Law

SECONDARY EDUCATION AUTHORITY (WA)

TIARY ENTRANCE EXAMINATION, 1986 - QUESTION/ANSWER BOOKLET

SICS

Please place one of your student identification labels in this box

DENT NUMBER - In figures

In words _____

_____

E ALLOWED FOR THIS PAPER

ding time before commencing: Ten minutes
king time for paper: Three hours

TRUCTIONS TO CANDIDATES

s paper consists of TWO (2) sections.

SECTION A, answer ALL thirty questions, and **write your answers in the ces provided beneath each question.** This section carries 48% of the al marks for the paper. Each of these questions is of equal value.

SECTION B, answer any FOUR (4) of the Five (5) questions, and write r answers in the Standard Answer Book provided. Each of these stions is of equal value and this section is worth 52%. Graph paper provided in the centre of the Standard Answer Book and should be used questions requiring graphical work.

both sections, note that all answers should be given numerically where sible, and that numerical answers should be evaluated and not left in ctional or radical form.

le rules, approved electronic calculators and approved mathematical les may be used to evaluate numerical answers.

pite an incorrect final result, credit may be obtained for method and king, provided these are clearly and legibly set out.

the commencement of this examination, attach one of your STUDENT NTIFICATION labels to the front cover of this Question/Answer Booklet one STUDENT IDENTIFICATION label to the Standard Answer Booklet. te your student number in the spaces provided in each Booklet.

INSTRUCTIONS TO CANDIDATES CONTINUED ON PAGE 2

SEE PAGE 2

STRUCTIONS TO CANDIDATES (cont'd)

the end of the examination, attach this Question/Answer Booklet to the CK of the Standard Answer Booklet with the paper binder provided. ction B, pages 15, 16, 17, 18, 19 and 20 which are perforated, may be moved by students at the end of the examination.

REFER TO PAGE 21 FOR PHYSICAL CONSTANTS

TE: Page 21 is perforated and may be removed for easier use during the examination.

TERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

BE PROVIDED BY THE SUPERVISOR

s Question/Answer Booklet comprising 21 pages (Section A - 30 estions, Section B - 5 questions)
ndard Answer Book (Graph paper provided in the centre)
per Binder

BE PROVIDED BY THE CANDIDATE

ndard Items

s, pencils, eraser, ruler

cial Items

d & Storer Mathematical & Statistical Tables, OR the combined Book of hematical & Statistical Tables and Chemical Data, an approved culator, slide rule, compass, protractor and set square.

TE: Personal copies of Tables/Chemical Data should not contain any handwritten or typewritten notes, symbols, signs, formulae or any other marks (including underlining and highlighting), except the name and address of the candidate, and may be inspected during the examination.

PORTANT NOTE TO CANDIDATES

other items may be taken into the examination room.

is your responsibility to ensure that you do not have any unauthorised es or other items of a non-personal nature in the examination room. ease check carefully and if you have any unauthorised material with you nd it to the supervisor BEFORE reading any further.

SEE PAGE 3

SECTION A

MARKS ALLOTTED : 48

Attempt ALL THIRTY (30) questions in this section. All questions are worth equal marks. Answers are to be written in the spaces provided for each question below or next to the question.

Evaluate answers numerically where possible. Credit will be given for working, if shown. Numerical constants are listed on page 21.

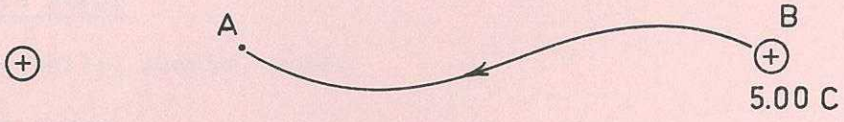
1. A 12.0 volt car battery is capable of supplying a current of 1.52A for 30.0 hours. How much heat energy is produced in completely draining the battery?

2. An electron travelling with a speed of 50.0 m s^{-1} enters a region of uniform magnetic field of strength 0.321 T normally to the field. What is the resulting acceleration of the electron?

