2005 FILE COPY

Student Number

North Sydney Girls High School

2005

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Examiner's Use only

Book 1_____

Book 2_____

Book 3_____

Book 4 _____

Physics

General Instructions

* Reading Time – 5 minutes
* Working time – 3 hours
* Write in black or blue pen
*Draw diagrams in pencil
*Board-approved calculators may be used
*Data and formulae sheets and a Periodic Table are provided at the back of this paper.
*Write your Student Number on each answer sheet or book.

Total Marks – 100

Section I Pages 1- 21

85 marks
This section has two parts, Part A and Part B

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

Part B – 70 marks
*Attempt Questions 16 –29
*Part B contains three booklets

Section II Page 22
15 marks
*Attempt Question 30
*Allow about 28 minutes for this section

This paper contains multiple choice questions and a separate answer sheet (Book 4). It also contains 3 books in Section I, Part B, each of which have questions as well as space to write your answers. There is also an elective question (Q 30) on page 22. For this question all working and answers are to be written in the "All Science Subjects" Option book supplied.

The words END OF PAPER appear after the last question, which is question 30 (e).

This paper does not have the same content or structure as the HSC examination paper in physics.

Put your answers for the multiple choice questions 1 to 15 on the cover sheet of book 4.

Question 1

Which of the following is a correct statement about escape velocity?

(A) The initial velocity which rockets must have to escape the earth's gravitational field.
(B) The initial velocity which rockets must have to achieve a stable earth orbit.
(C) The initial velocity which projectiles must have to achieve a stable earth orbit.
(D) The initial velocity which projectiles must have to escape the earth's gravitational field.

Question 2

A pendulum can be used to measure the acceleration due to gravity. The equation $T = 2\pi\sqrt{(l/g)}$ is used. At a distance R from the centre of a planet the period of such a pendulum is found to be 10.0 seconds. What will be the period of the pendulum at a distance 2R from the centre of the planet?

(A) 14 seconds
(B) 7 seconds
(C) 20 seconds
(D) 5 seconds

Question 3

When a space craft re-enters the earth's atmosphere the re-entry angle is important. In the statements below take a steep angle to be one greater than 15 degrees and a shallow one to be less than this. Which statement is the best description of re-entry?

(A) It should enter at a steep angle so that it travels less distance through the atmosphere.
(B) It should enter at a steep angle so that at does not bounce off the atmosphere.
(C) It should enter at a shallow angle so that it does not bounce off the atmosphere.
(D) It should enter at a shallow angle so that it slows at a lower rate.

Question 4

In the slingshot effect a space probe swings around behind a planet and emerges with increased momentum and kinetic energy. Which of the following is the ultimate source of that energy?

(A) The potential energy of the space probe
(B) The potential energy of the planet.
(C) The kinetic energy of the planet.
(D) The gravitational field of the planet

Question 5

Which of the following was not a postulated property of the aether which was investigated in the Michelson-Morley experiment?

(A) It was highly elastic.
(B) It was the medium carrying light waves which made the aether visible.
(C) It had negligible mass.
(D) It passed through all objects in the universe including solids.

