2006

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 at the back of this paper
- Write your student number and/or name at the top of every page

Section I (Pages 3 – 16)
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 16-29
Allow about 1 hour 45 minutes for this part

Section II (Pages 17 – ??)
Total marks (25)
Attempt ONE question from Questions 30-34
Allow about 45 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME: .....

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1. Jupiter has a gravitational acceleration equal to 2.53 that of Earth. An object on Jupiter weighs 253 N. What would be its weight on Earth?

(A) 9.8 N
(B) 98 N
(C) 100 N
(D) 980 N

2. An object is in a stable orbit around the earth. Which statement about the force acting on this object is correct?

(A) Both inertial and gravitational forces act on the object.
(B) Inertial force is the only force acting on the object.
(C) Gravitational force is the only force acting on the object.
(D) There is no net force acting on the object.

3. Two satellites are orbiting a planet. Satellite X is at an altitude of 3000 km and satellite Y is at an altitude of 6000 km. Which statement about X and Y is correct?

(A) X must have a smaller mass than Y.
(B) The frequency of Y will be smaller than that of X.
(C) X will have a smaller orbital speed than Y.
(D) The period of Y's orbit will be smaller than that of X.

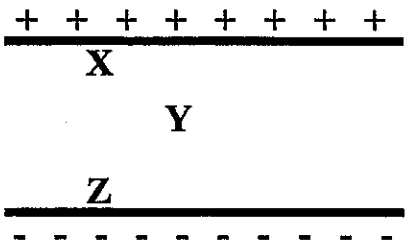
4. In his first thought experiment, Einstein, imagining he was inside a train travelling at the speed of light, concluded that he would see his reflection in a mirror he was holding in front of him. What caused him to make this conclusion?

(A) He knew that the mirror was at rest relative to him.
(B) This conclusion was consistent with the law of simultaneity.
(C) This had to be the situation if the principle of relativity was to hold true.
(D) This conclusion would make the existence of the aether unnecessary.

5. For most experimental purposes we accept the Earth as an inertial frame of reference. However, this is incorrect. Why?

(A) The velocity of the earth is constantly changing.
(B) The Earth is moving rapidly through space.
(C) The net force acting on the earth is zero.
(D) Gravitational and centripetal forces acting on the Earth cancel each other.

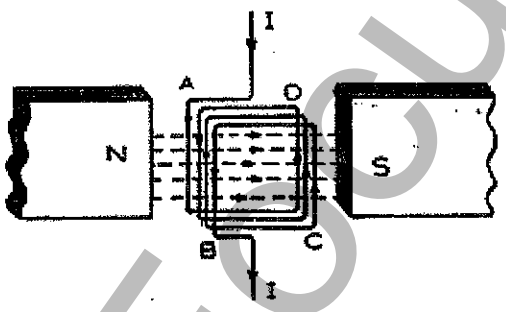
6. Two parallel metal plates carrying opposite charges are shown below.



Which alternative below correctly describes the electric field between the plates?

(A) The electric field at X is stronger than the electric fields at Y and Z.
(B) The electric field at X is stronger than the electric field at Y but the same as at Z.
(C) The electric field at X is weaker that the electric field at Z.
(D) The electric fields at X, Y and Z are all the same strength.

7. A simple motor has a rectangular coil ABCD. The side AB measures 0.14 m and the side BC measures 0.10 m. In a magnetic field of 0.5 T, the coil experiences a torque of 0.16 Nm.



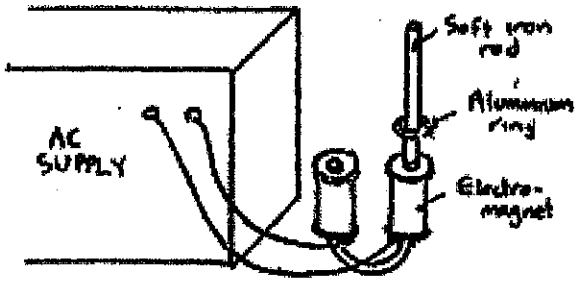
What is the magnitude of the force on side AB of the coil?

