# Physics Question Bank

Questions with Solutions, Arranged by Topic

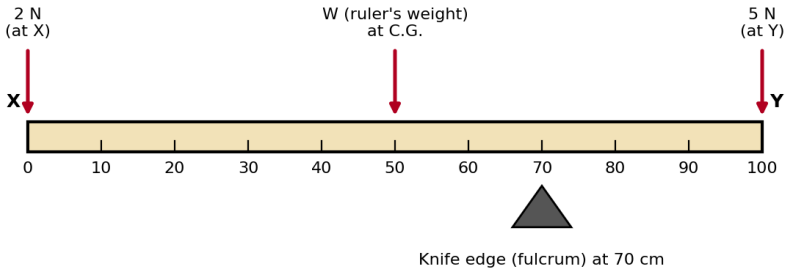
| Part | Topic | Questions |
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## Part 1: Force, Work, Power and Energy

> **Q1.** Akash takes a uniform meter scale and suspends a weight of 2 N at one end ‘X’ and a weight of 5 N on the other end ‘Y’. He then balances the ruler horizontally on a knife edge placed at 70 cm from X. Draw a diagram of the arrangement and calculate the weight of the ruler.

### Answer

**Setup:** A uniform meter scale has its centre of gravity at the 50 cm mark, so the weight of the ruler (W) acts there. X is at the 0 cm mark, Y is at the 100 cm mark, and the knife edge (fulcrum) is at 70 cm.




#### Distances from the fulcrum (70 cm mark)

- 2 N weight at X: 70 − 0 = 70 cm (left of fulcrum)
- Ruler’s weight W at 50 cm: 70 − 50 = 20 cm (left of fulcrum)
- 5 N weight at Y: 100 − 70 = 30 cm (right of fulcrum)

#### Principle of moments

For equilibrium, the anticlockwise moment equals the clockwise moment about the fulcrum.

$$(2 \times 70) + (W \times 20) = 5 \times 30$$
$$140 + 20W = 150$$
$$20W = 10$$
$$W = 0.5 \text{ N}$$

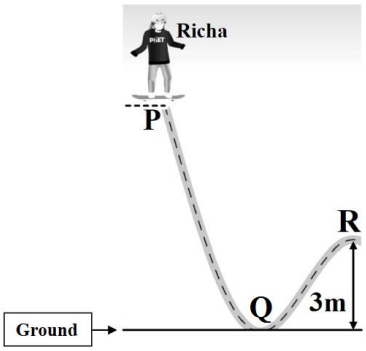
**Answer: The weight of the ruler is 0.5 N.**

**Q2.** Richa weighing 40 kgf leaves point P on her skateboard and reaches point Q on the ground with velocity 10 m/s. Calculate:

(a) the kinetic energy of Richa at point Q.

(b) the vertical height of point P above the ground. (Use g as 10 m/s² and neglect friction)

(c) the kinetic energy of Richa at point R. (While moving from Q to R, she loses 500 J of energy against friction.)




## Answer

**Given:** Weight = 40 kgf, so mass m = 40 kg. Velocity at Q, v = 10 m/s. g = 10 m/s². Height of R above the ground = 3 m. Q is on the ground (h = 0).

### (a) Kinetic energy at Q

$$\text{K.E.} = \tfrac{1}{2}mv^2 = \tfrac{1}{2} \times 40 \times (10)^2 = \tfrac{1}{2} \times 40 \times 100$$

**K.E. at Q = 2000 J**

### (b) Height of P above the ground

Friction is neglected from P to Q, so energy is conserved. Richa leaves P with no initial speed, so the potential energy at P is entirely converted into kinetic energy at Q.

$$\text{P.E. at P} = \text{K.E. at Q}$$
$$mgh = 2000$$
$$40 \times 10 \times h = 2000$$
$$h = 2000 / 400$$

**h = 5 m**

### (c) Kinetic energy at R

Total energy at Q (all kinetic, since Q is on the ground) = 2000 J. At R, she has gained potential energy and lost 500 J to friction.

