SYDNEY BOYS HIGH SCHOOL

HIGHER SCHOOL CERTIFICATE

TRIAL EXAMINATION

2001

PHYSICS

2 UNIT

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 and a Periodic Table are provided at the back of this paper
- Write your name on each page
- Show all working where necessary
- This is a school -based assessment

Section 1
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 16-32
- Allow about 1 hour and 45 minutes for this part

Section II

Total marks (25)
- Attempt option Question 33
- Allow about 45 minutes for this section

Section I
Total marks (75)

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

1 Compared to the Earth, the planet Mars has approximately $\frac{1}{10}$ the Earth's mass and approximately $\frac{1}{2}$ the Earth's radius.

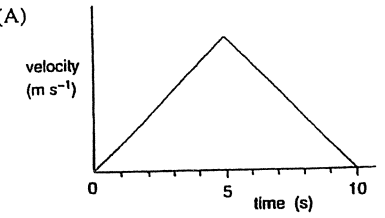
Which value would be closest to that of g on Mars?

(A) 24.5 m s^{-2}.
(B 1.96 m s^{-2}.
(C) 3.92 m s^{-2}.
(D) 4.90 m s^{-2}.

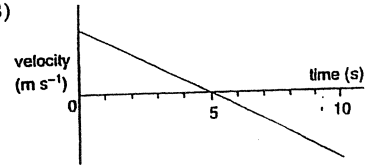
2 An object is projected vertically upwards from the ground. It returns to the ground in 10 seconds.

Which of the graphs below best represents the change in velocity of the ball over the course of its flight?

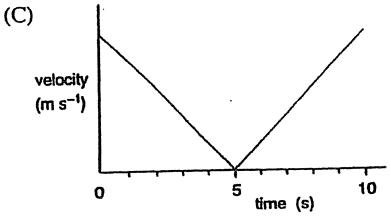
(A)



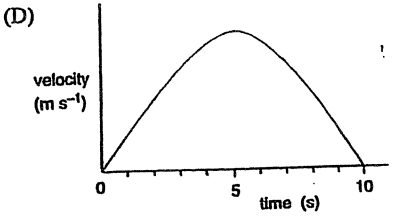
(B)



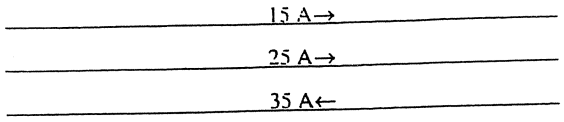
(C)



(D)



3 P, Q and R are three parallel wires carrying currents as indicated on the diagram below.



What is the direction of the resultant force on wire Q?

(A) Up the page.
(B) Down the page.
(C) Into the page.
(D) Upwards out of this page.

4. Kepler's Law of Periods $T^2 = kr^3$ shows the relationship between the period and the orbital radius of a planet that revolves around a star. The value k, a constant, can be changed by varying:

(A) the period of the planet
(B) the orbital radius of the planet
(C) the mass of the planet
(D) the mass of the star

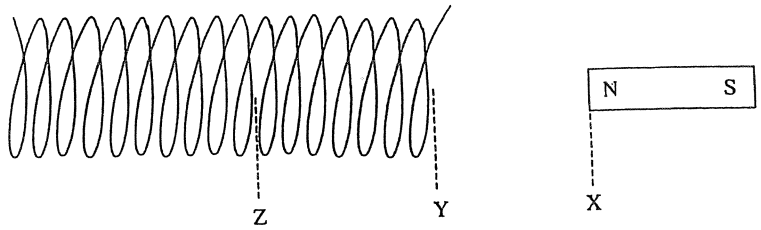
5. The Russian space station which was orbiting Earth for many years eventually crashed into the Earth. This occurred because of:

(A) a reduction in its orbital velocity due to friction from the magnetosphere
(B) a reduction in its orbital velocity due to friction from the atmosphere
(C) an increase in its orbital velocity due to a stronger gravitational force
(D) a reduction in its orbital velocity causing the gravitational force to increase

6. Eddy currents occur in circuits as a result of Lenz's Law. Sometimes these eddy currents are a nuisance and cause loss of efficiency. At other times devices have been designed which specifically make use of eddy currents. Which of the following devices works on the principle of eddy current production?

