SYDNEY GRAMMAR SCHOOL

2005
FORM VI
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
- A data sheet, formulae sheets and Periodic Table are provided at the back of this paper
- Write your candidate number at the top of each page in Part B
- Hand in the paper in ONE bundle at the end of the exam.

Check List
Each candidate must have
- Question paper
- Multiple choice answer sheet
- Five-page booklet

Total marks (100)

Section I Pages 2 - 26

(75 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 – 60 marks

- Attempt Questions 16 - 30
- Allow about 1 hour and 45 minutes for this part

Section II Pages 27 – 30

25 marks

- Attempt Question 34 only.
- Allow about 45 minutes for this section

Masters

AAH – Dr A. Haines
AGY – Mr A. Yabsley
AWW – Mr A. Woolnough
SRW – Mr S. Williams
MRW – Dr M. Ward

1 What is the work done to move a 10.0 kg mass from a very large distance away to a point on the surface of the Earth where the radius of the Earth is 6.38×10^6 m?

(A) 9.87 J
(B) – 98.0 J
(C) -6.3×10^7 J
(D) -6.3×10^8 J

2 A 500 kg satellite is in a stable circular orbit around the Earth. Given that the radius of the orbit is 8.16×10^6 m, what is the speed of the satellite?

(A) 6.39×10^4 ms^{-1}
(B) 7.00×10^3 ms^{-1}
(C) 8.50×10^3 ms^{-1}
(D) 9.90×10^3 ms^{-1}

3 For the launch of a rocket from the surface of the Earth, which of the following sets of launch conditions provides the most fuel (energy) efficient method of reaching a given orbit?

(A) a launch toward the east from a location near the equator.
(B) a launch toward the west from a location near the equator.
(C) a launch toward the north from a point near one of the poles.
(D) a launch toward either north or south from a point near the equator.

4 A space shuttle is in the Earth's gravitational field. Inside the shuttle, an astronaut tries to drop a pen but he observes that the pen remains stationary near his hand. Which of the following is the best description of the astronaut's frame of reference?

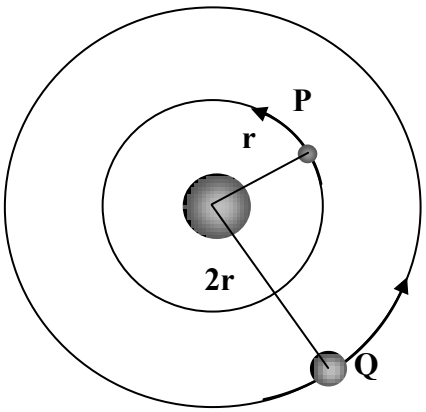
(A) a weightless, inertial frame of reference.
(B) a non-inertial frame of reference moving at constant velocity.
(C) an inertial frame of reference.
(D) a non-inertial frame of reference.

5 A space craft travelling at 0.80c passes a stationary asteroid. A passenger on the space craft measures the length of the asteroid to be 5000 m (along an axis in the direction of the motion of the space craft). What is the length of the asteroid as measured by an observer who is stationary on the asteroid?

(A) 1800 m.
(B) 3000 m.
(C) 8333 m.
(D) 13 889 m.

6 Two moons P and Q travel around the same planet in the same direction, in circular orbits. Moon P completes one revolution around the planet in time, *T*.

The radii of the orbits are in the ratio 1:2 as shown in the diagram below.



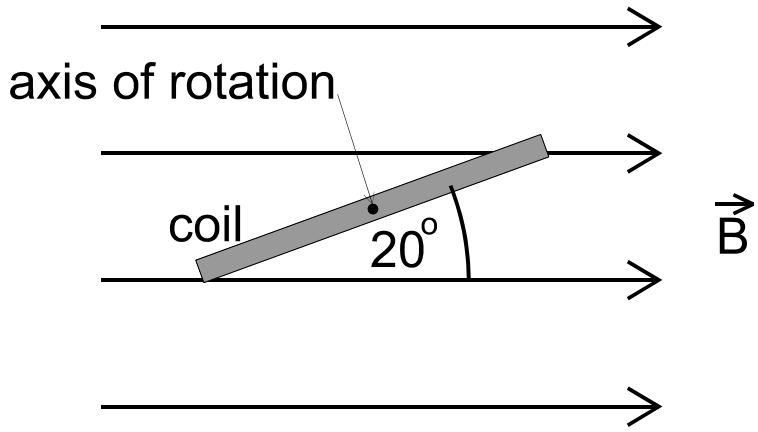
What is the period of rotation of moon Q?