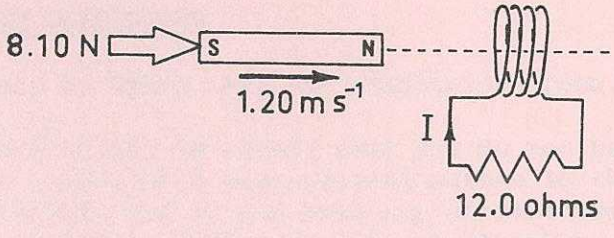
SEE PAGE 4

Sketch the form of the electric field distribution around a pair of equal positive charges as shown in the diagram. Indicate the point where a small test charge may be placed so that it will remain stationary when released.

Two small spheres are positively charged and the work done to bring one of them from point B to the point A as shown in the diagram is 0.765 J. If the charge on the sphere that was moved is 5.00 C what is the potential difference between the points?



A bar magnet is thrust into a coil at a constant speed of 1.20 m s^{-1} by a force of 8.10 N which is also constant. What current flows in a 12.0 ohm resistor connected to the coil as shown?



SEE PAGE 5

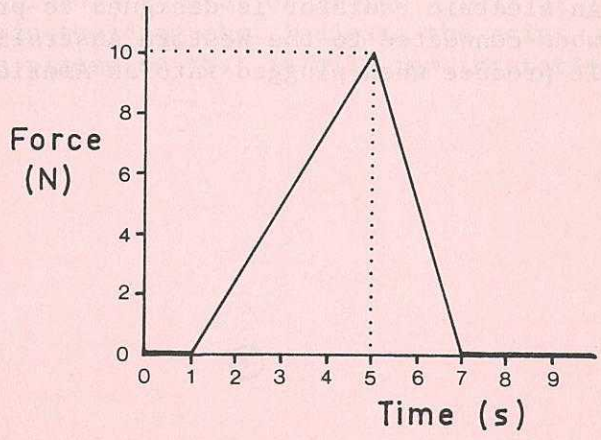
6. An electric radiator is designed to produce heat at the rate of 0.800 kW when connected to the Western Australian 250 V supply. What power will it produce when plugged into an American 110 V supply?

7. In a particle accelerator a 1.00 μA beam of electrons each of energy 255 keV strike a target of lead. Assuming all the kinetic energy of the electrons is converted to heat, how many joules of heat will be produced in 1.00 minute?

8. Explain why a person may swing a bucket containing water in a vertical plane up and over their head without spilling any water.

SEE PAGE 6

The graph at the right shows the relationship between a force and the time that it acts on an object. What impulse did the object gain between t = 0 and t = 8 seconds?



A jet aircraft takes in 75.0 kg of air per second at a velocity of 200 m s^{-1} and after combustion with 1.02 kg of fuel per second the burnt fuel and air are exhausted at 810 m s^{-1}. What forward force is produced by this engine on the moving aircraft?

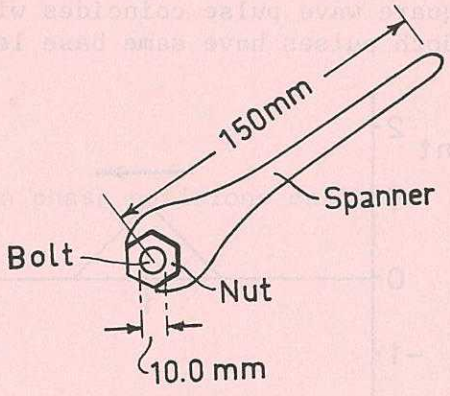
From the formula $g = G\frac{M}{r^2}$ calculate the dimensional units of G.

SEE PAGE 7

12. A tennis ball of mass 50.0×10^{-3} kg is rolled at 2.00 m s^{-1} directly at a stationary solid rubber ball of mass 100×10^{-3} kg. Immediately after the collision, the tennis ball is stationary. What is the solid rubber ball's velocity immediately after impact?

13. A nut is specified to be tightened to a torque of 20.0 N m.

(a) If the bolt is 10.0 mm in diameter what is the tangential force between the bolt and nut?



(b) If a 150 mm length spanner is used, what perpendicular force at the end of the spanner will achieve this torque?

