

# JEECUP Group-A Physics Sample Paper – 22

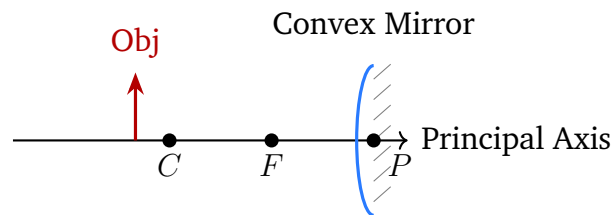
Duration: 45 Minutes

Maximum Marks: 100

## Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**. Incorrect and unattempted questions carry **0** marks.
- Only **one** option is correct for each question.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

**Q1.** Which of the following correctly describes the image formed by a convex mirror for any position of the object in front of it?



- (A) Virtual, erect and diminished for all object positions  
(B) Real, inverted and magnified for all object positions  
(C) Virtual, inverted and magnified when object is beyond  $C$   
(D) Real, erect and of the same size as the object
- Q2.** When a ray of light travels from a denser medium to a rarer medium, it:
- (A) Bends towards the normal  
(B) Bends away from the normal  
(C) Continues without bending  
(D) Reflects back completely in all cases
- Q3.** A concave lens has focal length  $f = -20$  cm. An object is placed 30 cm in front of it. Using the lens formula, the image distance  $v$  is:



- (A)  $-60 \text{ cm}$
- (B)  $+20 \text{ cm}$
- (C)  $-12 \text{ cm}$
- (D)  $+60 \text{ cm}$

**Q4.** The approximate speed of light in vacuum is:

- (A)  $3 \times 10^6 \text{ m s}^{-1}$
- (B)  $3 \times 10^4 \text{ m s}^{-1}$
- (C)  $3 \times 10^{10} \text{ m s}^{-1}$
- (D)  $3 \times 10^8 \text{ m s}^{-1}$

**Q5.** When light passes from air into glass (optically denser medium), keeping the frequency unchanged, what happens to its wavelength?

- (A) The wavelength decreases
- (B) The wavelength increases
- (C) The wavelength remains the same
- (D) The wavelength becomes zero

**Q6.** In the formula  $R = \rho L/A$ , the quantity  $\rho$  (rho) is called:

- (A) Conductance of the material
- (B) Resistivity (specific resistance) of the material
- (C) Temperature coefficient of the material
- (D) Current density of the material

**Q7.** A current of  $2 \text{ A}$  flows through a resistor of  $5 \Omega$ . The power dissipated in the resistor is:

- (A)  $2.5 \text{ W}$
- (B)  $10 \text{ W}$
- (C)  $20 \text{ W}$



(D) 40 W

**Q8.** A 100 W electric bulb is used for 2 hours daily. The electrical energy consumed in kilowatt-hours (kWh) is:

(A) 200 J

(B) 2 kWh

(C) 200 kWh

(D) 0.2 kWh

**Q9.** A cell has EMF  $E = 6 \text{ V}$  and internal resistance  $r = 0.5 \Omega$ . When a current of  $I = 2 \text{ A}$  is drawn, the terminal voltage across its terminals is:

(A) 5 V

(B) 6 V

(C) 7 V

(D) 4 V

**Q10.** A current of 3 A flows through a conductor for 4 seconds. The electric charge that passes through any cross-section of the conductor is:

(A) 0.75 C

(B) 12 C

(C) 7 C

(D) 1.33 C

**Q11.** A net force of 15 N acts on an object of mass 5 kg. The acceleration produced is:

(A)  $75 \text{ m s}^{-2}$

(B)  $0.33 \text{ m s}^{-2}$

(C)  $3 \text{ m s}^{-2}$

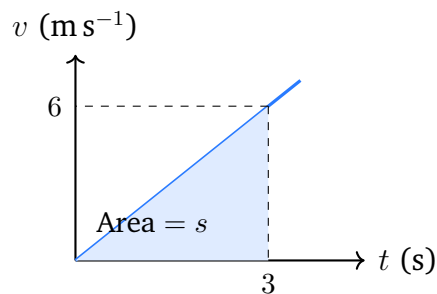
(D)  $10 \text{ m s}^{-2}$



**Q12.** The slope of a velocity–time ( $v-t$ ) graph gives:

- (A) Distance covered
- (B) Displacement of the body
- (C) Speed of the body
- (D) Acceleration of the body

