WESTERN AUSTRALIA

QUESTION/ANSWER BOOKLET

TERTIARY ADMISSIONS EXAMINATION, 1984

PHYSICS

Please place one of your Candidate Identification lables in this box

CANDIDATE'S NUMBER - In figures

In words _____

_____

TIME ALLOWED FOR THIS PAPER

Reading time before commencing: Ten minutes
For working of paper: Three hours

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR

This Question/Answer Booklet comprising 21 pages (Section A - 30 questions, Section B - 5 questions)
Standard Answer Book (Graph paper provided in the centre)
Paper Binder

TO BE PROVIDED BY THE CANDIDATE

Standard Items

Pens, pencils, eraser, ruler

Special Items

Hood & Storer Mathematical & Statistical Tables, OR the Combined Book of Mathematical & Statistical Tables and Chemical Data, an approved calculator, slide rule, compass, protractor and set square.

NOTE: Personal copies of Tables/Chemical Data should not contain any handwritten or typewritten notes or other marks and may be inspected at the examination.

*** IMPORTANT NOTE TO CANDIDATES ***

No other items may be taken into the examination room.

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

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'RUCTIONS TO CANDIDATES

; paper consists of two sections.

ECTION A , answer ALL thirty questions, and write your answers in the es provided beneath each question in SECTION A of this Question/Answer let. This section carries 48% of the total marks for the paper. of these questions is of equal value.

ECTION B, answer any FOUR of the five questions, and write your answers he Standard Answer Book provided. Each of these questions is of equal ie and this section is worth 52%. Graph paper is provided in the re of the Standard Answer Book and should be used for questions iiring graphical work.

oth sections, note that all answers should be given numerically where ible, and that numerical answers should be evaluated and not left in tional or radical form.

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

lit may be obtained for method and working, despite an incorrect final ilt, if these are clearly and legibly set out.

he commencement of this examination, attach one of your CANDIDATE NTIFICATION labels to the front cover of this Question/Answer Booklet one CANDIDATE IDENTIFICATION label to the Standard Answer Book. Write candidate number in the spaces provided in each Booklet.

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

REFER TO PAGE 21 FOR PHYSICAL CONSTANTS

SEE PAGE 3

SECTION A

MARKS ALLOTTED : 48

Attempt ALL thirty 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. Reasonable approximations are acceptable and credit will be given for working, if shown. Numerical constants are listed on page 21.

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1. Consider two displacements, one of magnitude 4.44 m and another of magnitude 3.33 m. Sketch (no detailed calculation required) how the displacement vectors may be combined to give a resultant magnitude of

   (i) 7.77 m

   (ii) 1.11 m

   (iii) 5.55 m

   (iv) 6.66 m

2. A 55.5 kg student runs up a flight of stairs having an overall vertical height of 4.50 m. If the time taken was 3.50 s what average power did the student supply?

SEE PAGE 4

A swinging pendulum eventually comes to rest. Is this a violation of the law of conservation of energy? Explain.

A glass cube of edge length "a" m contains an air bubble of volume "b" m^3. If the density of the glass is "ℓ" kg m^{-3} and that of the air "i" kg m^{-3} find the expression for the average overall density of the glass cube.

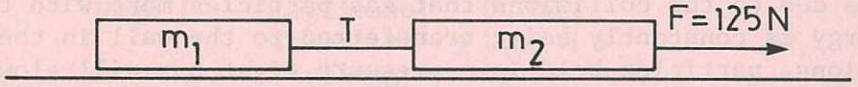
The speed of an object is given by the equation

$$v = 2\pi f \sqrt{A^2 - x^2}$$

where f is frequency, A is amplitude and x is displacement. Show whether or not this equation is dimensionally correct.

SEE PAGE 5

6. Two blocks on a smooth horizontal table are connected by a cord as shown. They are pulled to the right with a force of 125 N.



If block m_1 has a mass of 3.75 kg and m_2 a mass of 6.25 kg find

(i) the nett acceleration of the blocks,

(ii) the tension T in the cord between the blocks.

7. Two parallel metal plates sealed in an evacuated chamber are 25.0×10^{-3} m apart and have a potential difference of 8.00×10^{2} V. An electron initially at rest on one plate moves to the other plate. With what velocity does this electron strike the second plate?

8. What electric field strength exists midway between the two plates of question 7?

SEE PAGE 6

Criticise the following statements.

