

SCO INTERNATIONAL PHYSICS OLYMPIAD

CLASS 11 QUESTION PAPER

Official Question Paper | Set A

Rebranded from the latest uploaded Class 11 Physics Olympiad paper and corrected for Class 11 academic suitability.

- Class 11 physics pathway covering mechanics, properties of matter, heat, thermodynamics, oscillations, and waves.
- Olympiad-style reasoning with numerical, assertion-reason, case-study, and achievers-level questions.
- PDF-ready Word layout with compact question numbers and diagrams placed inside question blocks.

Mathematics in Physics	Measurement	Kinematics	Laws of Motion	Work & Energy	Rotation
Gravitation	Solids	Fluids	Thermal Physics	Oscillations	Waves

Official Question Paper 2025-26 | Set A

Candidate Guidelines

Total Questions	Time	Maximum Marks	Question Type
50	60 minutes	60	Multiple Choice Questions with one correct answer

1. Before the exam begins, candidates may use the additional time announced by the invigilator to complete the OMR/personal information section.
2. Write name, registration ID, class, school/organization details, and contact information clearly.
3. The paper has three segments: General Questions (Q1-Q30), Assertion-Reason (Q31-Q40), and Achievers Section (Q41-Q50).
4. Each Achievers Section question carries 2 marks. All other questions carry 1 mark. There is no negative marking unless separately announced by SCO.
5. Use only one response choice for each question. Calculators, smart watches, and electronic aids are not permitted.
6. For online mode, follow proctoring, camera, tab-switching, and integrity instructions exactly as displayed on the SCO platform.

Candidate Information

Name:

Registration ID: Contact No.:

School/Organization: Country:

Section A: General Physics Questions

Q1-Q30 carry 1 mark each. Choose one correct option.

Q1. The universal gravitational constant G appears in $F = Gm_1m_2/r^2$. What is the dimensional formula of G ?

- A. $[M L T^{-2}]$
- B. $[M L^2 T^{-2}]$
- C. $[M^{-1} L^3 T^{-2}]$
- D. $[M^{-2} L^2 T^{-1}]$

Q2. A student adds 3.26 m and 4.1 m using significant-figure rules. What should be reported?

- A. 7.36 m
- B. 7.4 m
- C. 7.3 m
- D. 7 m

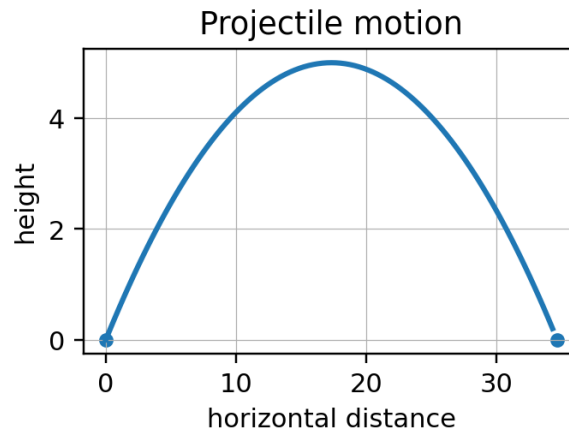
Q3. The position of a particle moving along a straight line is $x = 2t^3 - 3t^2 + 4$, where x is in metres and t in seconds. What is its instantaneous velocity at $t = 2$ s?

- A. 6 m/s
- B. 8 m/s
- C. 12 m/s
- D. 18 m/s

Q4. A boat moves across a 600 m wide river with speed 4 m/s perpendicular to the bank. The river current is 3 m/s. What is the downstream drift when it reaches the opposite bank?

- A. 150 m
- B. 300 m
- C. 450 m
- D. 600 m

Q5. A projectile is fired with speed 20 m/s at an angle of 30° to the horizontal. Taking $g = 10 \text{ m/s}^2$, what is the approximate horizontal range?



- A. 20.0 m
- B. 28.3 m
- C. 34.6 m
- D. 40.0 m

Q6. A particle moves in a circle of radius 5 m with constant speed 10 m/s. What is the magnitude of centripetal acceleration?

- A. 2 m/s^2
- B. 5 m/s^2
- C. 10 m/s^2
- D. 20 m/s^2

Q7. A 60 kg student stands in an elevator accelerating upward at 2 m/s^2 . Taking $g = 10 \text{ m/s}^2$, what normal reaction does the floor exert on the student?

- A. 480 N
- B. 600 N
- C. 720 N
- D. 840 N

Q8. A 5 kg block on a rough horizontal surface is pulled with a horizontal force of 20 N. If the coefficient of friction is 0.2 and $g = 10 \text{ m/s}^2$, what is its acceleration?

- A. 1 m/s^2
- B. 2 m/s^2
- C. 3 m/s^2
- D. 4 m/s^2

Q9. A variable force $F = 5x$ newton acts on a particle as it moves from $x = 0 \text{ m}$ to $x = 4 \text{ m}$. What work is done by the force?

- A. 20 J
- B. 30 J
- C. 40 J
- D. 80 J

Q10. A spring of force constant 200 N/m is compressed by 0.10 m. How much potential energy is stored?