(A) $2T$
(B) $4T$
(C) $\sqrt{8}\ (T)$
(D) $8T$

7 Electricity tends to be generated in large scale power stations which are located close to coal deposits or other energy supplies. These are usually some distance away from large cities. The electricity is delivered to the cities by transmission through power lines at high voltages.
Why are high voltages used in this application?

(A) A.C. generators can only produce high voltages.
(B) losses due to heating are compensated because high voltages produce larger currents due to Ohm's Law.
(C) the transmission lines are less prone to lightning strike because the high voltages repel the static charge associated with lightning.
(D) higher voltages produce lower currents leading to less Ohmic heating.

8 The diagram below shows a side-on view of a square coil of 100 turns and length of side 0.050 m placed at 20º to a uniform magnetic field of 0.750 T.



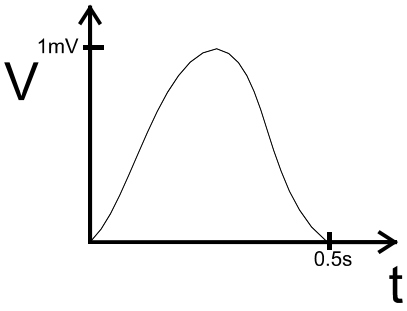
If the current in the coil is 2.27 A, what is the magnitude of the torque on the coil when it is in this position?

(A) 0.400 Nm
(B) 0.426 Nm
(C) 8.00 Nm
(D) 8.51 Nm

9 A transformer in the street is designed to convert the electricity supply from 11000 volts to 240 volts for domestic use in houses. Assuming 100% efficiency, which of the following statements describes a transformer capable of making this transformation?

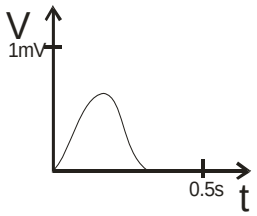
(A) a step-up transformer with 1100 turns in the primary coil and 24 turns in the secondary coil.
(B) a step-down transformer with 24 turns in the primary coil and 1100 turns in the secondary coil.
(C) a step-down transformer with 1100 turns in the primary coil and 24 turns in the secondary coil.
(D) a step-down transformer with 1100 turns in the primary coil and 240 turns in the secondary coil.

10 The following graph shows the induced emf, V, when a magnet is plunged into a coil.

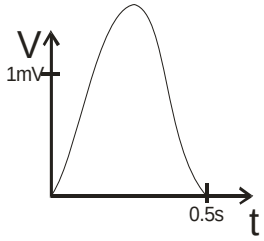


Which of the following diagrams best represents the graph when the same magnet is plunged into the same coil at a faster rate?

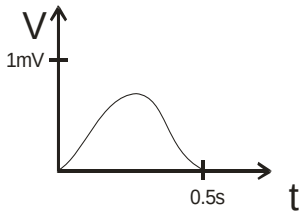
(A)



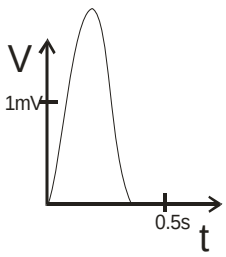
(B)



(C)