In the kinetic theory of gases the pressure that a gas exerts on a wall is due to the collisions that gas particles make with the wall. As energy is constantly being transferred to the wall in these collisions, particles held in a pressure tight box will slowly lose energy. As temperature is directly proportional to the energy of these particles the gas will slowly cool towards absolute zero.

An electric element is used to melt ice. When the element is connected to a 12.0 volt battery it is found to draw a steady current of 5.00 amps. What is the minimum time needed to melt 0.100 kg of ice at $0.00^{o}C$ using this battery?

An observer in a boat noticed that large, long wavelength waves tended to bend around a pole in the river, while very small ripples on the surface of the water were completely blocked by the pole. Explain.

SEE PAGE 7

12. Two wave trains are travelling in water at the same time. The characteristics of the two wave trains are

Wave 1	Amplitude	0.200 m
	Velocity	$+1.00\ m\ s^{-1}$
	Wavelength	1.00 m
Wave 2	Amplitude	0.100 m
	Velocity	$+1.00\ m\ s^{-1}$
	Wavelength	1.00 m

Find the resultant amplitude, velocity and frequency as the two waves interact given that the relative phase difference between them is 180^{o}.

13. A microscope is fitted with a red and blue filter on its light source. It is found that the user must adjust the focus when the specimen illumination is changed from red light to blue light. What is the most likely explanation of this?

SEE PAGE 8

A person uses a convex (converging) lens as a magnifying glass to look at an insect which is 0.150 m from the lens. The virtual image has a magnification of 4.00 times. What is the focal length of the lens?

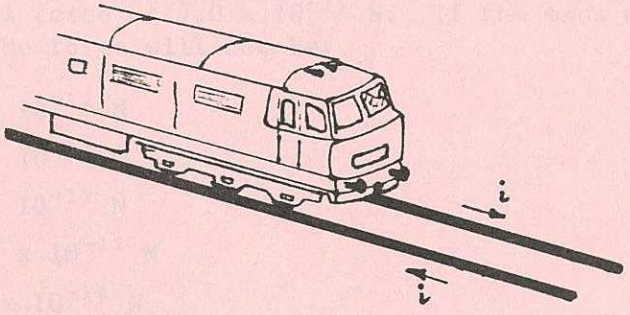
Calculate the longest wavelength of the light emitted as a result of electron transitions between energy levels of 1.98×10^{-19} J, 4.86×10^{-19} J and 8.65×10^{-19} J in an atom.

After 32 seconds the number of disintegrations per second of a radio-active material drops to one thirty secondth of its initial value. Calculate the half life of the material. Give your answer to 2 significant figures.

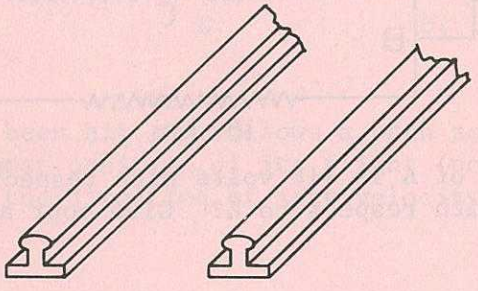
SEE PAGE 9

17. A model train locomotive draws direct current from one rail and returns this current through the other rail. The rails are 1.60×10^{-2} m apart and the locomotive is drawing 300 m A of current.

What is the force per metre length of rail between the two rails due to the 300 m A current?

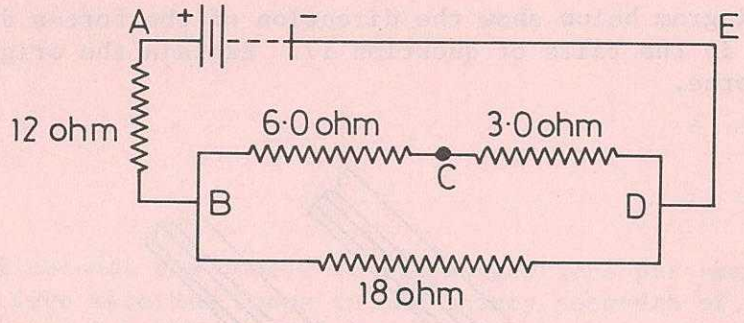


18. On the diagram below show the direction of the forces due to the currents in the rails of question 17. Explain the origin of either force.