**Q13.** A body starts from rest and accelerates uniformly at  $a = 2 \text{ m s}^{-2}$ . The  $v-t$  graph is shown below. The distance covered in  $t = 3 \text{ s}$  (equal to the shaded area) is:



- (A) 9 m
- (B) 6 m
- (C) 18 m
- (D) 3 m

**Q14.** The momentum of a body of mass 4 kg moving with a velocity of  $5 \text{ m s}^{-1}$  is:

- (A)  $1.25 \text{ kg m s}^{-1}$
- (B)  $20 \text{ kg m s}^{-1}$
- (C)  $9 \text{ kg m s}^{-1}$
- (D)  $0.8 \text{ kg m s}^{-1}$

**Q15.** A body of mass 2 kg is raised to a height of 5 m above the ground (take  $g = 10 \text{ m s}^{-2}$ ). Its gravitational potential energy is:

- (A) 10 J



- (B) 25 J
- (C) 100 J
- (D) 1000 J

**Q16.** A machine does 200 J of work in 4 s. Its power output is:

- (A) 800 W
- (B) 0.02 W
- (C) 40 W
- (D) 50 W

**Q17.** A porter carries a heavy load horizontally on his head on a level road. The work done by gravity on the load during this motion is:

- (A) Zero, because gravity and displacement are perpendicular
- (B) Positive, because gravity acts downward
- (C) Negative, because the porter exerts an upward force
- (D) Equal to the weight of the load

**Q18.** In the formula  $\Delta L = L_0 \alpha \Delta T$  for linear thermal expansion, the symbol  $\alpha$  represents:

- (A) The mass of the material
- (B) The coefficient of linear thermal expansion
- (C) The density of the material
- (D) The initial temperature of the material

**Q19.** When ice at  $0^\circ\text{C}$  is converted to water at  $0^\circ\text{C}$ , the temperature:

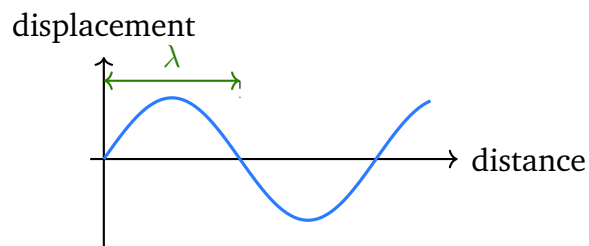
- (A) Increases during melting
- (B) Decreases during melting
- (C) Remains constant; the heat absorbed is the latent heat of fusion
- (D) Drops below  $0^\circ\text{C}$



**Q20.** Metals are generally good conductors of heat because they contain:

- (A) Heavy nuclei
- (B) Large atomic mass
- (C) Strong ionic bonds
- (D) Large numbers of free (mobile) electrons

**Q21.** The speed of sound in air is  $340 \text{ m s}^{-1}$ . A sound wave of frequency  $170 \text{ Hz}$  is produced. The diagram below shows such a wave; its wavelength  $\lambda$  is:



- (A) 2 m
- (B) 0.5 m
- (C) 170 m
- (D) 57800 m

**Q22.** The minimum distance from a reflecting surface required to hear a distinct echo (speed of sound =  $340 \text{ m s}^{-1}$ , minimum time to distinguish echo = 0.1 s) is:

- (A) 34 m
- (B) 17 m
- (C) 8.5 m
- (D) 340 m

**Q23.** Beta ( $\beta^-$ ) particles emitted during radioactive decay are:

- (A) Helium nuclei
- (B) High-energy gamma photons



- (C) High-speed electrons emitted from the nucleus
- (D) Uncharged neutrons

**Q24.** The half-life of a radioactive substance is defined as:

- (A) The time for the substance to completely decay
- (B) The time for its temperature to halve
- (C) The time for its atomic mass to halve
- (D) The time for half the radioactive nuclei to decay

**Q25.** Pascal's Law states that pressure applied at any point to a confined fluid is:

- (A) Transmitted equally and undiminished in all directions
- (B) Absorbed by the fluid
- (C) Converted to heat
- (D) Reduced proportionally with depth



## Detailed Solutions

Q1.

## Solution

**Concept — Convex Mirror:** A convex mirror always has its focus and centre of curvature behind the mirror (virtual). Regardless of object position, the image is always virtual, erect, and diminished.

