2004

Higher School Certificate

Trial Examination

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- A Data Sheet, Formulae Sheets and Periodic Table are provided
- Write your student number and/or name at the top of every page

Total marks – 100

Section I (Pages 2 – 19)
Total marks (75)
This section has two parts, Part A and Part B

Part A
Total marks (15)
Attempt questions 1-15
Allow about 30 minutes for this part

Part B
Total marks (60)
Attempt questions 16 – 27
Allow about 1 hour 45 minutes for this part

Section II (Pages 20 – 29)
Total marks (25)
Attempt ONE question from Questions 28-32
Allow about 45 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME: .....

STUDENT NUMBER/NAME: .....

Section I

Total marks (75)

Part A

Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
1				
2				
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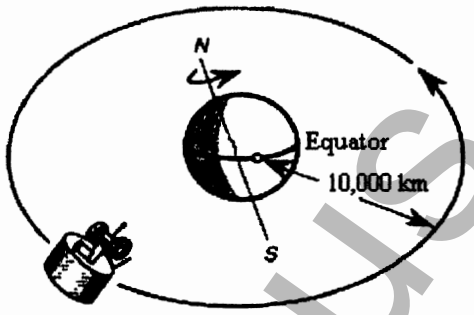
10				
11				
12				
13				
14				
15				

1. An astronaut is at rest in her chair waiting for launch.

   Which of the following statements best describes this situation?

   (A) There are no forces acting on the astronaut.
   (B) The resultant force acting on the astronaut is zero.
   (C) The astronaut is at rest in any frame of reference.
   (D) The g force is zero.

2. A space probe is in orbit around a newly discovered planet at a distance of 10,000 km above the planet's surface.
   The planet's diameter is measured as being 14,000 km and the mass of the planet is found to be 1.2×10^{25} kg.



   What is the value of gravitational acceleration in the space probe's orbit?

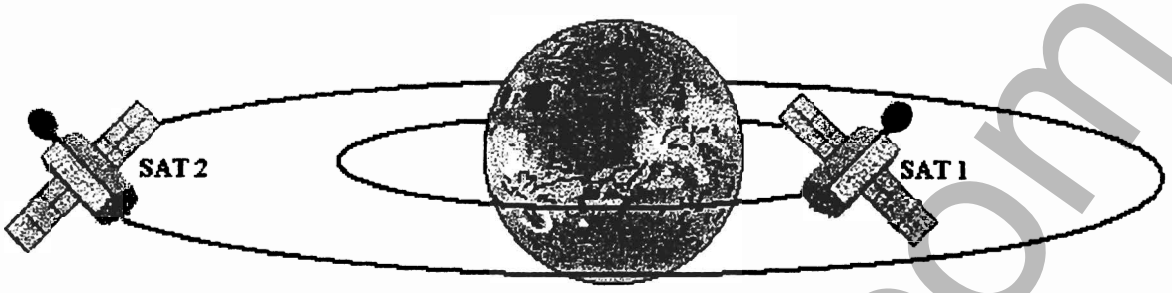
   (A) 16.25 ms^{-2}
   (B) 8.00 ms^{-2}
   (C) 2.75 ms^{-2}
   (D) 1.40 ms^{-2}

3. How does Einstein's theory of General Relativity account for the null result of the Michelson Morley experiment?

   (A) The aether existed.
   (B) The aether wind was too small to measure.
   (C) The speed of light was dependent on the observer.
   (D) The speed of light was independent of the observer.

4. NASA sent two probes, SAT 1 and SAT 2 to planet Cmos. Both probes lie on the same plane as they orbit Cmos. Data from the probes was sent back to NASA and tabulated as shown below.