SEE PAGE 10

A jumbo jet has a wing span of 59.6 m (from one wing tip to the other wing tip). It is flying in a westerly direction at 936 km per hour in a region where the vertical earth's magnetic field is 5.10×10^{-6} T. What potential difference exists between the wing tips?



If the potential of A is +18 volts with respect to E, what is the potential of C with respect to E? Give your answer to 2 significant figures.

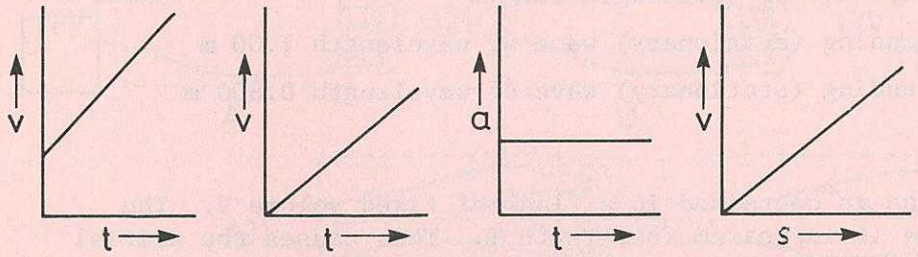
SEE PAGE 11

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.

21. Two stationary spherical bodies attract each other with a gravitational force of 7.0×10^{-12} N. If the mass of each body is tripled the force will now be:

A. 21×10^{-12} N
B. 63×10^{-12} N
C. 42×10^{-12} N
D. 0.77×10^{-12} N
E. 2.3×10^{-12} N

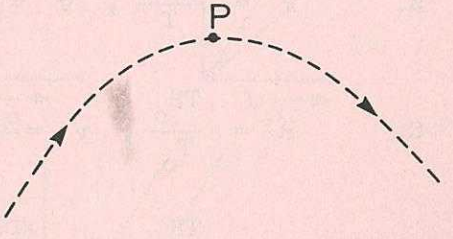
22. The graph representing motion with a variable acceleration is:



A. B. C. D. E. None of these

23. A golf ball has been hit and follows a path as shown. When the ball is at the uppermost position of its flight (point P) the set of vectors showing the direction of nett velocity, acceleration and force is:

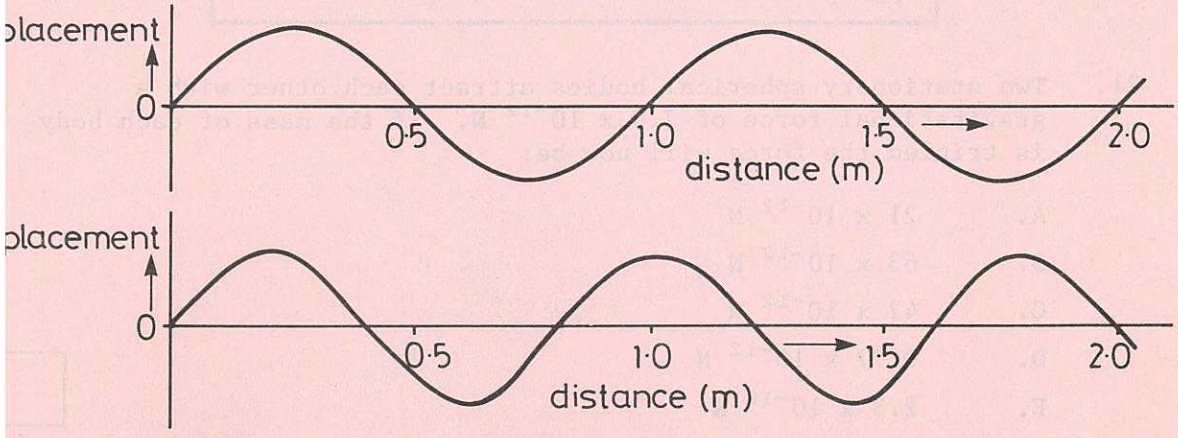
	v	a	F
A.	→	→	→
B.	0	→	→
C.	→	0	↓
D.	→	↓	↓
E.	→	0	0



0 indicates zero

SEE PAGE 12

. If the two wave motions shown in the graphs below are travelling in the same medium in the same direction at the same time with a velocity of +1.00 m s^{-1} and interfere with each other, then the resultant causes a:



A. complete cancellation at every point

B. beat frequency of 0.25 Hz

C. beat wave of wavelength 5.00 m

D. standing (stationary) wave of wavelength 1.00 m

E. standing (stationary) wave of wavelength 0.800 m

. An ideal gas is contained in a flask of fixed volume V. The temperature is increased from T_o to T. This causes the initial pressure P_o to change to P, the initial average particle speed v_o to change to v and the initial frequency of wall collisions of the particles to change from f_o to f.

