Physics

Trial Examination

HSC Course

2008

General Instructions

Reading time - *5 minutes*

Working time - *2 hours 15 minutes*

Board-approved calculators may be used.

Write using blue or black pen.

Draw diagrams using pencil.

Formulae sheets and a Periodic Table are provided with this question paper.

Answer all questions in the spaces provided.

Total Marks (75)

This paper has one section with two parts:

Section I

Total marks (75)

Part A

15 marks – attempt questions 1 - 15

Part B

60 marks – attempt questions 16 - 27

Candidate Number: ……

Section I

Part A

Multiple Choice Answers

For questions 1 to 15 place a cross (X) in the column which matches your choice.

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

Marking Summary

Space	1 – 5	……. / 5	
	16 – 19	……. / 20	*Space Total* ……. / 25
Motors	6 – 10	……. / 5	
	20 – 23	……. / 20	*Motors Total* ……. / 25
Ideas	11 – 15	……. / 5	
	24 – 27	……. / 20	*Ideas Total* ……. / 25
			Final Mark ……. / 75

Section I

75 marks

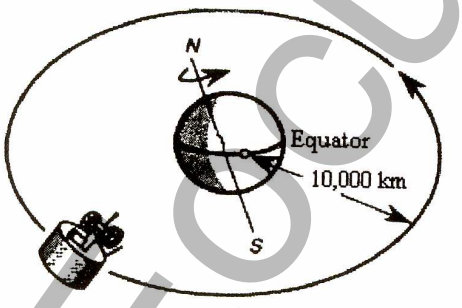
Part A – 15 marks

Attempt Questions 1 – 15

Allow about 30 minutes for this part

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.

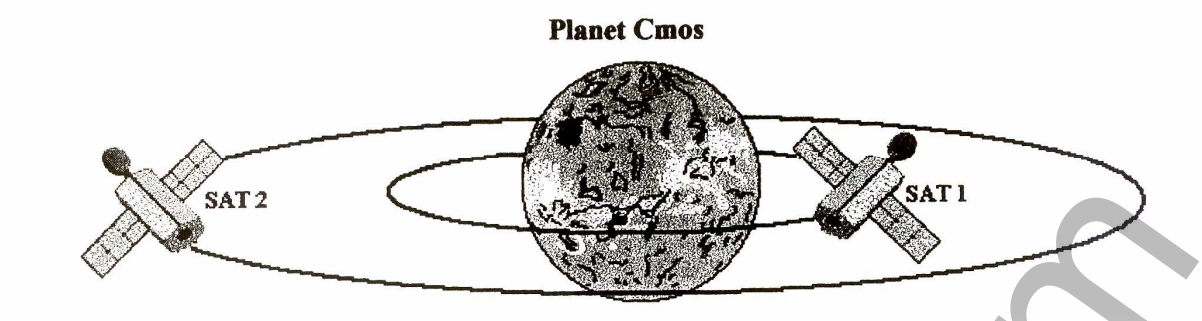
2. A space probe is in orbit around a newly discovered planet at a distance of 10 000 km above the planet's surface.
   The planet's diameter is measured as being 14 000 km and the mass of the planet is 1.2×10^{25} kg.



   The value of the gravitational acceleration in the space probe's orbit is (in ms^{-2})
   A. 16.25 B. 8.00 C. 2.75 D. 1.40

3. Einstein's theory of General Relativity accounts for the null result of the Michelson Morley experiment by stating
   A. the aether wind existed
   B. the aether wind speed was too small to be measured
   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.



Probe	Radius of orbit (km)	Period of Revolution (hours)
SAT 1	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, NASA scientists calculated the period of revolution of SAT 2 to be (in hours)

A. 4.8 B. 5.0 C. 5.2 D. 5.4

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

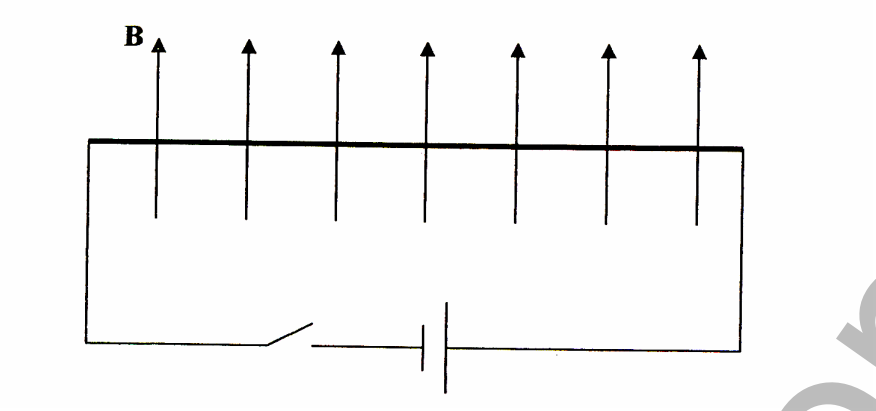
A. The clock will run faster, the faster the speed of the space ship.