- A. 0.5 J
- B. 1.0 J
- C. 2.0 J
- D. 10 J

Q11. A 2 kg object increases its speed from 4 m/s to 10 m/s. What is the change in kinetic energy?

- A. 36 J
- B. 60 J
- C. 84 J
- D. 100 J

Q12. A motor lifts a 50 kg mass vertically through 2 m in 5 s. Taking $g = 10 \text{ m/s}^2$, what is the minimum useful power?

- A. 100 W
- B. 200 W
- C. 500 W
- D. 1000 W

Q13. Two particles of masses 2 kg and 3 kg are placed at $x = 0$ m and $x = 5$ m respectively. Where is their centre of mass?

- A. 2 m from the 2 kg mass
- B. 2.5 m from the 2 kg mass
- C. 3 m from the 2 kg mass
- D. 4 m from the 2 kg mass

Q14. A force of 20 N acts perpendicular to a 0.50 m long wrench. What torque is produced about the turning point?

- A. 5 N m
- B. 10 N m
- C. 20 N m
- D. 40 N m

Q15. A thin hoop of mass 2 kg and radius 0.50 m rotates about its central axis. What is its moment of inertia?

- A. 0.25 kg m^2
- B. 0.50 kg m^2
- C. 1.00 kg m^2
- D. 2.00 kg m^2

Q16. Using $g = 9.8 \text{ m/s}^2$ and Earth radius $R = 6.4 \times 10^6$ m, the approximate orbital speed of a satellite close to Earth is:

- A. 3.9 km/s
- B. 5.6 km/s
- C. 7.9 km/s
- D. 11.2 km/s

Q17. A wire of cross-sectional area $1.0 \times 10^{-4} \text{ m}^2$ is stretched by a force of 100 N. If the strain is 1.0×10^{-3} , what is Young's modulus?

- A. 1.0×10^7 Pa
- B. 1.0×10^8 Pa
- C. 1.0×10^9 Pa
- D. 1.0×10^{10} Pa

Q18. In a hydraulic press, the small piston area is 0.02 m^2 and the large piston area is 1.00 m^2 . If 400 N is applied to the small piston, what force acts on the large piston?

- A. 8000 N
- B. 12000 N
- C. 16000 N
- D. 20000 N

Q19. What is the gauge pressure at a depth of 5 m below the surface of water? Take density of water = 1000 kg/m^3 and $g = 10 \text{ m/s}^2$.

- A. $5.0 \times 10^3 \text{ Pa}$
- B. $2.5 \times 10^4 \text{ Pa}$
- C. $5.0 \times 10^4 \text{ Pa}$
- D. $1.0 \times 10^5 \text{ Pa}$

Q20. Water flows out from a small hole at the bottom of a tank where the water surface is 20 m above the hole. Taking $g = 10 \text{ m/s}^2$, what is the efflux speed?

- A. 10 m/s
- B. 14 m/s
- C. 20 m/s
- D. 40 m/s

Q21. A 2 m steel rod has coefficient of linear expansion 1.2×10^{-5} per $^\circ\text{C}$. How much does it expand when heated by $50 \text{ }^\circ\text{C}$?

- A. 0.12 mm
- B. 0.60 mm
- C. 1.20 mm
- D. 12.0 mm

Q22. How much heat is needed to raise 0.5 kg of water from 20 °C to 80 °C? Take $c = 4200 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$.

- A. 42,000 J
- B. 84,000 J
- C. 126,000 J
- D. 168,000 J

Q23. For a fixed amount of ideal gas, pressure is doubled while volume is halved. What happens to the absolute temperature?

- A. It becomes one-fourth
- B. It becomes half
- C. It remains unchanged
- D. It doubles

Q24. A gas receives 500 J of heat and does 200 J of work on the surroundings. What is the change in internal energy?

- A. -300 J
- B. 200 J
- C. 300 J
- D. 700 J

Q25. A Carnot engine works between 600 K and 300 K. What is its efficiency?

- A. 25%
- B. 40%
- C. 50%
- D. 60%

Q26. The absolute temperature of an ideal gas is made four times its initial value. How does the rms speed of molecules change?

- A. It becomes half
- B. It remains the same
- C. It becomes twice
- D. It becomes four times

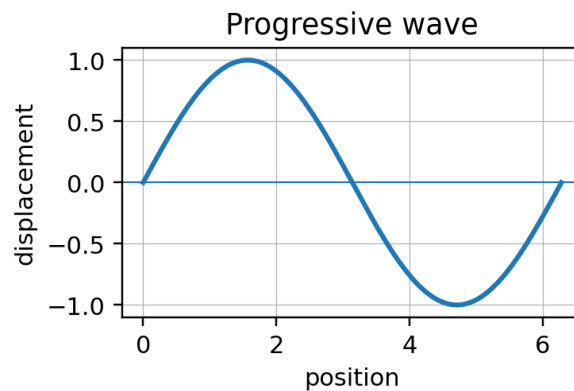
Q27. A 0.50 kg mass is attached to a spring of force constant 200 N/m. What is the approximate period of oscillation?