Planet Cmos



Probe	Radius of Orbit (km)	Period of revolution (hours)
SAT1	6,300	4
SAT 2	7,500	Data not received

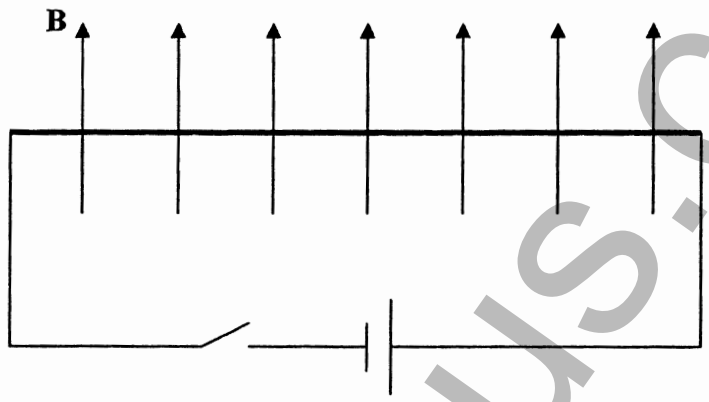
The period of revolution for SAT 2 was not received due to sunspot interference. From the received data, what did NASA scientists calculate the period of revolution for SAT 2 to be?

(A) 4.8 hours
(B) 5.0 hours
(C) 5.2 hours
(D) 5.4 hours

5. Compared to an identical clock back on Earth, which statement about a clock carried by astronauts in a space ship is true?

(A) The clock will run faster the faster the speed of the space ship.
(B) The clock will run slower the faster the speed of the space ship.
(C) The clock will run at the same rate regardless of the speed of the ship.
(D) The speed of the clock will depend on Earth's rotational speed.

6. A conductor, which is in a magnetic field, is connected to a power source through a switch as shown below.



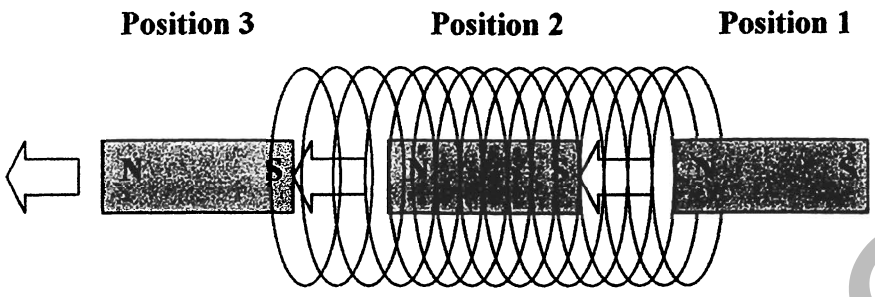
When the switch is closed, what will be the direction of the force on the conductor?

(A) into the page
(B) down the page
(C) up the page
(D) out of the page

7. A direct current electric motor has a square armature of 500 turns. Which statement below about this motor is correct?

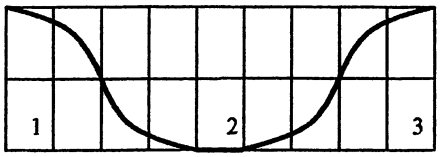
(A) The slip rings reverse the current flow in the armature every half turn.
(B) The torque on the armature is a maximum when the plane of the armature is at right angles to the magnetic field.
(C) The torque on the armature is a maximum when the plane of the armature is parallel to the magnetic field.
(D) The back emf causes the net force on the armature to be zero.

8. A bar magnet is moved at constant speed into, all the way through, and out the other side of a solenoid.

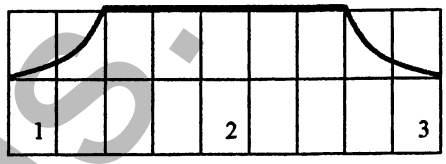


Which of the following graphs best represents how the emf generated in the coil changes as the bar magnet moves from position 1, through 2, to 3?