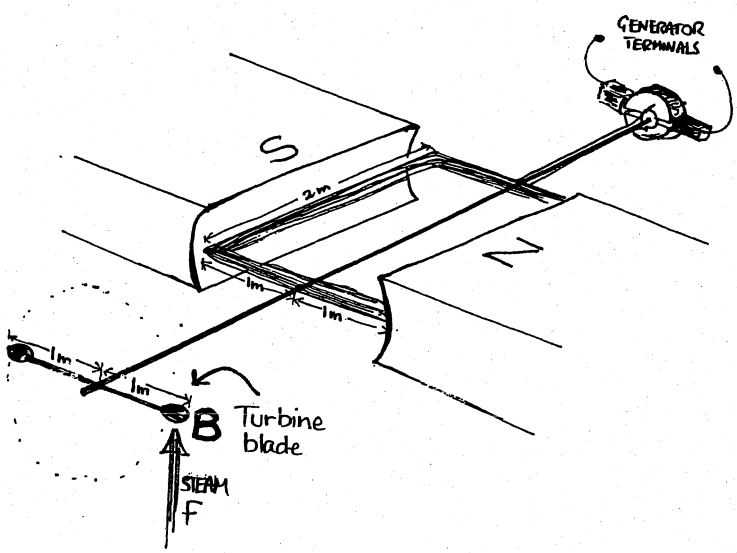
Question 6

Which of the following is the best description of the outcome of the Michelson-Morley experiment?

(A) It failed to detect any motion of the earth relative to the aether.
(B) It produced an interference shift when the apparatus was rotated.
(C) It showed that the speed of light was a constant.
(D) It showed that all velocities are relative to the speed of light.

Question 7

Refer to the diagram below, and assume frictionless bearings.
F is the only force being applied to the blade of a steam driven turbine in an early power station.
What magnitude of force F must the steam apply at B to produce the torque necessary to generate a current of 15A in a 500 turn coil which is in a magnetic field of 5T?



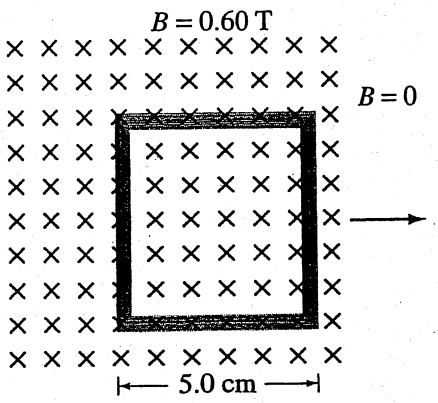
(A) Zero N
(B) 1.5×10^2 N
(C) 3.0×10^2 N
(D) 1.5×10^5 N

Question 8

A field of magnetic flux density (magnetic field intensity) 4 T could be formed by a magnetic flux of 2 Wb passing through a circular coil. What is the radius of the coil?

(A) 0.2 m
(B) 0.4 m
(C) 0.8 m
(D) 1.0 m

Question 9



Faraday's Law can be expressed as $\mathcal{E} = -\Delta\Phi_B/\Delta t$. Where $\mathcal{E}$ = induced emf, $\Delta\Phi_B$ = change in magnetic flux, Δt = change in time. The square metallic coil (see diagram above) has **100 loops** and is in a magnetic field where **B = 0.60 T**. Over a period of **0.50 s** it is pulled smoothly to the right into a region where **B = 0.** What will be the change in the magnetic flux through the square coil, the emf induced and the direction of the induced (conventional) current?

(A)	1.5×10^{-1} Wb,	3.0×10^{-4} V,	anticlockwise
(B)	1.5×10^{-3} Wb,	0.3 V,	clockwise
(C)	-1.5×10^{-1} Wb,	3.0×10^{-4} V,	anticlockwise
(D)	-1.5×10^{-3} Wb,	0.3 V,	clockwise

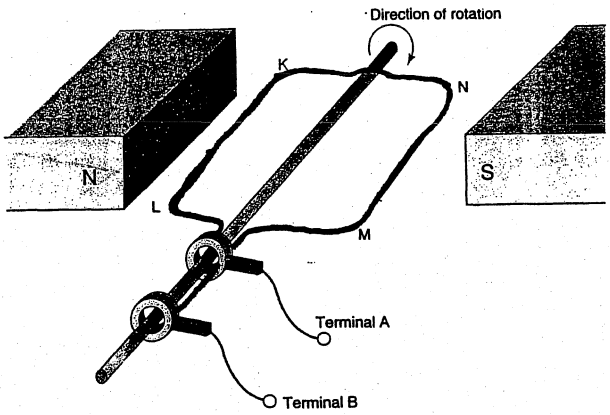
Question 10

Which of the following alternatives best describes what a simple, 240V, 50Hz, AC motor will do when switched on and allowed to run at the rate of the current supplied?