B. The clock will run slower, the faster the speed of the space ship.

C. The clock will run at the same speed regardless of the speed of the space ship.

D. The speed of the clock will depend on the 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.



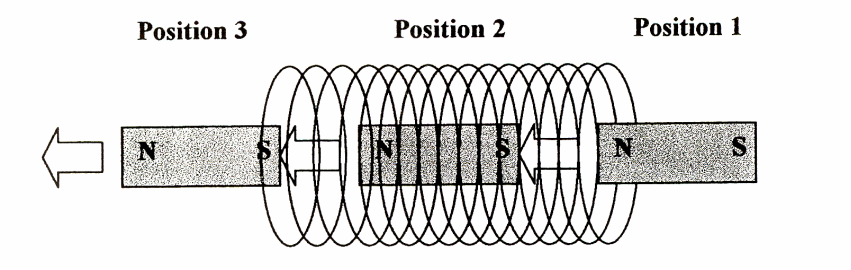
When the switch is closed, the direction of the force on the conductor will be

A. into the page
B. down the page
C. up the page
D. out of the page

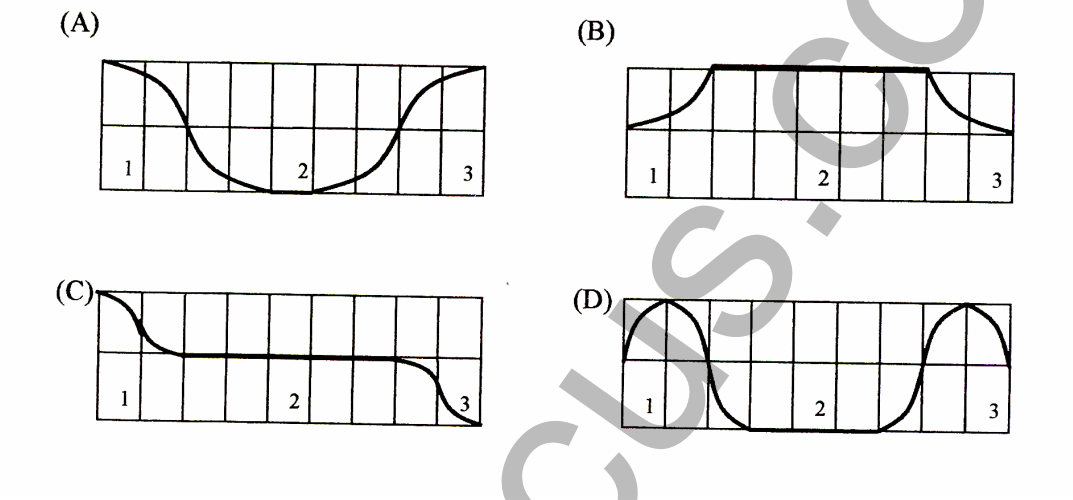
7. A direct current electric motor has a square armature of 500 turns. The correct statement about the operation of this motor is

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

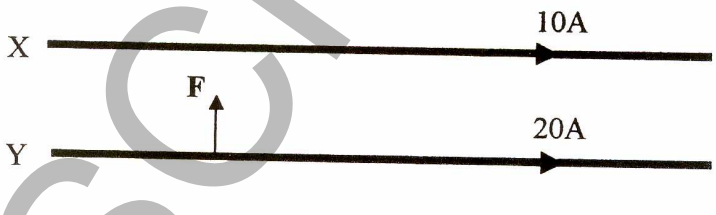
8. A bar magnet is moved at constant speed into, all the way through, and out the other end of a solenoid.



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?



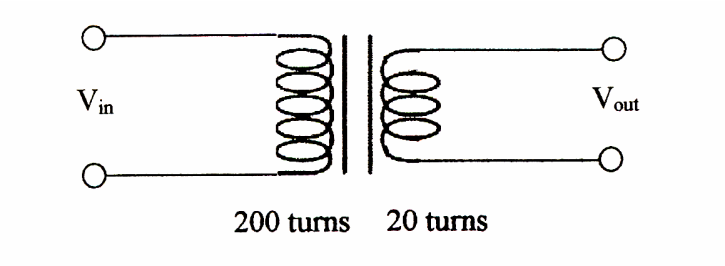
9. Two conductors labelled X and Y are carrying currents of 10 A and 20 A as shown. The magnitude of the force experienced by conductor Y is F newton.



