

2011

Trial HSC Examination

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your student number at the top of each page where relevant
- A formula sheet, data sheet and Periodic Table are provided at the back of this paper

Total marks – 100

This examination has TWO SECTIONS, Section I and Section II

SECTION I – Total marks 75

This section has two parts **Part A** and **Part B**

Part A – 20 marks- Multiple Choice

Attempt Questions 1–20

- Allow about 40 minutes for this part

Part B – 55 marks

Longer Answer Questions

- Attempt Questions 21– 36
- Allow about 90 minutes for this part

SECTION II – Total marks 25

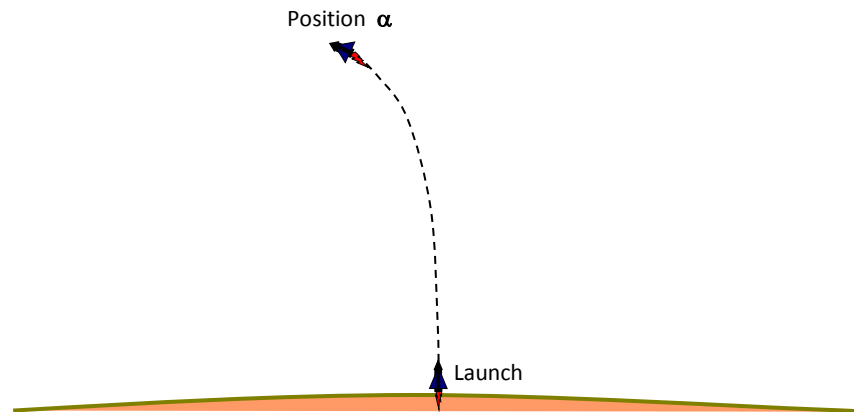
Option Question

- Attempt Question 37
- Allow about 50 minutes for this part
- **USE THE SEPARATE OPTION BOOKLET FOR YOUR ANSWERS**

Section 1 (75 marks)**Part A (20 marks)**

Use the multiple choice answer sheet provided for questions 1-20

1. A rocket was launched and during the early stage of its flight into orbit followed a path that was initially vertical, but then tipped to the west, as shown in the diagram below.



During the time the rocket travelled from the launch site to the Position α shown, the thrust from the rocket engines was controlled to produce a constant acceleration of the rocket in the direction that it was heading. When the human passengers on board the rocket are considered, which of the following statements is correct?

- A The g -forces experienced by the passengers will remain constant after launch while the rocket travels to Position α .
- B The path of the rocket is tipped over to the west to gain the speed from the earth's rotation
- C As the path of the rocket tilts from the vertical the g -forces experienced by the passengers will begin to reduce.
- D As the path of the rocket tilts over to the west the gain in speed due to the earth's rotation will increase the g -forces experienced by the passengers.

2. Nasa is focused on exploring Mars. At some time in the future they will be sending astronauts to the planet for a lengthy stay. They will find the gravity on Mars different because the mass is 0.11 times that of Earth and gravitational acceleration at the surface is 3.8 ms^{-2} . If a piece of equipment has a weight of 196N on Earth, what will its mass be on Mars?

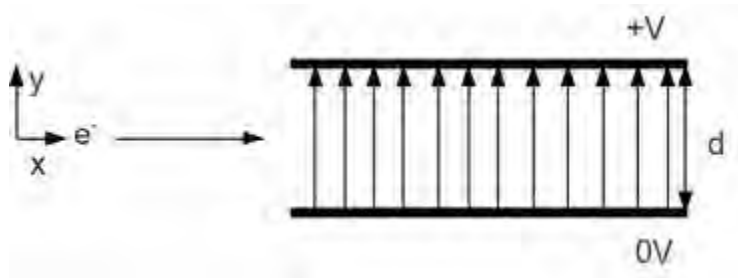
- A 20 kg
- B 51.6 kg
- C 21.6 kg
- D 20 g

