Subject Code: YC PHYSICS 4	YASHWANT CLASSES Estd.1995	Subject: PHYSICS

Answer to this Paper must be written on the paper provided separately.
You will not be allowed to write during first 15 minutes.
This time is to be spent in reading the question paper.
The time given at the head of this Paper is the time allowed for writing the answers.
Section A is compulsory. Attempt any four questions from Section B.
The intended marks for questions or parts of questions are given in brackets [].

SECTION A (40 MARKS)
(Attempt all questions from this Section)

QUESTION 1 [15]

Choose the correct answers to the questions from the given options:

(i) The condition for equilibrium of a body is:

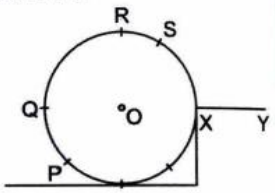
(a) Resultant of all the linear forces acting on the body should be zero.

(b) Resultant of all the moment of forces acting about the turning point should be zero.

(c) Both (a) and (b)

(d) None of these

(ii) The diagram alongside shows a heavy roller, with its axle at 'O', which to be pushed upward on the pavement XY by applying minimum force. This force should be applied at

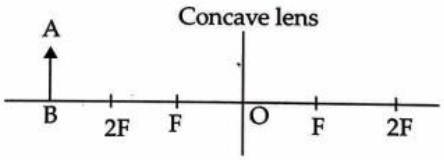


(a) P (b) Q (c) R (d) S

(iii) A force of 13 N, produces a moment of couple of magnitude 14.3 Nm. The arm of couple in such a situation is :

(a) 1.1 m (b) 0.11 m (c) 11 m (d) 1.3 m

(iv) From the diagram given alongside identify the characteristic which is incorrect for the image formed in a concave lens.



(a) Image is virtual (b) Image is diminished

(c) Image is formed on the right hand side of the lens (d) Image is erect.

(v) A boy of mass 40 kg, runs up a flight 50 stairs, each measuring 30 cm. The potential energy gained by the boy is: [Take g = 10 ms^{-2}]

(a) 4000 J (b) 4500 J (c) 5000 J (d) 6000 J

(vi) A bullet of mass 0.1 kg is moving with a momentum of 20 kg ms^{-1}. The kinetic energy of the bullet is:

(a) 2200 J (b) 1800 J (c) 2000 J (d) 1600 J

(vii) A uniform plank of a see-saw is 5 m long is supported at its centre. A boy weighing 40 kgf sits at a distance of 1.5 m from one end, whereas as a girl weighing 25 kgf sits at distance x from the centre of plank, such that plank is balanced. The magnitude of x is:

(a) 1.5 m (b) 1.6 m (c) 1.4 m (d) 1.7 m

(viii) An actual pulley system of velocity ratio 5 has actual mechanical advantage less than 5. It is because:

(a) a part of effort is wasted in overcoming friction at movable parts.

(b) a part of effort is wasted in overcoming load of movable block.

(c) both (a) and (b)

(d) none of these

(ix) A block of metal has a thermal capacity of 500 J $^{o}C^{-1}$ and its specific heat capacity is 0.4 Jg^{-1} °C. The mass of block is:

(a) 1250 g (b) 1200 g (c) 1150 g (d) 1100 g

(x) The base of cooking pan is made thicker and heavy because:

(a) It lowers heat capacity of pan

(b) It increases heat capacity of pan

(c) Food does not get charred and keeps hot for a longer time

(d) Both (b) and (c)

(xi) Icebergs are carried thousands of kilometres away, without melting substantially because:

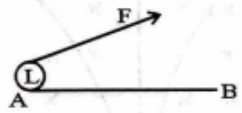
(a) They are too huge and do not melt easily.

(b) The ice has a very low sp. latent heat and hence they melt slowly

(c) The ice has highest sp. latent heat of fusion and hence they melt slowly

(d) Sea water is too cool and hence prevents cooling.

(xii) A boy drags a load 'L' along horizontal plane AB by applying a force F. The boy does



(a) no work (b) some positive work

(c) negative work (d) none of these

(xiii) Magnitude of lateral displacement caused by a glass block in the path of light:

(a) Increases with the increase in thickness of glass slab.

(b) Decreases with the increase in the angle of incidence.

(c) Decreases with the increase in refractive index.

(d) Decreases with the increase in thickness of glass slab.

(xiv) When an object moves slowly from infinity to the optical centre of a convex lens, the image formed by the lens :

(a) also moves towards the optical centre of the lens

(b) also moves away from the optical centre of lens.

