QUESTION/ANSWER BOOKLET

ɪRY ADMISSIONS EXAMINATION, 1985

ɪCS

Please place one of your Candidate Identification labels in this box.

)ATE'S NUMBER - In figures

- In words

ɪLLOWED FOR THIS PAPER

ɪg time before commencing : TEN (10) MINUTES
)rking of paper : THREE (3) HOURS

ɪAL REQUIRED/RECOMMENDED FOR THIS PAPER

PROVIDED BY THE SUPERVISOR

ɪs Question/Answer Booklet comprising 21 pages (Section A - 30 questions, ɪtion B - 5 questions).
ɪndard Answer Book (Graph paper provided in the centre).
)er Binder.

PROVIDED BY THE CANDIDATE

ɪndard Items

ɪs, pencils, eraser, ruler

ɪcial Items

)d & Storer Mathematical & Statistical Tables, OR the Combined Book of ɪhematical and Statistical Tables and Chemical Data, an approved ɪculator, slide rule, compass, protractor and set square.

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

*ɪPORTANT NOTE TO CANDIDATES ****

ɪer items may be taken into the examination room.

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

SEE PAGE 2

RUCTIONS TO CANDIDATES

paper consists of TWO (2) sections.

ECTION A, answer ALL thirty questions, and write your answers in the es provided beneath each question. This section carries 48% of the 1 marks for the paper. Each of these questions is of equal value.

ECTION B, answer any FOUR (4) of the Five (5) questions, and write your ers in the Standard Answer Book provided. Each of these questions is of 1 value and this section is worth 52%. Graph paper is provided in the re of the Standard Answer Book and should be used for questions requiring hical 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.

e rules, approved electronic calculators and approved mathematical tables be used to evaluate numerical answers.

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

he commencement of this examination, attach one of your CANDIDATE TIFICATION 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 17, 18, 19 and 20 which are perforated, may be removed by ents at the end of the examination.

REFER TO PAGE 21 FOR PHYSICAL CONSTANTS.

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

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.

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1. Three resistors of resistances 1.00 ohm, 2.00 ohms and 3.00 ohms are connected in parallel across a constant voltage supply. Calculate the ratio

$$\frac{\text{Current through the 1.00 ohm resistor}}{\text{Current through the 2.00 ohm resistor}}.$$

2. The potential difference between a cloud and the earth of 1.00×10^{9} V results in a lightning flash during which 40.0 C of charge flows in 1.11×10^{-2} seconds. Calculate the average current.

SEE PAGE 4

A copper loop and an iron loop of the same size and shape are placed in a uniform magnetic field perpendicular to the plane of the loops. The magnetic field is gradually increased. Discuss

(i) the emf's induced in the two loops

(ii) the currents induced in the two loops

given that the resistivity of iron is greater than that of copper.

What is the strength of an electric field that exerts a force of 3.20×10^{-16} N on an electron?

Two wires of the same length and diameter are connected in turn between two points maintained at constant potential difference. Will heat energy be developed at the faster rate in the wire of

(i) smaller resistance?

(ii) larger resistance?

Explain your answer.

SEE PAGE 5

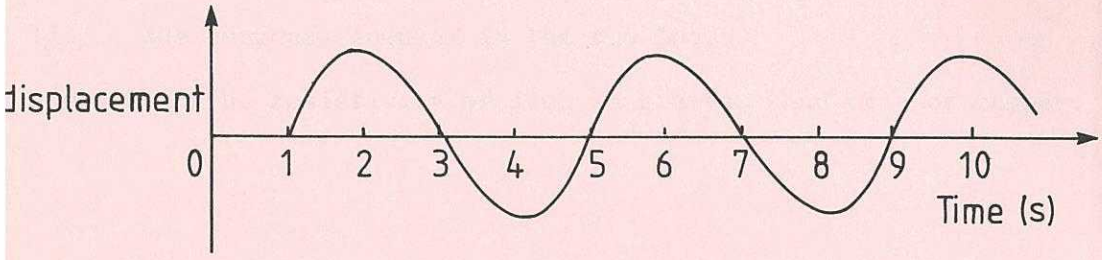
6. Describe the difference between the spectra produced by a red hot iron poker and a red neon discharge tube.