The force per metre experienced by conductor X is

A. F ↑
B. F ↓
C. 2F ↑
D. 2F ↓

10. This question refers to the diagram below.



The transformer in the diagram is being used in a circuit where the input voltage is 240 V, with a current of 0.2 A. 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. In the cathode ray tube of a conventional TV display or oscilloscope, which components focus the beam, control brightness and accelerate electrons along the tube?

A. Heating filament
B. Electrodes in the electron gun
C. Deflection plates or coils
D. Fluorescent screen

12. The wavelength of waves being broadcast from radio station 2MMM in Sydney is 2.86 m.
The energy of a photon of that wave (in joules) is:

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

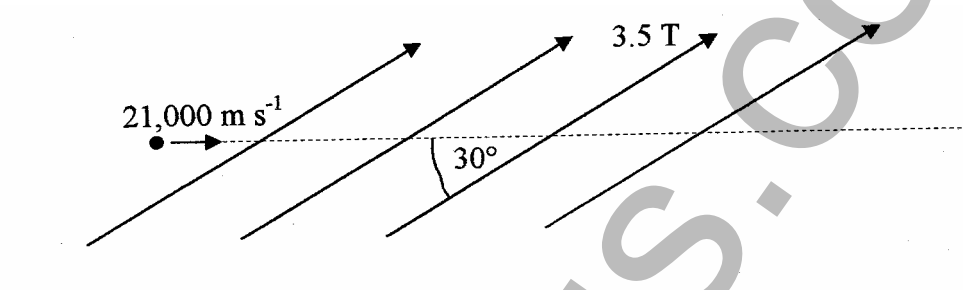
13. Germanium was widely used as a semi-conducting material when scientists knew that silicon was more useful because germanium:

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

14. When subjected to an electric field, the electrons in the valence band of a conductor

A. require an additional energy input to move to the conduction band
B. require no additional energy and move freely in the direction of the electric field
C. are free to maintain a random, cloud-like motion in all directions
D. are derandomised and move freely in the direction opposite to the electric field

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



The force on the electron is:

A. 1.2 x 10^{-14} N into the page
B. 1.2 x 10^{-14} N out of the page
C. 5.9 x 10^{-15} N into the page
D. 5.9 x 10^{-15} N out of the page

Section I

Part B

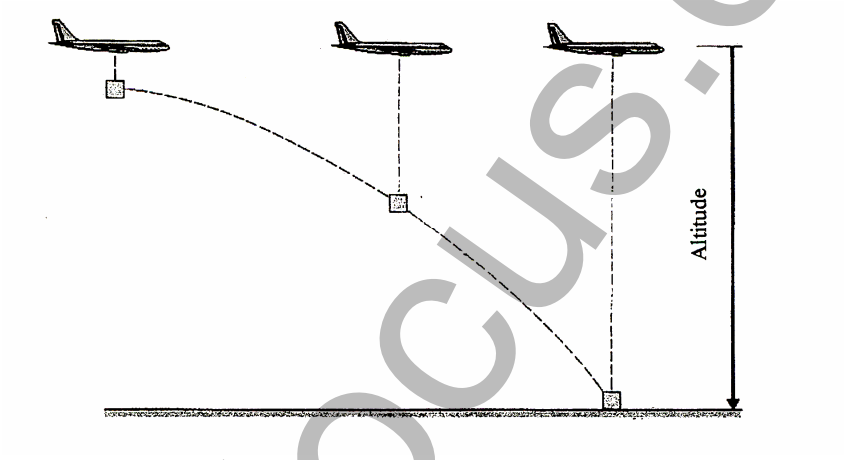
Total marks (60)

Attempt questions 16 – 27

Allow about 1 hour 45 minutes for this part

Question 16 (4 marks)

A plane drops emergency food rations to the Red Cross in Central Africa. The plane is flying at 216 kmph and keeping a constant altitude above the 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. **1**

.....

.....

(b) Calculate the plane's altitude. **1**

.....

.....

(c) Calculate the horizontal distance travelled by the rations during the fall. **1**

.....

.....

