Wave and Motion : Rest of Geometrical – Typical Questions

No of Questions:23 **Time Allotted: 3 Hours**

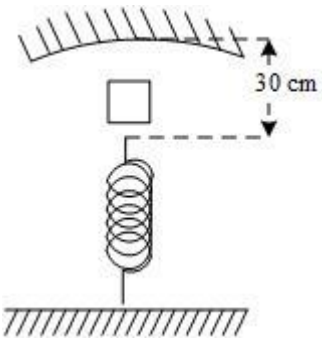
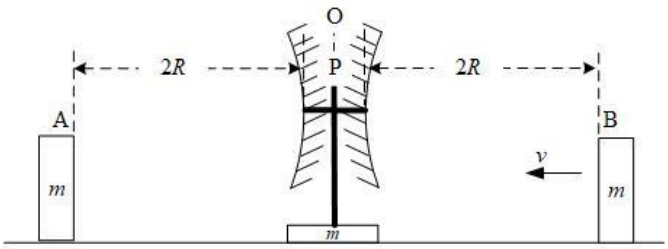
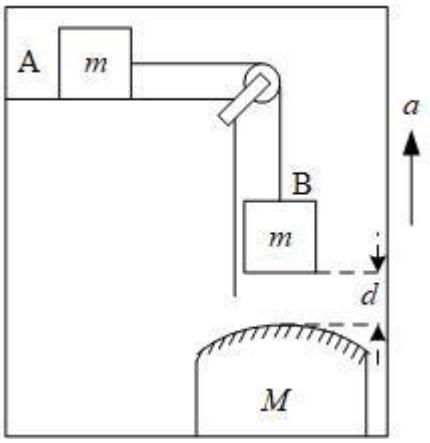
All questions are compulsory

[Note: a. Figures are conceptual only and not to the scale**]**

[b. It is advised to attempt question under examination conditions**]**

Q-01	A Convex lens produces a double size real image when an object is placed at a distance of 18 cm from it. Where should the object be placed to produce a triple size image?
Q-02	A pin of length 2.0 cm lies along the principal axis of a converging lens, the centre being at a distance of 11 cm from the lens. The focal length of the lens is 6 cm. Find the size of the image.
Q-03	The diameter of the sun is 1.4×10^9m and its distance from the earth is 1.5×10^{11}m. Find the radius of the image of the sun formed by a lens of focal length 20 cm.
Q-04	A 5.0 diopter lens forms a virtual image which is 4 times the object placed perpendicularly on the principal axis of the lens. Find the distance of the object from the lens.
Q-05	A diverging lens of focal length 20 cm and a converging mirror of focal length 10 cm are placed coaxially at a separation of 5.0 cm. Where should an object be placed so that a real image is formed at the object itself?
Q-06	A converging lens of focal length 12 cm and a diverging mirror of a focal length 7.5 cm are placed 5.0 cm apart with their axes coinciding. Where should an object be placed so that its image falls on itself?
Q-07	A converging lens and a diverging mirror are placed at a separation of 15 cm. The focal length of the lens is 25 cm and that of the mirror is 40 cm. Where should a point source be placed between the lens and the mirror so that the light, after getting reflected by the mirror and then getting transmitted by the lens, comes out parallel to the principal axis?
Q-08	A converging lens of focal length 15 cm and a converging mirror of focal length 10 cm are placed 50 cm apart with common principal axis. A point source is placed in between the lens and the mirror at a distance of 40 cm from the lens. Find location of two images formed.
Q-09	A converging lens of focal length 15 cm and a converging mirror of focal length 10 cm are placed 50 cm apart with common principal axis. Where should a point source be placed on the principal axis so that the two images form at the same place?
Q-10	A converging lens of focal length 15 cm and a converging mirror of focal length 10 cm are placed 50 cm apart. If a pin of length 2.0 cm is placed, perpendicular to the principal axis, 30 from the lens farther away from the mirror, where will the final image form and what will be the size of the final image?
A-10	At the object itself, of the same size
Q-11	A point object is placed on the principal axis of a convex lens ($f = 15$ cm) at a distance of 30 cm apart. A glass plate ($\mu = 1.50$) of thickness 1 cm is placed on the other side of the lens perpendicular to the axis. Locate the image of the point object.