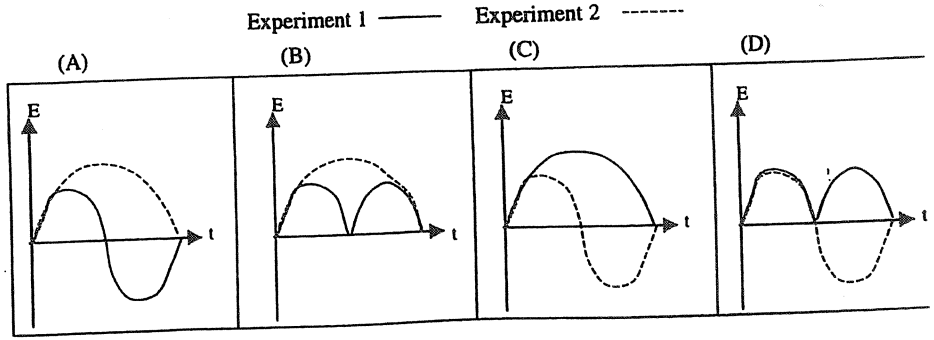
(A) a transformer
(B) a resistor
(C) an electric motor
(D) a braking device in a roller coaster

7 Two experiments are performed with a coil and a magnet.



Experiment 1: Magnet moved from X to Y, then back to X
Experiment 2: Magnet moved from X through Y to Z
(The magnet was stationary at the beginning and at the end of each experiment)

Which of the following graphs of induced emf in the coil vs time best illustrates the experimental results?



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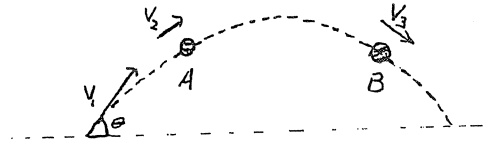
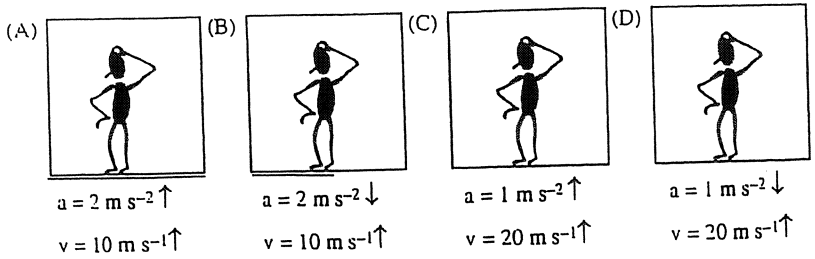


A ball is thrown upwards at velocity, v and at an angle, θ to the horizontal. At A the velocity of the ball is v_2 and at B, the velocity is v_3. As the directions of travel at A and B are different, v_2 and v_3 are different, but the speed at A and B is found to be the same.

Why is the speed at A and B the same?

(A) the height of A and B above the ground is the same.
(B) the angle of projection, θ, was exactly 45° to ensure maximum range and uniform speed.
(C) the force on the ball at A and B is the same.
(D) the speed of the ball is constant in events of this type.

9 A man is standing in a moving lift. The velocity and the acceleration of the lift is given and the direction indicated by the arrow. The greatest net force acting on the man in the lift occurs in which situation (A), (B), (C) or (D)?



10 The miniaturisation of electronic circuits began with the invention of the transistor in 1947. Initially, transistors were mainly made using the element germanium. In recent times, silicon has been largely used in place of germanium.

Why has silicon largely replaced germanium?

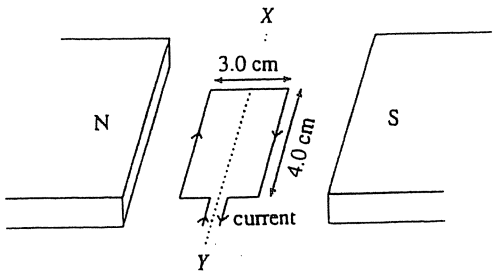
(A) Silicon transistors were invented in 1992 so were unknown before 1990.