(A) Spin near 3000 revolutions per minute.
(B) Spin at a rate that is dependent on the amount of electricity that is supplied to the motor.
(C) Spin its stator at 50Hz to induce the rotor to spin in step with it.
(D) Very quickly overheat the bearings supporting the rotor, seize-up, and stop.

Question 11

Which of the following statements best describes the generator in the diagram below?



(A) This is a DC generator and at the instant shown in the diagram Terminal A is negative.
(B) This is a DC generator and at the instant shown in the diagram Terminal A is positive.
(C) This is an AC generator and at the instant shown in the diagram Terminal A is negative.
(D) This is an AC generator and at the instant shown in the diagram Terminal A is positive.

Question 12

In an ideal situation there should be no power loss when changing from one voltage to another. That is, the primary power will be equal to the secondary power, or $P_p = P_s$.
In these circumstances it is also possible to calculate the secondary current, I_s.
Which equation below allows I_s to be calculated correctly?

(A) $I_s = I_p n_p / n_s$

(B) $I_s = n_p / n_s I_p$

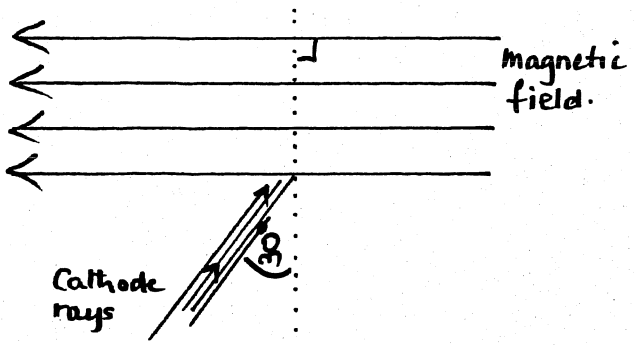
(C) $I_s = I_p V_s / V_p$

(D) $I_s = V_p / V_s I_p$

Question 13 is on the next page

Question 13

Cathode rays enter a 0.1 T magnetic field at an angle of 30° and at 5.0×10^6 ms^{-1} as shown in the diagram below. What is the force on each electron in the beam as it enters the magnetic field?



(A) 4.0×10^{-14} N into the page
(B) 6.9×10^{-14} N into the page
(C) 4.0×10^{-14} N out of the page
(D) 6.9×10^{-14} N out of the page

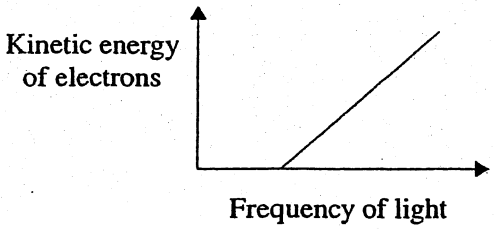
Question 14

Shortly after cathode rays were discovered there was debate as to whether they were particles or waves. Which of the following was most important in leading some scientists to think they were waves?

(A) They were not deflected by electric fields
(B) They moved in straight lines.
(C) They could be reflected.
(D) They were emitted from the anode.

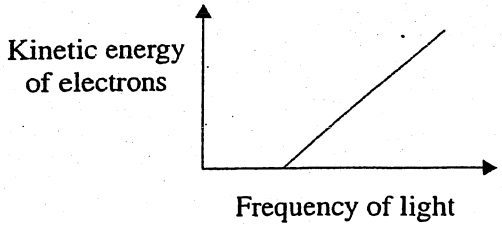
Question 15

In a photoelectric effect experiment, the following graph was obtained using zinc metal.

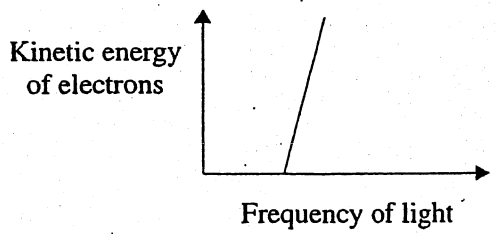


Which of the graphs below would be obtained with an identical experiment in which only the metal was changed?