14. Complete the equation shown :

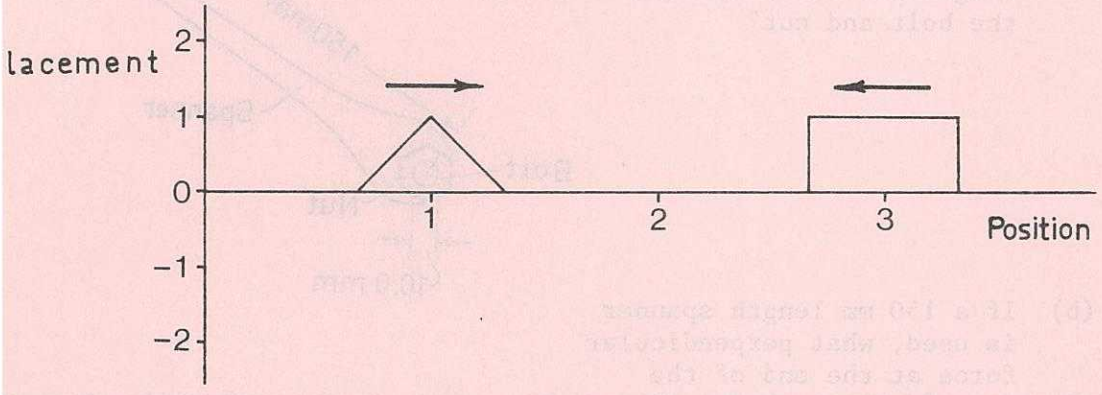
$$ {}^{1}_{0}n + U \rightarrow {}^{236}_{92}U \rightarrow {}^{141}_{56}Ba + Kr + 3\,{}^{1}_{0}n $$

What is the name of the process that the ${}^{236}_{92}U$ has undergone?

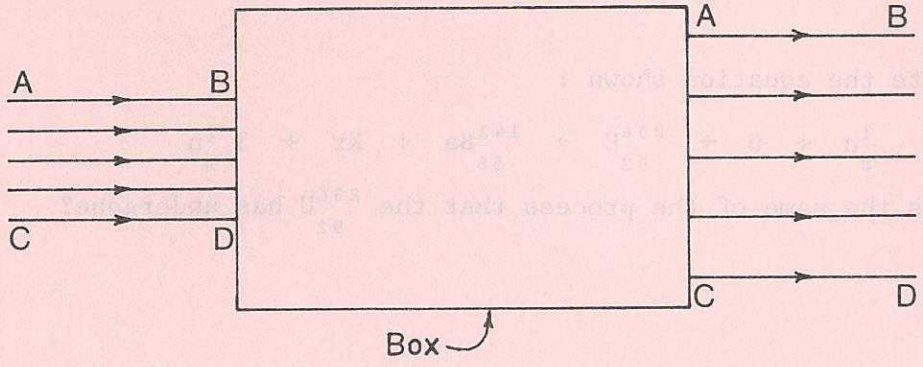
SEE PAGE 8

Light is incident <u>in water</u> on an air-water boundary at an angle of 30.0° to the normal. What are the angles of reflection and refraction?

Two wave pulses travel toward each other at the same speed as shown in the diagram. Sketch the resultant wave at the instant when the centre of the square wave pulse coincides with the tip of the triangular wave pulse. Both pulses have same base length.



An optical system located in a box produces the effect shown in the diagram. What is the simplest optical system that the box can contain? Sketch your answer.



SEE PAGE 9

18. Fill in the missing words.

(a) In a region of stationary waves, nodes indicate _____ vibration of particles.

(b) Light travels _____ in a vacuum than in any other transparent medium.

(c) The time for one complete oscillation of a particle in a wave is called the _____.

(d) When an external vibrating force acts on an oscillator, the condition for maximum amplitude of vibration of the oscillator is called _____.

19. (a) Two microwaves travel through space in the same direction. If the wavelengths are 30.0 mm and 29.0 mm what is the distance between successive in phase positions?

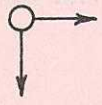
(b) What are these successive in phase positions called?

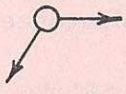
20. Both prisms and gratings may be used to disperse light. What are 2 differences in the appearance of the spectra produced by these methods?

SEE PAGE 10

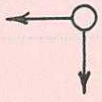
For the next ten questions, choose which of the alternatives best answer the questions and indicate your choice by writing the appropriate letter in the box provided.