7. Explain the role which the "work function" of a material plays in the photoelectric effect.

8. Explain why people in adjacent rooms may not be able to see one another, but they can still hear one another talking quite clearly through an open doorway.

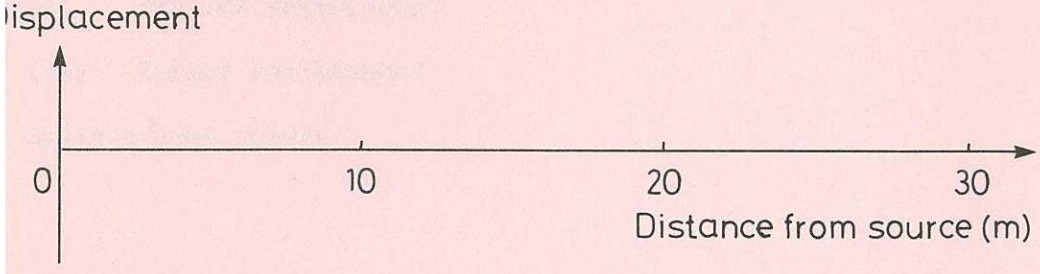
SEE PAGE 6

following diagram refers to questions 9 and 10 and illustrates the ion of a particle J.



Given that the velocity of the wave is $4.00\ m\ s^{-1}$ in this medium, how far is J from the point source, assuming the wave motion commenced at the source at time t = 0 seconds?

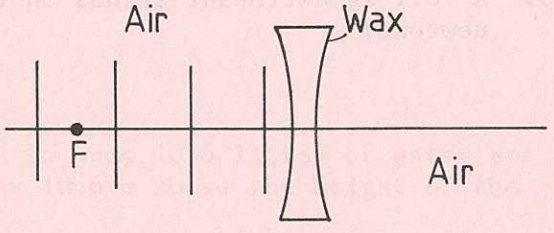
From the above information and knowing the wave's velocity in the medium is $4.00\ m\ s^{-1}$ complete the displacement-distance graph for time t = 5 seconds.



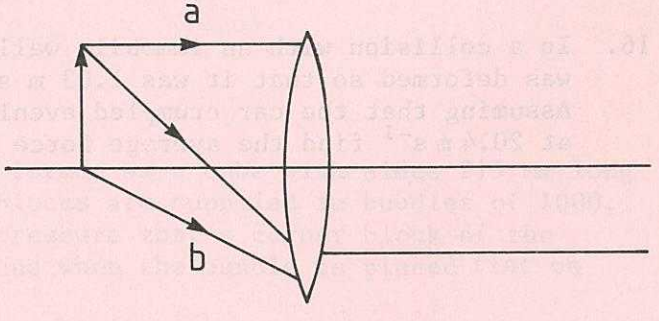
SEE PAGE 7

11. By what factor would the air pressure inside a car tyre change if during a long drive its temperature increased from 27.0°C to 54.0°C? Assume the tyre volume is constant.

12. The diagram at the right illustrates a wax lens with a train of microwave wave fronts approaching the lens. Sketch the next THREE (3) wavefronts that have passed through the lens.



13. On the diagram at the right, graphically locate the image and complete the paths for light rays 'a' and 'b'.



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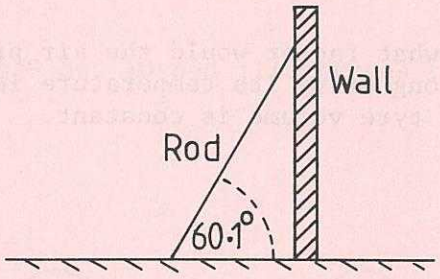
A uniform iron rod 1.01 m long of 102 kg mass is leant at an angle of 60.1° to the horizontal against a smooth (frictionless) wall. What is the force on the wall due to the rod?

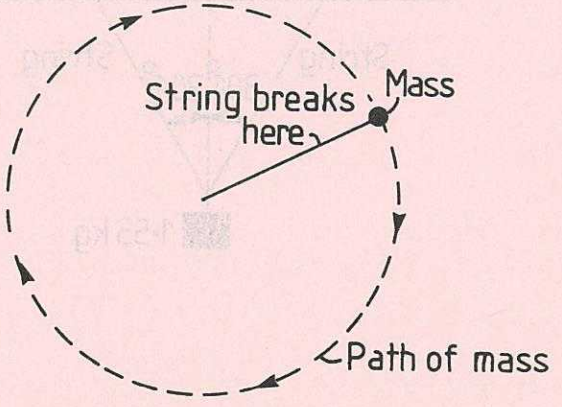


A 78.1 kg astronaut stands on the moon. What is his moon weight in newtons?

