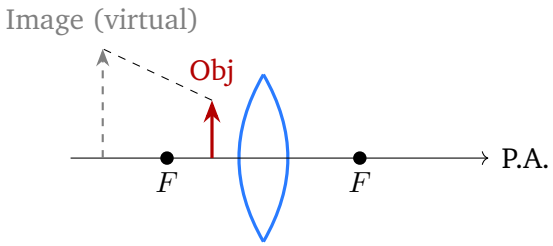
JEECUP Group-A Physics Sample Paper – 25

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 simple microscope (magnifying glass) uses a single convex lens. The object is placed *between* the lens and its focus F. The image formed is:



(A) Virtual, erect and magnified on the same side as the object

(B) Real, inverted and magnified on the other side

(C) Virtual, inverted and diminished

(D) Real, erect and of the same size

Q2. In a compound microscope, the objective lens forms:

(A) A virtual, erect, diminished image of the object

(B) A real, inverted, magnified intermediate image of the object

(C) A real, erect image directly on the eyepiece

(D) The final virtual image seen by the observer

Q3. A refracting telescope uses two convex lenses. Its main purpose is to:

(A) Magnify very small nearby objects

(B) Produce a rainbow of colours

(C) View distant objects (stars, planets) by collecting and magnifying their light

(D) Project images onto a screen

Q4. A periscope is used in submarines to see objects above the water surface. It works on the principle of:

(A) Total internal reflection in glass prisms only

(B) Refraction through two convex lenses

(C) Dispersion of light

(D) Successive reflections from two plane mirrors placed at 45° to the vertical

Q5. A mirage, seen in hot deserts where the ground appears wet (as if water is present), is an optical illusion caused by:

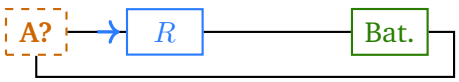
(A) Total internal reflection of light in the hot air layers near the ground

(B) Scattering of light by dust particles

(C) Refraction through water vapour

(D) Reflection from the hot sand

Q6. An ammeter is used to measure electric current in a circuit. In the circuit diagram shown, where should the ammeter be connected to correctly measure the current through resistor R?



Ammeter **A** must go *in series*

(A) In parallel with the resistor R

(B) In series in the circuit (as shown), so the same current flows through it

(C) Across the battery terminals

(D) Between the positive terminal and the negative terminal of the battery only

Q7. A voltmeter is used to measure the potential difference (voltage) across a component. It should be connected:

(A) In series with the component

(B) Across the battery, not the component

(C) In parallel with the component (across its two ends)

(D) Between the ammeter and the component

Q8. An LED (Light Emitting Diode) is a:

(A) Resistor that emits light when it gets very hot

(B) Gas-filled tube that glows when electric discharge passes

(C) Semiconductor device that emits light when electric current flows through it in the forward direction

(D) Photovoltaic cell that converts light to electricity

Q9. A primary cell (e.g., a dry cell / Leclanche cell) converts:

(A) Chemical energy into electrical energy

(B) Electrical energy into chemical energy

(C) Heat energy into electrical energy

(D) Mechanical energy into electrical energy

Q10. A capacitor is a device that:

(A) Converts AC to DC

(B) Stores electrical energy in the electric field between its plates

(C) Amplifies electric current

(D) Produces a magnetic field

Q11. Kepler's Second Law (Law of Areas) states that a planet revolving around the Sun sweeps out:

(A) Equal distances in equal times

(B) Distances proportional to the square of the time

(C) Equal areas in equal intervals of time

(D) Areas proportional to the orbital speed

Q12. According to Newton's Law of Universal Gravitation, the gravitational force between two bodies is:

(A) Directly proportional to the sum of their masses and independent of distance

(B) Directly proportional to the product of their masses and inversely proportional to the distance between them

(C) Independent of mass; depends only on distance

(D) Directly proportional to the product of masses and inversely proportional to the **square** of the distance

Q13. Which of the following correctly distinguishes between mass and weight?