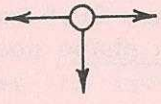
A golfball travels a distance through the air as a result of a very powerful hit. If the ball is travelling to the right which of the diagrams best represents the forces acting on the ball at the highest point of its path?

(a) 

(b) 

(c) 

(d) 

(e) 

A satellite of mass M is orbiting a planet at a velocity V and altitude H above the planet's surface. If a larger satellite of mass 2 M is planned to orbit the same planet also at velocity V, its altitude must be

(a) 2H

(b) $\sqrt{2}$ H

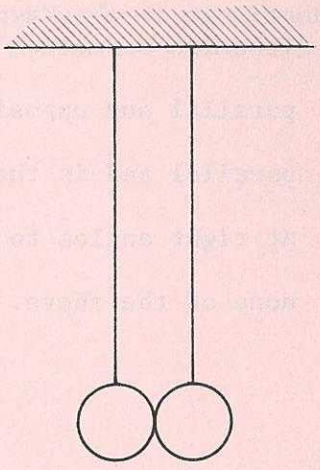
(c) 4H

(d) H

(e) $\frac{H}{\sqrt{2}}$

SEE PAGE 11

23. Two spherical balls of mass M_1 and radius r_1 are suspended and just touch each other with gravitational attraction force F_1. Another two balls of the same material have radius r_2 and mass M_2 ($M_2 = 8M_1$) are also suspended and just touch with gravitational attraction force F_2. The ratio $F_2:F_1$ is



(a) 2:1

(b) 4:1

(c) 8:1

(d) 16:1

(e) 1:2

(f) 1:4

24. A tennis ball of mass 0.050 kg whose weight is 0.490 N is dropped from a height of 1.00 m onto a hard surface and rebounds to a height of 0.800 m. During contact of the ball on the hard surface the reaction force of the surface is

(a) 0.490 N because action and reaction are equal in magnitude.

(b) less than 0.490 N otherwise the ball will be broken and couldn't rebound.

(c) less than 0.490 N otherwise the surface will be damaged.

(d) less than 0.490 N as the ball doesn't rebound to its original height.

(e) greater than 0.490 N as the ball is being accelerated upwards.

SEE PAGE 12

An electron enters a region where there is an electric field and subsequently it is observed that the speed of the electron increases while its direction of motion is unaltered. The motion of the electron was

(a) parallel and opposite to the electric field.

(b) parallel and in the same direction as the electric field.

(c) at right angles to the field.

(d) none of the above.

Two long straight parallel wires are separated by a distance of 0.10 m. The wires each carry a current of 5.0 A. If one current is reversed and changed to 10 A while the distance between the wires is increased to 0.20 m the force between the wires is multiplied by a factor of

(a) 4.0

(b) 1.0

(c) 2.0

(d) -1.0

(e) -2.0

SEE PAGE 13

27. Charges of equal magnitude and opposite sign are placed at two vertices of a triangle as shown. Which of the following best represents the direction of the resultant electric field at the third vertex X?

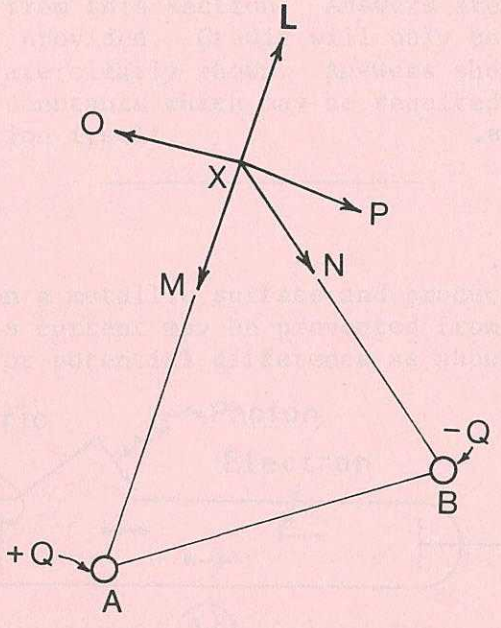
(a) XL

(b) XM

(c) XN

(d) XO

(e) XP



28. A parallel sided sheet of glass (refractive index n_g) separates water (refractive index n_w) from air (refractive index 1.0) as shown in the diagram. A ray of light in the water is incident at an angle θ on the glass and emerges into the air at a grazing angle. Sin θ is