3. Calculate the orbital period of a satellite in orbit around the Earth at a height above the surface of 42,000 km.
- A 39 hours
 - B 2.9 hours
 - C 29 hours
 - D 25 hours
4. The aether model for the transmission of light was adopted because
- A light was found to have wave characteristics and it was thought waves need a medium in which to propagate.
 - B the speed of light was found to be constant
 - C time and distance was found to be relative to the motion of the aether.
 - D light was found to have particulate nature and momentum needed to be conserved as it was discovered that light slowed on its journey from the Sun to the Earth.
5. A traveller in a spacecraft moving at 50% of the speed of light turns a torch on in the direction of motion. Which of the following statements most correctly describes this situation?
- A The combined speed of the torch light and the spacecraft will be 1.5 c as seen by a stationary observer.
 - B The light coming from the torch will have a speed of 1.0 c relative to a stationary observer.
 - C The torch will shine brighter because of the added momentum from the spacecraft.
 - D The length of the torch will increase relative to a stationary observer.
6. An electric motor is often placed in series with an adjustable resistor. This resistor is connected in this manner to
- A reduce the operating current and protect the windings in the coil.
 - B increase the starting current and improve efficiency of the motor
 - C increase the operating current and reduce the starting current
 - D reduce the starting current and protect the windings in the coil
7. The energy that is possessed by a photon of light of wavelength 20 nm is
- A 1.0×10^{-13} J
 - B 1.0×10^{-14} J
 - C 1.0×10^{-17} J
 - D 1.0×10^{-26} J

8. Metallic conductors have a fairly constant resistance at specific temperatures. Which statement best explains why this resistance is usually low?

- A The conduction band has much greater energy than the valance band.
- B The valence band has much greater energy than the conduction band.
- C There are many electrons available for conduction.
- D There are few electrons available for conduction.

9.



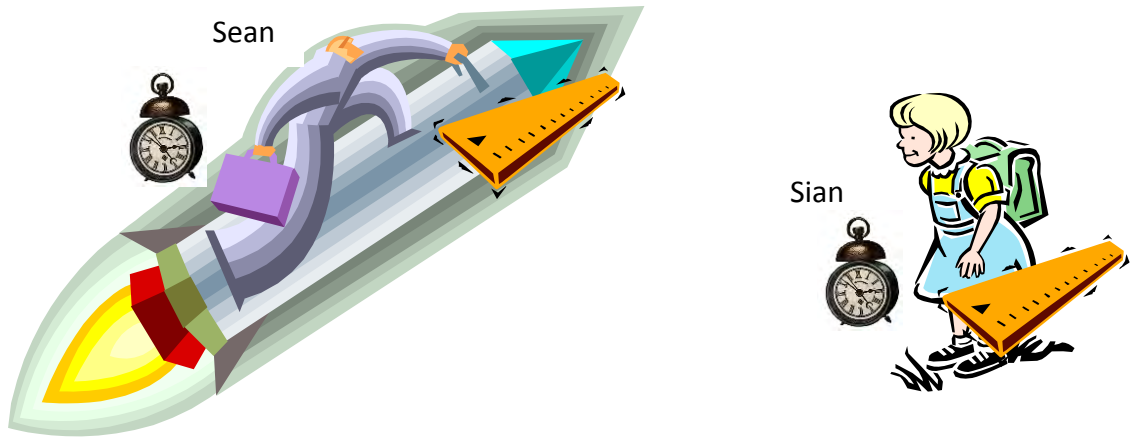
An electron enters an electric field at right angles in a cathode ray tube. If the potential difference between the plates is 100 V and they are 10 cm apart, the magnitude and the direction of the force being applied to the electron is

- A 1.6×10^{-18} N up
- B 1.6×10^{-16} N down
- C 1.6×10^{-17} N up
- D 1.6×10^{-16} N up

10. Which of the following situations would result in the production of a p-type semiconductor?

- A Silicon doped with phosphorus
- B Germanium doped with gallium
- C Silicon doped with arsenic
- D Germanium doped with silicon

11. If Sean were to fly past Sian in a rocket at a **very high** constant relative velocity,

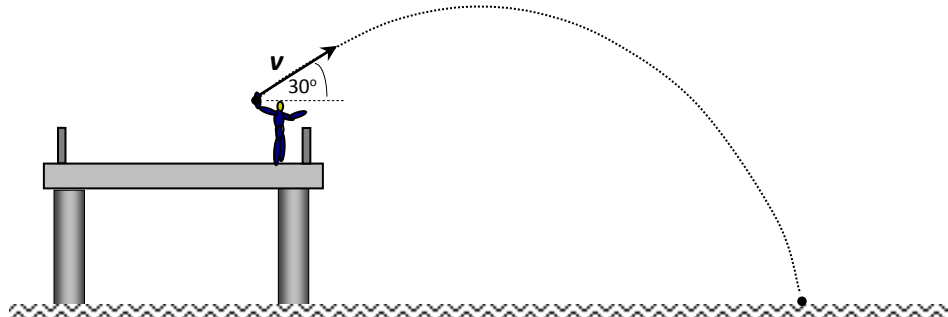


then, by Einstein's Theory of Special Relativity, Sian would observe Sean's clock as running slower than her own.