Q-12	A convex lens of focal length 20 cm and a concave lens of focal length 10 cm are placed 10 cm apart from their principal axes coinciding. A beam of light travelling parallel to the principal axis and having a beam diameter 5.00 mm, is incident on the combination. Show that the emergent beam is parallel to the incident one. Find the beam diameter of the emergent beam.
Q-13	A divergent lens of focal length 20 cm and a converging lens of focal length 30 cm are placed 15 cm apart with their principal axes coinciding. Where should an object be placed on the principal axis so that image is formed at infinity?
Q-14	A 5 mm high pin is placed at a distance of 15 cm from a convex lens of focal length 10 cm. A second convex lens of focal length 5 cm is placed 40 cm from the first lens and 55 cm from the pin. Find – (a) The position of the final image, (b) Its nature and (c) Its size.
Q-15	A point object is placed at a distance of 15 cm from a convex lens. The image is formed on the other side at a distance of 30 cm from the lens. When a concave lens is placed in contact with the convex lens, the image shifts away farther by 30 cm. Calculate focal length of the two lenses.
Q-16	Two convex lenses, each of focal length 10 cm, are placed at a separation of 15 cm with their principal axes coinciding. (a) Show that a light beam coming parallel to the principal axis diverges as it comes out of the lens system. (b) Find location of the virtual image formed by the lens system of an object placed far away. (c) Find the focal length of the equivalent lens. (Note: Sign of focal length is positive although the lens system actually diverges a parallel beam incident on it)
Q-17	A ball is kept at a height h above the surface of a transparent sphere made of a material of refractive index μ. The radius of sphere is R. At $t = 0$, the ball is dropped to fall normally on the sphere. Find the speed of the image formed as a function of time for $t < \sqrt{\frac{2h}{g}}$. Consider only image by a single refraction.
Q-18	A particle is moving at a constant speed V from a large distance towards a concave mirror of radius R along its principal axis. Find the speed of the image formed by the mirror as a function of distance x of the particle from the mirror.
Q-19	A small block of mass m and a concave mirror of radius R fitted with a stand lies on a smooth horizontal table with a separation d between them. The mirror together with its stand has a mass m. The block is pushed at $t = 0$ towards the mirror so that it starts moving towards the mirror at a constant speed V and collides with it. The collision is perfectly elastic. Find velocity of the image- (a) at a time $t < \frac{d}{V}$ (b) at a time $t > \frac{d}{V}$
Q-20	A gun of mass M fires a bullet of mass m with a horizontal speed V. The gun is fitted with a concave mirror of focal length f facing towards the receding bullet. Find the speed of separation of the bullet and the image just after the gun was fired.

Q-21	A mass $m = 50$ g is dropped on a vertical spring of spring constant 500 N/m from a height $h = 10$ cm as shown in the figure. The mass sticks to the spring and executes simple harmonic oscillation after that. A concave mirror of focal length 12 cm facing the mass is fixed with its principal axis coinciding with the line of motion of the mass, its pole being at a distance of 30 cm from the free end of the spring. Find the length in which the image of the mass oscillates. 
Q-22	Two concave mirrors of equal radii of curvature R are fixed on a stand back to back. The whole system has a mass m and is kept on a frictionless horizontal table. The two blocks A and B, each of mass m are placed on two sides of the stand. At $t = 0$, the separation between A and the mirror is $2R$ and also separation between B and the mirror is $2R$. The block B moves towards the mirror at a speed v. All collisions which take place are elastic. Taking the original positions of the mirror-stand system at $x = 0$ and X-axis along AB, find the position of images of A and B at $t =$  (a) $\frac{R}{v}$ (b) $\frac{3R}{v}$ (c) $\frac{5R}{v}$
Q-23	Consider the situation shown in the figure. The elevator is going up with an acceleration of 2.00 m/s^2 and the focal length of the mirror is 12.0 cm. All the surfaces are smooth and the pulley is light. The mass-pulley system is released from rest (with respect to the elevator) at $t = 0$ when the distance of B from the mirror is 42.0 cm. Find the distance between the image of the block B and the mirror at $t = 0.200$ s. Take $g = 10$ m/s^2. 

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