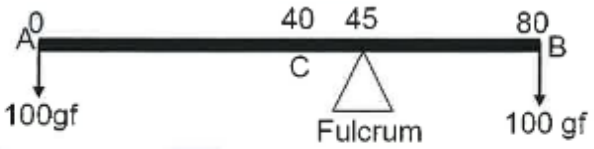
$$\text{P.E. at R} = mgh = 40 \times 10 \times 3 = 1200 \text{ J}$$
$$\text{K.E. at R} = \text{Energy at Q} - \text{P.E. at R} - \text{Energy lost to friction}$$
$$\text{K.E. at R} = 2000 - 1200 - 500$$

**K.E. at R = 300 J**

**Q3.** A metal rod AB of length 80 cm is balanced at 45 cm from the end A with 100 gf weights suspended from the two ends.

(a) If this rod is cut at the centre C, then compare the weight of AC to the weight of BC.

(b) Give a reason for your answer in (a).




## Answer

### (a) Comparison of weights

The centre C is at the 40 cm mark. The weight of AC is **less than** the weight of BC (W_AC < W_BC).

### (b) Reason

Both ends carry equal loads (100 gf), but the fulcrum is 45 cm from A and only 35 cm from B. So the loads alone give an anticlockwise moment greater by 100 × (45 − 35) = 1000 gf·cm. The rod's own weight must supply the extra clockwise moment. This is possible only if the rod is non-uniform, with its centre of gravity on the B side of the fulcrum, which means the BC half is heavier than the AC half.

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**Q4.** For each of the following scenarios, state whether the work done by gravity is positive, negative, or zero.

(a) a person walks on a levelled road.

(b) a person climbs a ladder.

(c) a car in neutral gear is coming down the slope.

## Answer

**(a) Zero.** The displacement is horizontal, perpendicular to the force of gravity.

**(b) Negative.** The displacement is upward, opposite to gravity (which acts downward).

**(c) Positive.** The car moves downward, so it has a displacement component in the direction of gravity.

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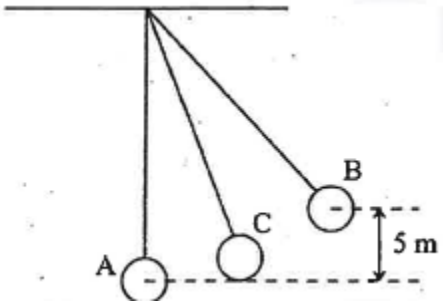
**Q5.** The figure below shows a simple pendulum of mass 200 g. It is displaced from the mean position A to the extreme position B. The potential energy at the position A is zero. At the position B the pendulum bob is raised by 5 m.

(a) What is the potential energy of the pendulum at the position B?

(b) What is the total mechanical energy at point C?

(c) What is the speed of the bob at the position A when released from B?

(Take g = 10 m/s² and given that there is no loss of energy.)




## Answer

**Given:** m = 200 g = 0.2 kg, h = 5 m, g = 10 m/s².

### (a) Potential energy at B

$$\text{P.E. at B} = mgh = 0.2 \times 10 \times 5$$

**P.E. at B = 10 J**

### (b) Total mechanical energy at C

There is no loss of energy, so the total mechanical energy is the same at every position of the pendulum.

**Total mechanical energy at C = 10 J**

### (c) Speed of the bob at A

At A all the energy is kinetic (P.E. = 0).

$$\tfrac{1}{2}mv^2 = 10$$

$$\tfrac{1}{2} \times 0.2 \times v^2 = 10, \text{ so } v^2 = 100$$

**v = 10 m/s**

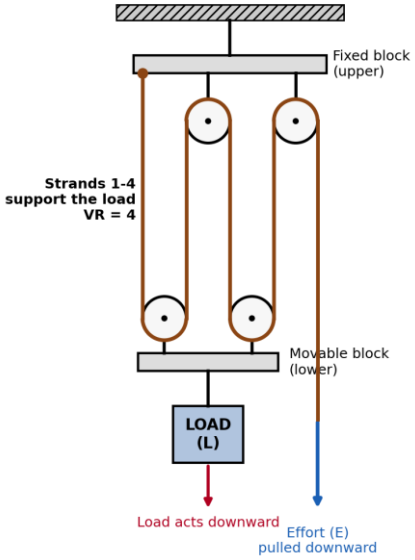
**Q6.** A block and tackle system of pulleys has velocity ratio 4.