(c) becomes smaller in size.

(d) becomes virtual.

(xv) During spear fishing a fisherman aims at the:

(a) tail of fish (b) head of fish

(c) slightly ahead of the head of fish (d) none of these

QUESTION 2

(i) Complete the following sentences : [3]

(a) In the figure given below, the direction of current in the loop is ..... . So, it behaves as a ..... .

(b) A current carrying solenoid when freely suspended, it always rests in ..... direction.

(c) The mass number and atomic number of an element are not changed when it emits .....

(ii) A convex lens can be used for burning dry grass, by focussing the rays of sun. Show by drawing a diagram. [2]

(iii) What is the nature of lens and its focal length, if its power is –2.5 D? [2]

(iv) (a) What is range of wavelength of ultraviolet rays in Å? [2]

(b) Name the phenomenon which takes place when ultraviolet rays are focussed on barium platinocyanide.

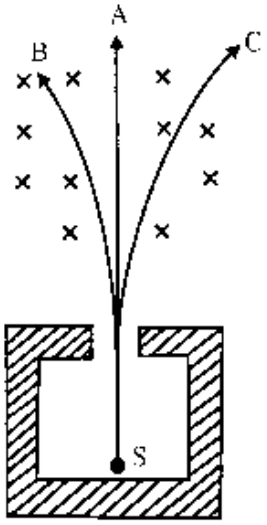
(v) (a) Which is most visible colour of white light? [2]

(b) Which colour of white light has maximum angle of deviation?

(vi) (a) What are reverberation? [2]

(b) Name and explain how reverberation are produced during thunderstorm.

(vii) The adjacent diagram shows a radioactive source S placed in a thick walled lead container. The radiations given off are allowed to pass through a magnetic field. The magnetic field (shown as ×) acts perpendicular to the plane of paper inwards. Arrows show the paths of the radiations A, B and C. [2]

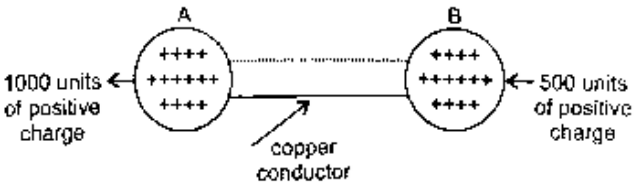


(a) Name the radiations labelled A, B and C.

(b) Explain clearly how you used the diagram to arrive at the answer in part (a).

QUESTION 3

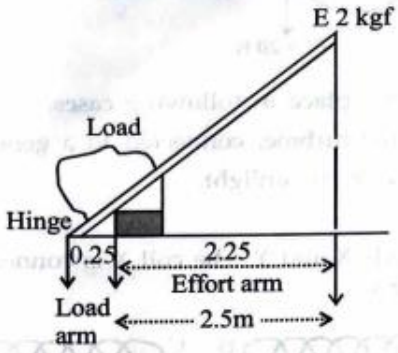
(i) Diagram below shows two insulated copper spheres charged positively and connected by a copper conductor. Copy the diagram and show: [2]



(a) Direction of conventional current by arrow head in copper conductor.

(b) Direction of electronic current by arrow head in dotted line.

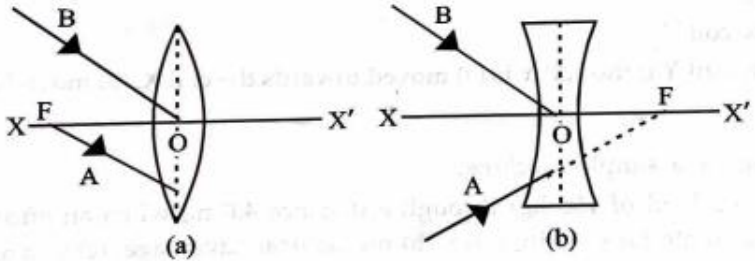
(ii) A crowbar of length 2.5 m is pivoted at a point 25 cm from its tip. Calculate (a) mechanical advantage of crowbar (b) the maximum load displaced by it by applying an effort of 100 kgf on its extreme end. **[2]**



(iii) A wire of specific resistance 0.0004 ohm-cm and of length 100 cm has a resistance of 2.0 ohms. Calculate the area of cross-section of wire. **[2]**