**Step 1:** For a convex mirror,  $f > 0$  (focus is behind mirror, virtual). For any real object ( $u < 0$ ), using the mirror formula shows  $v > 0$  always (image behind mirror = virtual).

**Step 2:** Magnification  $m = -v/u > 0$  (erect) and  $|m| < 1$  (diminished), irrespective of where the object is placed.

**Step 3:** Convex mirrors are used as rear-view mirrors in vehicles because they give a wide field of view and always form a diminished, erect image.

**Final Answer:** Virtual, erect and diminished  $\Rightarrow$  (A)

Answer: (A) [Go Back to Q1](#)

Q2.

## Solution

**Concept — Refraction at Denser-to-Rarer Interface:** By Snell's law,  $n_1 \sin \theta_1 = n_2 \sin \theta_2$ . Going from denser ( $n_1 > n_2$ ) to rarer,  $\sin \theta_2 > \sin \theta_1$ , so  $\theta_2 > \theta_1$ : ray bends away from normal.

**Step 1:** Example: glass to air.  $n_{\text{glass}} = 1.5$ ,  $n_{\text{air}} = 1$ .  $\sin \theta_2 = 1.5 \sin \theta_1 > \sin \theta_1$ , so  $\theta_2 > \theta_1$ . The refracted ray is farther from the normal.

**Step 2 — Compare:** Going from rarer to denser (air to glass), the ray bends *towards* the normal (opposite). Option D is only true at/beyond the critical angle (total internal reflection), not always.

**Final Answer:** Bends away from the normal  $\Rightarrow$  (B)

Answer: (B) [Go Back to Q2](#)

Q3.

## Solution

**Concept — Lens Formula:**  $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ , with sign convention: distances measured from optical centre; real objects have  $u < 0$ .

**Step 1:**  $f = -20$  cm (concave lens, diverging),  $u = -30$  cm.

**Step 2:**  $\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{-20} + \frac{1}{-30} = -\frac{3}{60} - \frac{2}{60} = -\frac{5}{60} = -\frac{1}{12}$ .

**Step 3:**  $v = -12$  cm. Negative sign means the image is on the same side as the object



(virtual image). A concave lens always forms a virtual, erect, diminished image.

**Final Answer:**  $v = -12 \text{ cm} \Rightarrow$

**Answer: (C)**    [Go Back to Q3](#)

Q4.

### Solution

**Concept — Speed of Light:** Light is an electromagnetic wave. In vacuum, it travels at the universal constant  $c = 3 \times 10^8 \text{ m s}^{-1}$ .

**Step 1:**  $c \approx 3 \times 10^8 \text{ m s}^{-1} = 300,000 \text{ km s}^{-1}$ . This value is used in all electromagnetic calculations.

**Step 2:** In a medium with refractive index  $n$ , the speed of light is  $v = c/n < c$ .

**Step 3 — Eliminate options:**  $3 \times 10^{10}$  (Option C) is the speed in cm/s units, not SI. Options A and B are far too slow.

**Final Answer:**  $3 \times 10^8 \text{ m s}^{-1} \Rightarrow$

**Answer: (D)**    [Go Back to Q4](#)

Q5.

### Solution

**Concept — Wavelength in a Denser Medium:**  $v = f\lambda$ . When light enters glass, the frequency  $f$  stays the same (it is a property of the source), but the speed  $v$  decreases ( $v = c/n < c$ ). Therefore  $\lambda = v/f$  also decreases.

**Step 1:** In air:  $\lambda_{\text{air}} = c/f$ .

**Step 2:** In glass ( $n = 1.5$ ):  $v_{\text{glass}} = c/1.5$ , so  $\lambda_{\text{glass}} = v_{\text{glass}}/f = c/(1.5f) = \lambda_{\text{air}}/1.5$ . The wavelength is smaller.

**Step 3:** This is why colours separate in a prism: each colour has a different wavelength, and each bends by a different amount.

**Final Answer:** Wavelength decreases  $\Rightarrow$

**Answer: (A)**    [Go Back to Q5](#)



Q6.

**Solution**

**Concept — Resistivity:**  $\rho = RA/L$  is the resistivity (specific resistance) of a material. It depends only on the material and temperature, not on the dimensions of the conductor.