(a) Draw a labelled diagram of the system indicating clearly, the direction of the load and effort.

(b) Calculate the potential energy of the load 100 kgf lifted by this pulley to a height 5 m. (g = 10 m/s²)

## Answer

### (a) Labelled diagram




The system has two pulleys in the fixed (upper) block and two in the movable (lower) block. The rope is tied to the upper block and passes round the pulleys in turn, with its free end pulled downward. Four strands of rope support the movable block, so **V.R. = 4**. The load acts downward and the effort is applied downward.

### (b) Potential energy of the load

Load = 100 kgf, so m = 100 kg. h = 5 m, g = 10 m/s².

$$\text{P.E.} = mgh = 100 \times 10 \times 5$$

**P.E. = 5000 J**

# Part 2: Light

**Q1.** A ray of light enters a rectangular glass slab submerged in water at an angle of incidence 55°. Does this ray undergo total internal reflection when it moves from water to glass? Justify your answer. (The critical angle for glass-water interface is 54°.)

## Answer

**No, the ray does not undergo total internal reflection when it moves from water to glass.**

### Justification

Total internal reflection can occur only when both of these conditions are met:

- Light travels from an optically **denser** medium to an optically **rarer** medium.
- The angle of incidence is **greater than the critical angle** for that pair of media.

Here, the ray goes from water to glass. Glass has a higher refractive index than water (about 1.5 compared to 1.33), so light is moving from the optically **rarer** medium (water) into the optically **denser** medium (glass). The first condition fails.

The critical angle of 54° applies only to light travelling from glass to water. Although the angle of incidence (55°) is numerically greater than 54°, that is irrelevant here, because when light enters a denser medium it bends **towards the normal**. The ray is simply refracted into the glass, with an angle of refraction smaller than 55°.

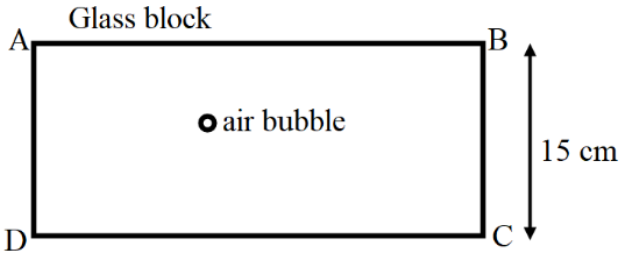
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**Q2.** A rectangular glass block of refractive index 1.5 has an air bubble trapped inside it as shown in the diagram. When seen from the surface AB, it appears to be 4 cm deep.

(a) Calculate the actual depth of the air bubble from the surface AB.

(b) For which colour of light, blue or yellow, the apparent depth will be greater?

(c) Turning the glass block upside down, DOES NOT change the apparent depth of the air bubble. State True or False.




## Answer

**Given:** Refractive index of glass, n = 1.5; apparent depth from AB = 4 cm; thickness of block (AD or BC) = 15 cm.

### (a) Actual depth of the bubble from AB

The bubble is inside the glass (denser medium) and is viewed from air (rarer medium), so:

n = real depth / apparent depth

Real depth = n × apparent depth = 1.5 × 4 = 6 cm

**The bubble is 6 cm below surface AB.**

### (b) Blue or yellow light?

Apparent depth = real depth / n. The real depth is fixed, so the apparent depth is greater when n is smaller. Blue light has a shorter wavelength and is bent more, so glass has a higher refractive index for blue than for yellow. Yellow light therefore has the smaller n, which gives it the greater apparent depth.

**Answer: Yellow light.**

### (c) Turning the block upside down

The bubble is 6 cm from AB, so its distance from the opposite surface CD is 15 − 6 = 9 cm.

- Viewed from AB (original position): real depth 6 cm, apparent depth = 6 / 1.5 = 4 cm.
- After turning the block upside down, CD becomes the top surface. Now the real depth is 9 cm, so apparent depth = 9 / 1.5 = 6 cm.

The apparent depth changes from 4 cm to 6 cm, so the statement is incorrect.