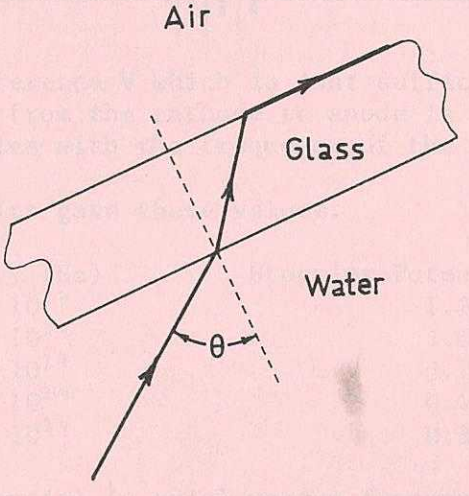
(a) $n_g - n_w$

(b) $\frac{1}{n_g}$

(c) $\frac{1}{n_w}$

(d) $\frac{n_g}{n_w}$

(e) $\frac{n_w}{n_g}$



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Charred wood near an ancient campfire site was found to have only about 1/30 as much of the radioactive isotope carbon 14 as present day wood does. The half-life of carbon 14 is 5730 years. The camp-site age is approximately

(a) 5730 years.

(b) 29000 years.

(c) 171×10^3 years.

(d) 191 years.

(e) 17×10^3 years.

A beam of light passes from a vacuum into glass of refractive index n. If the speed of light in a vacuum is c then the correct expression for the speed of light in the glass is

(a) $\frac{c}{n}$

(b) nc

(c) c

(d) $\frac{n}{c}$

(e) c - n

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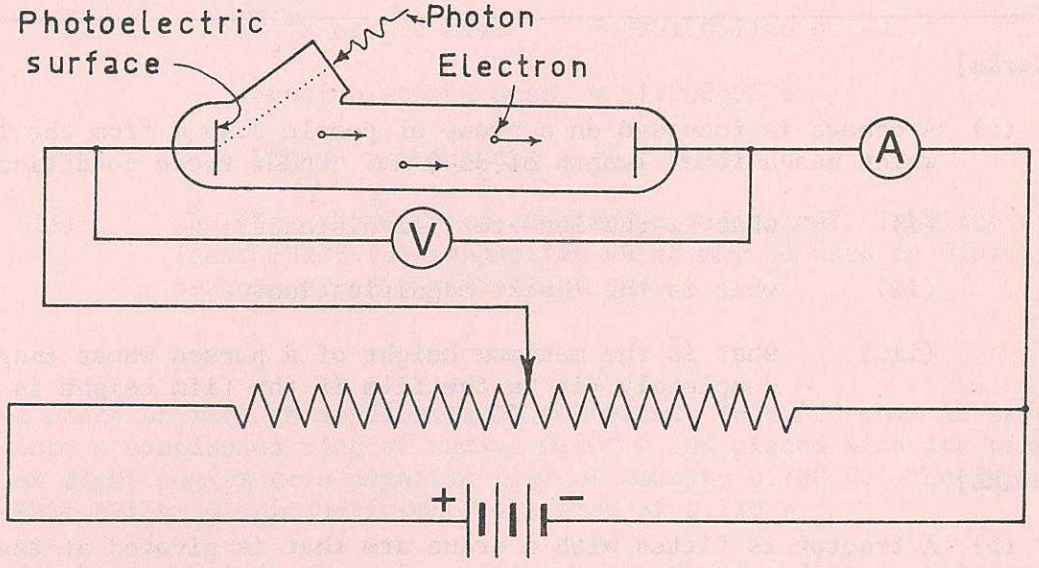
SECTION B

MARKS ALLOTTED : 52

Attempt FOUR questions from this section. Answers are to be written in the Standard Answer Booklet provided. Credit will only be obtained for method and reasoning if these are clearly shown. Answers should be evaluated numerically. Numerical constants which may be required are listed on page **21** and/or within the question itself.

[6 Marks]

1. (a) Light falls on a metallic surface and produces a photoelectric current. This current may be prevented from flowing by using a reverse bias or potential difference as shown in the circuit.



The potential difference V which is just sufficient to prevent electrons passing from the cathode to anode is called the stopping potential and varies with the frequency of the incident radiation.