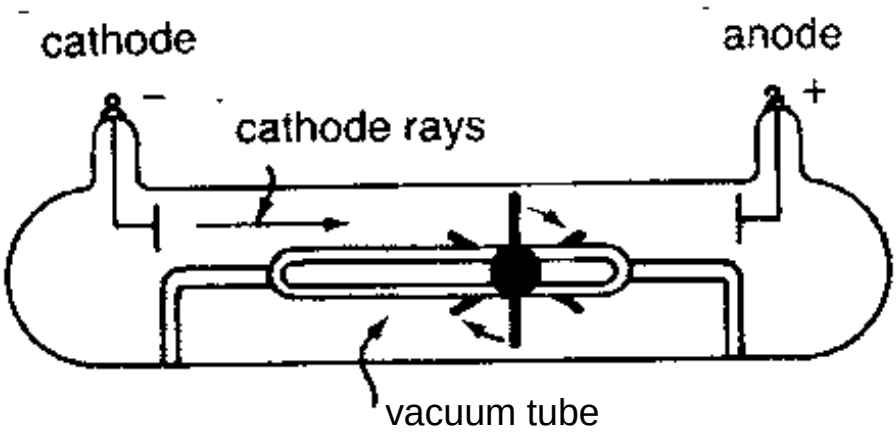
(D)



11 In the design of a TV cathode ray tube, it was calculated that the magnetic field strength in the deflection coils needed to have a maximum value of $B = 1.00 \times 10^2$ T. Assuming that the coils have a circular cross-section with diameter of 0.084 m, what is the value of the total magnetic flux inside the coils when the magnetic field strength is at maximum?

(A) 0.554 Wb
(B) 2.22 Wb
(C) 4.51×10^3 Wb
(D) 1.81×10^3 Wb

12 What property of cathode rays is being investigated in the apparatus below?



(A) Cathode rays possess momentum.
(B) Cathode rays travel in straight lines.
(C) Cathode rays are charged particles.
(D) Cathode rays are deflected by electric fields.

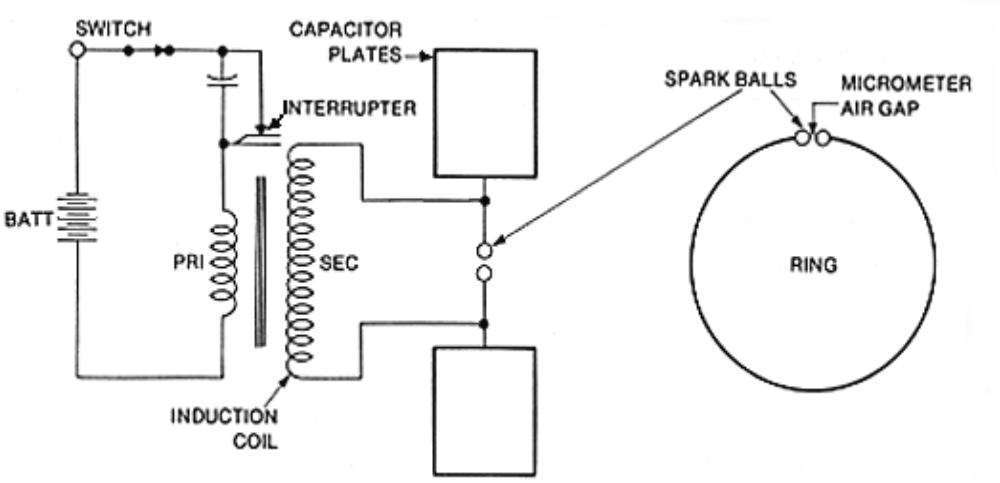
13 During a photoelectric experiment, light of a certain frequency was allowed to fall on a copper electrode. However no photoelectrons were emitted even after a few minutes wait. Which of the following changes to the light is most likely to produce photoelectrons from the copper electrode?

(A) an increase in intensity at the same frequency.
(B) an increase in frequency with a decrease in intensity.
(C) an decrease in intensity at the same frequency.
(D) an increase in intensity with an increase in wavelength.

14 Determine the wavelength of a photon of light with energy = 3.3×10^{-19} J.

(A) 300 nm
(B) 400 nm
(C) 500 nm
(D) 600 nm

15 The diagram below shows a battery connected to an induction coil and, nearby, a metal ring with a small air gap between the spark balls.