**Step 1:** Units of  $\rho$ :  $[\Omega \text{ m}]$ .

**Step 2:** Good conductors (copper, silver) have very low  $\rho$ ; insulators (rubber, glass) have very high  $\rho$ .

**Step 3:** This quantity allows us to compare electrical properties of materials independent of size and shape.

**Final Answer:** Resistivity (specific resistance)  $\Rightarrow$  (B)

Answer: (B)    [Go Back to Q6](#)

Q7.

**Solution**

**Concept — Power Dissipation:**  $P = I^2 R$  (derived from  $P = VI$  and  $V = IR$ ).

**Step 1:**  $P = I^2 R = (2)^2 \times 5 = 4 \times 5 = 20 \text{ W}$ .

**Step 2:** Option B (10 W) results from  $I \times R = 2 \times 5$  (forgetting to square  $I$ ). Option D (40 W) doubles the correct answer.

**Final Answer:**  $P = 20 \text{ W} \Rightarrow$  (C)

Answer: (C)    [Go Back to Q7](#)

Q8.

**Solution**

**Concept — kWh (Commercial Unit of Energy):**  $1 \text{ kWh} = 1000 \text{ W} \times 3600 \text{ s} = 3.6 \times 10^6 \text{ J}$ .

**Step 1:** Energy = Power  $\times$  Time =  $100 \text{ W} \times 2 \text{ h} = 200 \text{ Wh}$ .

**Step 2:** Convert to kWh:  $200 \text{ Wh} \div 1000 = 0.2 \text{ kWh}$ .

**Step 3:** Option A (200 J) confuses Wh with Joules. Option C (200 kWh) forgets to divide by 1000.

**Final Answer:**  $0.2 \text{ kWh} \Rightarrow$  (D)

Answer: (D)    [Go Back to Q8](#)



Q9.

**Solution**

**Concept — Terminal Voltage:** The terminal voltage of a cell is  $V = E - Ir$ , where  $E$  is EMF,  $I$  is current, and  $r$  is internal resistance.

**Step 1:**  $V = E - Ir = 6 - (2)(0.5) = 6 - 1 = 5 \text{ V}$ .

**Step 2:** When  $I = 0$  (open circuit),  $V = E = 6 \text{ V}$ . Current flow reduces terminal voltage due to internal resistance voltage drop ( $Ir = 1 \text{ V}$ ).

**Step 3:** Option C (7 V) adds instead of subtracting the internal drop.

**Final Answer:** Terminal voltage = 5 V  $\Rightarrow$  (A)

Answer: (A)

[Go Back to Q9](#)

Q10.

**Solution**

**Concept — Electric Charge and Current:**  $Q = It$ .

**Step 1:**  $Q = I \times t = 3 \text{ A} \times 4 \text{ s} = 12 \text{ C}$ .

**Step 2:** Charge is measured in coulombs (C). One ampere means one coulomb per second ( $1 \text{ A} = 1 \text{ C s}^{-1}$ ).

**Final Answer:**  $Q = 12 \text{ C} \Rightarrow$  (B)

Answer: (B)

[Go Back to Q10](#)

Q11.

**Solution**

**Concept — Newton's Second Law:**  $a = F/m$ .

**Step 1:**  $a = F/m = 15/5 = 3 \text{ m s}^{-2}$ .

**Step 2:** Options A (75) and D (10) result from  $F \times m$  or  $F - m$ . Option B (0.33) inverts to  $m/F$ .

**Final Answer:**  $a = 3 \text{ m s}^{-2} \Rightarrow$  (C)

Answer: (C)

[Go Back to Q11](#)



Q12.

**Solution**

**Concept — v-t Graph Slope:** The slope (gradient) of a velocity–time graph =  $\Delta v/\Delta t$  = acceleration.

**Step 1:** Slope =  $(v_2 - v_1)/(t_2 - t_1) = \Delta v/\Delta t = a$ .

**Step 2:** The *area* under a  $v$ - $t$  graph gives displacement (distance for straight-line motion).

**Step 3:** The slope of a  $d$ - $t$  graph (not  $v$ - $t$ ) gives velocity.

**Final Answer:** Slope of  $v$ - $t$  graph = acceleration  $\Rightarrow$  (D)

Answer: (D)

[Go Back to Q12](#)

Q13.