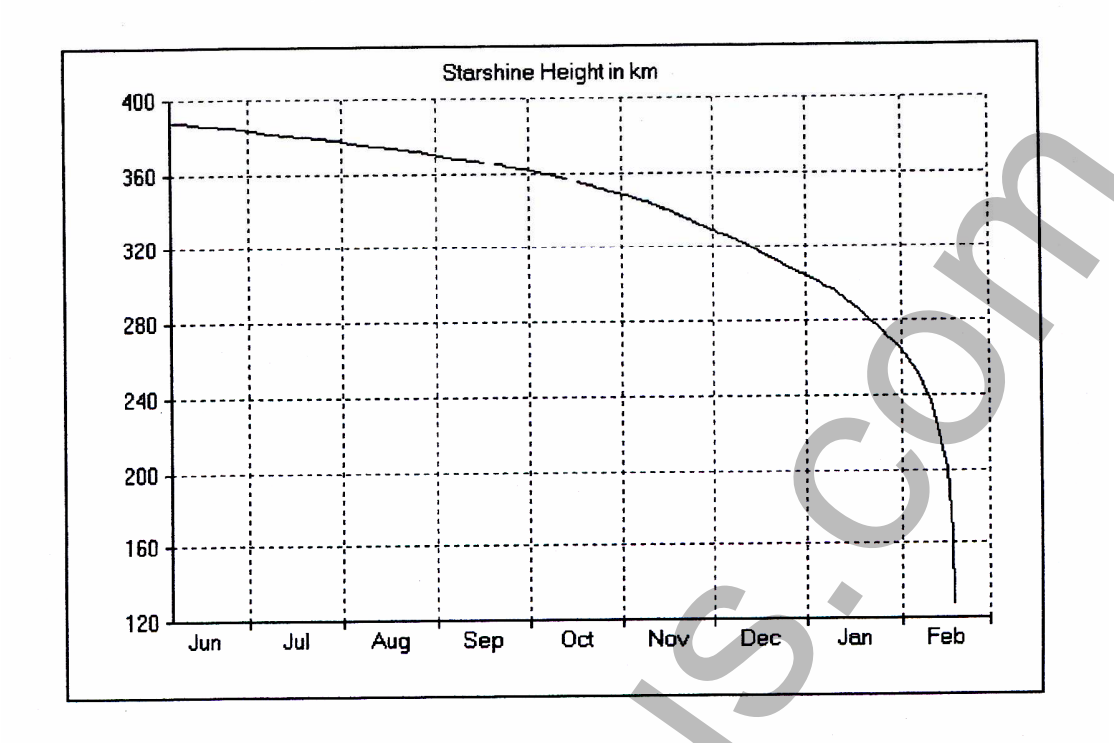
(d) Compare the horizontal distance travelled by the plane and the rations during the fall. Include a reference to any assumptions made. **1**

.....

.....

Question 17 (3 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) Define the term "orbital decay". **1**

……

……

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

……

……

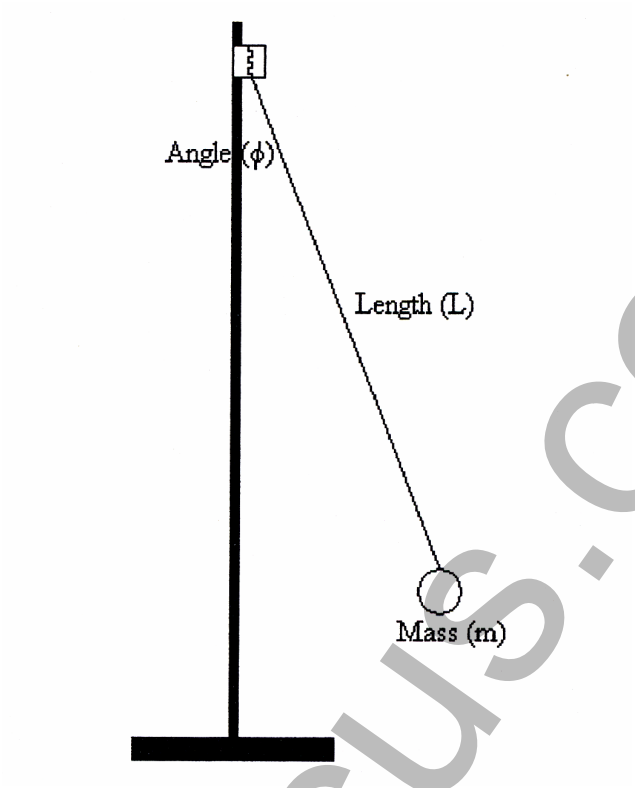
……

……

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.