Experimental results gave these values.

Frequency (Hz)	Stopping Potential (Volts)
7.50×10^{14}	1.28
6.90×10^{14}	1.04
6.10×10^{14}	0.70
5.50×10^{14}	0.46
5.18×10^{14}	0.32

Plot stopping potential (y axis) versus frequency (x axis) and determine (from graph or otherwise)

(i) threshold frequency and wavelength.
(ii) work function of the surface.

NOTE: QUESTION 1 (b) COMMENCES ON PAGE 16

SEE PAGE 16

rks]

(b) Two small spheres each of mass 0.200×10^{-3} kg hang by light threads from a support point. The threads are each 0.700 m long. When equal charges are placed on the spheres they separate so that the angle between the threads is 30.0°.

(i) What is the magnitude of the charge on either sphere?

(ii) If the charge on one sphere is halved and the other is doubled what is the change in the angle between the threads?

(iii) If a thick plastic slab is placed in the space between the charged spheres, will the angle between the threads change? Elaborate on your answer.
[No calculations are necessary.]

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rks]

(a) A camera is focussed on a group of people 3.45 m from the lens which has a focal length of 35.0 mm. Under these conditions

(i) what is the lens to film distance?

(ii) what is the linear magnification?

(iii) what is the maximum height of a person whose image can completely fit on the film if the film height is 0.0240 m?

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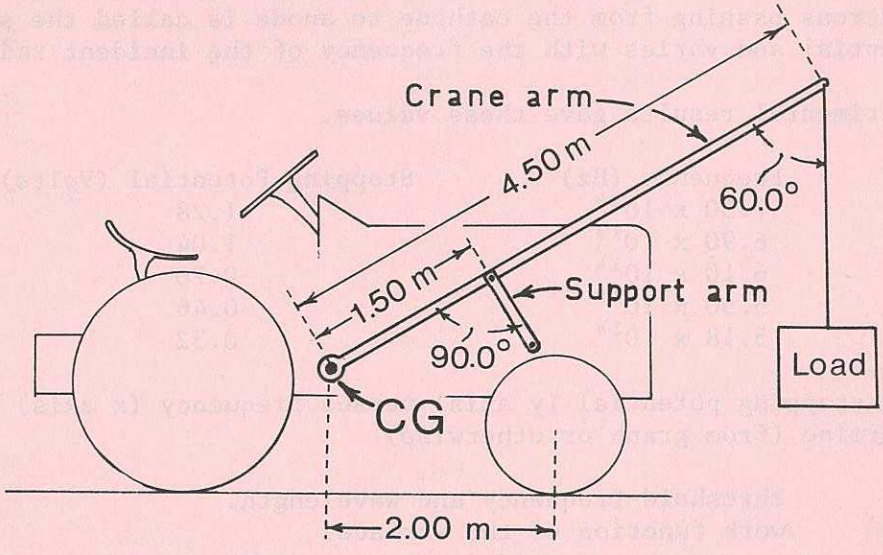
(b) A tractor is fitted with a crane arm that is pivoted at the tractor's centre of gravity.



SEE PAGE 17

2. (b) (Cont'd).

(i) What force is exerted by the support arm on the crane arm when a 1.00×10^3 kg load is hung from the end of the crane arm?

(ii) If the tractor's mass is 4.00×10^3 kg what is the maximum load which can be hung from the end of the crane arm, without the tractor tipping over?

(iii) Explain why the tractor will continue to tip over once the maximum load is exceeded.

[6 Marks]

3. (a) (i) Calculate the binding energy in MeV per nucleon for $^{232}_{92}U$.

$^{232}_{92}U$ atomic mass = 232.037140 u

Neutron atomic mass = 1.008665 u

Proton atomic mass = 1.007825 u

(ii) What are the natures of α and β radiation? Tabulate at least THREE (3) properties which may be used to distinguish between α and β radiation.

[7 Marks]

(b) A piece of wire whose electrical resistance is 0.300 ohms is made into a continuous ring of radius 0.200 m and placed with its plane at right angles to a magnetic flux of density 0.700 T. The flux then falls to zero uniformly in a time of 0.130 s.

(i) What is the value of the induced emf and the resulting current in the ring?