(A) 1.1×10^{-3}N
(B) 3.3×10^{-3}N
(C) 1.6N
(D) 3.2N

8. Which of the following forms of energy is always produced whenever electricity is converted for use in the home or industry?

(A) Heat
(B) Light
(C) Sound
(D) Electromagnetic

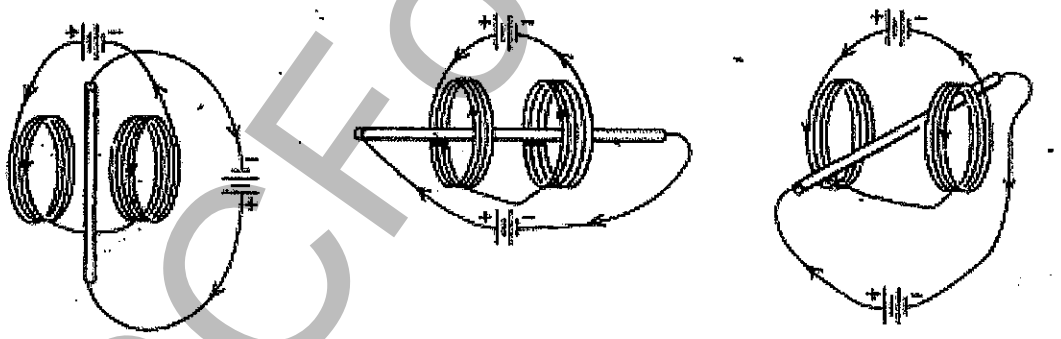
9. A student made the sketch below of an experiment demonstrated by his teacher. It appears to show a metal ring suspended on a long soft iron rod core of an electromagnet.



Which statement is the best explanation of the record made by the student?

(A) The student's diagram has to be incorrect as aluminium rings cannot be made to stay suspended.
(B) The aluminium ring is magnetic and therefore repelled by the magnetic field of the electromagnet.
(C) The aluminium ring is a superconductor and is demonstrating magnetic levitation.
(D) There are eddy currents set up in the aluminium ring and their magnetic field results in repulsion by the magnetic field of the electromagnet.

10. A conductor carrying a current is placed in various orientations between two solenoids, also carrying currents as shown.



X **Y** **Z**

In which of the diagrams will the conducting rod experience a force?

(A) In X and Y only
(B) In X and Z only
(C) In Y and Z only
(D) In Y only

11. Light of a frequency greater than the threshold frequency is incident on the surface of a piece of metal. Which of the following changes would be observed if the wavelength and intensity of the incident light are altered?

(A) The kinetic energy of the ejected electrons is increased if either the frequency or the intensity of the incident light is increased.
(B) The kinetic energy of the ejected electrons is increased if the frequency of the incident light is increased but not changed if the intensity of the light is altered.
(C) The kinetic energy of the ejected electrons is decreased if either the frequency or the intensity of the incident light is increased
(D) The kinetic energy of the ejected electrons is increased if the intensity of the incident light is increased but not changed if the frequency of the light is altered.

12. Two parallel conductors with identical currents into the page are represented below.

• A

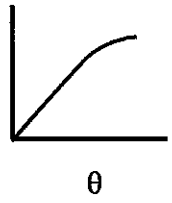
What is the direction of the magnetic field at point A?

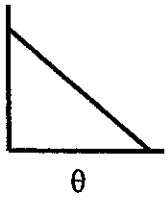
(A) ←
(B) ↑
(C) →
(D) ↓

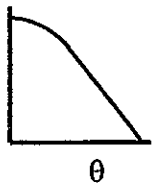
13. Which of the following items would be used inside a cathode ray tube to provide evidence for the particle nature of cathode rays?

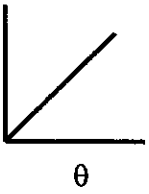
(A) Parallel charged plates
(B) A maltese cross
(C) Fluorescent display screen
(D) Glass paddle wheel

14. A negative charge moving at a constant speed enters a magnetic field **B** at an angle θ. Which alternative below shows how the force on the charge varies for values of θ between 0° and 90°?