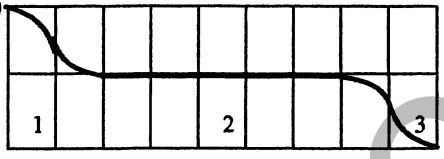
(A)



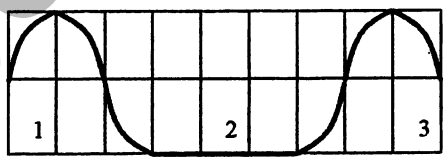
(B)



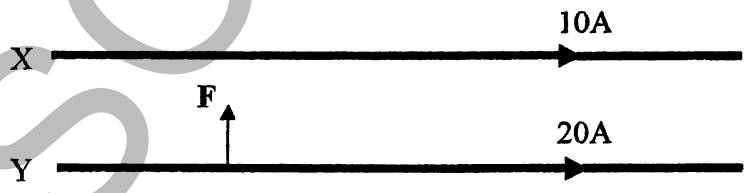
(C)



(D)



9. Two conductors labelled X and Y are carrying currents of 10A and 20A as shown. The force experienced by conductor Y is F Newtons.



The force experienced by conductor X would be:

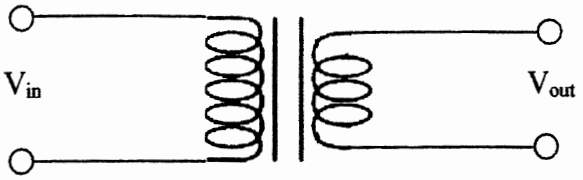
(A) F ↑

(B) F ↓

C) 2F ↑

D) 2F ↓

10. This question refers to the diagram below.



The above transformer is being used in a circuit where the input voltage is 240V, with a current of 0.2A. Which combination of output voltage and current is supplied by the secondary coil?

(A) 24 V, 2.0 A
(B) 24 V, 0.02 A
(C) 2400 V, 2.0 A
(D) 2400 V, 0.02 A

11. A student observes the different striation patterns in a set of discharge tubes. The pressures in the tubes are different but are not in any particular order. He records the following observations:

Tube 1: There is no glow, only the glass at the anode end of the tube glows green.
Tube 2: The column is broken up into striations, separated from the glow at the cathode by a dark space.
Tube 3: The tube is filled with a purple glow.
Tube 4: The glow at the cathode is slightly separated from the cathode leaving a dark space next to the cathode.

What is the order of the discharge tubes from greatest to least pressure?

(A) Tube 1, Tube 2, Tube 4, Tube 3
(B) Tube 3, Tube 2, Tube 4, Tube 1
(C) Tube 1, Tube 4, Tube 2, Tube 3
(D) Tube 3, Tube 4, Tube 2, Tube 1

12. The wavelength of the radio waves being broadcast from radio station 2MMM in Sydney is 2.86 m.

What is the energy of a photon of that wave?

(A) 6.95×10^{-26} J
(B) 1.895×10^{-33} J
(C) 1.988×10^{-25} J
(D) 2.32×10^{-34} J

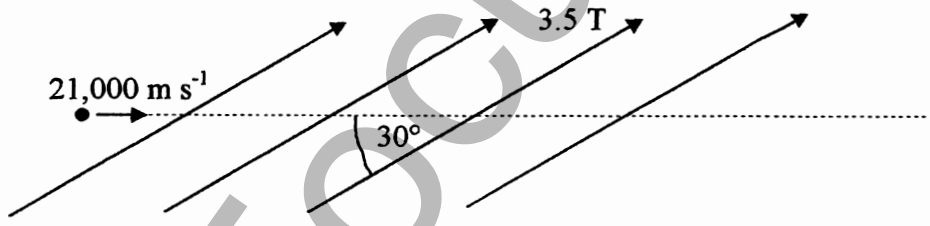
13. Why was germanium widely used as a semi-conducting material when scientists knew that silicon was more useful?

(A) It could be more easily doped with impurities.
(B) It was more readily available.
(C) It was far less expensive to obtain.
(D) It could be produced with the necessary purity.