Sean would see the situation as follows:

- A Sian's clock would appear to run faster than his own, and Sian's ruler would appear longer than his own.
- B Sian's clock would appear to run faster than his own, but Sian's ruler, being solid, would appear the same as his own.
- C Sian's clock would appear to run slower than his own, but Sian's ruler, being solid, would appear the same as his own.
- D Sian's clock would appear to run slower than his own, and Sian's ruler would appear shorter than his own.

12. A ball is thrown from a bridge at $v \text{ ms}^{-1}$, at angle of 30° to the horizontal, and travels out over the river below, landing in the water. The ball followed a path as shown in the diagram below,



The ball was recorded to take 2.5 seconds from when thrown, till it hit the water, travelling horizontally a distance 22.5 m. Considering this, which of the following is closest to, v , the speed the ball was thrown?

- A 7.8 ms^{-1}
- B 9.0 ms^{-1}
- C 10.4 ms^{-1}
- D 18.0 ms^{-1}

13. If you tie an object to a piece of string then swing the object in a circle the string provides a force on the object allowing the object to be swung in a circle at a constant speed
For a satellite in Geostationary orbit around the earth

- A there is no similar force needed because the satellite is “stationary” above the same point on the earth’s surface
- B the needed force is provided by the thrusters on the satellite
- C the needed force is provide by the tiny amount of air friction that exists even at that height
- D the needed force is provided by the gravitational attraction between the satellite and the earth

14. Which of the following is NOT a necessary component of an AC generator?

- A a magnetic field.
- B a coil or loop of conducting wire
- C a commutator.
- D a change in magnetic flux through the coil or loop

15. Electric motors used to drive fans in appliances such as video cassette recorders and CD players are usually AC induction motors because

- A there are no brushes to wear out
- B there are no ozone producing sparks.
- C they are simple and cheap to make
- D all of the above.

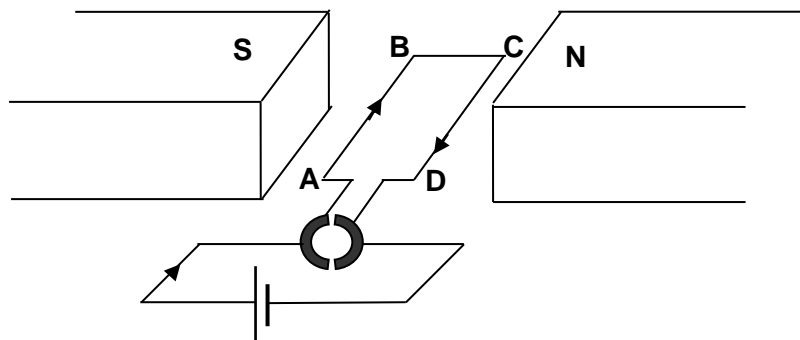
16. The following diagram is of a simple electric motor with a single loop forming a rectangular coil.

Information on the motor is provided.

Current in loop = 5.0 A Magnetic field strength = 1.0×10^{-2} T

AB = CD = 0.080 m

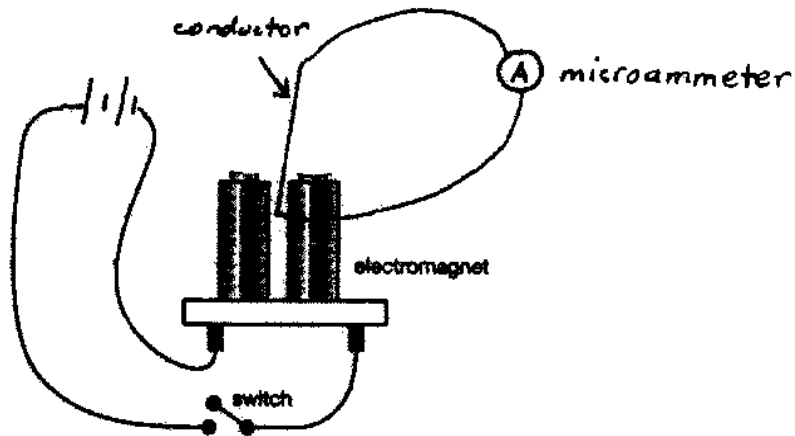
BC = 0.020 m



If the coil is viewed from this side, which of the following conclusions about this motor is correct?