(A) Mass changes with location; weight remains constant everywhere

(B) Both mass and weight are the same quantity; they are interchangeable

(C) Mass is the amount of matter in a body (constant); weight depends on gravitational acceleration (varies)

(D) Weight is measured in kilograms; mass is measured in newtons

Q14. For the same object on the same surface, the force of friction is:

(A) Greater for rolling than for sliding

(B) Less for rolling than for sliding

(C) Equal for rolling and sliding

(D) Zero for rolling motion

Q15. The SI unit of work and energy is the:

(A) Watt (W)

(B) Newton (N)

(C) Joule (J), equal to one newton-metre

(D) Pascal (Pa)

Q16. The relation between kilowatt-hour (kWh) and joule (J) is:

(A) $1\,\mathrm{kWh} = 1000\,\mathrm{J}$

(B) $1\,\mathrm{kWh} = 3600\,\mathrm{J}$

(C) $1\,\mathrm{kWh} = 10^6\,\mathrm{J}$

(D) $1\,\mathrm{kWh} = 3.6 \times 10^6\,\mathrm{J}$

Q17. Which of the following is classified as a **non-renewable** source of energy?

(A) Coal and petroleum (fossil fuels formed over millions of years; limited reserves)

(B) Solar energy (from nuclear fusion in the Sun)

(C) Wind energy (driven by solar heating of the atmosphere)

(D) Tidal energy (from gravitational interaction with the Moon)

Q18. A thermos flask (vacuum flask) is designed to minimise heat exchange with the surroundings. It achieves this by:

(A) Using a thick plastic outer shell to reduce conduction

(B) Eliminating all three modes of heat transfer: a vacuum eliminates conduction and convection; silvered walls minimise radiation

(C) Filling the space between walls with a good conductor to spread heat evenly

(D) Allowing radiation but blocking conduction

Q19. The specific heat capacity of a substance is defined as the amount of heat required to:

(A) Melt $1\,\text{kg}$ of the substance at its melting point

(B) Vaporise $1\,\text{kg}$ of the substance at its boiling point

(C) Raise the temperature of $1\,\text{kg}$ of the substance by $1\,^\circ\text{C}$ (or $1\,\text{K}$)

(D) Raise the temperature of the whole substance by $1\,^\circ\text{C}$

Q20. Water is widely used as a coolant in car radiators and industrial machinery. The main reason is that water has:

(A) A very low density

(B) A low boiling point

(C) A low electrical conductivity

(D) A very high specific heat capacity, so it absorbs a large amount of heat for a small rise in temperature

Q21. Infrasound is sound with a frequency:

(A) Below $20\,\text{Hz}$ (below the lower limit of human hearing)

(B) Above $20{,}000\,\text{Hz}$

(C) Between $200\,\text{Hz}$ and $2000\,\text{Hz}$

(D) Exactly $20\,\text{Hz}$

Q22. The quality (timbre) of a musical note that allows us to distinguish the same note played on a violin from the same note on a flute depends on:

(A) The amplitude (loudness) of the note

(B) The waveform (mixture of harmonics/overtones) of the sound

(C) The speed at which the note travels

(D) The frequency (pitch) of the note

Q23. Radiocarbon dating (used in archaeology) relies on the radioactive isotope:

(A) Uranium-238 (very long half-life, used for rocks)

(B) Radium-226

(C) Carbon-14 (half-life ≈ 5730 years; incorporated into organisms during life)

(D) Iodine-131

Q24. A nuclear reactor generates electricity by using:

(A) Fusion of hydrogen nuclei releasing heat

(B) Chemical combustion of uranium to produce steam

(C) Uncontrolled chain reaction in a small bomb

(D) Controlled nuclear fission chain reaction (usually of U-235) to produce heat, which generates steam

Q25. Capillary action (capillarity) is the rise or fall of a liquid in a very narrow tube. This phenomenon is due to:

(A) The interplay of surface tension (cohesion between liquid molecules) and adhesion between liquid and tube walls

(B) Gravity alone pulling the liquid up

(C) Atmospheric pressure pushing the liquid into the tube

(D) The temperature of the liquid

Detailed Solutions

Q1.