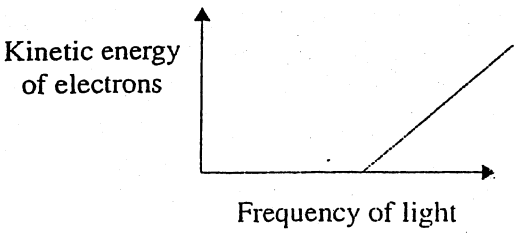
(A)



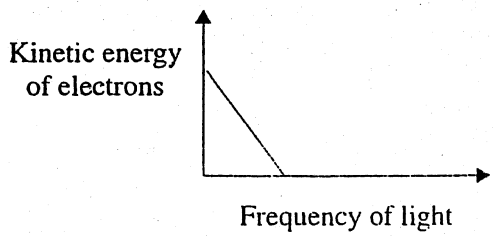
(B)



(C)



(D)



This is the end of Section 1, Part A.
Section 1, Part B starts on the next page.

Student Number

Section I (continued)

Part B – 75 marks
Attempt Questions 16 –29

Answer Book 1
This book contains questions 16 to 19.

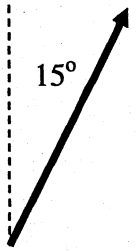
Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Marks

Question 16 (6 marks)

A rocket is fired upwards. By the time its fuel runs out it has tilted away from the vertical by an angle of 15 degrees. When its fuel ran out it was travelling at $400ms^{-1}$.



(a) Calculate the vertical and horizontal components of the velocity. **2**

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(b) Calculate how much higher the rocket will rise before it starts to fall to the ground. **2**

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(c) Calculate how much time passes between when the fuel runs out and when the rocket starts to fall to the ground. **2**

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(a) Identify two differences between low earth orbits and geostationary orbits. **2**

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(b) Considering a satellite in each of these two types of orbits, state why one is more likely to suffer orbital decay than the other. **1**

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(c) When such a satellite goes into orbital decay it will experience intense heat in the same way that a space capsule does on re-entry. Identify one way to protect the satellite from such heat if it were considered important to do so. **1**

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(d) A satellite moves in a circular orbit of radius 7.1×10^6 metres. **Use Kepler's law** to find the period of rotation of the satellite. **2**

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(e) Find the orbital velocity and then centripetal acceleration of the satellite. **2**