(iv) State Faraday's two laws of electromagnetic induction. **[2]**

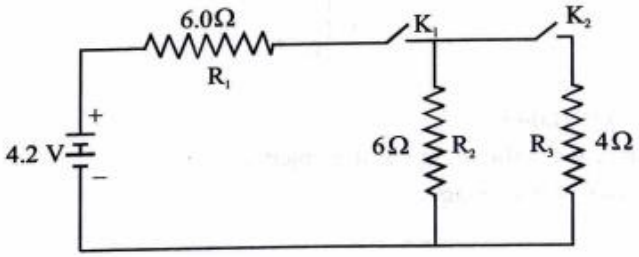
(v) In the diagram below, XX' represents the principal axis, O the optical centre and F, the focus of the lens. Complete the path of rays A and B as they emerge out of the lens. **[2]**



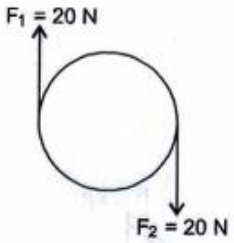
SECTION B
(Attempt any four questions)

QUESTION 4

(i) A circuit is set up as shown in Fig. Calculate : the current and the potential difference across R_1, R_2 and R_3 when (a) keys K_1 and K_2 both are closed (b) key K_1 is closed and K_2 is open (c) key K_1 is open and K_2 is closed. **[3]**



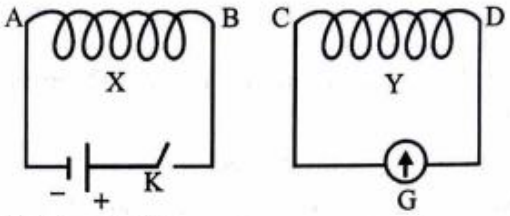
(ii) (a) Forces F_1 and F_2 are applied on a circular body such that moment of force is 16 Nm in clockwise direction. What is the radius of circular body. **[4]**



(b) State the energy changes taking place in following cases.

1. Water in the dam rotates the turbine, connected to a generator.
2. Exposure of photographic film in sunlight.

(iii) The diagram below shows two coils X and Y. The coil X is connected to a battery S and a key K. The coil Y is connected to a galvanometer G.



When the key K is closed, State the polarity.

(i) at the end B of the coil X.

(ii) at the end C of the coil Y.

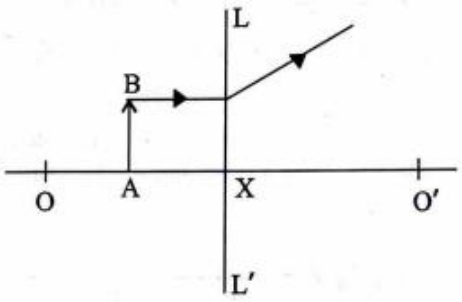
(iii) at the end C of the coil Y if the coil Y is (*a*) moved towards the coil X, (*b*) moved away from the coil X. **[3]**

QUESTION 5

(i) State three functions of a simple machine. **[3]**

(ii) A machine displaces a load of 150 kgf through a distance 4.0 m, when an effort of 15 kgf acts through a distance of 60 m. Calculate (a) velocity ratio, (b) mechanical advantage, (c) % age effeciency of machine. **[3]**

(iii) Study the diagram below. **[4]**



(a) Name the lens LL'.

(b) What are the points O, O' called ?

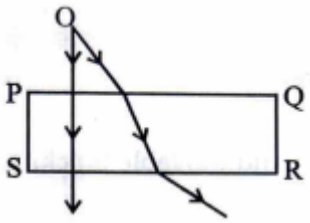
(c) Complete the diagram to form the image of the object AB.

(d) State three characteristics of the image.

QUESTION 6

(i) A point source of light O of single colour is seen through a rectangular glass slab *PQRS*. The paths of two rays, in and outside the slab are shown. **[4]**

(a) Label the position *I* of the source *O* where it will appear when seen through the surface *RS*.



(b) Does the source O appear to be nearer or farther w.r.t. the surface *PQ* ?

(c) How does the shift depend on the thickness *PS* or *QR* of the slab ?

(d) Justify your answer in (b) with the help of appropriate ray diagram.

(e) For the same rectangular glass slab.

Which colour from the visible spectra (violet or red) will produce the maximum shift?

(ii) A piece of brass of mass 200 g and at 100°C is placed in 400 g of turpentine oil, contained in a copper calorimeter of mass 50 g and at 15°C. The final temperature recorded is 25°C. Calculate [6]

[SHC of brass = 370 J $kg^{-1}{}^{\circ}C^{-1}$ and S.H.C. of copper is 400 J $kg^{-1}{}^{\circ}C^{-1}$]

(a) Heat energy lost by brass.

(b) Heat energy gained by turpentine oil

(c) Heat energy gained by calorimeter.