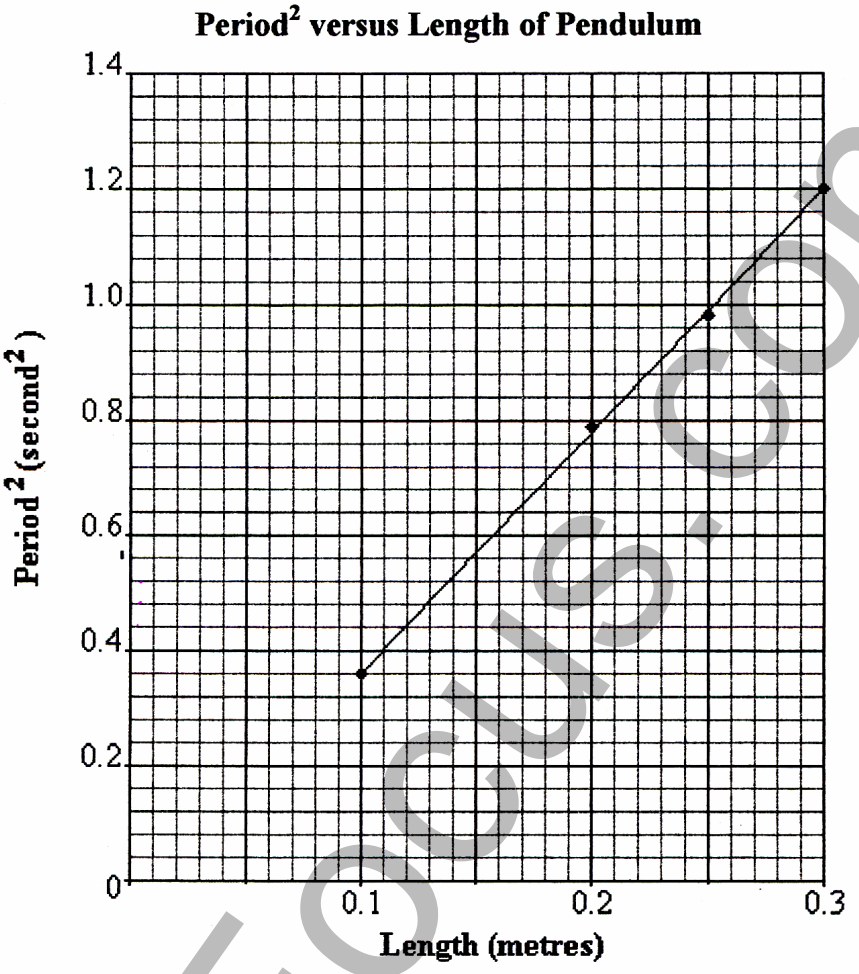
Length (L) (metres)	**Period^2 (T^2) (seconds^2)**
0.10	0.36
0.15	Not calculated
0.20	0.79
0.20	0.97
0.30	1.2

Students carried out a practical to determine how the length of a pendulum influences the period of the pendulum's motion. As part of their report they produced the following graph.

Question 18 continues on next page.

Question 18 (continued)

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**

……

(b) Given that the formula for the period of a pendulum is

$T = 2\pi\sqrt{L / g}$ where T is the period; L is the length; g is acceleration due to gravity; describe how the value of acceleration due to gravity can be determined from the gradient of the graph. **2**

……

……

……

……

Question 18 (continued)

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

.....

.....

.....

.....

(d) Given that the average value of acceleration due to gravity is 9.80 ms^{-2}, and that the students used accurate and reliable methods to obtain their data, suggest a reason why the students' value for the acceleration due to gravity is NOT 9.80 ms^{-2}. **1**

.....

.....

Question 19 (7 marks)

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

.....

.....

.....

.....

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

.....

.....

.....

.....

(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**

.....

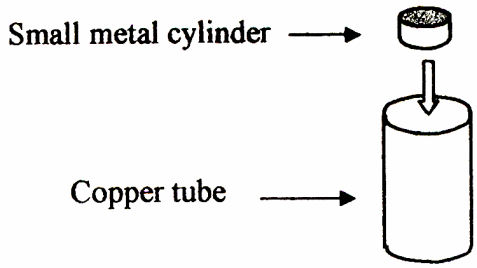
.....

.....

.....

Question 20 (5 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**

.....

.....