**Answer: False.**

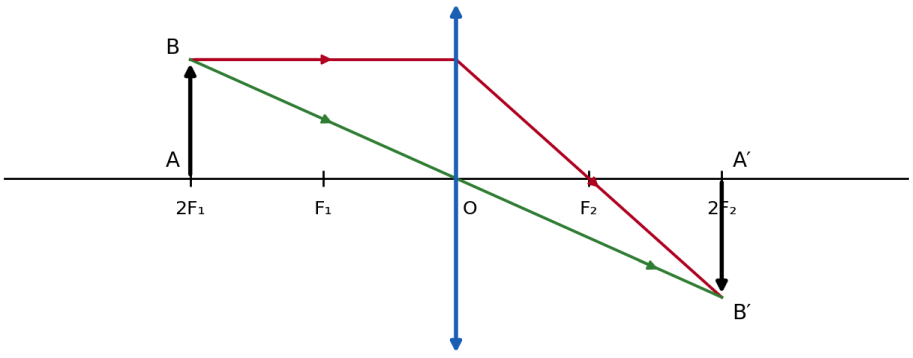
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**Q3.** (a) An object is placed at 2F position of a convex lens. Draw a ray diagram showing the formation of the image.

(b) How will the size of the image change if we, ONLY replace the lens in the above arrangement with another lens of a greater focal length?

## Answer

### (a) Object at 2F of a convex lens




**Steps to draw:**

- Draw the principal axis and a vertical line for the convex lens, with its optical centre **O** on the axis.
- Mark **$F_1$ and $2F_1$** on the left of the lens and **$F_2$ and $2F_2$** on the right, at equal distances.

- Place the object **AB** (an upright arrow) at **$2F_1$**.
- **Ray 1:** From B, draw a ray parallel to the principal axis. After refraction, it passes through **$F_2$**.
- **Ray 2:** From B, draw a ray through the optical centre **O**. It goes straight without deviation.
- The two refracted rays meet on the right side, below the axis, at **$2F_2$**. Mark this point **B'**, and drop a perpendicular to the axis to get **A'**.

**Nature of image:** formed at $2F_2$ on the other side of the lens; same size as the object; real and inverted.

### (b) Replacing the lens with one of greater focal length

The object distance stays the same, $u = 2f_1$ (the original focal length). With a new lens of focal length $f_2 > f_1$, the object now lies between F and 2F of the new lens. For an object between F and 2F of a convex lens, the image is formed **beyond 2F**, and it is **real, inverted and enlarged**.

**Check with the lens formula:** let $f_1 = 10$ cm, so $u = -20$ cm. For a new lens with $f_2 = 15$ cm:

$$1/v = 1/f - 1/|u| = 1/15 - 1/20 = 1/60, \text{ so } v = 60 \text{ cm}$$
$$m = v/u = 60/(-20) = -3 \quad (\text{image is 3 times the object size})$$

**Answer: The size of the image increases** (the image becomes larger than the object).

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> **Q4.** An object is placed in front of a concave lens at a distance of 45 cm from it. If its image is formed at a distance of 30 cm from the lens, calculate the focal length of the lens.

## Answer

**Given:** Object distance $u = -45$ cm (object is in front of the lens). A concave lens always forms a virtual, erect image on the same side as the object, so image distance $v = -30$ cm.

### Lens formula

$$1/f = 1/v - 1/u$$
$$1/f = 1/(-30) - 1/(-45)$$
$$1/f = -1/30 + 1/45$$

Taking the LCM (90):

$$1/f = -3/90 + 2/90 = -1/90$$
$$f = -90 \text{ cm}$$

**Answer: The focal length of the concave lens is −90 cm, that is, 90 cm in magnitude.** The negative sign confirms it is a diverging (concave) lens.

**Check:** Magnification $m = v/u = (-30)/(-45) = +2/3$. This is positive and less than 1, so the image is virtual, erect and diminished, which is exactly what a concave lens produces.