14. Which area of physics knowledge was used by the Braggs in their work on crystal lattices?

(A) interference of waves
(B) the particle nature of light
(C) the law of refraction
(D) deflection of electrons in an electric field

15. An electron moving at 21 000 ms^{-1} enters a magnetic field of 3.5 tesla at an angle of 30° as shown in the diagram.



What is the force on the electron?

(A) 1.2×10^{-14} newtons into the page
(B) 1.2×10^{-14} newtons out of the page
(C) 5.9×10^{-15} newtons out of the page
(D) 5.9×10^{-15} newtons into the page

Section I - continued

Part B

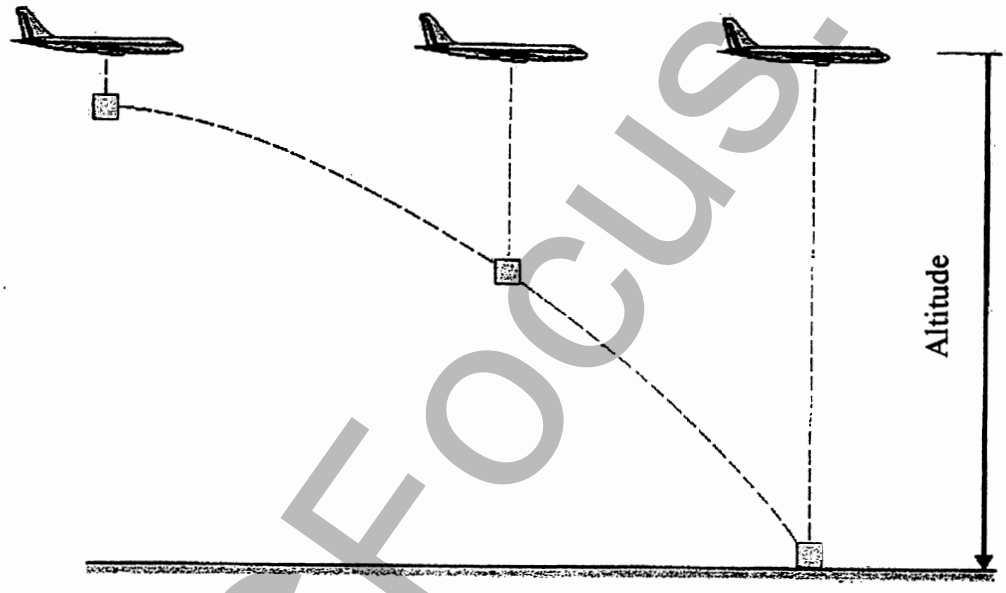
Total marks (60)
Attempt questions 16 - 27
Allow about 1 hour 45 minutes for this part

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Question 16 (4 marks) **Marks**

A plane drops emergency food rations to the Red Cross in Central Africa. The plane is travelling at 200 km/hour and keeping a constant altitude above the flat plains below.



The person dropping the rations measures the time of fall to be 15 seconds to impact.

(a) Calculate the final vertical velocity of the food rations just before impact. **2**

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(b) Calculate the plane's altitude. **2**