(B) Silicon transistors last longer in electric circuits so are more reliable.

(C) Germanium is hard to purify to the degree required for semi-conductors.

(D) A cheap method to manufacture very pure silicon was unavailable until 1975.

11 A rectangular loop of wire is placed between the north and south poles of a magnet as shown below. The loop is 3 cm wide and 4 cm long. The magnetic flux density is 2×10^{-3} T. The loop is horizontal.



12. **Hertz's experiments with radio waves provided convincing evidence that:**

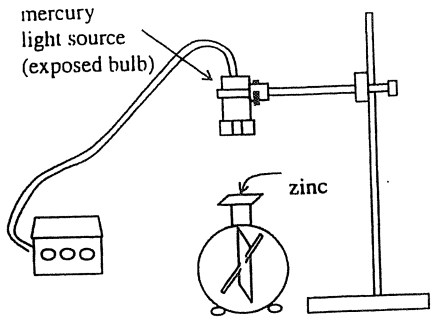
(A) **light rays travel at 3 x 10^8 m s^{-1}**

(B) **radio waves are electromagnetic waves**

(C) **light is a form of electromagnetic radiation**

(D) **there are many frequencies of radio waves**

13. When a negatively charged electroscope surmounted by a piece of zinc is illuminated with ultraviolet light, the electroscope is observed to discharge rather rapidly.



The observation is explained by:

(A) **a chemical reaction occurred between the zinc and the radiation**

(B) **the radiation caused the air surrounding the electroscope to become positively ionised**

(C) **ultraviolet radiation is positively charged**

(D) **the radiation caused the zinc to lose negative charges**

14. **In semiconductors, the energy gap between the valence band and the conduction band is:**

(A) **equal to the energy of electrons that occupy the valence band**

(B) **very small because they are poor conductors at low temperatures**

(C) **very small so some electrons can be excited to the conduction band at normal temperatures**

(D) **equal to the energy of electrons that occupy the conduction band**

15 Induction is a highly efficient means of producing heat for cooking. The efficiency of induction stoves is 80% compared with gas stoves 43% and standard electric elements 44%.

Which type of cookware cannot be used to heat food on an induction cooktop?

(A) Enamelled steel cookware.

(B) Stainless steel cookware.

(C) Aluminium cookware.

(D) Cast iron cookware.

TEACHER: NAME:

SYDNEY BOYS HIGH SCHOOL

HIGHER SCHOOL CERTIFICATE

TRIAL EXAMINATION

2001

2 U PHYSICS

ANSWER BOOKLET

PART A: **Multiple Choice grid**

* **Put a cross in the correct box**

	A	B	C	D
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2				
3				
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13				
14				
15				

Teacher Name

Section I

Part B

Total marks (60)
Attempt questions 16 – 32
Allow about 1 hour 45 minutes for this part

Answer the questions in the spaces provided

Question 16 (5 marks) Marks

(a) Explain the difference between a satellite that has a geostationary orbit and one that has a low earth orbit. 2

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(b) What is ONE advantage of a geostationary satellite over a low earth orbiting satellite? 1

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(c) Give an example of an application where scientists would choose to use a low earth orbiting satellite over a geostationary satellite. Explain why they would choose the low earth orbiting satellite for this particular application. 1

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(d) State ONE safety precaution that should be taken when a satellite eventually crashes back to Earth? 1

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Teacher _____ Name: _____

Question 17 (5 marks) Marks

VARIATION IN MEAN g WITH LATITUDE AT SEA LEVEL

Latitude(degree south)	g (metre sec^{-2})
0°	9.78039
10°	9.78195
20°	9.78641
30°	9.79329
40°	9.80171
50°	9.81071
60°	9.81918
70°	9.82608
80°	9.83059
90°	9.83217

Polar radius of earth = 6.357×10^6 m

Equatorial radius of earth = 6.378×10^6 m

(a) The table above gives the mean values of g because there are local variations of small magnitude at different locations. Discuss the reasons for these local variations. 1

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(b) The lower mean value of g at the equator compared to the value of g at the poles can only partly be explained by the earth's greater equatorial radius. Describe other factor(s) that influence the value of g at the equator. 2