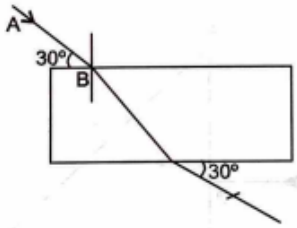
(d) Total heat energy gained.

(e) Specific heat capacity of turpentine oil.

QUESTION 7

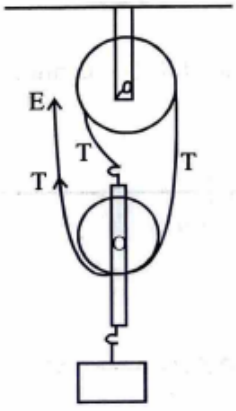
(i) (a) Diagram below shows the path taken by a ray of light through a rectangular glass slab. **[5]**

Copy the diagram and show lateral displacement of the ray AB by letters PQ.



(b) State three factors on which lateral displacement depends.

(ii) A pulley system with velocity ratio 3 is used to lift a load of 60 kgf through a height of 20 m. The force is applied in upward direction and its magnitude is 25 kgf. Calculate: **[5]**



(a) Distance through which effort is applied

(b) Work done by the effort

(c) Mechanical advantage of pulley system

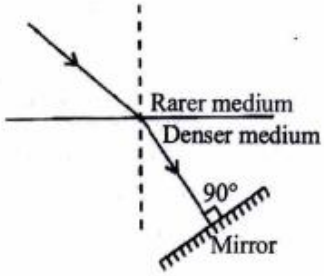
(d) Efficiency of pulley system

(e) Total number of pulleys in the fixed and movable block.

[Take g = 10 N kg^{-1}]

QUESTION 8

(i) A ray of light is moving from a rarer medium to a denser medium and strikes a plane mirror placed at 90° to the direction of the ray as shown in the diagram. [3]



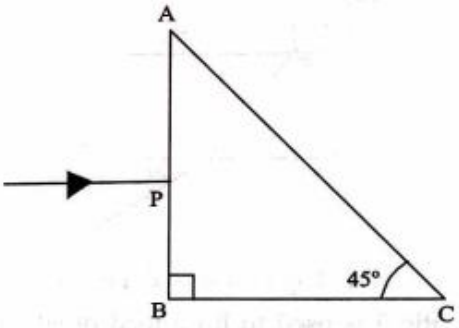
(a) Copy the diagram and mark arrows to show the path of the ray of light after it is reflected from the mirror.

(b) Name the principle you have used to mark the arrows to show the direction of the ray.

(ii) (a) What is meant by the terms (1) amplitude (2) frequency of a wave? [2]

(b) Explain why stringed musical instruments, like guitar are provided with hollow box. [2]

(iii) The diagram given below shows a right-angled prism with a ray of light incident on the side AB. (The critical angle for glass is 42º). [3]

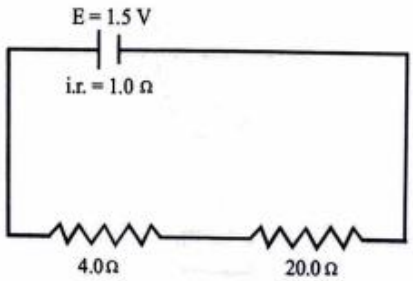


(i) Copy the diagram and complete the path of the ray of light in and out of the glass prism.

(ii) What is the value of the angle of deviation shown by the ray ?

QUESTION 9

(i) A cell of e.m.f. 1.5 V and internal resistance 1.0 Ω is connected to two resistors of 4.0 Ω and 20.0 Ω in series as shown in the figure: [4]



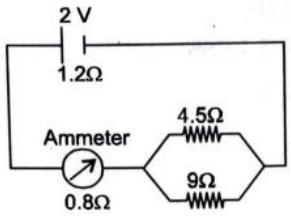
(a) current in the circuit.

(b) potential difference across the 4.0 ohm resistor.

(c) voltage drop when the current is flowing.

(d) potential difference across the cell.

(ii) A cell of emf 2 V and internal resistance 1.2 Ω connected to an ammeter of resistance 0.8 Ω and two resistors 4.5 Ω and 9.0 Ω in parallel as shown in diagram alongside.