(ii) Sketch a graph to show the way in which the current in the ring varies with time, before, during and after the decay of the flux. Label and scale axes.

(iii) How much heat is produced in the wire?

(iv) How does the amount of heat produced vary with the time taken for the flux to fall to zero? Justify your answer.

(v) If the resistance of the wire had been 0.150 ohms how much heat would have been generated?

SEE PAGE 18

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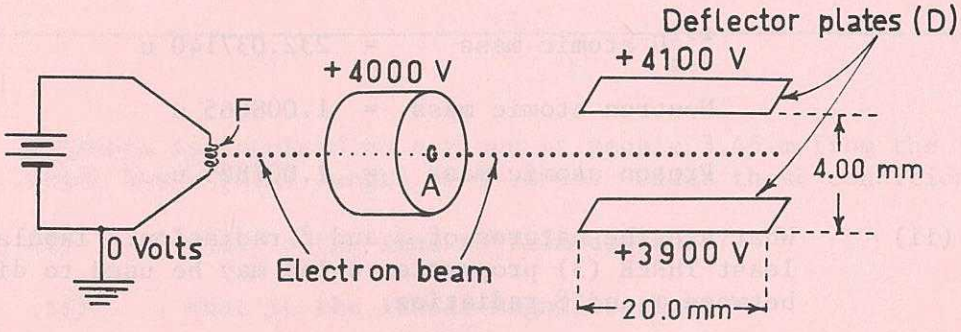
(a) An electron is emitted from the filament (F) of a cathode ray tube as shown diagrammatically below and is accelerated towards the anode (A) which is maintained at a potential of +4000 V. If the filament is maintained at earth potential and the electron is emitted with negligible initial velocity

(i) what is its energy (in eV) when it reaches the anode?
(ii) what is its velocity at this point?

The electron passes through a small hole in A and enters the region between the parallel deflector plates (D), length 20.0 mm and separation distance 4.00 mm whose voltages are both maintained at +4000 V.



(iii) What is the time taken for the electron to pass through the deflector plates?

(iv) If one deflector plate had a voltage of +4100 V and the other +3900 V, calculate the transverse velocity acquired by the electron whilst passing through the deflector plates.

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(b) Astronomers observe the planet Jupiter which has a moon Io which takes 42.1 hours to make a circular orbit of the planet. They estimate the orbit's radius to be 4.20×10^5 km.

(i) What is Io's orbital speed?

(ii) What is the mass of the planet Jupiter?

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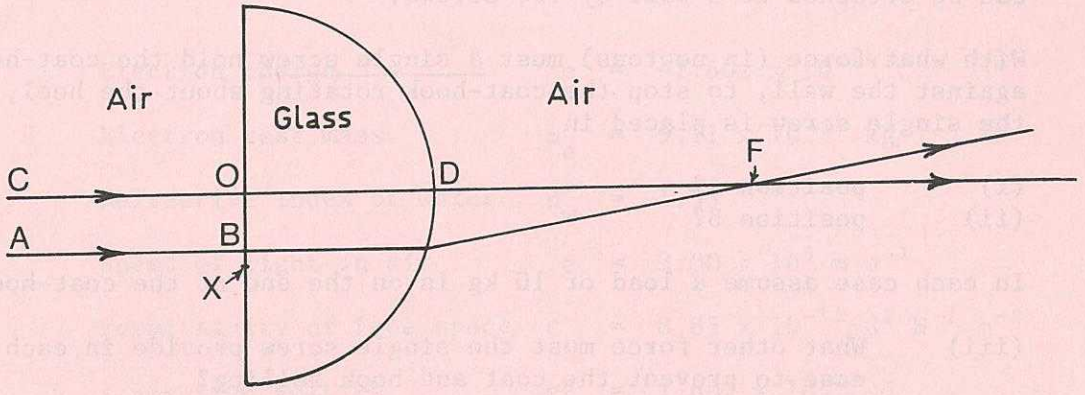
[7 Marks]

5. (a)



Two rays of light CO and AB pass through a lens of semicircular cross section as shown. These emergent rays pass through a focal point F.

If COF is the principal axis of this lens, OD is the radius of curvature of length 10.0 mm, distance OB is 3.00 mm and the refractive index of the glass is 1.52 then

(i) calculate the distance OF.