What was the purpose of this apparatus?

(A) to measure the velocity of the Earth through the Ether.
(B) to determine black body curves.
(C) to investigate the photoelectric effect.
(D) to generate and detect radio waves.

Class

Candidate Number

Part B

Total marks - 60
Attempt Questions 16 - 30
Allow about 1 hour and 45 minutes for this Part

Answer the questions in the spaces provided
Show all relevant working in questions involving calculations

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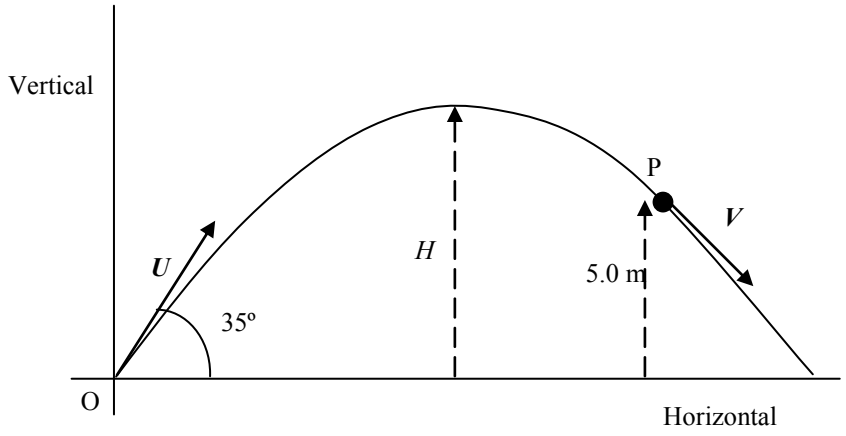
Marks

Question 16 (6 marks)

A cricket ball is thrown at an initial velocity $U = 25$ ms^{-1} at an angle of 35˚ up from the horizontal. The trajectory is shown in the following diagram with the cricket ball at point P at one instant during the flight. Point P is at a vertical height of 5.0 metres.



(a) Calculate the maximum height, H, reached by the cricket ball during its flight. (Ignore air resistance). **2**

Vertical component / *2a* $\qquad$ *2 x -9.8*

$u_y = 25 \sin 35$ [illegible] *(1 mark)*

$= v^2 - u^2 \quad = 0 - (14.34)^2 \quad = \quad 10.5m$ *(1 mark)*

Class

Candidate Number

Question 16 (continued) **Marks**

(b) Calculate the magnitude and direction of the velocity, *V,* of the cricket ball when it is at point P as shown in the diagram on the previous page? **4**

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Class

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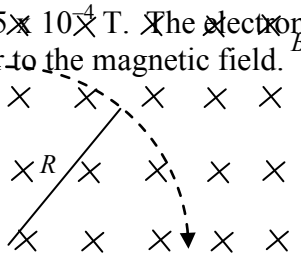
Marks

Question 17 (2 marks)

The following diagram shows an electron in the vacuum of a cathode ray tube entering a uniform magnetic field of 4.5×10^{-4} T. The electron is travelling at a velocity of 5.0×10^6 ms^{-1} perpendicular to the magnetic field. While in the field the electron travels in a circular path. **2**



Calculate the radius of the path, R, of the electron while it is in the magnetic field.

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Class

Candidate Number

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Question 18 (4 marks)

Explain the importance of Newton's Law of Universal Gravitation in understanding and calculating the motion of planets around the sun. **4**

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Class

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Question 19 (8 marks)

In his theory of special relativity, Einstein assumed that the speed of light is constant for all observers. Describe the significance of this assumption. Your answer should make reference to at least one thought experiment. **8**

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Class

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Class

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Section I – Part B (continued)

Marks

Question 20 (1 marks)

1

Explain why some household appliances which are connected to the mains electrical supply use a transformer.