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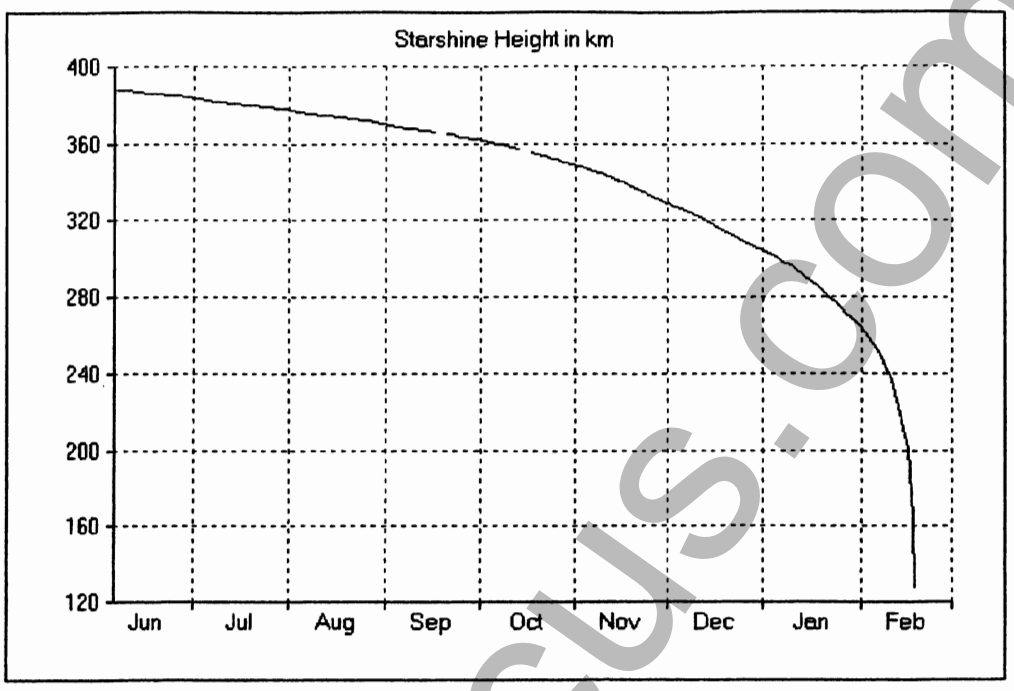
STUDENT NUMBER/NAME: .....

Question 17 (3 marks) **Marks**

The graph below shows the orbital decay of the satellite, Starshine. The height is plotted against the date. The altitude in early June was 385 km above the Earth's surface.



(a) Describe the term "orbital decay". **1**

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(b) List TWO factors causing the changing rate of orbital decay of Starshine from June to February. **2**

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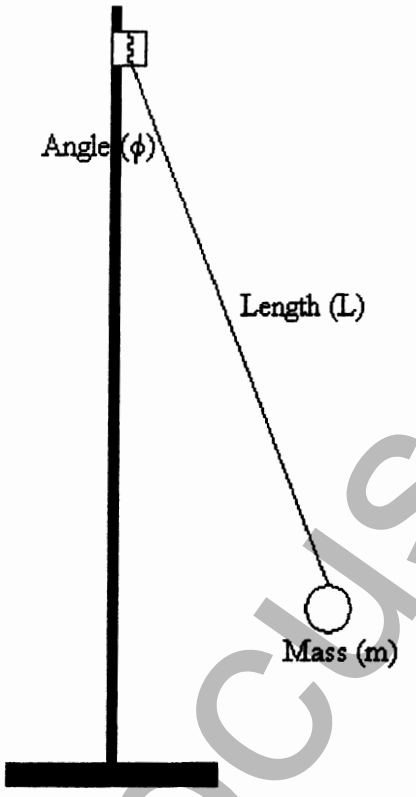
Question 18 (6 marks)

Two students carried out an investigation to determine the acceleration due to gravity using pendulum motion.

They set up the equipment as shown in the diagram below:



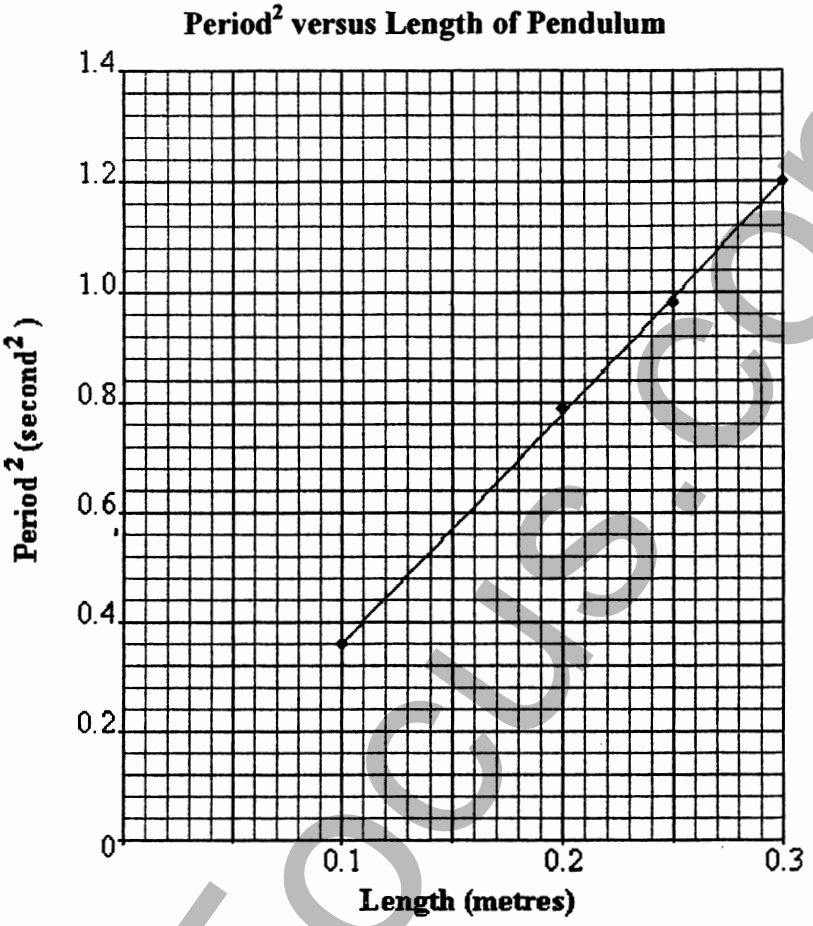
Their results allowed them to construct the following table. One value was omitted.

Length - L (metres)	Period^2 (T^2) (seconds^2)
0.10	0.36
0.15	Not calculated
0.20	0.79
0.25	0.97
0.30	1.2

Question 18 continues on page 12

Question 18 (continued) **Marks**

The results from the table were used to plot a graph of period^2 against length as shown below:



(a) State the value and units for the missing data. **1**

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(b) Given that the period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, describe how the value of acceleration due to gravity can be determined from the slope of the graph. **2**

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Question 18 continues on page 13

Question 18 (continued) **Marks**

(c) Calculate the value of acceleration due to gravity in this situation. **2**

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(d) The average value for acceleration due to gravity is 9.8 ms^{-2}. Assuming that the results recorded and the measurements taken were accurate, and assuming that the density of the earth is uniform, what does your answer in (c) indicate with reference to the distance from the Earth's centre of mass? **1**

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Question 19 (7 marks)

(a) Distinguish between inertial and non-inertial frames of reference. **2**

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(b) Calculate the mass of a proton when it is travelling at 75% the speed of light. **2**

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(c) Einstein's Theory of Special Relativity made predictions about time, length and mass measurements for objects travelling at speeds approaching the speed of light. Discuss the experimental evidence for ONE of these predictions. **3**

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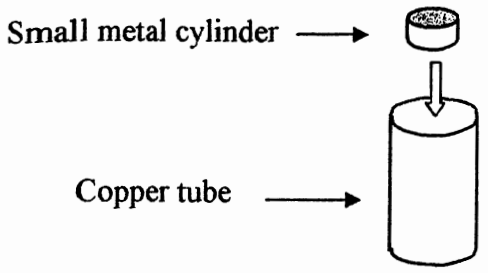
Question 20 (5 marks) **Marks**

When a small metal cylinder is dropped into one end of the copper tube shown below, it falls freely under the action of gravity.



Yet a small magnet of identical dimensions takes much longer to fall through the tube.