(a) What would be the reading of ammeter? [3]

(b) What is the potential difference across the terminals of cell? [1]

(c) What is potential difference across resistors in parallel? [1]

(d) What is the magnitude of current in 4.5 Ω resistor? [1]

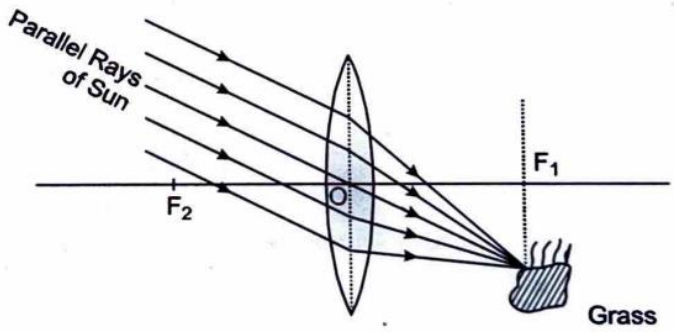
ANSWER 1

(i) (c) (ii) (b) (iii) (a) (iv) (a) (v) (d) (vi) (c) (vii) (b) (viii) (c) (ix) (a) (x) (d)
(xi) (c) (xii) (b) (xiii) (a) (xiv) (b) (xv) (a)

ANSWER 2

(i) (a) anticlockwise, north pole
(b) north-south
(c) γ radiations

(ii) Convex lens used for burning grass



(iii) Lens is **concave** as power is negative.

$$\text{Focal length (in cm.)} = \frac{100}{\text{Power}} = \frac{100}{2.5} = 40 \text{ cm.}$$

(iv) (a) Range of ultraviolet rays in between 4000 Å and 100 Å.
(b) Fluorescence is the phenomenon which takes place.

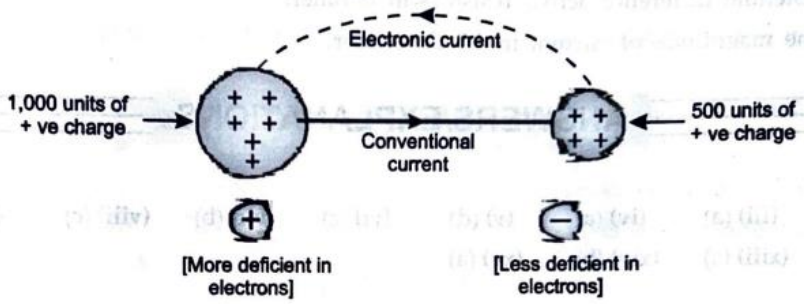
(v) (a) Orange colour is the most visible colour of white light.
(b) Violet colour of white light has maximum angle of deviation.

(vi) (a) Reverberation : Formation of multiple echoes from various reflectors present surrounding of the source of sound, thereby producing rolling sound are called reverberations.
(b) When the lightning produces a crack of thunder, it is reflected from various reflectors such as buildings, hillocks, etc., thereby producing multiple echoes and hence producing reverberation.

(vii) (a) A represents γ GAMMA RADIATIONS which are not deflected by magnetic field as these radiations are neutral.
B is β-BETA particle deviated MORE.
C is α –ALPHA particle is deviated LESS
(b) A is not deviated is γ-ray neutral)
B is β-beta ray deviated MORE
C is α-alpha ray deviated Less.

ANSWER 3

(i) Diagram shows direction of (a) conventional current (b) electronic current



(ii) Load arm = 25 cm = 0.25 m

Effort arm = 25 – 0.25 = 2.25 m

(a) M.A. = V.R.

$$\text{V.R.} = \frac{\text{Effort arm}}{\text{Load arm}} = \frac{2.25}{0.25} = 9$$

$\therefore$ M.A. = 9

$$\frac{\text{Load}}{\text{Effort}} = 9$$

(b) $\frac{L}{100} = 9$

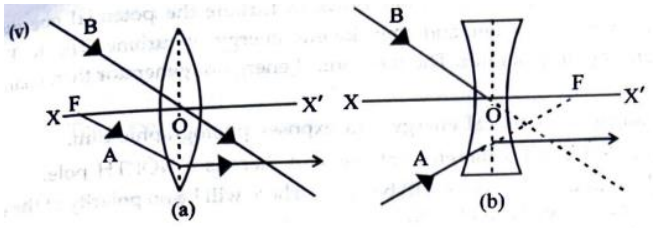
$\therefore \quad L = 9 \times 100 = 900$ kgf

(iii) $R = \rho\frac{l}{a} \quad \therefore \quad a = \frac{\rho l}{R} = \frac{0.0004 \times 100}{2} = 0.02 \text{ cm}^2$

(iv) Faraday's law of electromagnetic induction :

1. Whenever the magnetic flux changes within a coil connected in a closed circuit an induced e.m.f. is set up at the terminals of coil, as long as magnetic flux varies.
2. The magnitude of induced emf is directly proportional to the rate of change of magnetic flux within the coil.