The correct set of equations for these changes is:

A. $P = \frac{TP_o}{T_o}$, $v = v_o\sqrt{\frac{T}{T_o}}$, $f = f_o\sqrt{\frac{T_o}{T}}$

B. $P = \frac{T_o P_o}{T}$, $v = v_o\sqrt{\frac{T_o}{T}}$, $f = f_o\sqrt{\frac{T_o}{T}}$

C. $P = \frac{TP_o}{T_o}$, $v = v_o\sqrt{\frac{T}{T_o}}$, $f = f_o\sqrt{\frac{T}{T_o}}$

D. $P = \frac{TP_o}{T_o}$, $v = v_o\sqrt{\frac{T_o}{T}}$, $f = f_o\sqrt{\frac{T}{T_o}}$

SEE PAGE 13

26. A parallel beam of light of diameter 2.00×10^{-3} m passes through the centre of a lens of focal length $+15.0 \times 10^{-3}$ m. Immediately after it passes through the lens the light:

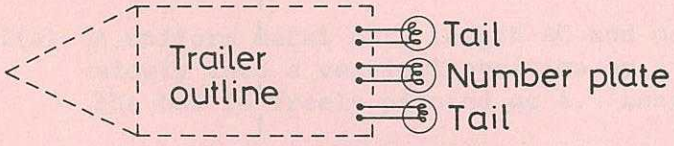
A. continues as a parallel beam

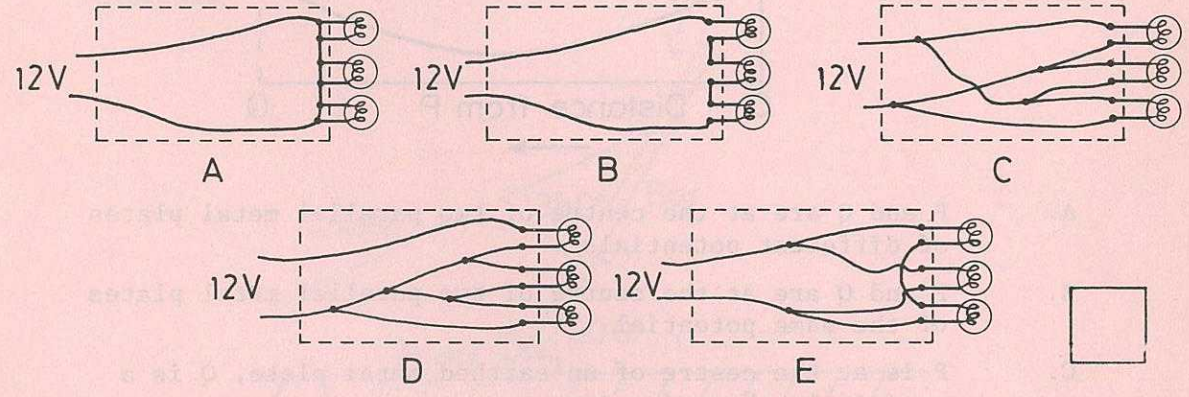
B. converges with a total angular width of 1.24^{o}

C. diverges with a total angular width of 2.16×10^{-2} radians

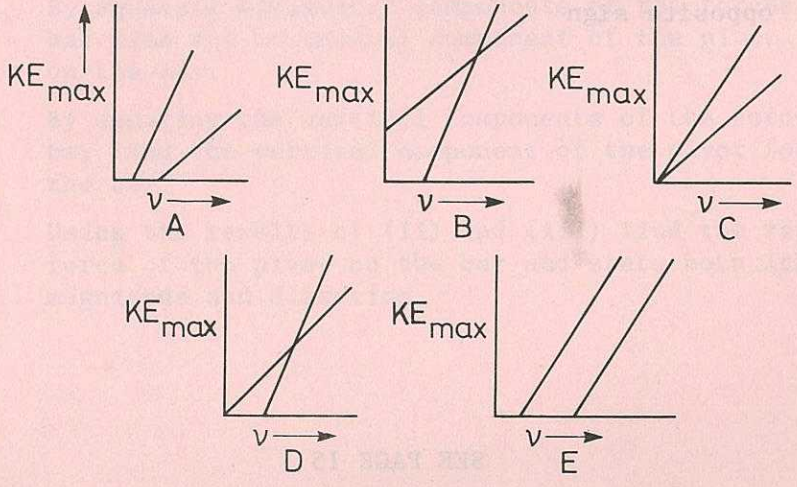
D. converges with a total angular width of 7.63^{o}