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(c) Calculate the value of g at a point 3.189×10^6 m above the earth at the equator. 2

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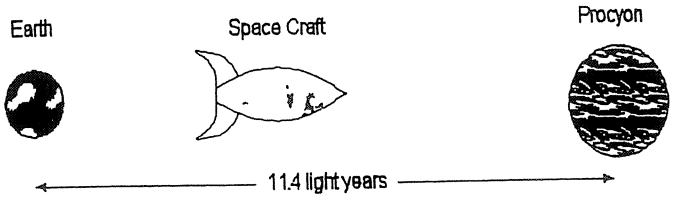
Teacher: _____ Name: _____

Question 18 (4 marks) Marks

Procyon is 11.4 light years away. Imagine that Siobhan (a foxy lady of the 23rd century) wants to visit her friend Conor who lives near that star. Her star buggy can travel at 70% of the speed of light (0.7c).Siobhan will leave her brother Fergus behind.



(a) The trip may well be a comfortable hop in the 23rd century but it is impossible now. Why would a present-day person have trouble travelling as fast as Siobhan plans to? 1

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(b) How much time will have passed for Fergus if Siobhan has a fight with Conor and turns for home as soon as she reaches Procyon? 1

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(c) How much time will Siobhan spend on the trip? 1

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(d) The time that Siobhan and Fergus experience are different. In this frame of reference, Fergus is considered to be still and Siobhan to be moving at 0.7c. The times each experience would be reversed if Fergus (on the Earth) was considered to moving and Siobhan (on the star buggy) was considered to be still. Discuss why this reference frame would not be used. 1

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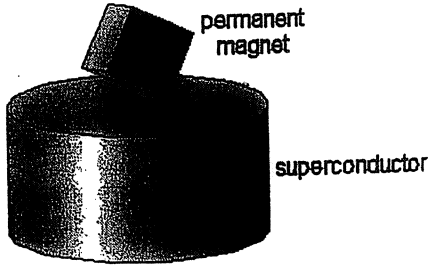
Teacher: _____ Name: _____

Marks

Question 19 (7 marks)

"Their charm is in three words: zero, infinity and perfect"...
Albert Einstein on superconductors

The following diagram represents a permanent magnet levitating just above a superconductor.



(a) Explain why the magnet is able to levitate above the superconductor and discuss how this technology has been utilised in the maglev train. 4

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(b) Until 1987, the highest temperature that any substance had been found to superconduct was 23 K. In recent years, compounds such as the ceramic, $HgBa_2Ca_2Cu_3O_9$ have been discovered that superconduct at temperatures >160 K. 1

Discuss the advantages of using superconductors.

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(c) How could these new discoveries affect current limitations on superconductor's use? 2

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Teacher: _____ Name: _____

Question 20 (2 marks)

The evaluation of a scientific theory is based on the experimental evidence sustaining the theory.

Describe ONE experiment that has verified Einstein's theory of time dilation. 2

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Marks

Question 21 (2 marks)

A transformer consists of two coils which are electrically insulated from each other, but wound on the same core. The core consists of several thin sheets (*laminations*) of soft iron that are insulated from each other.

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Explain why the core is constructed like this.

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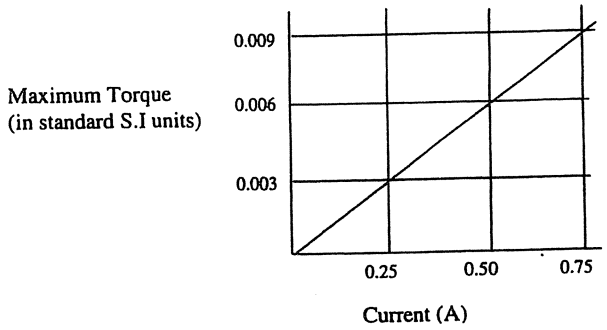
Teacher: _____ Name: _____

Question 22 (3 marks)

A rectangular coil of sides 2.0 cm and 6.0 cm is placed in a uniform magnetic field of strength 0.1 Tesla. The current in the coil is steadily increased, and the maximum torque acting on the coil is measured. The following graph was obtained from the results.