In a collision with an immobile wall the front of a 1.02×10^3 kg car was deformed so that it was 1.03 m shorter than before the crash. Assuming that the car crumpled evenly and given that it was travelling at 20.4 m s^{-1} find the average force applied to the car during the crash.

SEE PAGE 9

17. A person swings a mass on a string in a horizontal plane above his/her head. The string breaks. Describe with the aid of a sketch what an observer would see if this event was viewed from above. Use the diagram below.

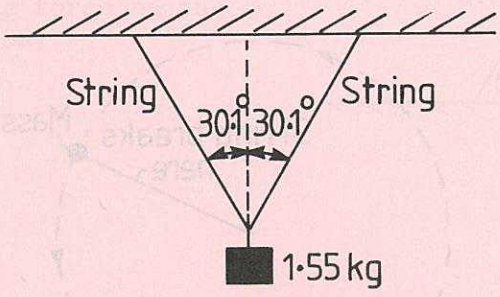


18. What minimum power would a pump need to pump 10.5 litres of water per second from a stream to a water tower 10.6 m above the height of the stream? Neglect friction.

19. A particular building block is formed as a cube with sides 215 mm long and a mass of 2.07 kg. These blocks are supplied in bundles of 1000, arranged as a cube. Find the pressure that a corner block of the bottom layer exerts on the ground when the bundle is placed flat on the ground.

SEE PAGE 10

Calculate the tension in either string.



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.

Of the following combinations of units the one that is NOT equal to the watt is

A. joule second^{-1}

B. ampere^{2} ohm

C. ampere volt

D. ohm^{2} volt

E. newton metre second^{-1}

SEE PAGE 11

22. Two charges repel each other with a force of 1.00×10^{-6} N when they are 1.00×10^{2} mm apart. When they are brought closer together until they are 0.200×10^{2} mm apart the magnitude of the force between them becomes

A. 4.00×10^{-8} N

B. 8.00×10^{-6} N

C. 5.00×10^{-6} N

D. 25.00×10^{-6} N

23. A drawing of the lines of force of a magnetic field provides information on

A. the direction of the field only

B. the magnitude of the field only

C. both the direction and magnitude of the field

D. the time rate of change of the field

SEE PAGE 12

For refraction of a wave motion into a denser medium which of the following could be correct for the wave in the denser medium?

	DIRECTION	VELOCITY	FREQUENCY	WAVELENGTH
A.	same	decreases	unchanged	increases
B.	changes	constant	constant	constant
C.	same	fluctuates	decreases	increases
D.	changes	decreases	constant	decreases
E.	changes	increases	increases	constant

A light ray is traced as it enters a medium (diagram at right). What is the critical angle for this medium (relative to air)?

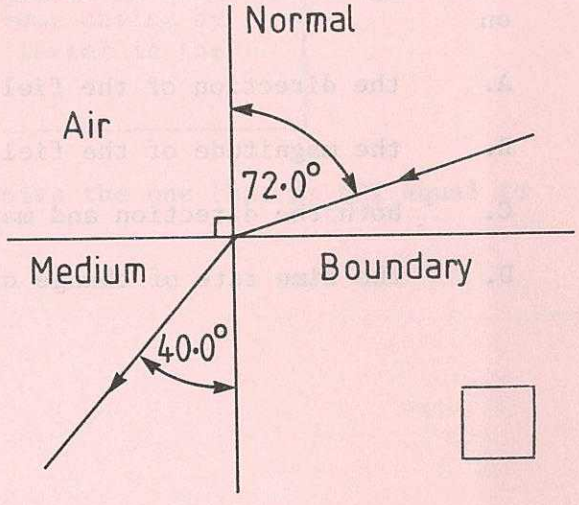
A. 52.0°

B. 42.5°

C. 1.48

D. 0.68

E. 55.7°



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26. A dentist's mirror produces a magnified and upright image of a tooth when used correctly. The mirror is