27. A car trailer has 2 tail lights and a number plate light (all to operate off 12 volts). The circuit which will correctly light all globes when connected to the car's 12 volt supply is:





28. For the photoelectric effect when graphing the relationship of maximum KE of emitted electrons and incident radiation frequency for TWO different metals the expected graph would be:



SEE PAGE 14

If $^{9}_{4}Be$ + unknown → $^{13}_{6}C$ + hν the unknown is:

A. α particle

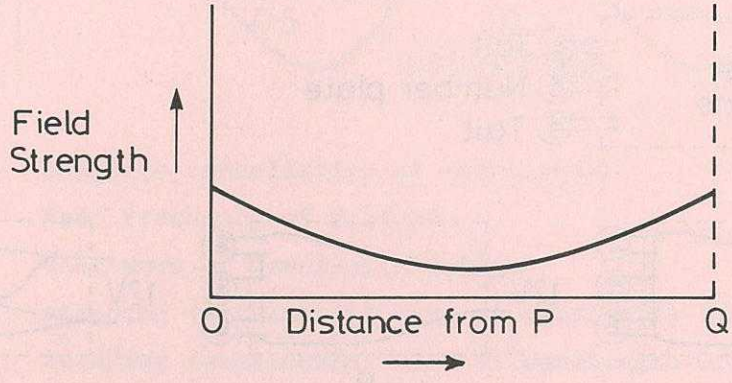
B. β particle

C. γ radiation

D. proton

E. neutron

The electric field strength along a straight line from P to Q gave the graph shown here. The situation which would produce this graph is:



A. P and Q are at the centre of two parallel metal plates of different potentials

B. P and Q are at the centre of two parallel metal plates of the same potential

C. P is at the centre of an earthed metal plate, Q is a positively charged point

D. P and Q are point charges of identical sign and magnitude

E. P and Q are point charges of identical magnitude but opposite sign

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SECTION B

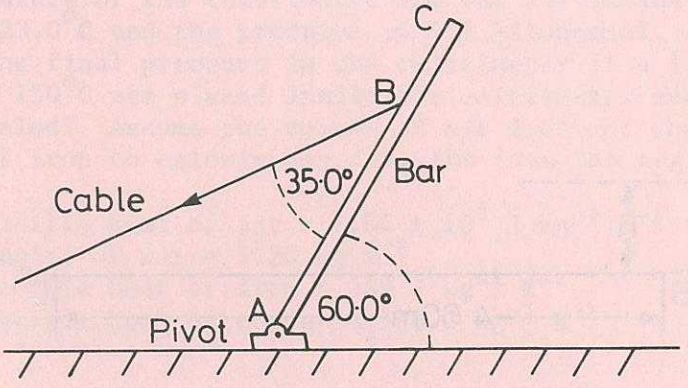
MARKS ALLOTTED : 52

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.

(8 marks)

1(a) A uniform metal bar, length AC and mass 512 kg is being hoisted slowly into a vertical position by a cable attached to point B. The bar is freely pivoted at A. Lengths AB = 6.00 m and BC = 2.00 m.

The angular position of the bar and the cable is shown in the diagram.



(i) Take moments about the pivot point A and calculate the tension T in the cable.

(ii) By equating horizontal components of the forces on the bar find the horizontal component of the pivot force on the bar.

(iii) By equating the vertical components of the forces on the bar find the vertical component of the pivot force on the bar.

(iv) Using the results of (ii) and (iii) find the resultant force of the pivot on the bar and state both its magnitude and direction.

SEE PAGE 16

rks)

Explain why fusion of two deuterium atoms ($_1^2H$) to form a helium atom is an energy producing reaction but fission of a single uranium atom to form several atoms and particles is also energy producing. Use graphs and diagrams to help you answer the question.