(a) Explain this observation. **3**

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(b) Outline how a similar phenomenon is used in certain braking mechanisms. **2**

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Question 21 (6 marks) **Marks**

Discuss the competition between Westinghouse and Edison for the contracts to provide electric power to American cities in the late 1800s. **6**

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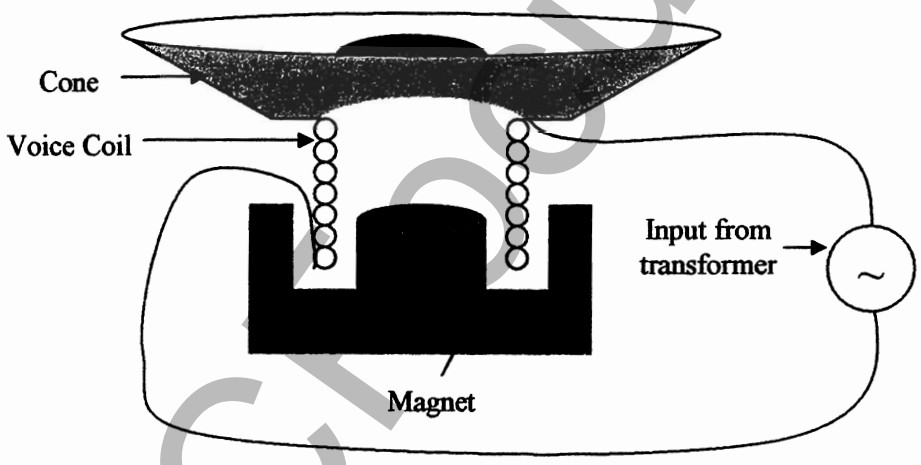
Question 22 (4 marks)

The diagram below shows a simplified cross-section of a loudspeaker.



(a) Using principles of physics, explain how the cone of this device is made to vibrate. **2**

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(b) Discuss how ONE other electrical device makes use of the same physics principle that is involved in the operation of the loudspeaker. **2**

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STUDENT NUMBER/NAME: .....

Question 23 (5 marks) **Marks**

(a) Excess heat in transformers can be a major problem. What causes this generation of heat and how is the problem reduced? **2**

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(b) Discuss why some electrical appliances in the home that are connected to the mains domestic supply use a transformer. **3**

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Question 24 (4 marks)

Cathode rays were first investigated over 150 years ago. Experiments, since that time, have indicated that cathode rays have the following properties:

- Cathode rays travel in straight lines.
- Cathode rays are charged particles.
- The charge on the cathode rays is negative.
- Cathode rays are able to transfer energy and do work.

(a) For any TWO of these properties, describe how they can be demonstrated in the laboratory using discharge tubes. **2**

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(b) Justify the conclusion of the demonstrations you chose in (a). **2**

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Question 25 (5 marks)

Outline Einstein's explanation of the photoelectric effect. **5**

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Question 26 (6 marks) **Marks**

This question refers to the electrical resistivity of different materials at room temperature.

Material	Approximate resistivity (ohm centimetres)
Diamond	10^{14}
Glass	10^{10}
Pure silicon	10^{5}
Doped silicon	10^{3}
Pure germanium	10^{2}
Doped germanium	10^{0}
Copper	10^{-6}

Both silicon and germanium are semiconductor materials.

(a) Distinguish between pure silicon and doped silicon. **2**

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(b) By referring to the table, explain how doping a semiconductor can change its electrical properties. **4**

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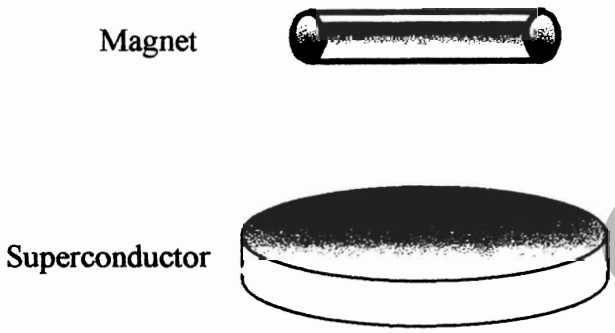
STUDENT NUMBER/NAME: .....