A. convex and is held at a distance greater than the focal length from the tooth.

B. convex and is held at a distance less than the focal length from the tooth.

C. concave and is held at a distance less than the focal length from the tooth.

D. concave and is held at a distance greater than the focal length from the tooth.

E. plane and is held at a distance less than the focal length from the tooth.

27. A student measured the temperature of a block of wax as it was heated and obtained the graph below. If the heater's rate of heat input was 'R' and the mass of wax was 'M', the latent heat of fusion of the wax is given by

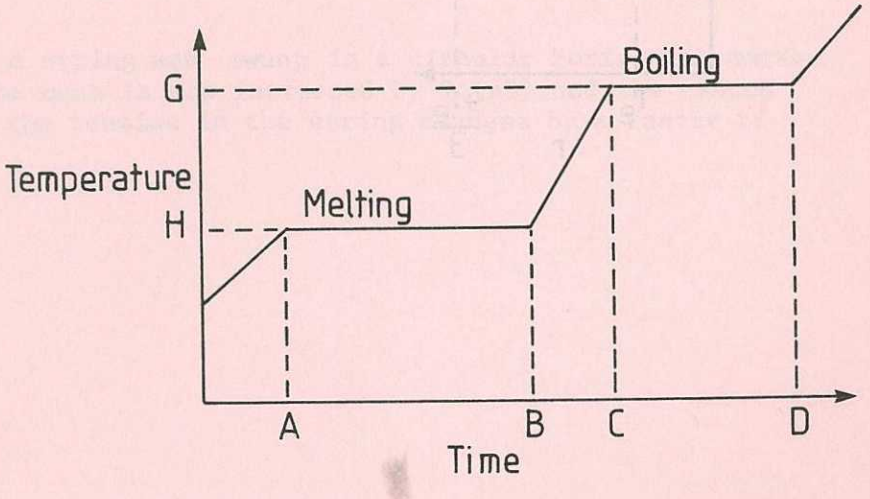
A. $\frac{R}{M} \cdot EF$

B. $\frac{R}{M} \cdot \frac{BC}{GH}$

C. $\frac{R}{M} \cdot AB$

D. $\frac{M}{R} \cdot \frac{EF}{AB}$

E. $\frac{M}{R} \cdot \frac{BD}{DF}$



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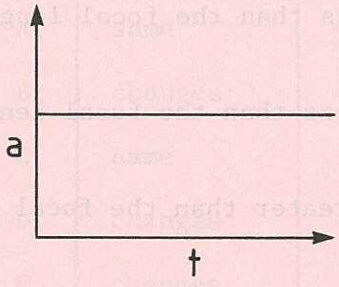
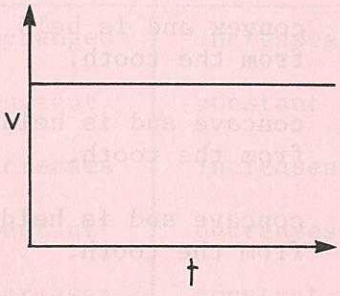
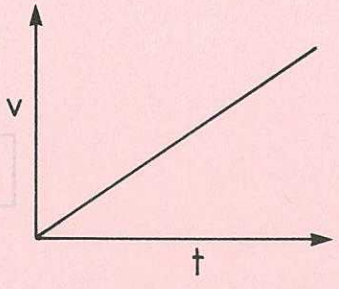
A body is taken above the earth's surface to a height equivalent to $\frac{1}{3}$ of the earth's radius. The graph that best represents the body's motion as it falls back to earth (assuming no air resistance effects) is

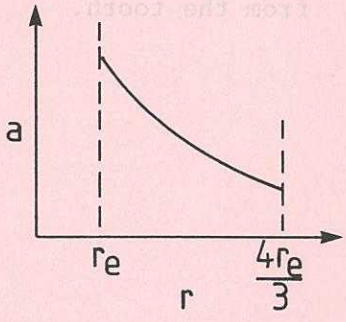


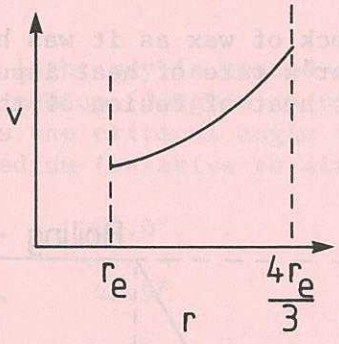
B.