(v)



ANSWER 4

(i) (a) When both the keys K_1 and K_2 are closed.

The resistors R_2 (= 6Ω) and R_3 = (= 4Ω) are in parallel. The equivalent resistance R_p is given as

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{4} = \frac{2+3}{12} = \frac{5}{12} \quad \text{or} \quad R_p = \frac{12}{5}\ \Omega = 2.4\Omega$$

Total resistance of circuit $R_s = 6 + 2.4 = 8.4\Omega$

$$\text{Current } I = \frac{V}{R_S} = \frac{4.2}{8.4} = 0.5A \text{ Ans.} \qquad V = 4.2 \text{ V} \quad \text{...given}$$

p.d. across R_1 is $V_1 = I_1 R_1 = 0.5 \times 6 = 3V$ Ans.

p.d. across the combination of R_2 and R_3 is

$$V' = 4.2 - 3 = 1.2\ V$$

Since R_2 and R_3 are in parallel,

p.d. across R_2 = p.d. across R_3 is $V' = 1.2\ V$ Ans.

$$\text{Current through } R_2 \text{ is } I_2 = \frac{V'}{R_2} = \frac{1.2}{6} = 0.2\ A \text{ Ans.}$$

$$\text{Current through } R_3 \text{ is } I_3 = \frac{V'}{R_3} = \frac{1.2}{4} = 0.3\ A \text{ Ans.}$$

(b) When the key K_1 is closed and K_2 is open. The resistor R_3 will not be in circuit. The resistors R_1 and R_2 are in series.

∴ Total resistance $R_S = R_1 + R_2 = 6 + 6 = 12\Omega$

$$\text{Current } I = \frac{V}{R_S} = \frac{4.2}{12} = 0.35\ A$$

Same current will flow through each resistance R_1 and R_2.

p.d. across R_1 is $V_1 = IR_1 = 0.35 \times 6 = 2.1V$ Ans.

p.d. across R_2 is $V_2 = IR_2 = 0.35 \times 6 = 2.1V$ Ans.

(c) When key K_1 is open and K_2 is closed : No current flows through R_1, R_2 and R_3, since the circuit is incomplete. Hence p.d. across R_1, R_2 and R_3 is zero.

(ii) (a) Forces, F_1 and F_2 constitute a couple.

∴ Moment of force = Force × diameter of circle

⇒ 16 Nm = 20 N × diameter of circle

$$\therefore \text{ Diameter of circle } = \frac{16}{20}\text{ m} = 0.8\text{ m}$$

$$\therefore \text{ Radius of circular body } = \frac{0.8\text{ m}}{2} = 0.4\text{ m}$$

(b) 1. Water in the dam has potential energy. When the water flows to turbine the potential energy of water is converted first kinetic energy of water and then kinetic energy of turbine. The K. E. of turbine changes to mechanical energy of generator. The mechanical energy of generator then changes to electric energy.

2. The light energy of the sun changes to chemical energy and exposes photographic film.

(iii) (a) Current at the end B of coil X is anti-clockwise therefore at this end there is a NORTH pole.

(b) While closing the key, polarity at the end C of the coil Y will be north. There will be no polarity at the end C of the coil Y when the current becomes steady in the coil X.

(c) (i) While the coil Y is moved towards the coil X, the polarity at the end C of the coil Y is NORTH.

(ii) While the coil Y is moved away from the coil X, the polarity at the end C of the coil B is SOUTH.

ANSWER 5

(i) 1. A machine can multiply effort.

2. A machine can increase speed.

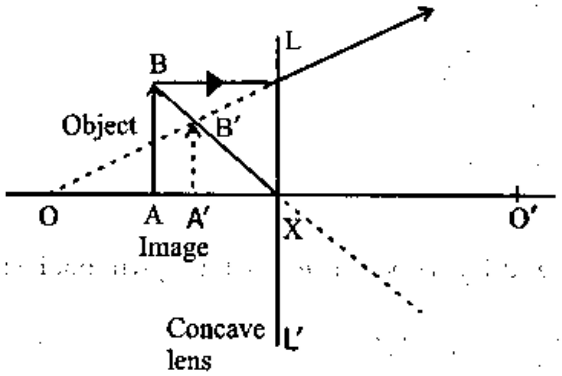
3. A machine can change the direction of effort in convenient direction.