(ii) If another ray parallel to AB and CO passes through the lens at point X, approximately where does it cross the principal axis? There is no need to calculate this position.

(iii) What is this lens defect called?

(iv) How may this lens defect be reduced?

NOTE: QUESTION 5 (b) COMMENCES ON PAGE 20

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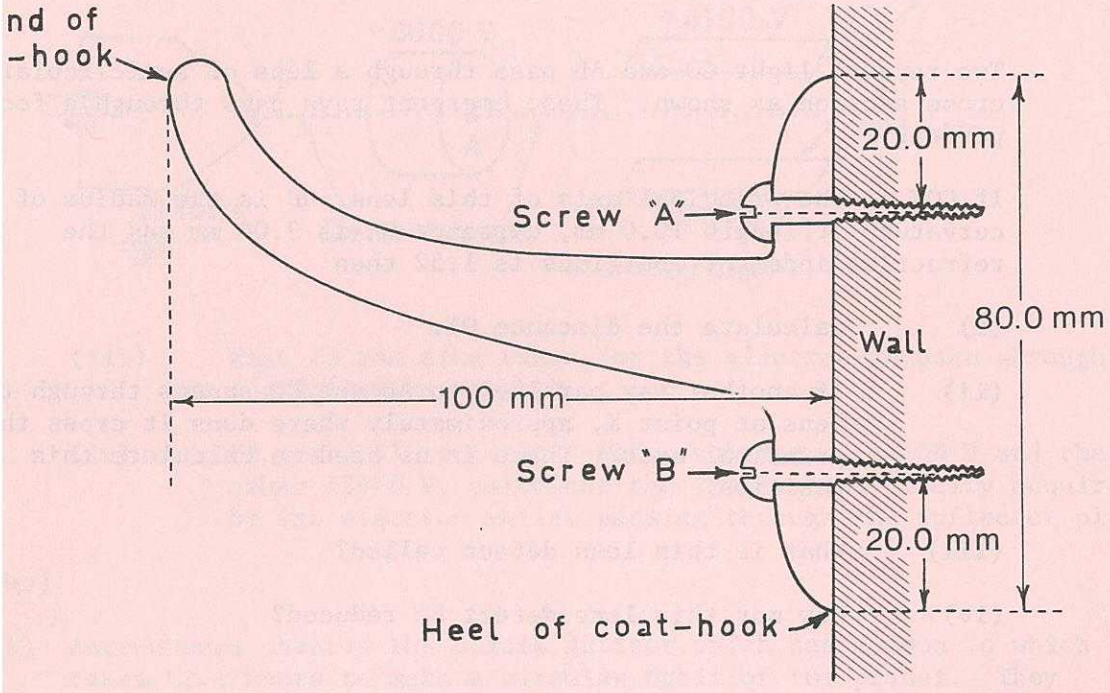
b) A light coat-hook, designed to support a maximum mass of 10.0 kg, can be attached to a wall by two screws.

With what force (in newtons) must a single screw hold the coat-hook against the wall, to stop the coat-hook rotating about the heel, if the single screw is placed in

(i) position A?
(ii) position B?

In each case assume a load of 10 kg is on the end of the coat-hook.

(iii) What other force must the single screw provide in each case to prevent the coat and hook falling?



END OF PAPER

REFER TO PAGE 21 FOR PHYSICAL CONSTANTS.

SEE PAGE 21

PHYSICAL CONSTANTS

The following physical constants should be used where necessary :

Electron charge	e	=	-1.602×10^{-19} C
Electron rest mass	m_e	=	9.11×10^{-31} kg
Refractive index of water	n_w	=	1.33
Speed of light in air	c	=	3.00×10^{8} m s^{-1}
Permittivity of free space	ε_o	=	8.85×10^{-12} C^2 N^{-1} m^{-2}
1 electron volt eV	eV	=	1.602×10^{-19} J
1 atomic mass unit	u	=	1.661×10^{-27} kg
Refractive index of air	n_a	=	1.00
Acceleration due to gravity	g	=	9.80 m s^{-2}
Universal gravitational constant	G	=	6.67×10^{-11} N m^2 kg^{-2}
Planck's constant	h	=	6.63×10^{-34} J s