PHYSICS (SCIENCE PAPER - 1)

Maximum Marks: 80 | Time allowed: Two hours

Answers to this Paper must be written on the paper provided separately.
You will not be allowed to write during the first 15 minutes.
This time is to be spent in reading the question paper.
The time given at the head of this Paper is the time allowed for writing the answers.
Section A is compulsory. Attempt any four questions from Section B.
The intended marks for questions or parts of questions are given in brackets [ ].

SECTION A (40 Marks)

(Attempt all questions from this Section.)

1. Choose the correct answers to the questions from the given options. **[15]**
(Do not copy the question, write the correct answers only.)

(i) A heavy object and a light object are placed on a seesaw. Which arrangement produces the maximum turning effect about the pivot?

(a) Both objects near the pivot on opposite sides.
(b) Heavy object close to the pivot; light object at the far end on the opposite side.
(c) Light object close to the pivot; heavy object at the far end on the opposite side.
(d) Both objects at the ends of the seesaw, on opposite sides of pivot.

(ii) Two balls, A and B have the same gravitational potential energy. Ball A is six times the mass of ball B. How do their heights above the ground compare?

(a) Height of A is the same as height of B.
(b) Height of A is twice the height of B.
(c) Height of A is one-sixth the height of B.
(d) Height of A is six times the height of B.

(iii) The Velocity Ratio (V.R.) of a block and tackle system of three pulleys with the effort in upward direction is:

(a) 1 (b) 2 (c) 3 (d) 4

(iv) If red, blue, green and yellow lights are allowed to enter the same glass block with the same angle of incidence, then for which colour will the angle of deviation be the greatest?

(a) blue (b) green (c) yellow (d) red

(v) The figure shows a source of light S at the bottom of a trough containing a transparent liquid. Rays X and Y emerge from the source. If angle SOP = 43°, state the possible angle of incidence of ray Y. *(Diagram Reference: 2027 Specimen, Page 4)*

(a) 43° (b) 45° (c) 47° (d) 49°

(vi) A concave lens diverges light because its upper and lower parts act as:

(a) inverted prisms
(b) upright prisms
(c) upright and inverted prisms respectively
(d) inverted and upright prisms respectively

(vii) Two sound waves, X and Y have the same amplitude and the same wave pattern, but their frequencies are 60 Hz and 120 Hz respectively, then:

(a) X will be shriller, and Y will be grave.
(b) X will be grave, and Y will be shriller.
(c) X will differ in quality than Y.
(d) X will be louder than Y.

(viii) When objects are viewed through the rising heat of a campfire they appear to shimmer. The optical phenomenon responsible for this effect is:

(a) refraction (b) reflection (c) scattering (d) total internal reflection

(ix) A convex lens with a focal length of 12 cm has an object at a distance of 20 cm in front of the lens. A blurred image is obtained on the screen placed at a distance of 23 cm in front of the lens. In order to obtain a clear image, the screen has to be moved:

(a) towards the lens.
(b) away from the lens.
(c) to a position very far from the lens.
(d) either towards or away from the lens.

(x) A body is acted upon by two equal and opposite forces, that are NOT along the same straight line. The body will:

(a) remain stationary
(b) have only rotational motion
(c) have only rectilinear motion
(d) have both rectilinear and rotational motion

(xi) A ray of light is incident normally on a face of an equilateral prism. The ray gets totally reflected at the second refracting surface. The total deviation produced in the path of the ray is:

(a) 30° (b) 60° (c) 90° (d) 120°

(xii) A block of glass is pushed into the path of the light rays focusing at a point X through a convex lens. Then the converging point X will: *(Diagram Reference: 2024 QP, Page 5)*

(a) Move away from the slab
(b) Move towards the slab
(c) Not shift
(d) Move towards the left side of the lens

(xiii) Speed of blue light in water is:

(a) more than green light
(b) more than orange light
(c) more than violet light
(d) more than red light

(xiv) When a bell fixed on a cycle rings, then the energy conversion that takes place is:

(a) gravitational potential energy to sound energy
(b) kinetic energy to sound energy
(c) sound energy to electrical energy
(d) sound energy to mechanical energy

(xv) When the speed of a moving object is doubled, then its kinetic energy:

(a) remains the same (b) decreases (c) is doubled (d) becomes four times

2. (i) Complete the following by choosing the correct answers from the bracket: **[6]**

(a) Friction acts _____ [tangential / radial] to a car undergoing circular motion.
(b) A glass prism is immersed in water. The angle of minimum deviation will _____ [decrease / increase].
(c) The minimum distance for distinct echo formation is _____ [greater / lesser] in water as compared to air.
(d) A _____ [Class II / Class III] lever will always have M.A. > 1.
(e) When a stone tied to a string is rotated in a horizontal plane, the tension in the string provides _____ [centrifugal / centripetal] force.
(f) When a ray of light passes from a denser to a rarer medium, its wavelength _____ [decreases / increases].

