

# JEECUP Group-A Physics Sample Paper – 24

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.** A person suffering from myopia (short-sightedness) has the image of a distant object formed in front of the retina, as shown. This defect is corrected using:

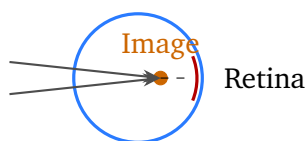


Image forms in front of retina

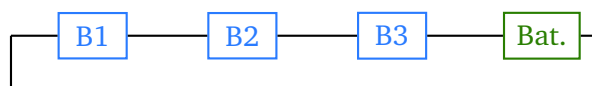
- (A) A concave (diverging) lens  
(B) A convex (converging) lens  
(C) A cylindrical lens  
(D) No lens can correct this
- Q2.** A person suffering from hypermetropia (far-sightedness) cannot see nearby objects clearly. This defect is corrected using:
- (A) A concave (diverging) lens  
(B) A convex (converging) lens  
(C) A prism  
(D) A plane mirror



- Q3.** In a camera, the component that controls the amount of light entering is the diaphragm/aperture. In the human eye, the equivalent component is:
- (A) The cornea
  - (B) The retina
  - (C) The pupil (controlled by the iris)
  - (D) The optic nerve
- Q4.** Motion pictures (films) appear continuous to the human eye because of the persistence of vision. The approximate duration for which an image persists on the retina is:
- (A) 1 second
  - (B) 1 minute
  - (C) 1 millisecond
  - (D)  $\frac{1}{16}$  second
- Q5.** Among all colours of the visible spectrum, which has the shortest wavelength?
- (A) Violet
  - (B) Red
  - (C) Orange
  - (D) Yellow
- Q6.** The commercial unit of electrical energy used in household electricity billing is:
- (A) Joule (J)
  - (B) Kilowatt-hour (kWh)
  - (C) Watt (W)
  - (D) Calorie (cal)



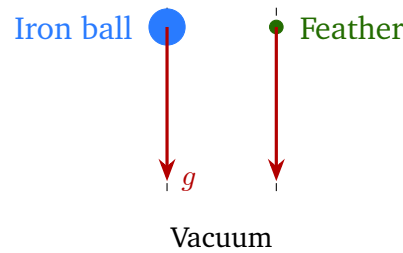
- Q7.** Three light bulbs B1, B2, and B3 are connected in series as shown. If bulb B2 fuses (breaks), what happens to the other bulbs?



- (A) B1 and B3 glow more brightly  
(B) B1 and B3 continue to glow normally  
(C) B1 and B3 also go off (circuit breaks)  
(D) Only B1 goes off
- Q8.** Three light bulbs are connected in **parallel** to a battery. If one bulb fuses, the other two bulbs:
- (A) Also go off because the circuit breaks  
(B) Glow less brightly  
(C) Glow more brightly (voltage is shared)  
(D) Continue to glow normally at the same brightness
- Q9.** Overloading in household electrical circuits (connecting too many high-power appliances to one circuit) is dangerous primarily because:
- (A) It draws excess current, overheating the wires and causing fire  
(B) It reduces the voltage at the socket  
(C) It reverses the direction of current  
(D) It causes the fuse to cool down
- Q10.** Earthing (grounding) of electrical appliances is done to:
- (A) Increase the power consumption  
(B) Protect users from electric shock if the metal body becomes live  
(C) Decrease the resistance of the circuit  
(D) Increase the voltage available



**Q11.** A heavy iron ball and a light feather are dropped simultaneously in a vacuum (no air resistance), as shown. Which statement is correct?



- (A) The iron ball reaches the ground first  
(B) The feather reaches the ground first  
(C) Both reach the ground at the same time (same acceleration  $g$ )  
(D) The heavier ball has greater acceleration
- Q12.** The weight of a person on the moon is  $\frac{1}{6}$  of their weight on Earth because:
- (A) The moon has no atmosphere  
(B) The moon's density is less  
(C) There is no gravity on the moon  
(D) The gravitational acceleration on the moon is about  $\frac{1}{6}$  of that on Earth
- Q13.** The minimum velocity required for an object to escape the gravitational pull of the Earth and never return is called the escape velocity. Its value at Earth's surface is approximately:
- (A)  $11.2 \text{ km s}^{-1}$   
(B)  $3 \times 10^5 \text{ km s}^{-1}$   
(C)  $1.6 \text{ km s}^{-1}$   
(D)  $9.8 \text{ km s}^{-1}$
- Q14.** A geostationary satellite revolves around the Earth in a circular orbit. Its orbital period is:
- (A) 90 minutes