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Question 21 (2 marks)

One of the design features of many electrical devices is some form of cooling to dissipate the heat generated by the transformers inside. Explain **one** source of heating in transformers.

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Class

Candidate Number

Marks

Question 22 (3 marks)

Account for the production of back emf in the coils of a D.C. electric motor. **3**

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Question 23 (3 marks)

Outline the competition between Edison and Westinghouse to supply electricity to cities in the United States. **3**

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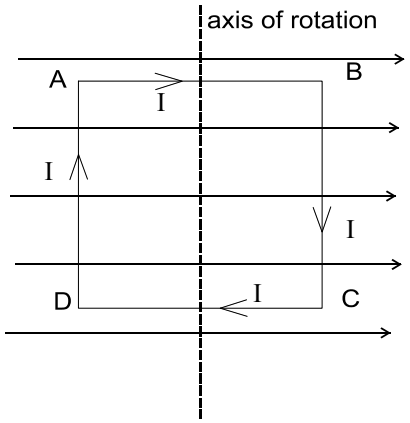
Class

Candidate Number

Marks

Question 24 (3 marks)

The diagram below shows a single loop of wire in a uniform magnetic field. The loop is a square of side 2.5 cm and is arranged parallel to the magnetic field of strength $B = 3.5 \times 10^{-2}$ T.



$B = 3.5 \times 10^{-2}$ T

(a) What is the direction of the force on the side BC of the loop if it carries a current of in a clockwise direction as shown above. (ie ABCD)? **1**

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(b) If the current in the loop is 150 mA, determine the magnitude of the force on side BC after the loop has rotated through an angle of 30˚ about the axis shown. Assume that the coil remains within the magnetic field as it rotates. **2**

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Class

Candidate Number

Question 25 (4 marks) **Marks**

Compare the structure and function of a DC generator to that of a DC electric motor. **4**

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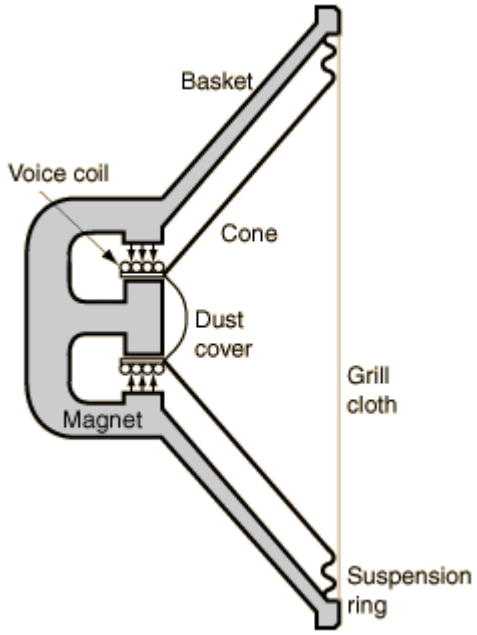
Class

Candidate Number

Marks

Question 26 (4 marks)

The following diagram shows a loudspeaker in cross-section. The electromagnetic principle upon which it is based is the motor effect



Describe the application of the motor effect in the functioning of the loudspeaker. **4**

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Class

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Class

Candidate Number

Section I – Part B (continued)

Question 27 (3 marks)

Marks

Outline Hertz's experiment to measure the speed of radio waves.

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Class

Candidate Number

Marks

Question 28 (6 marks)

Explain how developments in the model of light at the beginning of the twentieth century led to an increased understanding of the photoelectric effect. **6**