- A The torque is 4.0×10^{-5} Nm and a maximum when the loop is in the position shown.
- B The torque is kept uniform at 8.0×10^{-5} Nm due to the split ring commutator.
- C The maximum value of the turning effect of the force is 8.0×10^{-5} Nm clockwise.
- D The current causes a maximum turning effect of 4.0×10^{-5} Nm clockwise.

17. During a classroom experiment a student placed a conductor attached by leads to a microammeter, between the poles of an electromagnet. The student sketched the set-up, as shown below.



At the moment the electromagnet is switched on, which of the following would have been noticed by the student?

- A a current flows in the microammeter circuit for a brief time while the flux cutting the conductor is changing.
- B no current flows, as there is no relative movement between the conductor and the field.
- C a current flows while the magnet is operating because the conductor is in a magnetic field.
- D no current flows because of the angle between the magnetic flux and the conductor.

18. When the north pole of a magnet is moved towards the open end of a solenoid that is part of a closed circuit, this open end of the solenoid behaves like the north pole of a magnet. Which of the following provides the best explanation as to why a north pole formed?

- A Faraday's Law
- B Lenz's Law
- C the Law of Conservation of Momentum
- D the Motor Effect

19. A transformer is designed so that 240 volts AC is attached to the terminals of the primary coil with 3000 volts AC being supplied across the terminals of the secondary coil. When considering this transformer, which of the following statements is correct?

- A this is an example of a step-up transformer.
- B this transformer is impossible as transformers need DC voltages to operate.
- C there would be more coils in the primary than the secondary.
- D less than 3000 volts would be supplied when a circuit is attached to the secondary coil due to heat losses occurring in the attached circuit.

20. Which of the following actions could be used to demonstrate the production of alternating current?

- A Move a wire that is part of a closed circuit, down through a magnetic field.
- B Move a solenoid that is part of a closed circuit, vertically up and down.
- C Spin a piece of wire in a magnetic field that is changing.
- D Move a magnet in and out of a solenoid that is part of a closed circuit.

2011 Trial HSC Examination**Physics**

OUTCOME	MARK
Knowledge and Understanding	/70
Planning & Conducting Investigations Q17, Q20, Q27, Q28, Q29, Q33	/13
Problem Solving Q21, Q22, Q25, Q27	/17
TOTAL	/100

PART A: Answer the multiple choice questions HERE. Circle the letter of the BEST alternative.

1	A B C D	11	A B C D
2	A B C D	12	A B C D
3	A B C D	13	A B C D
4	A B C D	14	A B C D
5	A B C D	15	A B C D
6	A B C D	16	A B C D
7	A B C D	17	A B C D
8	A B C D	18	A B C D
9	A B C D	19	A B C D
10	A B C D	20	A B C D

Section I continued

Part B - 55 marks

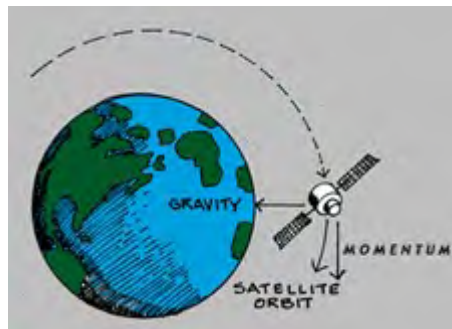
Attempt Questions 21- 36

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

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A 440 kg satellite is moved from an orbit of 300 km to 350 km above the Earth's surface. The energy to do this is supplied by rockets. Calculate the gravitational potential energy difference between the two orbit heights.

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22. An electron travelling in an easterly direction within the cathode ray tube of a television set travels at a velocity of $2.8 \times 10^7 \text{ ms}^{-1}$. It is acted upon by both the Earth's gravitational field and its magnetic field.

The horizontal component of the Earth's magnetic field in the area is $5.0 \times 10^{-5} \text{ T}$ and is directed towards the northeast.

- (a) Determine the direction of the magnetic force due to this horizontal component

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- (b) Determine the magnitude of the magnetic force and compare it with the gravitational force acting on the electron

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- 23.** Outline how transmission wires are protected from supporting structures **2**

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- 24.** Explain why germanium rather than silicon was used in early transistors. **2**

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25. Count von In trouble is being besieged by his arch enemy Baron Gotya. A cannon with a muzzle velocity of 500 km/h is being fired at the castle wall at an angle of 30° to the horizontal.