- (B) 24 hours
- (C) 1 year
- (D) 1 month

**Q15.** In a hydroelectric power plant, the energy conversion that takes place is:

- (A) Chemical energy  $\rightarrow$  electrical energy
- (B) Heat energy  $\rightarrow$  electrical energy
- (C) Gravitational potential energy of water  $\rightarrow$  electrical energy
- (D) Nuclear energy  $\rightarrow$  electrical energy

**Q16.** Solar energy is classified as:

- (A) Non-renewable and will be exhausted within 100 years
- (B) Non-renewable; depends on fossil fuels
- (C) Finite but slow to exhaust (a few million years)
- (D) Renewable; solar radiation is inexhaustible on a human timescale

**Q17.** The efficiency of a machine is defined as:

- (A)  $\frac{\text{Useful work output}}{\text{Total work input}} \times 100\%$
- (B)  $\frac{\text{Total work input}}{\text{Useful work output}} \times 100\%$
- (C)  $\frac{\text{Power output}}{\text{Power input}}$
- (D) Power output  $\times$  time

**Q18.** The greenhouse effect is caused by:

- (A) Ozone absorbing all solar radiation
- (B) Greenhouse gases ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{O}$  vapour) trapping infrared radiation re-emitted from Earth
- (C) The Sun emitting more infrared than visible light



(D) Deforestation cooling the planet

**Q19.** Water shows anomalous expansion. The temperature at which water has its **maximum density** is:

(A)  $0^{\circ}\text{C}$  (melting point of ice)

(B)  $100^{\circ}\text{C}$  (boiling point)

(C)  $4^{\circ}\text{C}$  (water is densest here and contracts above and below this temperature)

(D)  $-4^{\circ}\text{C}$  (below freezing)

**Q20.** Land breeze is a local wind that blows from land towards the sea. It occurs:

(A) During the day, because land heats up faster

(B) At any time, since land is always warmer

(C) Only during monsoon season

(D) At night, because land cools faster than sea and cool dense air flows seaward

**Q21.** SONAR (Sound Navigation And Ranging) is used to detect objects underwater. It works by emitting:

(A) Ultrasound pulses and measuring the time for their echo

(B) Visible light pulses

(C) Infrared radiation

(D) Gamma rays

**Q22.** Ultrasound is sound with a frequency:

(A) Below 20 Hz

(B) Above 20,000 Hz (beyond human hearing range)

(C) Between 20 Hz and 20,000 Hz



(D) Exactly 20,000 Hz

**Q23.** X-rays are:

- (A) Streams of electrons
- (B) Sound waves of very high frequency
- (C) Electromagnetic waves with very short wavelength (0.01–10 nm)
- (D) Alpha particles with high energy

**Q24.** Einstein's famous equation  $E = mc^2$  implies that:

- (A) Energy and mass are completely unrelated
- (B) Mass can be created from nothing
- (C) Energy cannot be released from matter
- (D) A tiny amount of mass can be converted into an enormous amount of energy

**Q25.** Insects like water-striders can walk on the surface of water without sinking. This is due to:

- (A) Surface tension of water supporting their weight
- (B) Upthrust exceeding their weight
- (C) Their legs are waterproof
- (D) Low density of their body



**Detailed Solutions**

Q1.

**Solution**

**Concept — Myopia Correction:** In myopia, the eyeball is too long (or lens too powerful), so the image of a distant object forms in front of the retina. A concave (diverging) lens spreads the rays so that they appear to come from a closer point, shifting the image onto the retina. **Step 1:** A concave lens has negative focal length. It diverges parallel rays, reducing the effective converging power of the eye's lens+cornea system. **Step 2:** Hypermetropia (far-sightedness) requires the opposite: a convex lens to converge rays more. **Final Answer:** Concave (diverging) lens  $\Rightarrow$  (A)

**Answer: (A)**    [Go Back to Q1](#)

Q2.

**Solution**

**Concept — Hypermetropia Correction:** In hypermetropia, the eyeball is too short or the lens too weak, so the image of a near object forms behind the retina. A convex (converging) lens helps converge the rays so the image falls on the retina. **Step 1:** A convex lens with positive focal length converges the diverging rays from a near object before they enter the eye. **Final Answer:** Convex (converging) lens  $\Rightarrow$  (B)

**Answer: (B)**    [Go Back to Q2](#)

Q3.