D.





r_e = radius of earth

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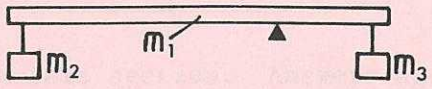
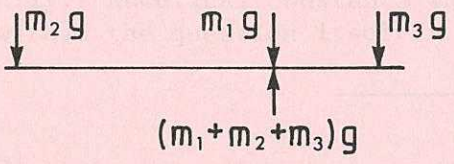
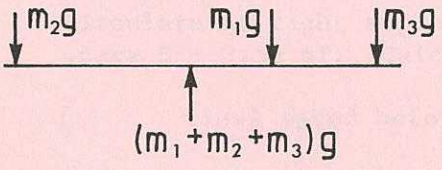
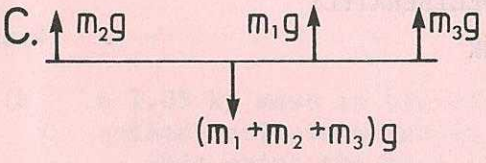
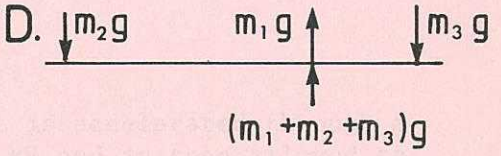
29. A uniform beam supports two masses in equilibrium as shown in the diagram. The best representation of the forces acting on the beam is given by

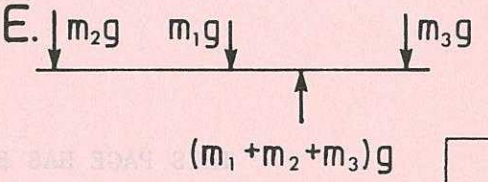


A.


B.


C.


D.


E.


30. A mass is tied to a string and swung in a circular horizontal motion. If the speed of the mass is now increased by 3 (x3) and the radius doubled (x2) then the tension in the string changes by a factor of

A. $\frac{3}{2}$.

B. $\frac{9}{2}$.

C. $\frac{2}{9}$

D. $\frac{3}{4}$.

E. $\frac{2}{3}$.

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SEE PAGE 17

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) An electron initially at rest is accelerated through a potential difference of 1.50 kV and is then allowed to circulate at right angles to a uniform magnetic field where B = 2.55 mT. Calculate the electron's

(i) final speed before entering the magnetic field.

(ii) path radius.

(iii) time of rotation.

(7 Marks)

(b) A 1.05 kg mass is placed on a plank. One end of the plank is raised until it makes an angle of 40.6° with the horizontal. At this point the mass just begins to slide down the plank.

(i) What is the magnitude and direction of the frictional force acting on the mass just before it moves?

(ii) Once the mass starts to move the plank is held still and the acceleration of the mass is found to be $4.00\ m\,s^{-2}$. When moving the frictional force is less. What is the magnitude and direction of the frictional force when the mass is moving?

(iii) If the mass slides a distance of 1.16 m down the plank, what is its final velocity?

(iv) What is the difference between the final kinetic energy after sliding 1.16 m and the potential energy before sliding 1.16 m?

SEE PAGE 18

rks)

(a) A deuteron consists of a proton and a neutron bound together by a strong interactive force. Determine the binding energy needed to separate the proton and neutron.

Proton atomic mass	=	1.00783 u
Neutron atomic mass	=	1.00867 u
Deuteron atomic mass	=	2.01410 u

1 atomic mass unit (u) = 1.66×10^{-27} kg.

rks)

(b) A bullet of mass 1.07×10^{-2} kg is fired horizontally from a gun with a velocity of 315 $m\,s^{-1}$. It lodges in the bob of a stationary pendulum. The pendulum has a string 1.15 m long and a mass of 1.02 kg.

(i) Find the kinetic energy of the bullet.

(ii) There is a difference in the initial kinetic energy of the bullet before impact and the kinetic energy of the pendulum and bullet immediately after impact. Where has this energy gone?

(iii) Find the maximum height to which the pendulum bob rises as it swings sideways.