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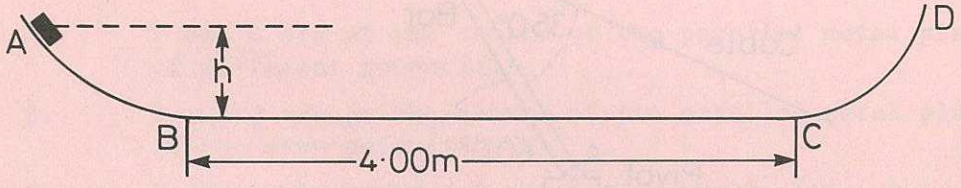
rks)

A particle of mass 0.125 kg slides along a track with elevated ends and a flat central part as shown in the diagram. The flat part BC has a length of 4.00 m.

The curved portions of the track are frictionless. For the flat portion the kinetic friction force has a constant value of 0.245 N. The particle is released at point A which is at a height of h = 1.00 m above the flat part of the track.



(i) What is the kinetic energy at point B?

(ii) What is the kinetic energy at point C?

(iii) At what point does the particle finally come to rest?

(iv) If the entire track were frictionless describe the behaviour of the particle.

SEE PAGE 17

(6 marks)

(b) (i) A fuse wire 50.0×10^{-3} m long is rated to "blow" (i.e. melt) at 15.0 amperes and average temperature 675°C. What would be the minimum time for this wire to heat from room temperature of 15.0°C to 675°C given that the:

fuse wire mass is 2.25×10^{-3} kg m^{-1}
fuse wire resistivity is 2.00×10^{-6} ohm m
fuse wire specific heat is 200 J kg^{-1} K^{-1}
fuse wire cross sectional area is 2.00×10^{-7} m^2

(ii) In practice why is this unlikely to be the exact time of melting?

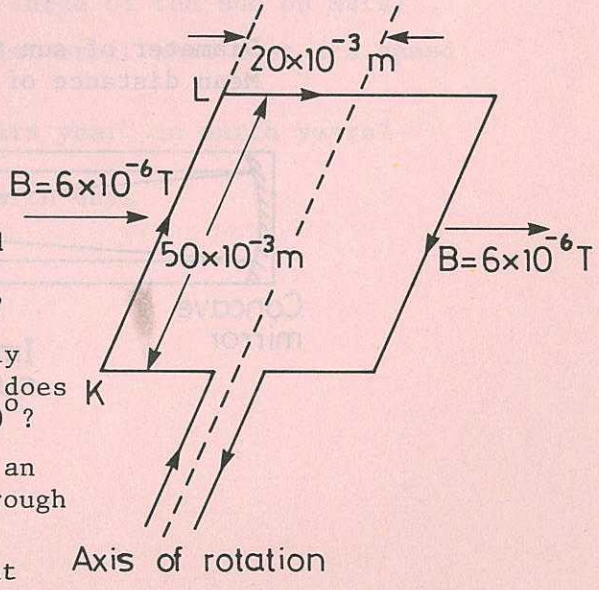
(8 marks)

3(a) A copper calorimeter of mass 250×10^{-3} kg has a pressure tight lid. The volume contained by the calorimeter is 10.0×10^{-3} m^3. The temperature of the calorimeter and the air inside it is initially 23.0°C and the pressure is 101 kilopascal. What would be the final pressure in the calorimeter if a 1.00 kg mass of iron at 150°C was placed inside the calorimeter and it was quickly sealed? Assume the volume of air does not change on addition of iron to calorimeter i.e. the iron has negligible volume.

specific heat of air = 1.04×10^3 J kg^{-1} K^{-1}
density of air = 1.20 kg m^{-3}
specific heat of iron = 449 J kg^{-1} K^{-1}
specific heat of copper = 386 J kg^{-1} K^{-1}

(5 marks)

(b) A rectangular wire loop has dimensions as shown. If the horizontal (from left to right) magnetic field has a strength of 6.00×10^{-6} T.



* (i) What force is experienced by KL when a current of 5.00 A flows in the loop?

(ii) If the loop rotates slowly about the axis shown, why does it only rotate through 90°?

(iii) Why does the armature of an electric motor rotate through more than 90°?