**Solution**

**Concept — Eye vs Camera:** Both form a real, inverted image. Corresponding parts: lens/lens, retina/film sensor, iris pupil/diaphragm aperture, ciliary muscles/focus ring. **Step 1:** The pupil is a hole in the iris; its size is controlled by the iris muscles. It regulates how much light enters the eye, exactly like the aperture/diaphragm in a camera. **Final Answer:** Pupil (controlled by iris)  $\Rightarrow$  (C)

**Answer: (C)**    [Go Back to Q3](#)



Q4.

**Solution**

**Concept — Persistence of Vision:** An image formed on the retina persists for about  $1/16$  of a second after the stimulus is removed, due to the slow response of the retinal photoreceptors. **Step 1:** If images are shown at a rate faster than 16 per second ( $\geq 16$  fps), the eye perceives them as continuous motion. Cinema typically uses 24 fps. **Final Answer:**  $1/16$  second  $\Rightarrow$  (D)

**Answer: (D)**    [Go Back to Q4](#)

Q5.

**Solution**

**Concept — Wavelength and Colour:**  $\lambda = c/f$ . Higher frequency  $\Rightarrow$  shorter wavelength. Violet has the highest frequency in visible light and thus the shortest wavelength ( $\approx 400$  nm). Red has the longest ( $\approx 700$  nm). **Final Answer:** Violet  $\Rightarrow$  (A)

**Answer: (A)**    [Go Back to Q5](#)

Q6.

**Solution**

**Concept — kWh:** The commercial unit is kilowatt-hour because domestic consumption is large.  $1 \text{ kWh} = 10^3 \text{ W} \times 3600 \text{ s} = 3.6 \times 10^6 \text{ J}$ . **Step 1:** The joule is the SI unit but is too small for household billing. Watt is power, not energy. Calorie is a heat unit. **Final Answer:** Kilowatt-hour (kWh)  $\Rightarrow$  (B)

**Answer: (B)**    [Go Back to Q6](#)

Q7.

**Solution**

**Concept — Series Circuit Break:** In a series circuit, all components share the same current path. If any one component breaks (open circuit), the current path is broken and no current flows anywhere. **Step 1:** When B2 fuses, the series circuit is broken at that point. Current cannot flow to B1 or B3, so both also go off. **Step 2:** This is why Christmas lights in old series strings all go out when one bulb fails. **Final Answer:** B1 and B3 also go off  $\Rightarrow$  (C)

**Answer: (C)**    [Go Back to Q7](#)



Q8.

**Solution**

**Concept — Parallel Circuit:** In parallel, each branch is independently connected to the source. Each bulb receives the full supply voltage. **Step 1:** If one bulb fuses, only that branch is broken. The other branches remain complete and connected to the supply, so other bulbs continue to glow normally. **Step 2:** This is why household wiring uses parallel circuits — one appliance failing does not affect others. **Final Answer:** Others continue to glow normally  $\Rightarrow$  (D)

**Answer: (D)**    [Go Back to Q8](#)

Q9.

**Solution**

**Concept — Overloading:** When too many appliances are connected to one circuit, the total current drawn exceeds the wire's safe current rating. **Step 1:** Excess current heats the wire (Joule heating:  $H = I^2Rt$ ). If the wire gets hot enough, it can melt its insulation and start a fire. **Step 2:** The fuse or MCB (miniature circuit breaker) protects against overloading by breaking the circuit when current exceeds a set value. **Final Answer:** Excess current overheats wires, causing fire  $\Rightarrow$  (A)

**Answer: (A)**    [Go Back to Q9](#)

Q10.

**Solution**

**Concept — Earthing:** A thick wire connects the metal body of an appliance to the Earth (low resistance path). **Step 1:** If a fault occurs and the live wire touches the metal casing, the current flows to Earth through the earthing wire rather than through the user's body. **Step 2:** This blows the fuse and prevents electric shock. **Final Answer:** Protects users from electric shock  $\Rightarrow$  (B)

**Answer: (B)**    [Go Back to Q10](#)



Q11.

**Solution**

**Concept — Free Fall:** All objects in vacuum experience the same gravitational acceleration  $g = 9.8 \text{ m s}^{-2}$ , regardless of mass ( $F = mg$ ;  $a = F/m = g$ , mass cancels). **Step 1:** In vacuum, there is no air resistance. The gravitational force on a heavy ball is larger, but so is its mass, so the acceleration is identical. **Step 2:** Galileo's experiment (Leaning Tower of Pisa) demonstrated this. In everyday life, feathers fall slower only because of air resistance. **Final Answer:** Both reach ground at the same time  $\Rightarrow$  (C)

**Answer: (C)**    [Go Back to Q11](#)

Q12.