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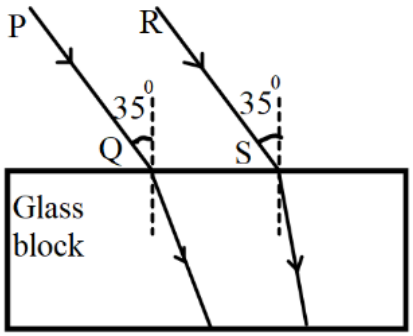
**Q5.** Two rays PQ and RS are incident on a rectangular glass block as shown in the diagram. Observe the diagram and answer the questions that follow.

Which of these two rays will:

(a) have greater lateral displacement on emerging out of the block?

(b) travel with greater speed in the block?

(c) scatter more in the atmosphere?




## Answer

**Reading the diagram:** Both rays strike the block at the same angle of incidence (35°), but they refract differently. Ray RS bends more towards the normal (smaller angle of refraction), while ray PQ bends less. For the same angle of incidence, a smaller angle of refraction means a higher refractive index ($n = \sin i / \sin r$). So the glass has a **higher refractive index for RS** and a **lower refractive index for PQ**.

In terms of colour, RS is the light of shorter wavelength (towards violet/blue), and PQ is the light of longer wavelength (towards red).

### (a) Greater lateral displacement: RS

The lateral displacement is $d = t \sin(i - r) / \cos r$. For the same thickness t and the same i, a smaller r (more bending) gives a larger displacement. RS bends more, so it is displaced more on emerging from the block.

### (b) Greater speed in the block: PQ

The speed of light in glass is $v = c/n$. PQ has the smaller refractive index, so it travels faster in the glass.

### (c) Scatters more in the atmosphere: RS

Scattering is inversely proportional to the fourth power of the wavelength ($\lambda^4$). RS has the shorter wavelength, so it is scattered more by the particles in the atmosphere.

**Q6.** (a) Name the radiations:

1. for which a quartz prism is used to study the spectrum.

2. which are used in remote sensing devices.

3. which are used in traffic signals in India.

(b) Name one property common to all electromagnetic radiations.

## Answer

### (a) Naming the radiations

**1. Ultraviolet rays.** Ordinary glass absorbs ultraviolet radiation, so a quartz prism (which is transparent to UV) is used to study the ultraviolet spectrum.

**2. Infrared rays.** Infrared radiation is used in remote sensing devices, for example in satellites and night-vision equipment, because objects emit and reflect it according to their temperature and surface.

**3. Visible light (red, yellow/amber and green).** Traffic signals use red (stop), yellow/amber (get ready) and green (go). Red is used for the stop signal because it has the longest wavelength in the visible range, so it is scattered the least and can be seen from far away.

### (b) Property common to all electromagnetic radiations

All electromagnetic waves **travel with the same speed in vacuum**, equal to $3 \times 10^8$ m/s.

(Other acceptable answers: they are all transverse waves, they need no material medium to travel, and they are not deflected by electric or magnetic fields.)

**Q7.** The diagram below shows a fish in the tank and its image seen in the surface of water.

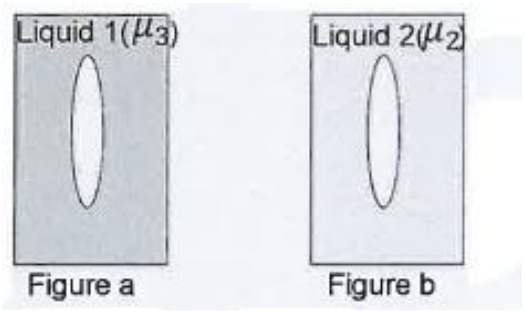
(a) Name the phenomenon responsible for the formation of this image.

(b) A double convex lens with refractive index $\mu_1$ inside two liquids of refractive indices $\mu_2$ and $\mu_3$ are shown in the diagrams below. The refractive indices are such that $\mu_2 > \mu_1$ and $\mu_1 > \mu_3$. How would a parallel incident beam of light refract when it comes out of the lens in each of the cases shown above?

(1) in Fig a.

(2) in Fig b.






## Answer

### (a) Phenomenon responsible for the image

**Total internal reflection.** Light from the fish travels upwards and strikes the water-air surface at an angle greater than the critical angle (about 48.6° for water). The surface then acts like a mirror and reflects all the light back into the water. This gives the second, reflected image of the fish.