(ii) (a) Velocity ratio $= \dfrac{\text{Distance through which effort acts}}{\text{Distance through which load moves}} = \dfrac{60\,\text{m}}{4\,\text{m}} = 15$

(b) Mechanical advantage $= \dfrac{\text{load}}{\text{effort}} = \dfrac{150\,\text{kgf}}{15\,\text{kgf}} = 10$

(c) $\therefore$ % age efficiency $= \dfrac{\text{M.A}}{\text{V.R}} \times 100 = \dfrac{10}{15} \times 100 = 66.67\%$

(iii) (a) Lens LL' is CONCAVE. Since light ray is diverged.



(b) Point O is second focus and O' is first focus.

(c) Diagram is completed.

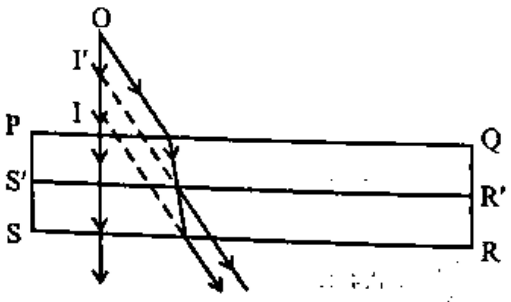
(d) Three characteristics of image are :

(i) Image is virtual (ii) erect (iii) diminished.

ANSWER 6

(i) (a) I is the position of source O when seen through the surface *RS*.

(b) The source O appears to be at *I*, NEARER w.r.t. the surface *PQ* when viewed through the surface *RS*.



(c) The shift *OI* DECREASES with the DECREASE IN THICKNESS *PS* or *QR* of the slab.

(d) The ray diagram is shown in which for the thickness *PS*, the image is *I*, while for the thickness *PS'* (< *PS*), another emergent ray (parallel to the given previous emergent ray) is drawn and the image is at *I'*. Now the shift is *OI'* which is less than the shift *OI* for the thickness *PS* of slab.

(e) The same rectangular glass slab will produce MAXIMUM SHIFT FOR THE VIOLET LIGHT incident on it for which the R.I of glass is most.

(ii)

Substance	Mass	S.H.C.	Initial Temp.	Final Temp. = 25°C
Brass	200 g	0·37 Jg^{-1} $°C^{-1}$	100°C	θ_f = (100 – 25) = 75°C
Calorimeter	50 g	0·40 Jg^{-1} $°C^{-1}$	15°C	θ_R = (25 – 15) = 10°C
Turpentine oil	400 g	? (x)	15°C	

(a) Heat energy lost by brass = $mc\theta_f$ = 200 × 0·37 × 75 = **5550 J**

(b) Heat energy gained by turpentine oil = $mc\theta_R$ = 400 × x × 10 = **4000 x g °C.**

(c) Heat energy gained by calorimeter = $mc\theta_R$ = 50 × 0·4 × 10 = **200 J**

(d) Total heat energy gained = **4000 x g C° + 200 J**

(e) By the principle of calorimetry :

Heat energy gained by turpentine oil and calorimeter = Heat energy lost by brass.

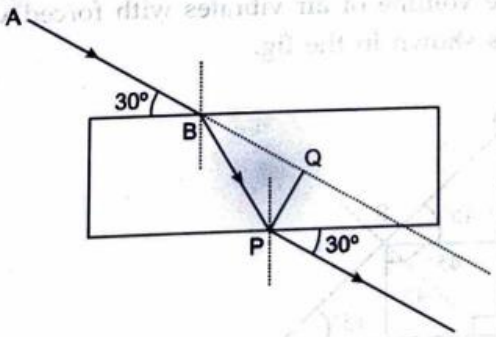
$\Rightarrow$ 4000 x g °C + 200 J = 5550 J $\Rightarrow$ 4000 x g °C = (5550 – 200) J = 5350 J

$\therefore$ $$x = \frac{5350\,\text{J}}{4000\,\text{g}\,°\text{C}} = 1.338\ \text{Jg}^{-1}\ °\text{C}^{-1}$$

Thus, specific heat capacity of turpentine oil = 1.338 Jg^{-1} $°C^{-1}$.

ANSWER 7

(i) (a) Lateral displacement PQ is shown in diagram alongside.



(b) Factor controlling lateral displacement :

1. It is directly proportional to the thickness of refracting material.
2. It is directly proportional to the refractive index of material.
3. It is directly proportional to the angle of incidence in less dense medium.