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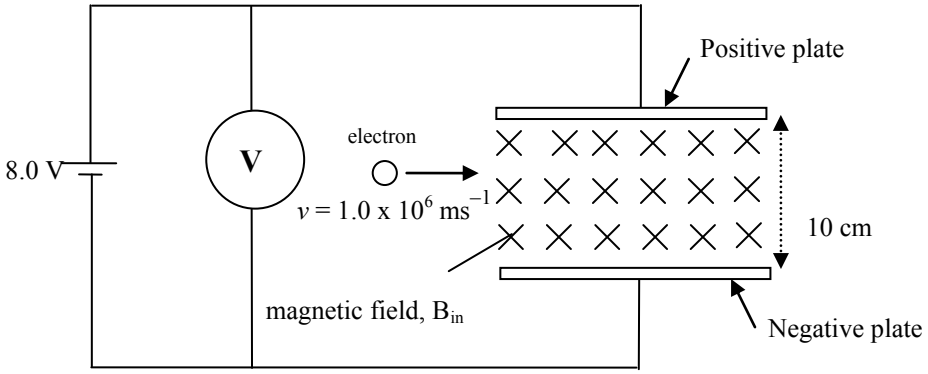
Class

Candidate Number

Marks

Question 29 (6 marks)

The diagram below shows an electron moving at a velocity of 1.0×10^6 ms^{-1} into perpendicular electric and magnetic fields. The potential difference between the plates is 8.0V and the distance between them is 10 cm. The magnetic field is produced by coils that are not shown in the diagram.



(a) Determine the magnitude of the electric field strength between the plates. **2**

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(b) Determine the magnitude of the force on the electron between the plates due to the electric field only. **1**

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Class

Candidate Number

Marks

Question 29 (continued)

(c) If the electron passes through without being deviated determine the magnetic field strength, B, between the plates. **2**

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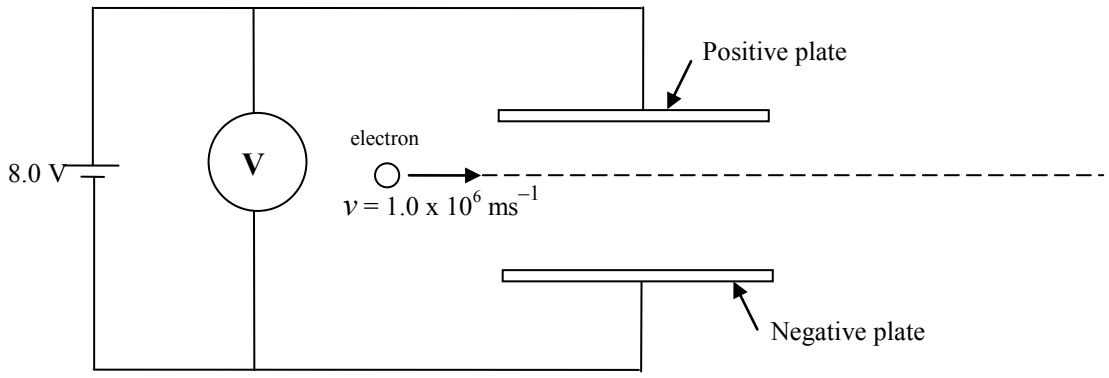
(d) If the magnetic field is now switched off, draw on the diagram below the resulting path of the electrons as they travel through and then out of the electric field. (Ignore the effect of gravity on the electron). **1**



