Global Scholars School

Final Examination

Date: 15 Mar 2027 | **Class XI · Physics** | Duration: 180 Minutes | Max. Marks: 70

Section A — 1 Mark Questions

Q1. A satellite S moves in an elliptical orbit round the Earth (mass of S negligible). Which is correct?

(A) the acceleration of S is always directed towards the centre of the Earth

(B) its angular momentum changes in direction but not in magnitude

(C) its total mechanical energy varies periodically

(D) its linear momentum is constant in magnitude

Q2. A gas absorbs 500 J of heat and does 200 J of work. The change in its internal energy is

(A) +700 J

(B) +300 J

(C) −300 J

(D) −700 J

Q3. If a machine is lubricated with oil,

(A) its mechanical advantage increases

(B) its mechanical efficiency increases

(C) both its mechanical advantage and efficiency increase

(D) its efficiency increases but its mechanical advantage decreases

Q4. A pipe closed at one end has a fundamental of 200 Hz. Its next resonant frequency is

(A) 400 Hz

(B) 600 Hz

(C) 300 Hz

(D) 800 Hz

Q5. A steel rod 100 cm long is clamped at its middle. The fundamental frequency of its longitudinal vibrations is 2.53 kHz. The speed of sound in steel (in km/s) is

(A) 2.53

(B) 10.1 km/s

(C) 1.27

(D) 5.06

Q6. A gas is taken from state D (P = 600 N/m², V = 2.0 m³) to state E (P = 300 N/m², V = 5.0 m³) along a straight line on the P–V diagram, and then from E to F (P = 300 N/m², V = 2.0 m³) at constant pressure. The total work done by the gas along D → E → F is

(A) 450 J

(B) 1350 J

(C) 900 J

(D) 0

Q7. A massless horizontal rod BD of length L hangs from two identical vertical strings AB (at end B) and CD (at end D). A block hangs from a point O on the rod with BO = x. The first harmonic frequency of AB equals the second harmonic frequency of CD. x is

(A) L/5

(B) 4L/5

(C) 3L/4

(D) L/4

Q8. Percentage errors in mass and speed are 2% and 3%. The error in kinetic energy obtained from them is

(A) 8% **(B)** 2%

(C) 12% **(D)** 10%

Q9. Which one of the following physical quantities is a vector?

(A) impulse **(B)** pressure

(C) energy **(D)** charge

Q10. Water flows through a horizontal pipe whose cross-section reduces from 10 cm^2 to 5 cm^2. If the speed in the wider part is 2 m s^{-1}, the speed in the narrower part is

(A) 1 m s^{-1} **(B)** 4 m s^{-1}

(C) 2 m s^{-1} **(D)** 8 m s^{-1}

Q11. For a diatomic gas whose molecules also vibrate (7 degrees of freedom), the ratio of specific heats γ is about

(A) 1.4 **(B)** 1.67

(C) 1.29 **(D)** 1.0

Q12. The total mechanical energy of a satellite of mass m in a circular orbit of radius r around the Earth (mass M) is

(A) +GMm/2r **(B)** −GMm/r

(C) −GMm/2r **(D)** 0

Q13. Assertion (A): It is easier to open a door by pushing at the handle (far from the hinges) than near the hinges.
Reason (R): Torque is the product of force and its perpendicular distance from the axis of rotation.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

Q14. Assertion (A): Cutting a spring in half halves its period with the same mass.
Reason (R): Each half has double the spring constant.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

Q15. Assertion (A): On a P–V diagram, an adiabatic curve is steeper than an isothermal curve through the same point.
Reason (R): The ratio of specific heats $\gamma = C_p/C_v$ is greater than 1.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

Q16. Assertion (A): At the highest point of a vertical throw the acceleration is zero.
Reason (R): The velocity there is zero.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

Section B — 2 Marks Questions

Q1. What force would be needed to stretch a steel wire of cross-section 1 cm^2 to double its length (if Hooke's law held)? $Y = 2 \times 10^{11}$ N/m^2.

Q2. Constant forces $F_1 = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $F_2 = -\hat{i} + 2\hat{j} - 3\hat{k}$ act on a particle displaced from A(2, 1, 0) to B(−3, −4, 2). Find the total work done.

Q3. Distinguish between average and instantaneous velocity. If the velocity does not change, are the average velocities over different intervals different?

Q4. Refrigerator A works between −10 °C and 27 °C, B between −27 °C and 17 °C (ideal). Which is better?

Q5. A liquid of volume 10 m^3 is given 100 kcal of heat and expands at a constant 10 atm to 10.2 m^3. Find the work done and ΔU.

Section C — 3 Marks Questions

Q1. State the two conditions for the equilibrium of a rigid body.

Q2. Explain the four readings of a scale in a lift.

Q3. Two rods of equal length and area — copper (K = 400 W/m K) and brass (K = 100 W/m K) — are joined in series with the free ends at 100 °C and 0 °C. Find the junction temperature, and compare the heat current with that when they are joined in parallel.

Q4. On a belt moving at 4 km h^{-1}, a child runs at 9 km h^{-1} (relative to the belt) between his father and mother 50 m apart on the belt. For a stationary observer find the child's speed (i) with the belt (ii) against it, and (iii) the time taken in each case. Which answers change for an observer who is one of the parents?

Q5. Consider a simple pendulum. The period of oscillation depends on its length l and acceleration due to gravity g. Derive the expression for its period of oscillation by the method of dimensions.

Q6. A particle of mass m moves in a straight line with retardation proportional to its displacement (a = −kx). Find the loss of kinetic energy for a displacement x.

Q7. For the travelling harmonic wave y(x, t) = 2.0 cos 2π (10t – 0.0080 x + 0.35) where x and y are in cm and t in s. Calculate the phase difference between oscillatory motion of two points separated by a distance of (a) 4 m, (b) 0.5 m, (c) λ/2, (d) 3λ/4

Section D — 4 Marks Questions

Q1. A weather satellite orbits the Earth in a circle at a height of 600 km ($R_E = 6400$ km, $g = 9.8$ m s^{-2} at the surface).

(a) What provides its centripetal force?

(b) Find its orbital speed.

(c) Find its period and say how the period of a higher satellite compares.

Q2. In a laboratory, steel balls of radius 1 mm (density 7800 kg/m^3) are dropped in a tall jar of glycerine (density 1260 kg/m^3, η = 1.5 Pa s).

(a) Find the terminal velocity of a ball.

(b) How does the terminal velocity change for a ball of twice the radius?

(c) Why is the measurement made only after the ball has fallen some distance?

Section E — 5 Marks Questions

Q1. Define static, limiting and kinetic friction. Draw the graph of friction against applied force and show that static friction is self-adjusting.

Q2. Derive the orbital speed, period and total energy of a satellite; define escape speed and derive it.

Q3. Explain static, kinetic and rolling friction; derive the angle of repose and the maximum speed on a banked road.