(ii) Match the movement of the body part in Column A to the class of lever in Column B. **[2]**

Column A	**Column B**
(a) Nodding head	1. Class III
(b) Lifting body weight on your toes	2. Class II
	3. Class I

(iii) Analyse the displacement position graphs (labelled a, b, c, d). *(Diagram Reference: 2027 Specimen, Page 8)*. Find two figures that show: **[2]**

(a) sound of same loudness and pitch but different quality.
(b) sound of same pitch but different loudness.

3. (i) A lens is made of two materials of different refractive indices μ_1 and μ_2. *(Diagram Reference: 2027 Specimen, Page 9)*. **[2]**

(a) If the rays are coming from a distant object, then how many images will be formed?
(b) A glass lens always forms a virtual, erect, and diminished image of an object kept in front of it. Identify the lens.

(ii) ABCDE is a regular pentagon with its centre of gravity at O. *(Diagram Reference: 2027 Specimen, Page 10)*. **[2]**

What will be the most probable position (W, X, Y, Z or O) of the new centre of gravity if a piece of clay is attached at point A?

(iii) Calculate the power spent by a crane while lifting a load of mass 2000 kg, at a velocity of 1.5 m/s. (g = 10 m/s²) **[2]**

(iv) An individual chooses to use a block and tackle system of '9' pulleys instead of a single movable pulley to lift a heavy load. **[2]**

(a) What is the advantage of using a block and tackle system over a single movable pulley?
(b) Why should they connect more number of pulleys in the upper fixed block?

(v) 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°). **[2]**

(vi) In a reading glass what is the position of the object with respect to the convex lens used? Why can we not use a concave lens for the same purpose? **[2]**

(vii) Advanced optical sensors in air-to-air missiles use fibre optic cables to transmit light signals with minimal loss. This relies on a physical phenomenon that confines light within the fibres, making the system very dependable for guiding the missile precisely. **[3]**

(a) Name the optical phenomenon that allows light signals to remain confined within the fibre optic cables during transmission.
(b) Explain the two main conditions necessary for this phenomenon to occur.

SECTION B (40 Marks)

(Attempt any four questions from this Section.)

4. (i) A diagram shows a ray of light travelling through three different transparent media having refractive indices μ_1, μ_2 and μ_3. Points Q and S are points on the surfaces separating the media. Given PQ || RS. *(Diagram Reference: 2027 Specimen, Page 12)*. **[3]**

(a) Among the three media shown, in which medium is the speed of light minimum?
(b) As the ray of light travels from medium 1 to medium 2, how does the wavelength of light change? (State whether it increases, decreases, or remains constant.)
(c) State the relationship between the refractive indices μ_1 and μ_3 that ensures the emergent ray (RS) is parallel to the incident ray (PQ).

(ii) The diagram shows two graphs representing variation in angle of deviation against angle of incidence for two colours of light (blue, orange) while passing through the same prism. *(Diagram Reference: 2027 Specimen, Page 13)*. **[3]**

(a) State with a reason whether the minimum deviation for blue (a) and minimum deviation for orange (b) follows the relation a = b, a < b, or a > b.
(b) If we increase the angle of the prism then what is the effect on the values of a and b?

(iii) A candle and a screen are placed 90 cm apart. Steve placed a lens between them such that a clear image is formed on the screen and the image is twice the size of the object. **[4]**

(a) Which type of lens is used by Steve?
(b) Write an equation relating the object distance u, image distance v, and the distance between the candle and the screen.
(c) State the ratio between the image distance v and the object distance u.
(d) Calculate the image distance.

5. (i) 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. *(Diagram Reference: 2027 Specimen, Page 14)*. **[3]**

(a) If this rod is cut at the centre C, then compare the weight of AC to the weight of BC. (Use >, < or =)
(b) Give a reason for your answer in (a).

(ii) For each of the following scenarios, state whether the work done by gravity is positive, negative, or zero. **[3]**

(a) A person walks on a levelled road.
(b) A person climbs a ladder.
(c) A car in a neutral gear is coming down the slope.

(iii) An empty supermarket trolley of mass 10 kg is moving with a speed of 8 m/s. An identical trolley is loaded with 10 kg of goods and moves with a speed of 4 m/s. Both trolleys are brought to rest over the same stopping distance. **[4]**

(a) Calculate the kinetic energy of the empty trolley.
(b) Calculate the kinetic energy of the loaded trolley.
(c) Compare the braking force required to stop the empty trolley and the loaded trolley.
(d) Name the principle applied in solving part (c).