**Solution**

**Concept:** Weight =  $mg$ . On the moon,  $g_{\text{moon}} \approx 1.63 \text{ m s}^{-2} \approx g_{\text{Earth}}/6$ . **Step 1:**  $W_{\text{moon}} = mg_{\text{moon}} = m \cdot g/6 = W_{\text{Earth}}/6$ . Mass is unchanged; only weight differs. **Step 2:** The moon has no atmosphere (Option A is irrelevant to weight). The moon's lower gravity results from its smaller mass and radius. **Final Answer:**  $g_{\text{moon}} \approx g_{\text{Earth}}/6 \Rightarrow$  (D)

**Answer: (D)**    [Go Back to Q12](#)

Q13.

**Solution**

**Concept — Escape Velocity:**  $v_e = \sqrt{2gR_E} = \sqrt{2 \times 9.8 \times 6.4 \times 10^6} \approx 11.2 \text{ km s}^{-1}$ . **Step 1:** At this speed, the kinetic energy equals the gravitational PE:  $\frac{1}{2}mv_e^2 = \frac{GMm}{R_E}$ . **Step 2:**  $11.2 \text{ km s}^{-1}$  applies to Earth. For the moon,  $v_e \approx 2.4 \text{ km s}^{-1}$ . **Final Answer:**  $11.2 \text{ km s}^{-1} \Rightarrow$  (A)

**Answer: (A)**    [Go Back to Q13](#)

Q14.

**Solution**

**Concept — Geostationary Orbit:** A satellite whose orbital period equals Earth's rotational period (24 hours) appears stationary relative to a point on Earth. **Step 1:** The orbit is at  $\approx 36,000 \text{ km}$  above the equator. These satellites are used for weather monitoring and communication (e.g., INSAT series). **Final Answer:** 24 hours  $\Rightarrow$  (B)

**Answer: (B)**    [Go Back to Q14](#)



Q15.

**Solution**

**Concept — Hydroelectric Power:** Water stored at a height has gravitational PE. When released, this converts to KE (driving turbines) and then to electrical energy via generators. **Step 1:** Chain: PE (water at height) → KE (falling water) → mechanical energy (turbine) → electrical energy (generator). **Final Answer:** PE of water → electrical energy ⇒

**Answer: (C)**      [Go Back to Q15](#)

Q16.

**Solution**

**Concept — Renewable Energy:** Solar energy is derived from nuclear fusion in the Sun, which will continue for about 5 billion more years. On a human timescale, it is effectively inexhaustible and renewable. **Step 1:** Unlike coal or petroleum (fossil fuels, non-renewable, formed over millions of years and being depleted), solar energy is replenished continuously. **Final Answer:** Renewable; effectively inexhaustible ⇒

**Answer: (D)**      [Go Back to Q16](#)

Q17.

**Solution**

**Concept — Efficiency:**  $\eta = \frac{W_{\text{output}}}{W_{\text{input}}} \times 100\%$ . Always  $\leq 100\%$  (some energy is always lost as heat due to friction, etc.). **Step 1:** Option B inverts the ratio (gives a number  $\geq 100\%$ , which is physically impossible). Option C gives a dimensionless ratio without the  $\times 100$  factor. **Final Answer:**  $\eta = \frac{\text{Useful output}}{\text{Total input}} \times 100\% \Rightarrow$

**Answer: (A)**      [Go Back to Q17](#)

Q18.

**Solution**

**Concept — Greenhouse Effect:** The Earth absorbs solar radiation and re-emits it as infrared. Greenhouse gases ( $\text{CO}_2$ ,  $\text{CH}_4$ , water vapour,  $\text{N}_2\text{O}$ ) absorb and re-emit this infrared, trapping heat in the lower atmosphere. **Step 1:** Without any greenhouse effect, Earth's average temperature would be about  $-18^\circ\text{C}$  (uninhabitable). The enhanced greenhouse effect from human emissions is causing global warming. **Final Answer:** Greenhouse gases trap infrared ⇒

**Answer: (B)**      [Go Back to Q18](#)



Q19.