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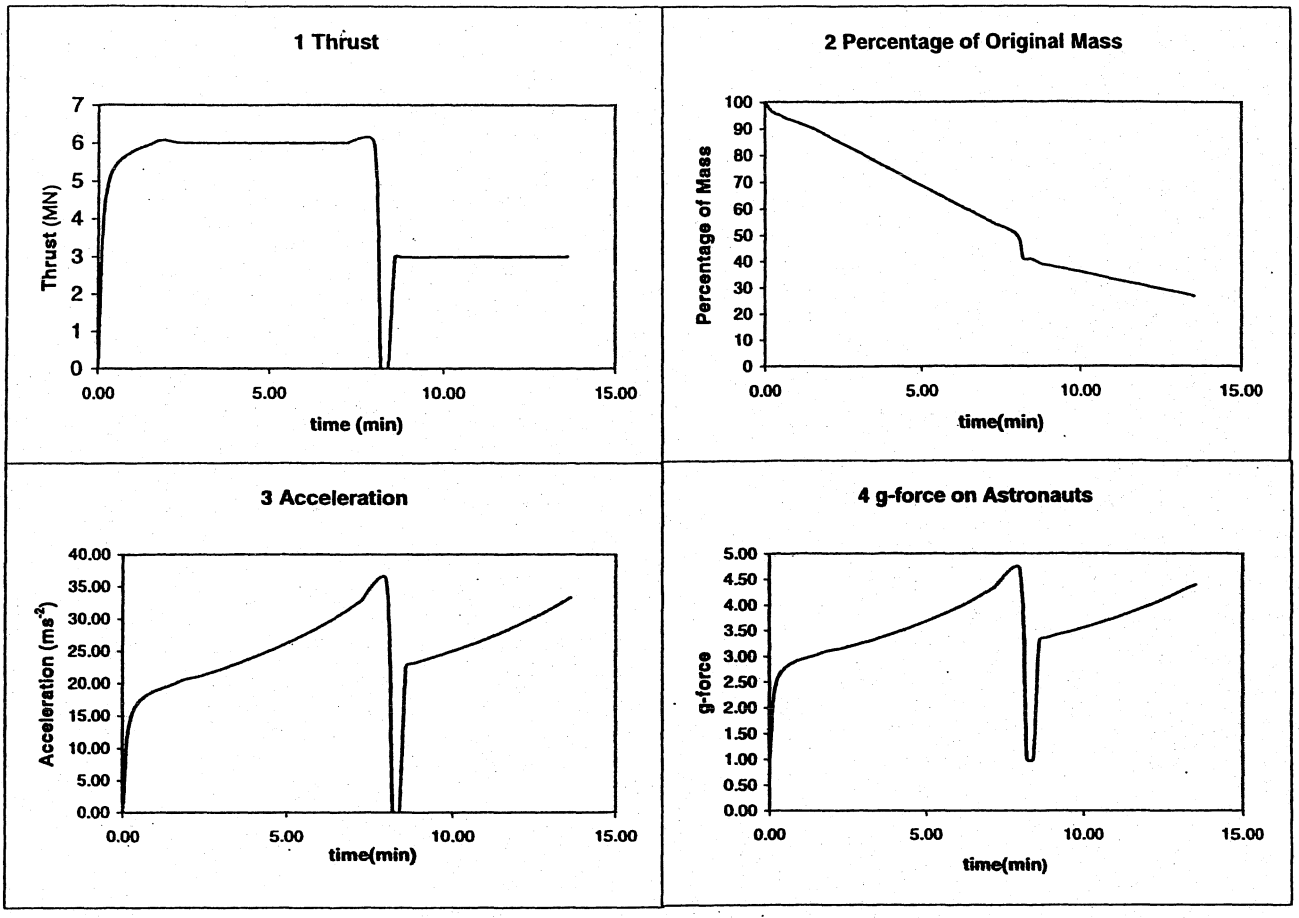
Question 18 is on the next page

Question 18 (7 marks) **Marks**

Graphs 1, 2, 3 and 4 show the variation in four quantities of a rocket during launch.



(a) Identify two ways in which the acceleration of a projectile is different to the acceleration of this rocket. **2**

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(b) According to Newton's second law acceleration is proportional to force. Explain then, why the shape of graph 3 (acceleration) and graph 1 (thrust) are different. **1**

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Marks

(c) It would be expected that the force experienced by the astronauts lifted by the rocket would be related to the thrust of the rocket. Explain then, why the shape of graph 4 (g-force on astronauts) is closely related to graph 3 (acceleration) rather than graph 1 (thrust). **2**

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(d) The gradient of the mass graph (#2) indicates the change in mass experienced by the rocket per minute. Explain, **using the law of conservation of momentum,** why the value of thrust in graph 1 is related to the gradient of graph 2 **2**

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Question 19 is on the next page

Question 19 (7 marks)

The Queen of the Universe, Queen Britney I, was travelling away from the earth at a velocity close to the speed of light. She woke up in her cabin one morning and said to her mirror:

"Mirror, mirror on the wall who is the most beautiful of them all?"

To which the mirror replied:

"As we are travelling close to the speed of light, the light from your face has not reached me yet and so I am unable to tell you."

Queen Britney had studied the thought experiments and ideas of Albert Einstein and knew that the mirror was not telling the truth.