Solution

Concept — Simple Microscope: When an object is placed between a convex lens and its focus, the lens formula gives v negative and $|m| > 1$: the image is virtual, erect, and magnified on the same side as the object. **Step 1:** $u < f$, so applying the lens formula: $v < 0$ (same side as object). $m = v/u > 1$ (magnified). **Step 2:** The magnifying power $M = 1 + D/f$, where $D = 25\,\text{cm}$ (near point). Higher M for shorter focal length f. **Final Answer:** Virtual, erect, magnified (same side) $\Rightarrow \boxed{(A)}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Compound Microscope: The objective (short focal length lens close to object) forms a real, inverted, magnified intermediate image inside the tube. The eyepiece then acts as a magnifying glass to view this intermediate image. **Step 1:** Object placed just outside the focal point of objective lens. The real inverted magnified image falls just inside the focal point of the eyepiece. **Step 2:** Total magnification $= m_{\text{obj}} \times m_{\text{eye}}$. **Final Answer:** Real, inverted, magnified intermediate image $\Rightarrow \boxed{(B)}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Telescope: A refracting telescope uses two convex lenses: the objective (large aperture, long focal length) collects and focuses light from distant objects; the eyepiece (short focal length) magnifies the intermediate image. **Step 1:** Magnifying power $M = -f_o/f_e$ (negative sign: image is inverted). Large f_o and small f_e give high magnification. **Step 2:** Telescopes collect more light (large aperture) than the naked eye, enabling us to see faint distant objects. **Final Answer:** View distant objects $\Rightarrow \boxed{(C)}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Periscope: Two plane mirrors (or right-angled prisms) are placed at 45° to the line of sight. Light from an object undergoes two reflections, each turning the ray through 90°, so the observer sees a laterally correct, upright image. **Step 1:** Incident ray hits upper mirror at 45°, reflects downward; hits lower mirror at 45°, reflects toward observer's eye. **Step 2:** Periscopes are used in submarines and trenches (military) to see over obstacles without exposing oneself. **Final Answer:** Two reflections from mirrors at $45^\circ \Rightarrow \boxed{(D)}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Mirage: On a hot day, air near the ground is much hotter (less dense) than air above. Refractive index decreases with height from the ground. Light from the sky is progressively refracted (bent) toward the horizontal, and when the angle of incidence exceeds the critical angle, total internal reflection occurs, directing sky-light toward the observer's eye from below — giving the illusion of water. **Step 1:** This is TIR in air, not a glass-air interface. It is an atmospheric optical phenomenon. **Final Answer:** TIR in hot air layers near the ground $\Rightarrow \boxed{(A)}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Ammeter Connection: An ammeter measures current. For the same current to flow through the ammeter and the component, they must be in *series* (one continuous path). **Step 1:** An ideal ammeter has zero resistance, so inserting it in series does not alter the circuit current. **Step 2:** A voltmeter (high resistance) is connected in *parallel*. Connecting an ammeter in parallel would short-circuit the component. **Final Answer:** In series $\Rightarrow \boxed{(B)}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Voltmeter: A voltmeter measures potential difference across a component. It must be placed in *parallel* so both ends connect to the same two terminals as the component. **Step 1:** Ideal voltmeter has infinite resistance, drawing no current, and thus does not affect the circuit. **Step 2:** Connecting a voltmeter in series would block the circuit (high resistance) and give a wrong reading. **Final Answer:** Parallel with the component $\Rightarrow \boxed{(C)}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — LED: An LED is a p-n junction semiconductor diode that emits photons when electrons recombine with holes in the forward-biased junction. The colour of light depends on the semiconductor material (energy band gap). **Step 1:** Energy is released as a photon of frequency f where $E = hf$ (band-gap energy). For visible light: gallium arsenide phosphide, gallium nitride, etc. **Step 2:** LEDs are highly energy-efficient (90%+ of energy becomes light, vs $\sim 5\%$ for incandescent bulbs). **Final Answer:** Semiconductor device emitting light when forward biased $\Rightarrow \boxed{(D)}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Primary Cell: A primary cell uses irreversible electrochemical reactions to produce EMF. Chemical energy of the reactants is converted to electrical energy. **Step 1:** Example: Dry cell (Leclanche cell): zinc anode, ammonium chloride electrolyte, carbon cathode with MnO_2. When connected, the chemical reaction produces a potential difference of $\sim 1.5\,\text{V}$. **Step 2:** Unlike a secondary cell (rechargeable battery), a primary cell cannot be recharged — the reactants are consumed. **Final Answer:** Chemical energy to electrical energy $\Rightarrow \boxed{(A)}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Capacitor: A capacitor consists of two conducting plates separated by an insulator (dielectric). When charged, equal and opposite charges accumulate on the plates, creating an electric field in between. Energy $E = \frac{1}{2}CV^2$ is stored in this field. **Step 1:** $C = \varepsilon_0 A/d$ (parallel plate): capacitance increases with plate area A and decreases with separation d. **Step 2:** Uses: power supply filters, camera flash, tuning circuits, energy storage in electric vehicles. **Final Answer:** Stores electrical energy in electric field $\Rightarrow \boxed{(B)}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Kepler's Second Law (Law of Areas): A line joining a planet to the Sun sweeps out equal areas in equal intervals of time. This means the planet moves faster when closer to the Sun (perihelion) and slower when farther away (aphelion). **Step 1:** This is a consequence of conservation of angular momentum: $L = mvr = \text{const}$; when r is small, v is large. **Final Answer:** Equal areas in equal times $\Rightarrow \boxed{(C)}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Newton's Universal Gravitation: $F = \dfrac{Gm_1m_2}{r^2}$. **Step 1:** $F \propto m_1m_2$ (product of masses) and $F \propto 1/r^2$ (inverse square of distance). Option B says $1/r$ (wrong); Option D says $1/r^2$ (correct). **Step 2:** $G = 6.674 \times 10^{-11}\,\text{N}\,\text{m}^2\,\text{kg}^{-2}$ is the universal gravitational constant. **Final Answer:** $F \propto m_1m_2/r^2 \Rightarrow \boxed{(D)}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Mass vs Weight: Mass (m) is the amount of matter in a body; it is a scalar quantity measured in kilograms. It is constant regardless of location. Weight ($W = mg$) is the gravitational force on a body; it varies with location. **Step 1:** On the moon, $g_{\text{moon}} \approx g/6$, so weight is $W/6$, but mass stays the same. **Step 2:** Weight is measured in newtons (not kilograms); mass is measured in kilograms (not newtons). Option D has