**Solution**

**Concept — Second Equation of Motion:**  $s = ut + \frac{1}{2}at^2$ . The area under the  $v$ - $t$  graph also equals displacement.

**Step 1:**  $u = 0$  (starts from rest),  $a = 2 \text{ m s}^{-2}$ ,  $t = 3 \text{ s}$ .

**Step 2:**  $s = 0 \times 3 + \frac{1}{2} \times 2 \times 9 = 0 + 9 = 9 \text{ m}$ .

**Step 3 (Area check):** At  $t = 3$ ,  $v = at = 6 \text{ m s}^{-1}$ . Area of triangle =  $\frac{1}{2} \times 3 \times 6 = 9 \text{ m} \checkmark$ .

**Final Answer:**  $s = 9 \text{ m} \Rightarrow$  (A)

Answer: (A)

[Go Back to Q13](#)

Q14.

**Solution**

**Concept — Momentum:**  $p = mv$ .

**Step 1:**  $p = 4 \text{ kg} \times 5 \text{ m s}^{-1} = 20 \text{ kg m s}^{-1}$ .

**Step 2:** Momentum is a vector quantity in the direction of velocity. Its SI unit is  $\text{kg m s}^{-1}$  or  $\text{N s}$ .

**Final Answer:**  $p = 20 \text{ kg m s}^{-1} \Rightarrow$  (B)

Answer: (B)

[Go Back to Q14](#)



Q15.

**Solution****Concept — Gravitational PE:**  $E_p = mgh$ .**Step 1:**  $E_p = 2 \times 10 \times 5 = 100 \text{ J}$ .**Step 2:** PE is measured relative to a chosen reference level (here, ground). At height  $h$ , PE is stored as gravitational potential energy.**Final Answer:**  $PE = 100 \text{ J} \Rightarrow$  [Go Back to Q15](#)

Q16.

**Solution****Concept — Power:**  $P = W/t$ .**Step 1:**  $P = 200 \text{ J}/4 \text{ s} = 50 \text{ W}$ .**Step 2:** Option A (800 W) uses  $W \times t$ ; Option C (40 W) divides incorrectly.**Final Answer:**  $P = 50 \text{ W} \Rightarrow$  [Go Back to Q16](#)

Q17.

**Solution****Concept — Work Done When Force  $\perp$  Displacement:**  $W = Fd \cos \theta$ . When  $\theta = 90^\circ$ ,  $\cos 90^\circ = 0$ , so  $W = 0$ .**Step 1:** Gravity acts vertically downward; displacement of load is horizontal. Angle between them =  $90^\circ$ .**Step 2:**  $W_{\text{gravity}} = F \times d \times \cos 90^\circ = 0$ .**Step 3:** The porter does work against gravity only when lifting vertically. Horizontal transport does no work against gravity.**Final Answer:** Work done by gravity = 0  $\Rightarrow$  [Go Back to Q17](#)

Q18.

**Solution**

**Concept — Linear Thermal Expansion:**  $\Delta L = L_0 \alpha \Delta T$ , so  $\alpha = \Delta L / (L_0 \Delta T)$ .

**Step 1:**  $\alpha$  is the coefficient of linear thermal expansion. It represents the fractional change in length per degree of temperature change.

**Step 2:** Units of  $\alpha$ :  $^{\circ}\text{C}^{-1}$  or  $\text{K}^{-1}$ .

**Step 3:** Different materials have different  $\alpha$  values: steel  $\approx 12 \times 10^{-6} \text{K}^{-1}$ ; aluminium  $\approx 24 \times 10^{-6} \text{K}^{-1}$ .

**Final Answer:** Coefficient of linear thermal expansion  $\Rightarrow$  (B)

Answer: (B)

[Go Back to Q18](#)

Q19.

**Solution**

**Concept — Latent Heat of Fusion:** During a change of state (e.g. melting), heat is absorbed or released without any change in temperature. This heat is called latent heat.

**Step 1:** When ice at  $0^{\circ}\text{C}$  melts to water at  $0^{\circ}\text{C}$ , energy is needed to break the bonds between molecules. The temperature stays constant.

**Step 2:** Latent heat of fusion of ice =  $334,000 \text{J kg}^{-1}$  (about 80 cal/g).

**Step 3:** This is why ice at  $0^{\circ}\text{C}$  cools drinks more effectively than water at  $0^{\circ}\text{C}$  — it absorbs extra heat during melting.