(a) Draw a diagram (with appropriate labels) that will assist you to answer the questions below

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(b) If the wall is 100 m above the level of the cannon and the shot (cannon ball) hits the wall while it is descending, determine:

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(i) the time of flight for the shot and,

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(ii) the horizontal distance of the cannon from the castle wall.

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26. Michelson and Morley attempted to measure, via experiment, the relative velocity of the Earth with respect to the 'aether' (ether).

(i) Describe this experiment and its results.

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(ii) Use Einstein's theory of relativity to explain the results of this experiment

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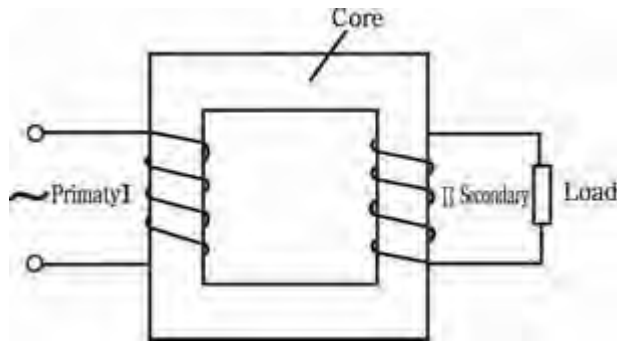
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27. A student drew the following transformer during a task in class. He discovered that the primary has 100 turns and is supplied with 24 volts. The load (a light globe) is emitting 192 watts when 2 amps are flowing through it. Use these measurements to determine the number of turns in the secondary coil.

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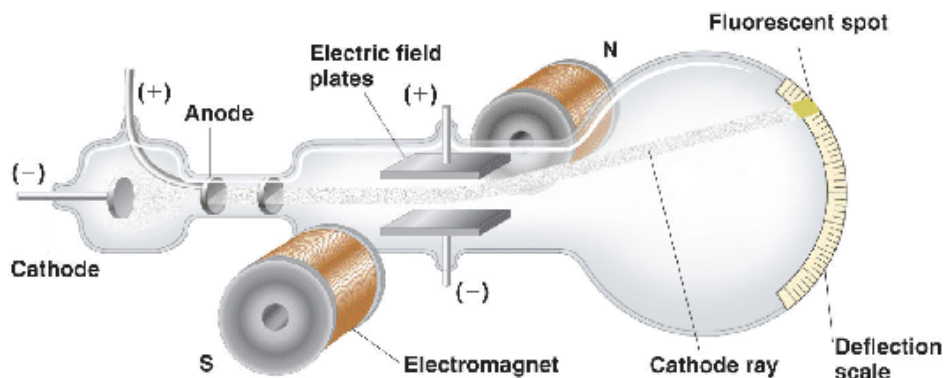
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28. Towards the end of the 19th century, the English physicist JJ Thomson was able to add to measure the charge to mass ratio of an electron using a cathode ray tube similar to the one below. A simplified diagram of Thomson’s experimental cathode ray tube is shown below.



Thomson’s observations included the following:

- when a cathode ray beam is subjected to an electric field only, it is deflected such that a spot above horizontal at the end of the tube glows
- when a cathode ray beam is subjected to a magnetic field only, it is deflected such that a spot below horizontal at the end of the tube glows
- when a cathode ray beam is subjected to both electric and magnetic fields, the beam is not deflected and the horizontal position at the end of the tube glows

- (i) Use your understanding of the nature of cathode rays to explain these observations. 1

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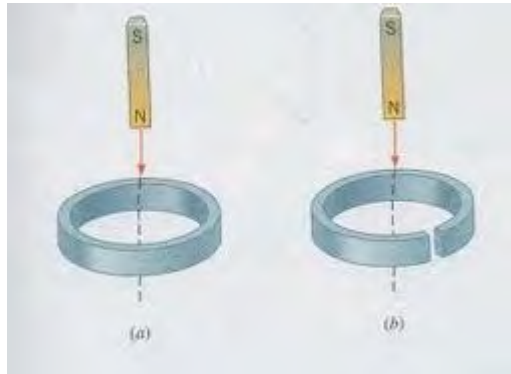
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- (ii) Use your understanding of the behaviour of cathode rays in electric and magnetic fields to outline how Thomson measured the value $\frac{q}{m}$ where q is the charge of the particle, of mass m moving with a speed v in a magnetic field B and electric field E . 1

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29. In an experiment identical magnets are dropped from the same heights through stationary aluminum rings as shown below.



(a) Describe any differences you would expect to observe in the motion of the magnet in (a) compared to (b)

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(b) Explain this observation.