6. (i) A boy is located asymmetrically between two parallel walls, closer to the left wall than the right. If he claps, the time interval between successive echoes is 0.25 s. Find the distance to the left wall (X) in metres. (Distance between walls = 68 m, speed of sound in air = 340 m/s). *(Diagram Reference: 2027 Specimen, Page 16).* **[3]**

(ii) Two identical marbles A and B are rolled down along Path 1 and Path 2 respectively. Path 1 is frictionless and Path 2 is rough. *(Diagram Reference: 2024 QP, Page 9).* **[3]**

(a) Which marble will surely reach the next peak?
(b) Along which path/s will the mechanical energy be conserved?
(c) Along which path/s is the law of conservation of energy obeyed?

(iii) Two wires A and B of the same material and length are fixed to a wooden board and stretched under the same tension. The cross-sectional area of wire A is greater than that of wire B. When set into vibration using identical tuning forks of frequency 300 Hz, only wire B produces a loud sound. **[4]**

(a) Name and explain the phenomenon responsible for the loud sound produced by wire B.
(b) A loud sound is heard from wire A when the experiment is repeated using a tuning fork of frequency f. Is 'f' greater than, less than or equal to 300 Hz? Justify your answer.

7. (i) A bar of length 120 cm is used as a lever to raise a load placed at point P. Seven equidistant points are marked along the bar: P, Q, R, S, T, U, and V, each 20 cm apart. You are permitted to place the fulcrum at any of the marked points and exert the effort at a different point. *(Diagram Reference: 2027 Specimen, Page 15).* **[3]**

(a) Specify the fulcrum and effort points that yield the greatest mechanical advantage.
(b) Compute the maximum mechanical advantage based on the given distances.
(c) To which class of lever does this arrangement belong?

(ii) Light travels a distance of '10x' units in time 't1' in vacuum and it travels a distance of '4x' units in time '4t2' in a denser medium. Using this information answer the question that follows: **[3]**

(a) 'Light covers a distance of 20x units in time t1 in diamond.' State true or false.
(b) Calculate the refractive index of the medium in terms of 't1' and 't2'.

(iii) Richa weighing 40 kgf leaves point P on her skateboard and reaches point Q on the ground with velocity 10 m/s. She then climbs a slope to reach point R which is 3m above the ground. *(Diagram Reference: 2025 QP, Page 13).* **[4]**

(a) Calculate the kinetic energy of Richa at point Q.
(b) Calculate the vertical height of point P above the ground. (Use g as 10 m/s^2 and neglect friction for descent).
(c) Calculate the kinetic energy of Richa at point R. (While moving from Q to R, she loses 500 J of energy against friction.)

8. (i) A block and tackle system of pulleys has a velocity ratio of 3. **[3]**

(a) Draw a labelled diagram of the system indicating clearly, the direction of the load and effort.
(b) State the number of strands of tackle supporting the load.

(ii) A rectangular glass block of refractive index 1.5 has an air bubble trapped inside it. When seen from the top surface AB, it appears to be 4 cm deep. *(Diagram Reference: 2025 QP, Page 10).* **[3]**

(a) Calculate the actual depth of the air bubble from the surface AB.
(b) For which colour of light, blue or yellow, will the apparent depth be greater?
(c) Turning the glass block upside down DOES NOT change the apparent depth of the air bubble. State True or False.

(iii) A, B, C and D are four points on a hemispherical cup placed inverted on the ground. Diameter BC = 360 cm and AE = R/3 (where R is the radius of the cup). A small spherical mass 500 g at rest at the top point A, slides down along the smooth surface of the cup. Assuming that there is no loss of energy, calculate its: *(Diagram Reference: 2026 SPQ, Page 12, 13)*. **[4]**

(a) Potential Energy at A relative to the ground B.
(b) Speed at the lowest point B.
(c) Kinetic Energy at horizontal level D. ($g = 10\ m/s^2$).

9. (i) In a given experiment, a vibrating tuning fork is kept near the mouth of a burette filled with water. The length of the air column is adjusted by opening the tap of the burette. At a length of 5 cm of the air column, a loud sound is heard. *(Diagram Reference: 2024 QP, Page 10)*. **[3]**

(a) Name the phenomenon illustrated by the experiment.
(b) Why is a loud sound heard at this particular length?
(c) If the present tuning fork is replaced with a tuning fork of higher frequency, should the length of the air column increase or decrease to produce a loud sound?

(ii) A monochromatic ray of light is incident on an equilateral prism placed at minimum deviation position with an angle of incidence 45°. *(Diagram Reference: 2024 QP, Page 8)*. **[3]**

(a) What is the angle of minimum deviation produced by the prism in this position?
(b) State two factors on which the angle of deviation depends.

(iii) A car of mass 120 kg is moving at a speed of 18 km/h and it accelerates to attain a speed of 54 km/h in 5 seconds. Calculate: **[4]**

(a) the work done by the engine.
(b) the power of the engine.