these reversed. **Final Answer:** Mass constant; weight varies $\Rightarrow \boxed{(A)}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Types of Friction: Rolling friction $<$ sliding (kinetic) friction $<$ static friction, for the same normal force and surface. **Step 1:** When an object rolls, only a small area contacts the surface at any instant, and there is very little deformation. When sliding, there is much greater surface interaction and molecular adhesion. **Step 2:** This is why wheels and ball bearings are used in machines — they replace sliding friction with rolling friction, reducing energy loss. **Final Answer:** Rolling friction $<$ sliding friction $\Rightarrow \boxed{(B)}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — SI Unit of Work: Work $W = Fd\cos\theta$. Unit: $\mathrm{N \cdot m} = \mathrm{J}$ (joule). $1\,\mathrm{J} = 1\,\mathrm{N \cdot m} = 1\,\mathrm{kg\,m^2\,s^{-2}}$. **Step 1:** Watt (W) is the unit of power ($1\,\mathrm{W} = 1\,\mathrm{J\,s^{-1}}$), not energy. Newton is a unit of force. Pascal is a unit of pressure. **Final Answer:** Joule (J) $\Rightarrow \boxed{(C)}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept: $1\,\mathrm{kWh} = 1000\,\mathrm{W} \times 3600\,\mathrm{s} = 3.6 \times 10^6\,\mathrm{J}$. **Step 1:** $1\,\mathrm{kW} = 1000\,\mathrm{W}$; $1\,\mathrm{h} = 3600\,\mathrm{s}$. So $1\,\mathrm{kWh} = 10^3 \times 3.6 \times 10^3 = 3.6 \times 10^6\,\mathrm{J}$. **Step 2:** Option C gives $10^6\,\mathrm{J}$ (missing the factor of 3.6). This conversion is frequently tested. **Final Answer:** $1\,\mathrm{kWh} = 3.6 \times 10^6\,\mathrm{J}$ $\Rightarrow \boxed{(D)}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Non-Renewable Energy: Fossil fuels (coal, petroleum, natural gas) were formed from ancient organic matter over millions of years. They are being consumed far faster than they can be replenished, so they are non-renewable. **Step 1:** Solar, wind, and tidal energy are renewable because they are replenished naturally and will not run out. **Step 2:** Fossil fuels release CO_2 when burned, contributing to the greenhouse effect. India's installed solar capacity has grown dramatically as an alternative. **Final Answer:** Coal and petroleum (fossil fuels) $\Rightarrow \boxed{(A)}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Thermos Flask (Dewar Flask): Step 1: Double-walled glass vessel with vacuum between walls: the vacuum eliminates conduction and convection (no medium for molecules to carry heat). **Step 2:** Inner surfaces are silvered: reduces radiation heat loss (polished silver surface has very low emissivity). **Step 3:** Plastic stopper on top: reduces conduction and convection through the opening. All three modes are minimised. **Final Answer:** Eliminates all three modes $\Rightarrow \boxed{(B)}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Specific Heat Capacity: $c = Q/(m\Delta T)$, so c is the heat needed per unit mass per unit temperature rise. **Step 1:** Unit of c: $\mathrm{J\,kg^{-1}\,K^{-1}}$ or $\mathrm{J\,kg^{-1}\,{}^{\circ}C^{-1}}$. **Step 2:** Heat needed to melt $1\,\mathrm{kg}$ at melting point (Option A) is the latent heat of fusion, not specific heat capacity. Option D refers to the heat capacity of the whole body, not per unit mass. **Final Answer:** Heat per kg per °C rise $\Rightarrow \boxed{(C)}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Water as Coolant: Specific heat of water $c_w \approx 4200\,\text{J}\,\text{kg}^{-1}\,\text{K}^{-1}$ — much higher than most liquids (alcohol ≈ 2400, engine oil $\approx 2000\,\text{J}\,\text{kg}^{-1}\,\text{K}^{-1}$). **Step 1:** High specific heat means water can absorb a lot of heat per kg without a large temperature rise, making it an effective coolant. **Step 2:** Water is also cheap, non-toxic, and has a high boiling point (100 °C at atmospheric pressure; higher with pressure cap). **Final Answer:** High specific heat capacity $\Rightarrow \boxed{(D)}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Infrasound: Sound below $20\,\text{Hz}$ is inaudible to humans. Range: 0–20 Hz. **Step 1:** Sources of infrasound: earthquakes, ocean waves, large explosions, volcanoes, and some animals (elephants communicate using infrasound over long distances). **Step 2:** Contrast: audible range $=$ 20–20,000 Hz; ultrasound $>$ 20,000 Hz. **Final Answer:** Frequency $< 20\,\text{Hz} \Rightarrow \boxed{(A)}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Timbre (Quality): Two sounds with the same pitch (frequency) and loudness (amplitude) can still be distinguished because they contain different mixtures of harmonics/overtones. This is called timbre or quality. **Step 1:** A pure sine wave has no harmonics. Real instruments produce complex waveforms with fundamental + harmonics. The relative strengths of harmonics are unique to each instrument. **Step 2:** Pitch depends on frequency; loudness depends on amplitude; timbre depends on waveform. **Final Answer:** Waveform (mixture of harmonics) $\Rightarrow \boxed{(B)}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Radiocarbon Dating: Living organisms continuously exchange carbon with the atmosphere, maintaining a constant ratio of ^{14}C to ^{12}C. After death, ^{14}C decays (half-life $\approx 5730\,\text{yr}$) and the ratio decreases. By measuring the ratio, the age of the specimen can be estimated. **Step 1:** Useful for organic materials up to $\sim 50{,}000$ years old. For older rocks, geologists use uranium-238 (half-life $\approx 4.5 \times 10^9\,\text{yr}$). **Final Answer:** Carbon-14 $\Rightarrow \boxed{(C)}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Nuclear Reactor: In a nuclear reactor, fission of U-235 releases neutrons; these cause further fissions (chain reaction). Control rods (boron, cadmium) absorb excess neutrons to keep the reaction controlled. **Step 1:** Heat produced is used to generate steam, which drives turbines connected to generators (electrical energy). **Step 2:** An atomic bomb uses an *un*controlled chain reaction. A reactor uses a controlled rate to produce steady power. India has nuclear plants at Tarapur, Rawatbhata, Kalpakkam, etc. **Final Answer:** Controlled fission chain reaction of U-235 $\Rightarrow \boxed{(D)}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Capillary Action: In a narrow tube, adhesion (attraction between liquid and tube wall) and cohesion (within liquid) combine with surface tension to pull liquid up (if adhesion $>$ cohesion, e.g., water in glass) or push it down (if cohesion $>$ adhesion, e.g., mercury in glass). **Step 1:** Height of rise $h = 2T\cos\theta/(\rho g r)$, where T is surface tension, θ is contact angle, ρ is liquid density, r is tube radius. Smaller tube, higher rise. **Step 2:** Applications: water rising in plant roots, oil rising in a lamp wick, water spreading in soil. **Final Answer:** Surface tension + adhesion $\Rightarrow \boxed{(A)}$

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