(a) Assess the mirror's statement in relation to the ideas of Albert Einstein. **2**

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Queen Britney rebuked the mirror and made it tell her the truth, so the mirror answered:

"Dear Queen, you used to be the most beautiful in the universe, however, Princess Paris is travelling away from us at two thirds the speed of light. Therefore, time has slowed down for her and she is not aging as fast as you. She is now the most beautiful in the universe."

(b) Calculate how many years Princess Paris lives for each year that Queen Britney lives, as seen by the Queen. **2**

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Question 19 continues on the next page

Queen Britney's advisers interrupted:

Brad: *"Princess Paris maybe aging more slowing but she has developed a huge mass."*
Tom : *"She may have developed a huge mass, but I have seen her standing at the back of her spaceship as she moves directly away from us and all of her body appears to be thinner."*

(c) Assess the truthfulness of the adviser's statements using the theory of relativity. **3**

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This is the end of Answer Book 1
Continue with Answer Book 2

Physics

Student Number

Section I (continued)

Part B – 75 marks
Attempt Questions 20 –26

Answer Book 2
This book contains questions 20 to 26.

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Marks

Question 20 (6 marks)

Although the most important application of the motor principle has been the invention of the electric motor there are other applications, one of which is the invention of the galvanometer.

(a) Identify the function of a galvanometer. **1**

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(b) Use a labelled diagram to explain how the motor principle is used to achieve the function of the galvanometer. **3**

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(c) The formula most related to a galvanometer is: $\tau = nBIA\cos\theta$

(i) List all the components of this formula that are set as constants in galvanometers. **1**

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Marks

(ii) Explain the design feature in galvanometers that eliminates the need to account for, or to measure, '**cosθ**' in the formula above. **1**

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Question 21 (6 marks)

While studying the topic: 'Motors and Generators,' you undertook an investigation to study the variables between a conductor and a magnetic field when generating an electrical voltage.

(a) In relation to this investigation, complete the following table: **4**

Factor under investigation:	**Your hypothesis when these factors are altered:**	**What you did to vary the factor under investigation:**
1. The strength of the magnet.		
2. The relative motion between the coil and the magnet.		

(b) Discuss your observations, made during your investigation, with respect to Faraday's Law of Induction equation: $\mathcal{E} = -\Delta\Phi_B/\Delta t$. Where $\mathcal{E}$ = induced emf, $\Delta\Phi_B$ = change in magnetic flux, Δt = change in time. **2**

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Marks

Question 22 (3 marks)

A power station generates electric power at 120 kW. It sends this power to a town 10 km away through transmission lines that have a total resistance of 0.40Ω. If the power is transmitted at 240V the following calculations can be made:

(i) the current in the transmission lines:

$P = VI$, therefore $I = P/V = 120\,000/240 = 500$ A

(ii) the voltage drop across the transmission lines

$V = IR = 500 \times 0.40 = 200$ V

(iii) the voltage available in the town

$V_{town} = V_{station} - V_{lines} = 240 - 200 = 40$ V

(iv) the power loss in the transmission lines

$P_{loss} = I^2R = (500)^2 \times 0.40 = 100\,000$ W $= 100$ kW

By using the figures calculated above, as well as similar calculations that you must make using very high voltage, compare and assess the merits of low voltage electricity transmission with high voltage transmission. **3**

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Question 23 is on the next page

Marks

Question 23 (4 marks)

Compare the structure and function of the components of a generator to an electric motor. **4**

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Question 24 is on the next page

Marks

Question 24 (2 marks)

Toby has returned from Japan with an electric rice-cooker. The information plate on the back of this cooking utensil states:

100V 450W 50-60Hz

Make a specific calculation (show working) leading to a recommendation concerning the ratio of the number of turns in the transformer that would be necessary to allow him to operate his cooker using a voltage of 240V. **2**

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Question 25 (2 marks)

Identify a difficulty caused by eddy currents in the transformers that are used in our domestic and commercial electricity system and describe two ways of dealing with this problem. **2**