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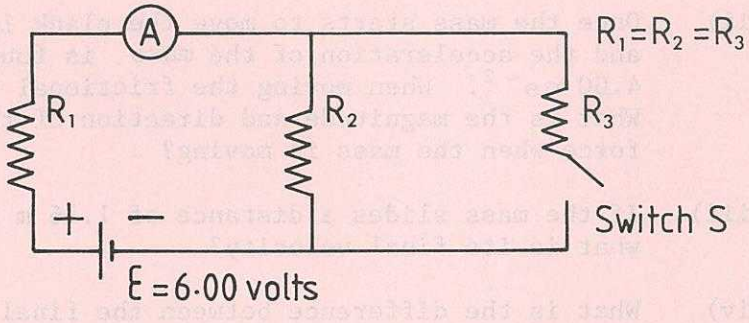
rks)

(a) Three resistors of equal resistance are connected as shown in the circuit. When the switch S is closed the reading of the ammeter changes by 50.0 mA.



(i) When the switch S is closed does the current through the ammeter increase or decrease? Explain your answer in words.

(ii) Determine the resistance of any one of the resistors.

(iii) What current flows in R_1 when switch S is closed?

(iv) What current flows in R_2 when switch S is closed?

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(5 Marks)

(b) In terms of the kinetic theory of gases explain why a partially inflated meteorological balloon expands as it rises in altitude above the earth. [Assume all temperatures to be constant.]

(6 Marks)

4. (a) If 255 mm of copper wire of diameter 1.23 mm is formed into a single circular loop of diameter 81.2 mm and placed at right angles to a uniform magnetic field that is increasing with time at the constant rate of 10.1 mT s^{-1} then calculate

(i) the resistance of the wire.

(ii) the induced emf in the wire.

(iii) the current in the wire.

(7 Marks)

(b) A type of photocopier works by a master sheet being strongly illuminated and white light reflected from the master being further reflected by plane mirrors and focussed by a lens on to a drum, over which the copy sheet passes.

(i) If the optical distance from master sheet to copy sheet is 0.500 m, what is the focal length of the lens for the copy to be the same size as the original master?

(ii) To obtain a photoreduced copy a mirror is moved to increase the optical distance from master to copy, and the lens is moved. For the copy to be exactly half the height of the master, what will be the optical distance from LENS to

(A) master sheet?

(B) photocopy drum?

(iii) If this photocopier only prints in black, would chromatic aberration of the lens affect the image? Explain.

SEE PAGE 20

rks)

(a) The specific heat of a silver rod is determined experimentally as follows.

The silver rod of mass 0.0551 kg is heated to 330°C and then plunged into an aluminium calorimeter of mass 0.0901 kg containing 0.150 kg of water at 11.5°C.

(i) If the final temperature is recorded at 17.0°C what is the specific heat of the rod?

(ii) What are two major factors that the experimenter would need to consider to gain the most accurate result?

(iii) Discuss the steps which should be taken to minimise the effect of the factors described in (ii).

rks)

(b) A sky diver of mass 60.5 kg is 1.00×10^3 m above the earth's surface and is falling downward at a velocity of $10.0\,m\,s^{-1}$, when he throws a 10.2 kg mass vertically upwards at a velocity relative to him of $15.0\,m\,s^{-1}$. Ignoring air resistance calculate

(i) the time taken for the mass to reach the ground.

(ii) the velocity of the diver immediately after throwing the mass.

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	=	$9.80\ m\ s^{-2}$
Mass of moon	M_m	=	7.36×10^{22} kg
Universal gravitational constant	G	=	$6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$
Radius of moon	R_m	=	1.74×10^{6} m
Electron charge	e	=	-1.60×10^{-19} C
Mass of an electron	m_e	=	9.11×10^{-31} kg
Resistivity of copper	ρ_{Cu}	=	1.70×10^{-8} ohm m
Absolute zero temperature		=	$-273°C$
Mass of 1 litre of water		=	1.00 kg
Specific heat of water	C_w	=	$4.18 \times 10^{3}\ J\ kg^{-1}\ K^{-1}$
Specific heat of aluminium	C_{Al}	=	$0.898 \times 10^{3}\ J\ kg^{-1}\ K^{-1}$
Speed of light in a vacuum	c	=	$3.00 \times 10^{8}\ m\ s^{-1}$