(ii) V.R. = 3

Load is raised through 20 m

$$\text{V.R.} = \frac{d_E}{d_L}$$

$$3 = \frac{\text{Distance through which effort moves}}{20}$$

(a) $\therefore$ Distance through which effort is applied = 3 × 20 = 60 m

(b) Work done by effort = E × Effort arm
= 60 kgf × 60 m
= (60 × 10) × 60
= 36000 N

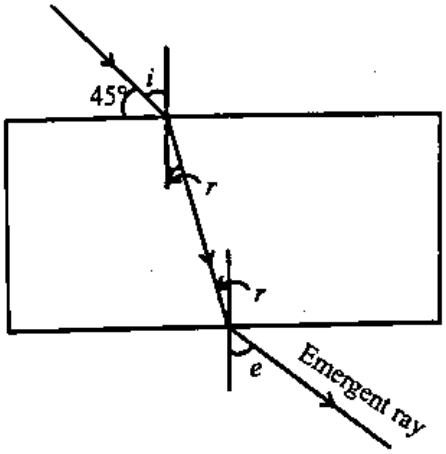
(c) $\text{M.A.} = \frac{L}{E} = \frac{60}{25} = 2.4$

(d) $\eta = \frac{\text{M.A.}}{\text{V.R.}} \times 100 = \frac{2.4}{3} \times 100 = 80\%$

(e) As the effort applied is in upward direction. There are 2 pulley one in fixed block and one in movable block as drawn.

ANSWER 8

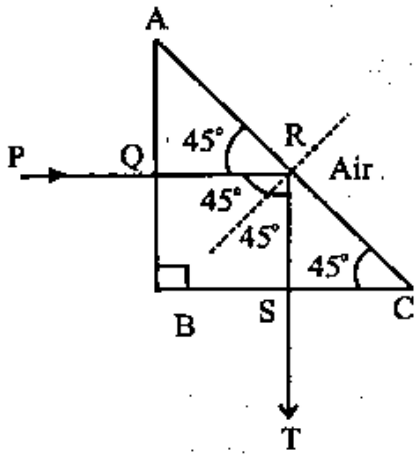
(i)



(ii) (a) 1. The maximum displacement of a vibrating particle from its mean position is called its amplitude.
2. The number of waves produced by a vibrating particle in one second is called its frequency.

(b) The hollow box contains large volume of trapped air. Thus, when the vibrating strings are impressed on the hollow box, a large volume of air vibrates with forced vibration producing a loud sound :

(iii) (a) The required diagram is as shown in the fig.



(b) The angle of deviation is 90° as shown.

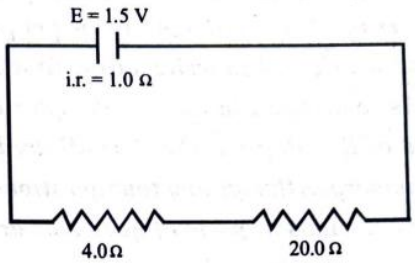
ANSWER 9

(i) Here e.m.f., E = 1.5 V

Internal resistance = 1.0 Ω

All the resistances are connected in series

∴ The total circuit resistance, R = 1 + 4 + 20 = 25 Ω



∴ The current, $i = \frac{E}{R} = \frac{1.5}{25} = 0.06A$

Potential difference across 4 Ω resistance = $r \times i = 4 \times 0.06 = 0.24$ V

Voltage drop across the cell = $0.06 \times 1 = 0.06$ V

Potential difference across the cell = $1.5 - 0.06 = 1.44$ V

(ii) (a) Resistance of 4·5 Ω and 9 Ω in parallel

$$\frac{1}{R_p} = \frac{1}{4.5} + \frac{1}{9} = \frac{2+1}{9} = \frac{3}{9} \quad \therefore R_p = 3\ \Omega$$

Total external resistance = 3 Ω + 0·8 Ω = 3·8 Ω

∴ Current in ammeter, $I = \frac{E}{R+r} = \frac{2}{3.8+1.2} = \frac{2}{5} = \mathbf{0.4\ A}$

(b) Now, $I = \frac{E-V}{r} \Rightarrow 0.4 = \frac{2-V}{1.2} \Rightarrow 0.48 = 2 - V$

∴ $V = 2 - 0.48 = \mathbf{1.52\ V}$; The P.D. across the terminals of cell = 1.52 V.

(c) P. D across parallel resistors

$V = I.R_s = 0.4 \times 3 = \mathbf{1.2\ V}$

(d) ∴ current in 4·5 Ω resistor, $I = \frac{V}{R} = \frac{1.2}{4.5} = \mathbf{0.27\ A}$