**Final Answer:** Temperature remains constant; heat absorbed is latent heat of fusion  $\Rightarrow$

(C)

Answer: (C)

[Go Back to Q19](#)

Q20.

**Solution**

**Concept — Free Electrons in Metals:** Metallic conductors have a large number of delocalised (free) electrons that are not bound to any particular atom and can move throughout the lattice.

**Step 1:** These free electrons act as heat carriers. When one end of a metal is heated, the electrons gain kinetic energy and quickly transfer it to cooler regions.

**Step 2:** Non-metals (wood, plastic) lack free electrons and are poor conductors of heat.

**Final Answer:** Large numbers of free electrons  $\Rightarrow$  (D)

Answer: (D)

[Go Back to Q20](#)



Q21.

**Solution**

**Concept — Wave Speed Equation:**  $v = f\lambda$ , so  $\lambda = v/f$ .

**Step 1:**  $\lambda = v/f = 340/170 = 2 \text{ m}$ .

**Step 2:** The diagram shows one complete wave cycle over 2 m (one wavelength marked as  $\lambda$ ), consistent with the calculation.

**Final Answer:**  $\lambda = 2 \text{ m} \Rightarrow$

[Go Back to Q21](#)

Q22.

**Solution**

**Concept — Echo Distance:** For an echo, the sound must travel to the wall and back (total distance =  $2d$ ) in at least 0.1 s (the minimum time gap our ears can distinguish two sounds).

**Step 1:** Total distance =  $v \times t = 340 \times 0.1 = 34 \text{ m}$ .

**Step 2:** Minimum one-way distance =  $34/2 = 17 \text{ m}$ .

**Step 3:** Option A (34 m) forgets to halve (that is the round-trip distance).

**Final Answer:** Minimum distance =  $17 \text{ m} \Rightarrow$

[Go Back to Q22](#)

Q23.

**Solution**

**Concept — Beta Decay:** In  $\beta^-$  decay, a neutron inside the nucleus converts into a proton, emitting a high-speed electron ( $\beta^-$  particle) and an antineutrino.

**Step 1:** The  $\beta^-$  particle is an electron: charge  $-e$ , mass  $\approx 9.1 \times 10^{-31} \text{ kg}$ . It originates from the nucleus, not the electron cloud.

**Step 2 — Compare:**  $\alpha$  = helium nucleus (Option A).  $\gamma$  = high-energy photons (Option B). Neutrons are uncharged (Option D).

**Step 3:**  $\beta^-$  particles have medium penetrating power (stopped by a few mm of aluminium).

**Final Answer:** High-speed electrons from the nucleus  $\Rightarrow$

[Go Back to Q23](#)



Q24.

**Solution**

**Concept — Half-Life:** The half-life  $T_{1/2}$  of a radioactive substance is the time required for exactly half of the radioactive nuclei in a sample to undergo decay.

**Step 1:** After 1 half-life:  $N = N_0/2$ . After 2 half-lives:  $N = N_0/4$ . After  $n$  half-lives:  $N = N_0/2^n$ .

**Step 2:** Half-life varies enormously: uranium-238 ( $T_{1/2} \approx 4.5 \times 10^9$  yr) vs. francium-223 ( $T_{1/2} \approx 22$  min).

**Final Answer:** Time for half the nuclei to decay  $\Rightarrow$

[Go Back to Q24](#)

Q25.

**Solution**

**Concept — Pascal's Law:** Pressure applied to an enclosed, static fluid is transmitted equally and undiminished to every point of the fluid and the walls of the container.

**Step 1:** Application — Hydraulic press/lift: a small force  $F_1$  on a small-area piston ( $A_1$ ) produces pressure  $P = F_1/A_1$ , which is transmitted to a large-area piston ( $A_2$ ), giving a large force  $F_2 = P A_2 \gg F_1$ .

**Step 2:** Used in car brakes, hydraulic jacks, and aircraft controls.

**Final Answer:** Transmitted equally in all directions  $\Rightarrow$

[Go Back to Q25](#)



## Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	C	4	D	5	A
6	B	7	C	8	D	9	A	10	B
11	C	12	D	13	A	14	B	15	C
16	D	17	A	18	B	19	C	20	D
21	A	22	B	23	C	24	D	25	A