(a) What is the standard S.I. unit for torque? 1

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(b) Clearly showing your working, determine the number of turns of wire in the coil. 2

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Teacher: _____ Name: _____

Marks

Question 23 (2 marks)

Describe TWO features of an A.C. generator which contribute to it being more efficient than a D.C. generator. 2

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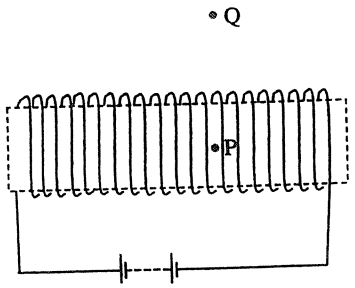
Question 24 (2 marks)

A coil is wound on a cardboard cylinder.



The ends of the wire are connected to a battery, producing a magnetic field in and around the coil.

Compare the size and direction of the field at points P and Q 2

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Teacher: _____ Name: _____

Marks

Question 25 (5 marks)

(a) Describe how electrical energy is transmitted from a power station to a domestic consumer.

Your description should clearly describe the changes which occur in the voltage and current. 3

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(b) What is the main source of energy loss in this transmission? Explain how the changes in voltage and/or current that you have described help to minimise this energy loss. 2

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Teacher: _____ Name: _____

Marks

Question 26 (3 marks)

A square coil is moved out of a magnetic field as shown, inducing an emf between the ends of the coil.

Diagram 1 (time = 0)

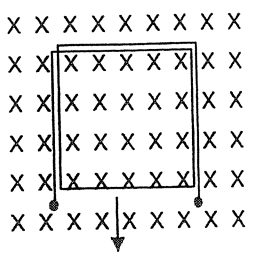
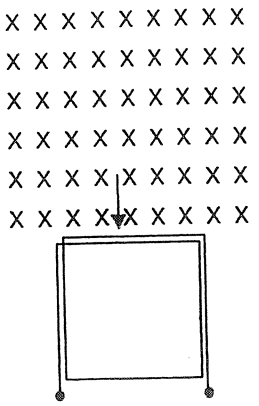


Diagram 2 (time = t)



Describe THREE ways in which this experiment could be modified so that a larger emf was induced between the ends of the coil. 3

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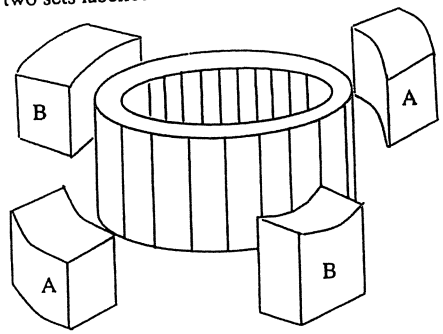
Teacher: _____ Name: _____

Marks)

Question 27 (3 marks)

In an A.C. induction motor the "squirrel cage" rotor is a copper cylindrical cage, mounted in a region where magnetic fields can be applied from two or three sets of electromagnets. The diagram below shows two sets labelled A and B.



(a) Alternating current is supplied to both sets A and B. What is different about the current supplied to A and B? 1

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(b) Explain the advantages of induction motors (over conventional A.C. motors). 2

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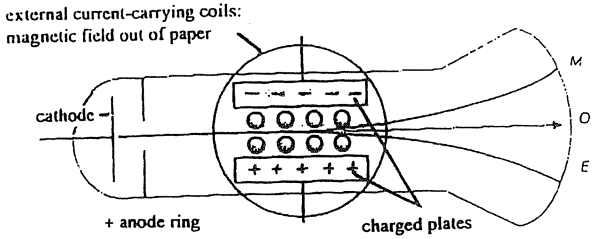
Teacher _____

Marks

Question 28 (5 marks)

(a) Towards the end of the 19th century, the English physicist JJ Thomson was able to add to the knowledge of cathode rays by his investigations into their charge to mass ratio. 3

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 the position marked E at the end of the tube glows
- when a cathode ray beam is subjected to a magnetic field only, it is deflected such that the position marked M glows
- when a cathode ray beam is subjected to both electric and magnetic fields, the beam is not deflected and the position at the end of the tube marked O glows

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

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(ii) Use your understanding of the behaviour of cathode rays in electric and magnetic force 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, and travelling in a circular path of radius r.

