ray tubes allow the manipulation of a stream of particles using electric and magnetic fields.

(a) Calculate the potential difference that would have to be applied to parallel conducting plates 4.0 mm apart to produce an electric field strength of 2.5×10^3 NC^{-1}. **2**

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(b) Calculate the magnitude of the magnetic field that would need to be applied to produce the same size force on an electron travelling at 1200 ms^{-1} as the electric field described in part (a). **2**

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(c) Identify the type of cathode ray tube used to demonstrate that cathode rays have momentum. **1**

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Question 26 (7 marks)

Compare the accepted models that are used to describe how an electric current flows in: **7**

- a metallic conductor at room temperature,
- a doped semiconductor at room temperature, and
- a superconductor below its critical temperature.

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) (i) Calculate the acoustic impedance of brain tissue using the values below. **1**

Tissue	Density (kgm^{-3})	Velocity of sound (ms^{-1})
blood	1025	1570
brain	1090	1541

(ii) Describe how ultrasound is used to measure bone density. **2**

(b) (i) Use a diagram to show how light is transferred through an optical fibre. **2**

(ii) Explain the need for coherent bundles of optical fibres in an endoscope. **2**

(c) (i) Which of the following technologies has been used to produce the image below?

- conventional X-ray
- CAT scan
- MRI
- PET

Justify your answer. **3**

(ii) Compare the advantages and disadvantages of CAT scans and MRI scans. **4**

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

(e) Assess the impact on society and the environment of the use of radioactivity in medical diagnosis. **7**

END OF PAPER

Student Number

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 =