### (b) Behaviour of the parallel beam

The lens (refractive index $\mu_1$) is double convex, so it converges light only when it is optically denser than its surroundings. When it is rarer than its surroundings, it diverges light instead.

**(1) Figure a (Liquid 1, $\mu_3$, with $\mu_1 > \mu_3$):** The lens is denser than the liquid, so it behaves as a normal convex lens. The parallel beam **converges** to a point (a real focus) on the other side of the lens.

**(2) Figure b (Liquid 2, $\mu_2$, with $\mu_2 > \mu_1$):** The lens is rarer than the liquid, so it behaves as a concave (diverging) lens. The parallel beam **diverges** after emerging, as if coming from a point on the incident side of the lens.

**Q8.** The refractive index of water is 1.33 at a certain temperature. When the temperature of water is increased by 40 °C, the refractive index changes to ‘x’.

(a) State whether x < 1.33 or x > 1.33.

(b) State two differences between normal reflection and total internal reflection.

## Answer

### (a) Refractive index at the higher temperature

**x < 1.33.** When water is heated, it becomes less dense, and light travels slightly faster in it. Since n = c/v, a higher speed means a lower refractive index.

### (b) Normal reflection and total internal reflection

| Normal reflection | Total internal reflection |
|---|---|
| Occurs at any angle of incidence, and for light going from a rarer to a denser medium or the reverse. | Occurs only when light goes from a denser to a rarer medium and the angle of incidence is greater than the critical angle. |
| Only part of the light is reflected. The rest is refracted or absorbed, so the reflected ray is weaker than the incident ray. | The whole of the light (100%) is reflected, so the reflected ray is as bright as the incident ray. |

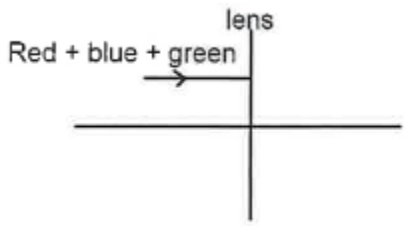
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**Q9.** (a) Mixture of red + blue + green is passed through a convex lens as shown in the diagram below. State whether the ray passes through a single point or through different points on the principal axis after refraction.

(b) Name the invisible radiations which are studied using the quartz prism.

(c) State one use of these radiations.

(d) Name one radiation having the wavelength longer than the wavelength of these radiations.




## Answer

### (a) Mixture of red, blue and green through a convex lens

The colours pass through **different points** on the principal axis after refraction. The refractive index of glass is different for each colour. Blue has the shortest wavelength and the highest refractive index, so it bends the most and focuses closest to the lens. Red has the longest wavelength and the lowest

refractive index, so it bends the least and focuses farthest from the lens. Green focuses in between. This defect is called **chromatic aberration**.

### (b) Invisible radiations studied using a quartz prism

**Ultraviolet rays.** Ordinary glass absorbs UV, but quartz is transparent to it.

### (c) One use of these radiations

Ultraviolet rays are used to **sterilise water and surgical instruments**, because they kill germs. (Other acceptable uses: detecting forged currency notes, and checking the purity of gems.)

### (d) A radiation with wavelength longer than UV

**Infrared rays.** (Visible light, microwaves and radio waves are also acceptable.)

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**Q10.** O is a luminescent particle trapped inside a glass block. A student traces the path of rays coming out of it and reflecting over a plane mirror as shown in the diagram below. Complete the table, using the labels from the figure. The first label is done for you.