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Question 28 continued on next page

Marks

(Question 28 continued)

(b) A television picture tube is a modern day application of cathode rays moving in an evacuated glass container.

Explain how deflection of the cathode rays is achieved differently in a television picture tube compared with a cathode ray oscilloscope (C.R.O.) 2

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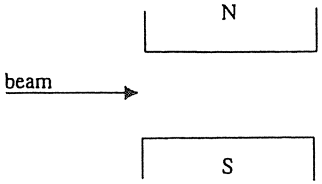
Question 29 (2 marks) Marks

A beam of cathode rays moving at 1×10^3 m s^{-1} passes at right angles through a magnetic field of intensity 0.5 T as shown:



Find the magnitude and direction of the force on each cathode ray particle. 2

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Question 30 (2 marks)

How much energy does a photon of ultraviolet light of wavelength 1.6×10^{-7} m have? 2

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Marks

Question 31 (3 marks)

Outline the composition of the two main types of silicon semiconductors and explain how this gives rise to their electrical properties. 4

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Teacher: _____ Name: _____

Question 32 (4 marks) **Marks**

(a) What is the photoelectric effect? 1

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(b) Identify the photon postulates of Einstein that are used to explain how the photoelectric effect is dependent on the frequency of incident electromagnetic radiation. 2

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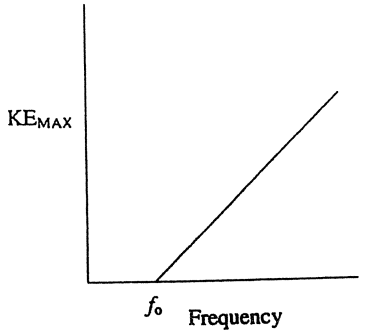
(c) The graph of maximum kinetic energy (of emitted electrons) vs frequency of radiation, shown below, was obtained when the polished surface of a metal was illuminated with light.



On the same axes above, sketch the kinetic energy vs frequency graph for a metal with a higher work function. 1

Section II

Teacher: _____ Name: _____

Total marks (25)

Question 33 – Quantum to Quarks (25 marks) **Marks**

(a) (i) The Balmer series is the line emission spectrum for hydrogen with wavelengths in the visible light range. Sketch a series of lines to represent this spectrum labelling the red line and the end of the spectrum with the highest frequency. 2

(ii) Outline the significance of the hydrogen line spectrum and the work of Max Planck in the development of Bohr's model of the atom. 3

(iii) Calculate the wavelength of the spectral line produced when an excited electron moves from energy level 4 to energy level 2 1

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(b) In this doctoral thesis Louis de Broglie proposed an unconventional view of the electron and his thesis was not accepted until Albert Einstein expressed approval of de Broglie's startling proposal.

(i) State de Broglie's proposal. 1

(ii) Use his proposal to explain the stability of certain electron orbits in the Bohr atom. 2

(iii) Describe how Davisson and Germer were able to provide evidence to support de Broglie's proposal. 3

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(c) Microscopes are either 5

- TEM (Transmission Electron Microscopes)
- SEM (Scanning Electron Microscopes), or
- STM (Scanning Tunnelling Microscopes).

With the aid of suitable diagrams, compare and contrast the operations of two (2) of these and indicate the relative capabilities in terms of resolving power and magnification of one of these compared to an optical Microscope.

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(d) (i) In a typical fission reaction, a neutron of thermal energy collides with a uranium U-235 nucleus. The product nuclei are barium and krypton and a number of neutrons. If the kinetic energy of the colliding neutron is negligible, calculate the energy in MeV carried away by the fission products. 3

Mass of ^{235}U nucleus	=	235.0439 u
Mass of neutron	=	1.0087 u
Mass of ^{141}Ba nucleus	=	140.9139 u
Mass of ^{92}Kr nucleus	=	91.8973 u

(ii) In the last 50 years, the number of radioisotopes used has greatly increased. Name one radioisotope used in industry and describe its application. 2

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