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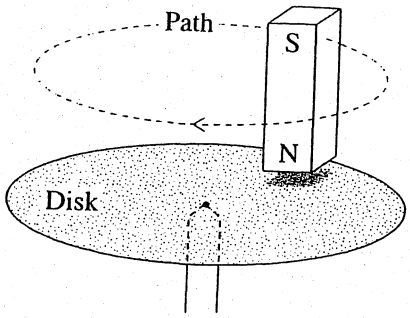
Question 26 begins on the next page

Question 26 (5 marks)

A non-magnetic metal disk is balanced on a support as shown in the diagram below. The disk is initially stationary. A magnet is moved in a circular path just above the surface of the disk, without touching it. The disk begins to spin.



(a) Explain how this demonstration works, and predict which direction the disk will spin. **3**

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(b) The principle involved in the demonstration above has been incorporated into the workings of domestic electrical appliances such as hair-dryers and power-tools. Describe one energy transfer and one energy transformation that occurs when a domestic hair-dryer is operating. **2**

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This is the end of Answer Book 2.
Continue with Book 3

Physics

Student Number

Section I (continued)

Part B – 75 marks
Attempt Questions 27 - 29

Answer Book 3
This book contains questions 27 to 29.

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Marks

Question 27 (3 marks)

Hertz is well known for his experiment to measure the speed of radio waves.

(a) Describe how he generated the radio waves? **1**

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(b) Describe how he detected that the radio waves had arrived at another point. **1**

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(c) Describe how he showed that they were electromagnetic transverse waves. **1**

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Question 28 is on the next page

Question 28 (4 marks)

From investigations your class has performed, describe the property of cathode rays which is shown in a cathode ray tube which contains:

i) A Maltese cross: **1**

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ii) Oppositely charged electric plates: **1**

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iii) A fluorescent display screen inside and a magnet held on the outside of the tube? **1**

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iv) A glass paddle-wheel **1**

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Question 29 is on the next page

Marks

Question 29 (7 marks)

(a) Describe the radiation produced when the walls of a black body cavity are heated. **2**

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(b) Identify Planck's hypothesis which was used to explain black body radiation. **1**

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(c) Describe how Einstein used Planck's hypothesis to develop a new model of light. **1**

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(d) Einstein used this new model to explain the way photoelectrons are produced from a metal surface by incident light. Explain how he used this model to account for the effect of light frequency and light intensity on the photoelectrons. **3**

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This is the end of Answer Book 3
Section II begins on the next page.

Section II

15 marks
Allow about 28 minutes for this section
Answer the questions in the answer book provided.
Make sure the information required on the front of the answer book is completed.
Extra writing books are available.
Show all relevant working in questions involving calculations.

Questions on the electives Geophysics, Medical Physics, Astrophysics and The Age of Silicon are not provided in this examination.

Question 30 From Quanta to Quarks (15 marks)

Marks

(a) Draw and label the structure of the Rutherford model of the atom. **1**

(b) Describe the significance of the results of Rutherford's scattering experiment. **2**

(c) In 1885, Jonathon Jacob Balmer found that he could describe four of the lines in the Hydrogen spectrum by using a relationship consistent with the one below:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \quad \text{(where } n_f = 2\text{).}$$

He went on to predict further undiscovered lines. The first of these was when $n_i = 7$.

(i) Calculate the wavelength of this line. **1**

(ii) Identify whether this line is closer to the red or violet end of the spectrum, stating a reason for your choice. **1**

(iii) Describe how Bohr's postulates led to the development of a mathematical model of the atom that could account for the existence of the hydrogen spectrum. **3**

(iv) Discuss the limitations of the Bohr model of the atom. **3**

(d) Identify de Broglie's proposal regarding particles and state how it was used to explain stable electron orbits in atoms. **2**

(e) Calculate the wavelength of an electron, travelling at a velocity of 1.67×10^8 ms^{-1}. **2**

END OF PAPER