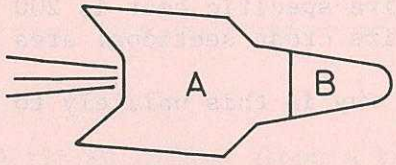
* Give your answer to 2 significant figures.

SEE PAGE 18

marks)

) A space rocket consists of two parts as shown. Part A supplies the thrust while Part B the cone may be detached from A when the fuel is exhausted.

Away in outer space the overall acceleration of A and B is 1.00 m s^{-2}.



If the mass of A is 525 kg and that of B 475 kg determine

(i) the overall force on A and B

(ii) the force of A on B

(iii) the force of B on A

(iv) the nett force on A only

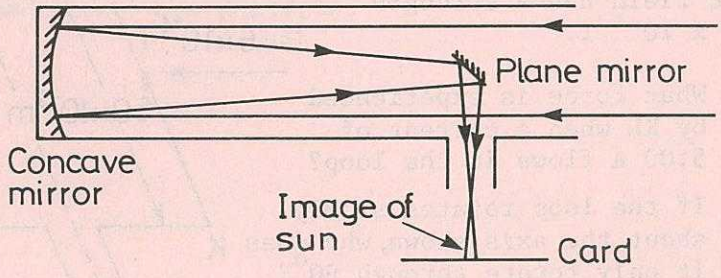
marks)

) An astronomical telescope is used to project an image of the sun onto a card as shown. The concave mirror used in the telescope had a radius of curvature of 1.50 m.

(i) Find the total distance of the image from the concave mirror.

(ii) What is the size of the image?

Diameter of sun = 1.39 x 10^9 m
Mean distance of earth from sun = 1.49 x 10^{11} m



SEE PAGE 19

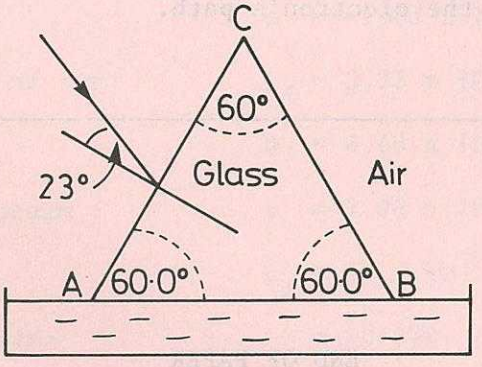
(5 marks)

(c) A parallel beam of light is incident on a glass prism at an angle of 23.0^{o} as shown. The volume beneath the prism can be filled with various fluids so that the fluids will contact the glass. Describe the path of the beam when the volume is occupied with

(i) water

(ii) air

Consider only the effect of interfaces AC and AB



(6 marks)

5(a) The mass of the planet Mars is 0.646×10^{24} kg and that of the sun 1.99×10^{30} kg. The mean distance between them is 228×10^{9} m.

(i) What is the gravitational force of the sun on Mars?

(ii) Assuming Mars has a circular orbit what must its speed be for a stable orbit?

(iii) What is the time for a "Mars year" in earth years?

1 earth year = 365 earth days

SEE PAGE 20

rks)

A fine electron beam enters a region at a speed of 6.00×10^6 m s^{-1} and is suddenly influenced by a field.

(i) Explain how the electron beam is affected if the field is magnetic and

(A) perpendicular to the beam
(B) parallel to the beam

(ii) If the electron beam of speed 6.00×10^6 m s^{-1} enters an electric field of strength 1.00×10^3 V m^{-1} parallel to the electron beam and in the same direction as the beam, calculate the electron's path.

END OF PAPER

REFER TO PAGE 21 FOR PHYSICAL CONSTANTS

SEE PAGE 21

PHYSICAL CONSTANTS

The following physical constants should be used where necessary:

Acceleration due to gravity (at the Earth's surface)	$g = 9.80 \text{ m s}^{-2}$
Refractive index of air	$n_a = 1.00$
Refractive index of glass	$n_g = 1.52$
Refractive index of water	$n_w = 1.33$
Mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
Latent heat of fusion of ice	$L_i = 3.33 \times 10^{5} \text{ J kg}^{-1}$
Planck's constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Speed of light in a vacuum	$c = 3.00 \times 10^{8} \text{ m s}^{-1}$
Permeability of air	$\mu_o = 4\pi \times 10^{-7} \text{ m kg C}^{-2}$
Absolute zero temperature	$= -273^{\circ}\text{C}$
Universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$