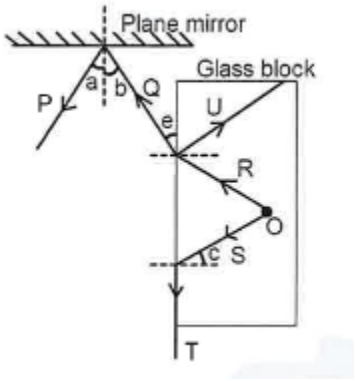
a. an angle of reflection on the mirror: a

b. a partially reflected ray in the glass slab

c. a critical angle

d. a refracted ray

e. an angle of refraction of the ray R




## Answer

**Reading the figure:** Ray R from O strikes the left face of the block at a point where part of the light refracts out (towards the mirror) and part is reflected back into the glass. Ray S strikes the lower point at the critical angle c, so its refracted ray T just grazes the surface (angle of refraction 90°).

| Sr. No | Description | Label |
|---|---|---|
| a. | an angle of reflection on the mirror | **a** |
| b. | a partially reflected ray in the glass slab | **U** |
| c. | a critical angle | **c** |

| Sr. No | Description | Label |
|---|---|---|
| d. | a refracted ray | **Q** |
| e. | an angle of refraction of the ray R | **e** |

For (d), ray T is also a refracted ray (it emerges at 90°), but Q is the refracted ray of R.

**Q11.** An object is placed at a distance 24 cm in front of a convex lens of focal length 8 cm.

(a) What is the nature of the image so formed?

(b) Calculate the distance of the image from the lens.

## Answer

**Given:** u = −24 cm, f = +8 cm.

### (b) Distance of the image (lens formula)

$$1/v = 1/f + 1/u$$
$$1/v = 1/8 + 1/(-24)$$
$$1/v = 3/24 - 1/24 = 2/24 = 1/12$$
$$v = +12 \text{ cm}$$

**The image is 12 cm from the lens**, on the opposite side from the object.

### (a) Nature of the image

v is positive, so the image is **real and inverted**. The magnification is m = v/u = 12/(−24) = −1/2, so the image is also **diminished** (half the size of the object).

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**Q12.** When sunlight passes through water droplets in the atmosphere it gets dispersed into its constituent colours forming a rainbow. A similar phenomenon is observed when white light passes through a prism.

(a) Which colour will show the maximum angle of deviation and which colour will show the minimum angle of deviation?

(b) If instead of sunlight, a green-coloured ray is passed through a glass prism. What will be the colour of the emergent ray?

## Answer

### (a) Deviation of colours in a prism

**Violet** shows the **maximum** angle of deviation, and **red** shows the **minimum**. Violet has the shortest wavelength and the highest refractive index in glass, so it bends the most. Red has the longest wavelength and the lowest refractive index, so it bends the least.

### (b) Green ray through a glass prism

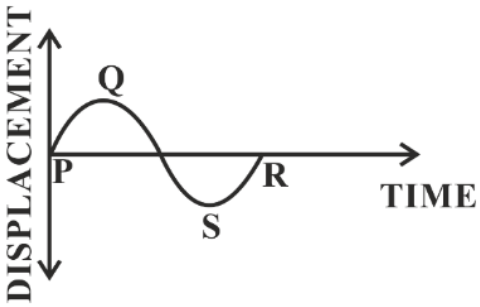
The emergent ray will be **green**. Green light is monochromatic (a single colour), so it cannot be split any further. It is only deviated, and its colour does not change.

## Part 3: Sound

**Q1.** The displacement-time graph of a sound wave produced by a vibrating wire is shown below.

(a) How will you adjust the tension in the wire, to reduce the length of PR?

(b) Which characteristic of sound is affected by the reduction in the length of PR?




### Answer

**Reading the graph:** PR is one complete cycle (P to Q to the zero line to S and back to R), so the length PR on the time axis is the **time period** of the vibration.

#### (a) Adjusting the tension

To reduce the length of PR, the time period must decrease, which means the frequency must increase. The frequency of a vibrating wire rises when the tension is increased, so **increase the tension** by tightening the wire.

#### (b) Characteristic affected

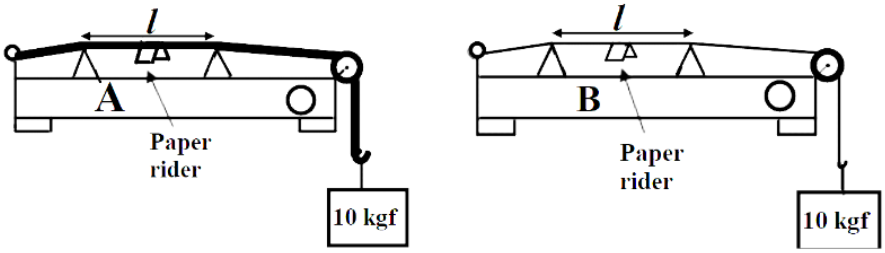
A shorter PR means a higher frequency, so the **pitch** of the sound is affected. The sound becomes shriller (higher pitched). The amplitude (height of Q or S) stays the same, so the loudness does not change.