(A) 

(B) 

(C) 

(D) 

15. Superconductivity has been demonstrated in particular metals, metal alloys and compounds. Each group of chemicals has critical temperatures in a different range.

Which alternative has the correct order for the critical temperatures of the group, from highest to lowest?

(A) metals, metal alloys, compounds
(B) compounds, metal alloys, metals
(C) compounds, metals, metal alloys
(D) metal alloys, metals, compounds

Section I - continued

Part B

Total marks (60)
Attempt questions 16 – 26
Allow about 1 hour 45 minutes for this part

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Marks

Question 16 (3 marks)

When the orbit of a satellite decays, its gravitational potential energy decreases. Explain this in terms of the Law of Conservation of Energy. **3**

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Question 17 (3 marks)

(a) Explain the concept of *g-force*. **2**

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(b) Recall one strategy used during rocket takeoff to minimise the g-force acting on astronauts. **1**

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STUDENT NUMBER/NAME: .....

Marks

Question 18 (4 marks)

A satellite has a mass of 250 kg and orbits the Earth at an altitude of 3000 km. Earth's equatorial diameter is 12 756 km.

(a) Determine its orbital speed. **2**

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(b) What would be the orbital speed of a 500 kg satellite in an identical orbit? **1**

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(c) Justify your answer to (b) **1**

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Question 19 (3 marks)

Explain the idea of the relativity of simultaneity, giving an example to support your answer. **3**

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Marks

Question 20 (4 marks)

(a) Why did early scientists feel the need for the existence of the aether? **1**

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(b) The Michelson-Morley experiment will always have a null result, whether or not the aether exists. Explain. **3**

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.Question 21 (3 marks)

Discuss the implications of time dilation and mass increase for space travel. **3**

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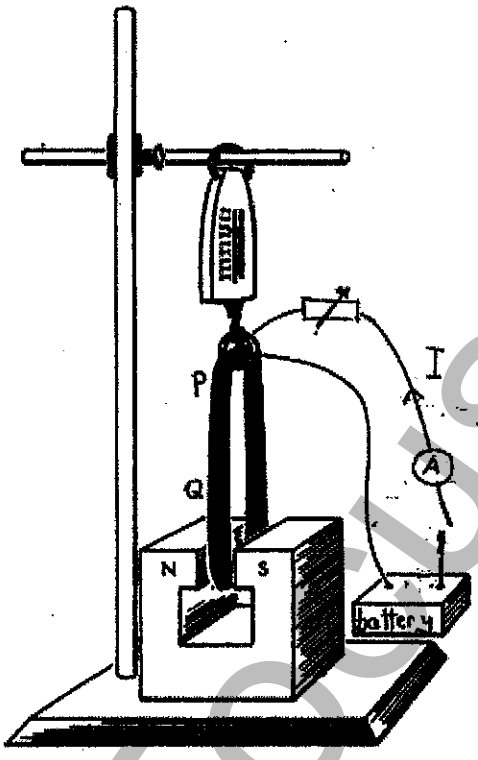
Marks

Question 22 (5 marks)

Asked to construct a model electrical meter, a group of students used a spring balance and a coil of wire suspended between the poles of a horseshoe magnet as shown below. The coil had 100 turns, weighed 1.6 N and was 20 cm high and 5 cm wide. The poles of the magnet were wider than the coil and the spring balance had a scale of 0 to 5 newtons. A variable resistor and an ammeter were included in the circuit for calibration purposes.



(a) When the switch was closed, the spring balance reading increased from 1.6N to 1.9N when a current of 0.20 A flowed through the circuit. What was the magnetic field strength between the poles of the magnet? **1**

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(b) In what direction was the current flow along section PQ of the coil? **1**

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(c) What is the largest current that could be measured using the spring balance? **1**

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Question 22 continues on the next page.

Marks

Question 22 continued.