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30. State two characteristics of the orbit of a geostationary satellite. **2**

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31. The greatest challenge for rocket designers is to develop engines that are capable of providing a thrust to overcome the Earth’s gravitational pull.

Outline the contribution towards the development of space exploration by one of Tsiolkovsky, Orbeth, Goddard, von Braun, O’Neill or Esnault-Pelterie. **2**

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32. One of the most exciting technologies of recent times has been the conversion of sunlight into electricity using semiconductors in the form of solar panels. Outline with the aid of a diagram how electrical energy is produced from sunlight in this way.

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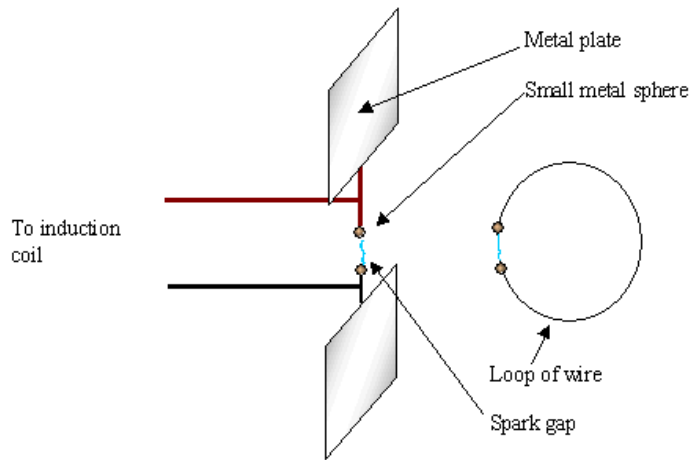
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33.



Hertz, in 1887, designed an experiment similar to the one above. He caused a high voltage spark to jump across a gap as shown and made observations of the loop of wire.

(i) State what Hertz observed in the loop of wire as the spark occurred between the small metal spheres. 1

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(ii) Explain this observation. 1

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(iii) Hertz found that ultraviolet light had an effect on this experiment. Describe his observation 1

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34. The next big leap forward for humans in space travel may see extended space travel across distances outside the solar system.

Discuss the implications of time dilation for future space travel.

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35. With reference to either the galvanometer or the loudspeaker, describe (using a suitable diagram) how the motor effect is used.

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36. Discuss differences between solid state and thermionic devices. In your answer include a discussion of why solid state devices replaced thermionic devices.

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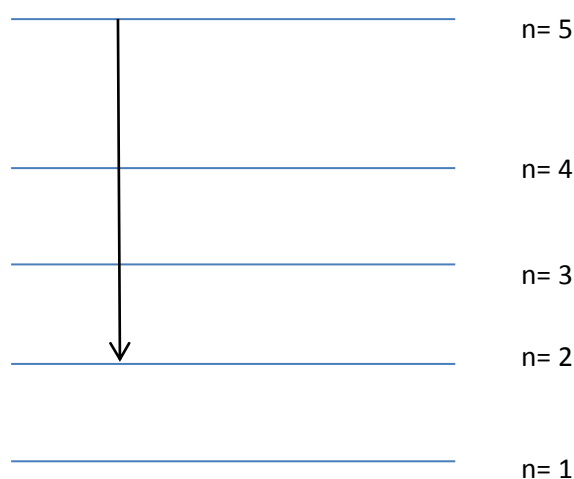
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Section II**Question 37 – Quanta to Quarks (25 marks)**

Answer this question in a separate writing booklet.

- (a) Outline Rutherford's model of the atom. **2**
- (b) (i) Outline Bohr's model of the atom. **2**
- (ii) Explain how Bohr's model of the atom accounts for the Balmer series of lines in the hydrogen spectrum. **2**
- (c) Discuss the limitations of the Bohr model of the hydrogen atom. **6**
- (d) Analyse how contributions of both Heisenberg and Pauli modified the atomic theory at that time **4**
- (e) The diagram below shows the first five energy levels or Bohr's 'stationary states' for the electron orbiting the nucleus of the hydrogen atom.



- (i) For the electron transition shown in the diagram, calculate the wavelength and hence the energy of the emitted photon. **3**
- (ii) State de Broglie's hypothesis, and calculate the wavelength of the electron in the second stationary state if its speed is $2.724 \times 10^6 \text{ ms}^{-1}$ **3**
- (iii) Describe how de Broglie's hypothesis was confirmed by Davisson and Germer. **3**

END OF EXAMINATION