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**Q2.** The diagrams given below show two sound boxes A and B with wires of same length (l) and tension (10 kgf) but different cross-sectional areas. Simultaneously, vibrating tuning forks of frequency 300 Hz are placed on the boxes A and B. The paper rider falls off in case of B but not in case of A.

(a) Name and explain the phenomenon responsible for the falling off of the paper rider in B.

(b) The wire A resonates with a tuning fork of frequency 'f'. Is 'f' greater than, less than or equal to 300 Hz? Justify your answer.




## Answer

**Reading the diagram:** This is a sonometer experiment. Wire A is thick and wire B is thin. Both have the same length (l) and the same tension (10 kgf).

### (a) Phenomenon: Resonance

The frequency of a vibrating wire is given by $f = (1/2l)\sqrt{(T/m)}$, where m is the mass per unit length. For the same length and tension, a thinner wire has a smaller mass per unit length, so it has a higher natural frequency.

In B, the natural frequency of the wire is equal to the frequency of the tuning fork (300 Hz). When the vibrating fork is placed on the box, it sets the wire into forced vibrations. Because the two frequencies match, the wire vibrates with a large amplitude. This is **resonance**. The large vibrations of the wire shake the paper rider, which then falls off.

In A, the natural frequency of the wire is not equal to 300 Hz, so there is no resonance. The wire vibrates only with a small amplitude, and the rider stays in place.

### (b) Frequency f of wire A

**f is less than 300 Hz.**

Justification: Wire A is thicker than wire B, so it has a greater mass per unit length (m). Since l and T are the same for both wires, $f \propto 1/\sqrt{m}$. A larger m gives a lower natural frequency. Wire B resonates at 300 Hz, so wire A, being thicker, has a natural frequency lower than 300 Hz. Therefore the tuning fork that resonates with wire A must have a frequency $f < 300$ Hz.

**Q3.** A person standing in front of a cliff fires a gun and hears its echo after 3 s. If the speed of sound in air is 336 m/s:

(a) Calculate the distance of the person from the cliff.

(b) After moving a certain distance from the cliff, he fires the gun again and this time the echo is heard 1.5 s later than the first. Calculate the distance that the person moved.

## Answer

### (a) Distance from the cliff

The sound travels to the cliff and back, covering twice the distance in 3 s.

$$2d = v \times t = 336 \times 3 = 1008 \text{ m}$$

**d = 504 m**

### (b) Distance moved

The echo is heard 1.5 s later, so the new echo time is 3 + 1.5 = 4.5 s.

$$2d' = 336 \times 4.5 = 1512 \text{ m, so } d' = 756 \text{ m}$$
$$\text{Distance moved} = 756 - 504 = 252 \text{ m}$$

**The person moved 252 m away from the cliff.**

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**Q4.** The picture below shows a mother pushing her daughter sitting on a swing. The swing is going through the positions A, B, C where A and C are extreme positions and B is the mean position.

(a) Which is the right position i.e. at A, B or C, for the mother to give a constant periodic push to the swing every time in the forward direction to increase the amplitude of the swing?

(b) Name the phenomenon involved in this.

(c) Explain with this example how this phenomenon helps to increase the amplitude of the swing.




## Answer

### (a) Right position for the push

Position **A**, the extreme position nearest the mother. She pushes forward just as the swing starts to move away from her, so each push is in the same direction as the swing's motion.

### (b) Phenomenon involved

**Resonance.**

### (c) How it increases the amplitude

The mother's pushes are periodic and match the natural frequency of the swing. Each push arrives at the right moment, in step with the swing's motion, so it adds a little more energy every time. The energy builds up without cancelling, and the swing moves with a larger and larger amplitude. If the pushes were at a different frequency, some would oppose the motion and the amplitude would not grow.