**Solution**

**Concept — Anomalous Expansion:** Most substances are densest just before freezing. Water is an exception: it is densest at  $4^{\circ}\text{C}$ , not at  $0^{\circ}\text{C}$ . **Step 1:** Below  $4^{\circ}\text{C}$ , water expands (becomes less dense); above  $4^{\circ}\text{C}$ , it also expands normally. Maximum density =  $1000\text{ kg m}^{-3}$  occurs at exactly  $4^{\circ}\text{C}$ . **Step 2:** Ecological importance: lakes freeze from the top down, not the bottom, because water at  $4^{\circ}\text{C}$  sinks and ice ( $< 4^{\circ}\text{C}$ ) floats, insulating aquatic life. **Final Answer:** Maximum density at  $4^{\circ}\text{C} \Rightarrow \boxed{(C)}$

**Answer: (C)**    [Go Back to Q19](#)

Q20.

**Solution**

**Concept — Land and Sea Breeze:** **Step 1 (Day):** Land heats up faster than sea in sunlight. Warm air over land rises; cooler sea air moves in to replace it — this is a *sea breeze* (sea  $\rightarrow$  land). **Step 2 (Night):** Land cools faster than sea. Air over the sea is now warmer and rises; cool air from land blows toward the sea — this is a *land breeze* (land  $\rightarrow$  sea). **Final Answer:** At night, cool land air flows toward sea  $\Rightarrow \boxed{(D)}$

**Answer: (D)**    [Go Back to Q20](#)

Q21.

**Solution**

**Concept — SONAR:** SONAR emits ultrasound pulses and measures the time  $t$  for the echo to return. Distance =  $v \cdot t/2$  (round trip). **Step 1:** Ultrasound is used (not audible sound) because it has a short wavelength and can detect smaller objects with greater resolution. **Step 2:** Used in submarines (for navigation), depth-finding ships (fathometers), and fish-finding by fishermen. **Final Answer:** Ultrasound pulses and their echoes  $\Rightarrow \boxed{(A)}$

**Answer: (A)**    [Go Back to Q21](#)



Q22.

**Solution**

**Concept — Sound Frequency Ranges:** Infrasound:  $< 20$  Hz (below human hearing). Audible: 20–20,000 Hz. Ultrasound:  $> 20,000$  Hz (above human hearing). **Step 1:** Ultrasound is inaudible to humans but is produced and detected by animals such as bats and dolphins (echolocation). Medical ultrasound scans use frequencies of 1–20 MHz. **Final Answer:** Frequency  $> 20,000$  Hz  $\Rightarrow$  (B)

**Answer: (B)**    [Go Back to Q22](#)

Q23.

**Solution**

**Concept — X-rays:** Discovered by Wilhelm Röntgen in 1895. X-rays are high-energy electromagnetic radiation with wavelength 0.01–10 nm (between UV and gamma rays on the EM spectrum). **Step 1:** They are not charged particles (not electrons or alpha particles) and are not sound waves. They travel at speed  $c = 3 \times 10^8$  m s<sup>-1</sup> in vacuum. **Step 2:** Applications: medical imaging (bones absorb X-rays more than soft tissue), airport security scanners, crystallography. **Final Answer:** Electromagnetic waves with very short wavelength  $\Rightarrow$  (C)

**Answer: (C)**    [Go Back to Q23](#)

Q24.

**Solution**

**Concept — Mass-Energy Equivalence:** Einstein's 1905 special relativity result:  $E = mc^2$ , where  $c = 3 \times 10^8$  m s<sup>-1</sup>. **Step 1:** Since  $c^2 = 9 \times 10^{16}$  m<sup>2</sup> s<sup>-2</sup>, even 1 kg of mass corresponds to  $9 \times 10^{16}$  J of energy — enormous. **Step 2:** This is the basis of nuclear energy: a small loss of mass (mass defect) in fission or fusion produces a huge energy release. **Final Answer:** Tiny mass  $\rightarrow$  enormous energy  $\Rightarrow$  (D)

**Answer: (D)**    [Go Back to Q24](#)



Q25.

**Solution**

**Concept — Surface Tension:** Water molecules attract each other (cohesion). At the surface, molecules are pulled inward and sideways, creating a skin-like film that resists being broken. **Step 1:** Insects like water-striders have hydrophobic (water-repellent) legs and spread their weight over a large area. Their weight is insufficient to break the surface tension film. **Step 2:** Surface tension also explains why water forms spherical drops and why a needle can float on water if placed carefully. **Final Answer:** Surface tension  $\Rightarrow$  (A)

**Answer: (A)**[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