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

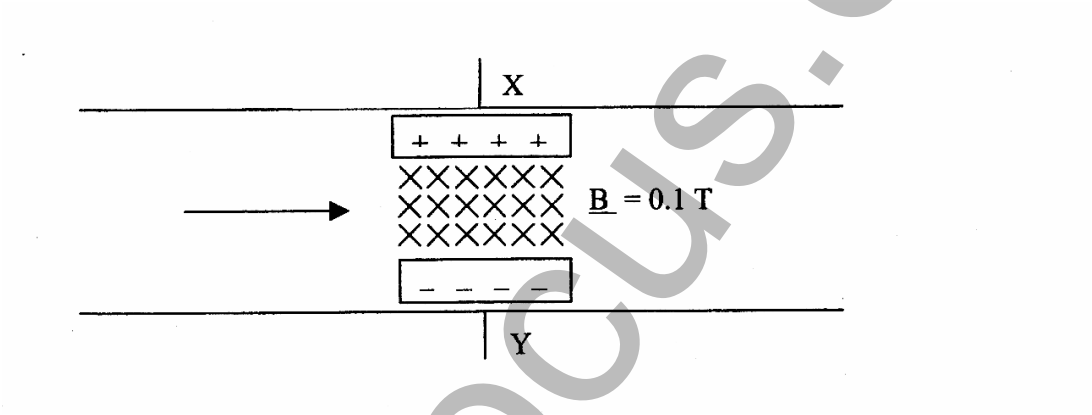
.....

Question 21 (6 marks)

(a) Outline Thomson's experiment to measure the charge / mass ratio of an electron. **3**

……
……
……
……
……
……

(b) An electron is accelerated to a speed of 1×10^4 ms^{-1} inside a cathode ray tube. The electron enters a region of crossed magnetic field of 0.1 T and electric fields as shown in the diagram below.

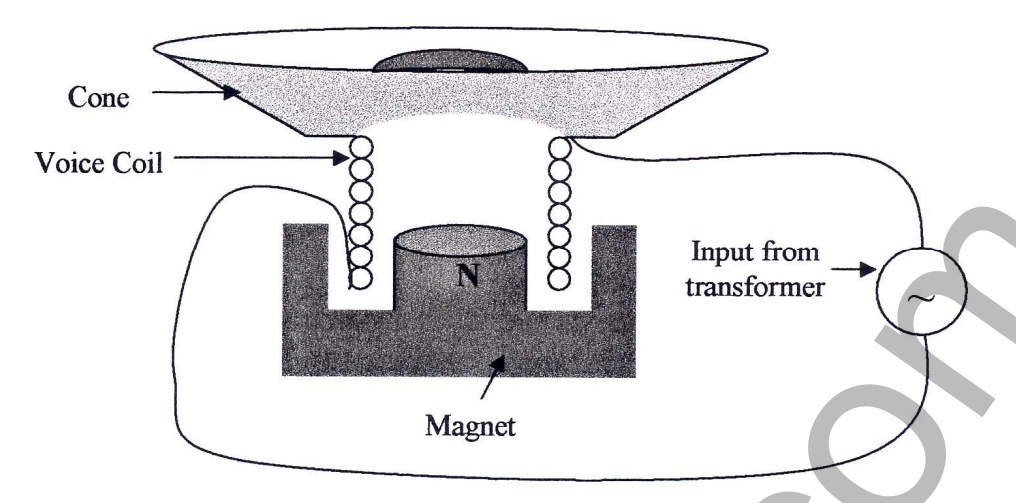


Calculate the potential difference across the parallel plates, XY, required to allow the electron to pass undeflected through the electric and magnetic fields. The distance between the plates is 10 cm. **3**

……
……
……
……
……
……
……
……
……

Question 22 (4 marks)

The diagram below shows a simplified section of a loudspeaker.



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

.....

.....

.....

.....

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

.....

.....

.....

.....

Question 23 (5 marks)

(a) Excess heat in transformers can be a major problem. Describe the cause of this excess heat and suggest a method for minimising the problem. **2**

.....

.....

.....

.....

(b) Discuss why some electrical devices in the home that are connected to the mains domestic power supply make use of a built in transformer. **3**

.....

.....

.....

.....

.....

.....

Question 24 (4 marks)

(a) 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**

.....

.....

.....

.....

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

.....

.....

.....

.....

Question 25 (5 marks)

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 26 (6 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**

.....

.....

.....

.....

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

.....

.....

.....

.....

.....

.....

.....

.....

Question 27 (5 marks)

Discuss how shortcomings in available communication technology led to the invention of the transistor. **5**