(d) The students stated that they could calculate the current by substituting the spring balance reading into a simple formula, provided they adjusted the position of the coil. How would they justify this statement? **2**

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Question 23 (5 marks)

In the 1880's Westinghouse and Edison competed to supply electricity to cities in America until finally it was decided that alternating current provided the most efficient electricity supply.

Discuss the reasons for the efficiency of alternating current in both its production and transmission when compared to direct current. **5**

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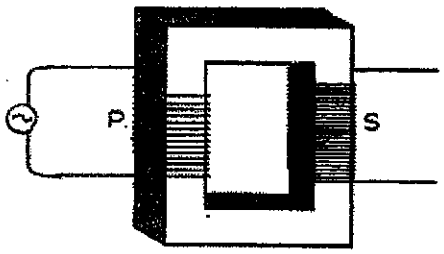
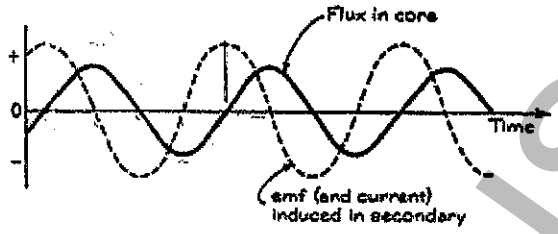
Marks

Question 24 (4 marks)

The transformer below has 14 turns in the primary coil and 28 turns in its secondary coil. The graph shows how the flux in the iron core of the transformer is related to the emf and current induced in the secondary coil.





(a) If the voltage across the secondary coil is 60 volts, what is the input voltage? **1**

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(b) The graph shows that the emf across the secondary coil is a maximum when the flux through the iron core is zero. Explain this relationship. **1**

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(c) Explain how the heating problems of transformer cores are overcome. **2**

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Marks

Question 25 (6 marks)

Induction has many applications, being used in a number of electrical devices.

(a) Describe an investigation performed in a school laboratory to demonstrate the principle of an AC induction motor. **3**

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(b) Manufacturers state that induction cooktops can only be used with saucepans made from iron and purchasers are advised to use a refrigerator magnet to test their saucepans.

Since currents can be induced in metals other than iron, discuss the reasons for designing induction cooktops that require iron based saucepans. **3**

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Question 26 (4 marks)

Explain the need for both a high voltage and a lower voltage in different parts of a cathode ray oscilloscope. **4**

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Marks

Question 27 (2 marks)

State the advantages of the maglev train and explain the impact of superconductors on the development of this mode of transportation. **2**

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Question 28 (5 marks)

In the1860's, Maxwell developed his famous equations describing the interaction of magnetic and electric fields resulting in the production of self-propagating "electromagnetic" waves.

(a) Outline the experiment performed by Hertz producing electromagnetic waves. (You may use a labelled diagram.) **2**

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(b) Explain how Hertz confirmed that his waves were the electromagnetic waves predicted by Maxwell's equations and that they had the same properties as light. **3**

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Question 28 continues on the next page.

Marks

Question 28 continued.

(c) Evaluate the importance of the experiments performed by Hertz to scientific theory and society. **2**

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Question 29 (7 marks)

Discuss the replacement of thermionic devices by solid state devices and assess the impact of solid state devices on society and modern technologies. **7**

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Question 33 – From Quanta to Quarks (25 marks)

(a) (i) Discuss the structure of the Rutherford model of the atom, explaining how this model differed from the model preceding it. 3

(ii) State one important change to the Rutherford model made by Bohr. 1

(b) State the equation that describes the Balmer series of spectral lines for electron transitions from higher energy levels to the first excited state of hydrogen. 2

(c) Assess the contributions made by Heisenberg and Pauli to the development of atomic theory. 5

(d) Outline how the hydrogen emission spectrum was observed in class. 2

(e) Identify the product in the beta decay of $_{11}Na^{22}$. 2

(f) With the aid of a diagram describe how Chadwick showed the existence of the neutron. 3

(g) Explain the contribution of Balmer, Bohr and de Broglie to our model of the atom 7

End of question 33

End of paper