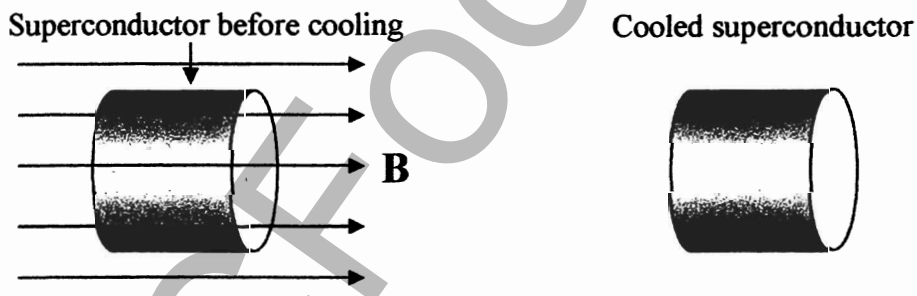
Question 27 (5 marks) **Marks**

(a) The diagram below represents a magnetic levitation situation that occurs when the superconducting material is below its critical temperature. Draw the forces acting on the magnet, and state their relative magnitudes and directions. **2**



(b) In 1933, two German physicists, W Meissner and R Oschenfeld, found that after a superconducting material is cooled below its critical temperature, and a magnetic field is applied, the material expels all magnetic flux from its interior.

The diagram on the left below represents a superconducting material in the presence of an applied magnetic field before it is cooled below its critical temperature.



(i) On the diagram on the right above, draw lines to represent the expulsion of an applied magnetic field from the superconductor after it has been cooled below its critical temperature. **1**

(ii) Explain the expulsion of the applied magnetic field from inside the superconductor. **2**

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Section II

Total marks (25)

Attempt ONE question from Questions 28 – 32
Allow about 45 minutes for this part

Answer the question in a separate writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations

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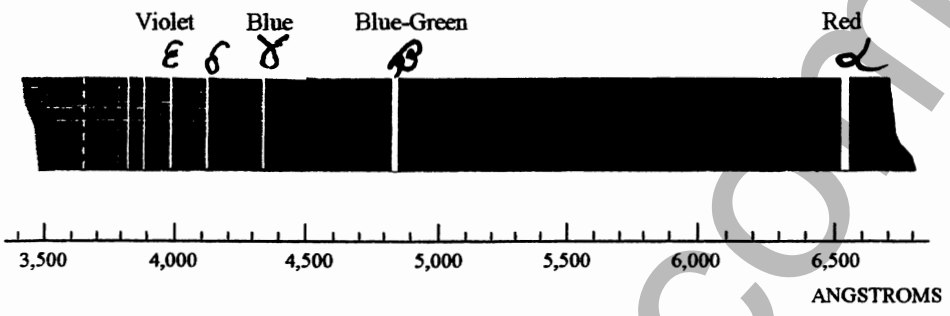
Marks

Question 31 From Quanta to Quarks (25 marks)

(a) (i) Describe a first hand laboratory investigation used to observe the visible spectrum of the hydrogen atom. **2**

(ii) The diagram represents the visible spectrum of the hydrogen atom.



Calculate the wavelength of the blue/green line. **2**

(iii) Predict the type of electromagnetic energy emitted by electrons jumping from higher energy levels into the third energy level. Justify your answer. **3**

(b) (i) Define diffraction. **1**

(ii) Describe the impact of de Broglie's proposal about electrons presented in his doctoral thesis. **3**

(c) (i) Explain the importance of moderators in nuclear reactors using a uranium fuel. **2**

(ii) Modern accelerators are very expensive to build and run. Assess their usefulness to society. **4**

(d) A famous scientist once stated that he was able to make scientific advances because he "stood on the shoulders of giants".

Discuss this statement with reference to the contributions that Bohr, Chadwick and Fermi made to our understanding of the atom. **8**

End of Question 31