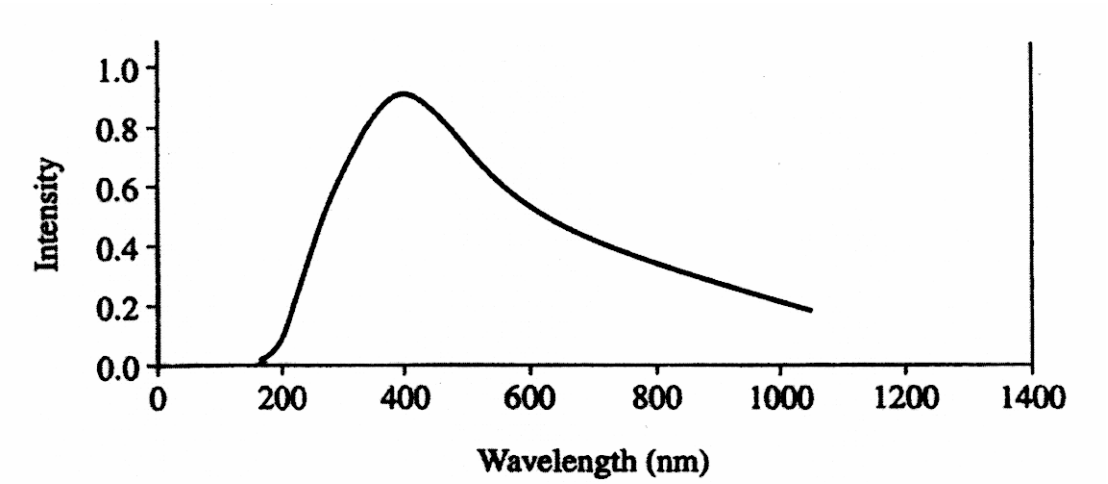
Class

Candidate Number

Marks

Question 30 (5 marks)

Consider the black body curve below



(a) Calculate the frequency at which the body is radiating the greatest intensity of radiation. **2**

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(b) On the graph above sketch in the black body curve for an object with a higher temperature than the one shown. **2**

(c) What hypothesis did Planck propose to explain the characteristics of black body radiation? **1**

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Class

Candidate Number

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Section II

25 marks
Attempt Question 34 only from Questions 31 - 35
Allow about 45 minutes for this section.

Answer the question in a writing booklet. Extra writing booklets are available.
Show all relevant working in questions involving calculations.

Pages

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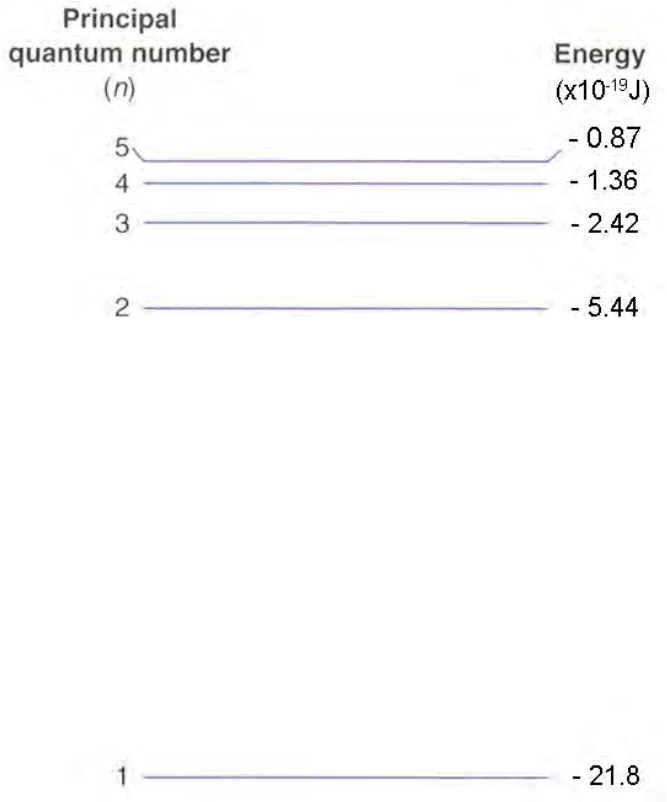
Marks

Question 34 - From Quanta to Quarks (25 marks)

(a) Identify a radio-isotope commonly used in medicine and outline how it is used. **2**

(b) Outline an investigation you have performed to observe the visible components of the hydrogen spectrum. **3**

(c) The diagram below shows the lowest electron energy states of a Hydrogen atom. **2**



Calculate the frequency of the photon emitted when an electron makes a transition from the n = 5 energy level to the n = 3 energy level.

Question 34 continues on the next page

Question 34 (continued)

(d) (i) Calculate the de Broglie wavelength of an electron travelling at 6.0×10^4 ms^{-1}. **2**

(ii) Explain the stability of the electron orbits in the Bohr atom using de Broglie's hypothesis. **3**

(e) Assess the significance of the Manhattan Project to society. **5**

(f) Assess the effectiveness of the Bohr model of the atom. **8**

END OF PAPER