- A. 0.157 s
- B. 0.314 s
- C. 0.628 s
- D. 1.57 s

Q28. A simple pendulum has length 1 m. Taking $g = 10 \text{ m/s}^2$, its small-oscillation period is closest to:

- A. 1.0 s
- B. 2.0 s
- C. 3.0 s
- D. 6.3 s

Q29. A string has tension 100 N and mass per unit length 0.01 kg/m. What is the speed of transverse waves on the string?



- A. 10 m/s
- B. 50 m/s
- C. 100 m/s
- D. 1000 m/s

Q30. A sound intensity becomes 100 times its original value. By how many decibels does the sound level increase?

- A. 10 dB
- B. 20 dB
- C. 40 dB
- D. 100 dB

Section B: Assertion-Reason Questions

Q31-Q40 carry 1 mark each. Use the option key given in each question.

Q31. Assertion (A): A physical equation must be dimensionally consistent.

Reason (R): Terms added or equated in a valid equation must have the same dimensions.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q32. Assertion (A): In projectile motion without air resistance, horizontal and vertical motions can be analysed independently.

Reason (R): Gravity acts only in the vertical direction.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q33. Assertion (A): Friction always acts opposite to the direction of motion of an object.

Reason (R): Friction opposes the relative motion or tendency of relative motion between surfaces.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q34. Assertion (A): The net work done on a body equals the change in its kinetic energy.

Reason (R): Work transfers mechanical energy to or from a body.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q35. Assertion (A): Angular momentum of a system is conserved if the net external torque is zero.

Reason (R): Torque is the time rate of change of angular momentum.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q36. Assertion (A): Elastic potential energy stored in a stretched wire increases with the square of strain for small deformations.

Reason (R): Within elastic limit, stress is proportional to strain.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q37. Assertion (A): Pressure in a stationary liquid increases with depth.

Reason (R): Hydrostatic pressure is given by $p = \rho gh$ for a depth h below the free surface.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q38. Assertion (A): The efficiency of a Carnot engine depends only on the temperatures of the reservoirs.

Reason (R): A Carnot engine is reversible and has maximum possible efficiency for given reservoirs.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q39. Assertion (A): The rms speed of gas molecules increases when temperature increases.
Reason (R): Average translational kinetic energy of a molecule is proportional to absolute temperature.

- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Q40. Assertion (A): Sound waves can travel through vacuum.
Reason (R): Sound requires a material medium for propagation.

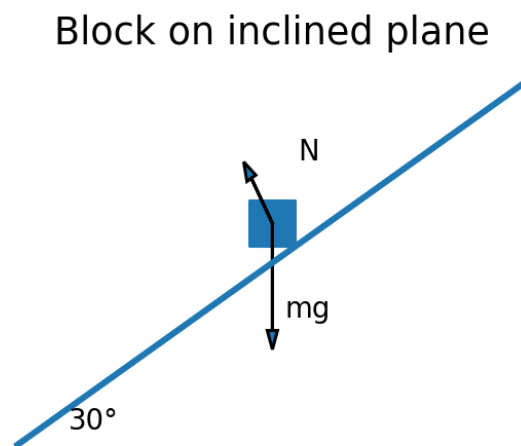
- A. Both A and R are true, and R correctly explains A
- B. Both A and R are true, but R does not explain A
- C. A is true, R is false
- D. A is false, R is true

Section C: Achievers Section

Q41-Q50 carry 2 marks each. Read each case carefully and choose one correct option.

Q41. Case Study: A solid sphere rolls without slipping down a 5.0 m long plane inclined at 30° . Take $g = 10 \text{ m/s}^2$ and $I = (2/5)MR^2$ for a solid sphere.

Q41. What is the speed of the sphere at the bottom?



- A. 5.0 m/s
- B. 6.0 m/s
- C. 7.1 m/s
- D. 10.0 m/s

Q42. Case Study: A satellite moves in an elliptical orbit around Earth. The perigee altitude is 300 km and the apogee altitude is 1500 km. Use Earth radius $R = 6371$ km and $\mu = 3.986 \times 10^{14} \text{ m}^3/\text{s}^2$.

Q42. What is the approximate speed of the satellite at perigee?

- A. 7300 m/s
- B. 8040 m/s
- C. 8675 m/s
- D. 9100 m/s

Q43. Case Study: One mole of a gas is compressed polytropically with $n = 1.3$ from $V_1 = 0.010 \text{ m}^3$ and $T_1 = 300 \text{ K}$ to $V_2 = 0.002 \text{ m}^3$.

Q43. What is the final temperature?

- A. 430 K
- B. 486 K
- C. 540 K
- D. 600 K

Q44. Case Study: A helium sample behaves like an ideal monatomic gas. Use $\gamma = 5/3$, molar mass $M = 4 \text{ g/mol}$, $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$, and $T = 300 \text{ K}$.

Q44. What is the speed of sound in helium?

- A. 940 m/s
- B. 1019 m/s
- C. 1050 m/s
- D. 1100 m/s

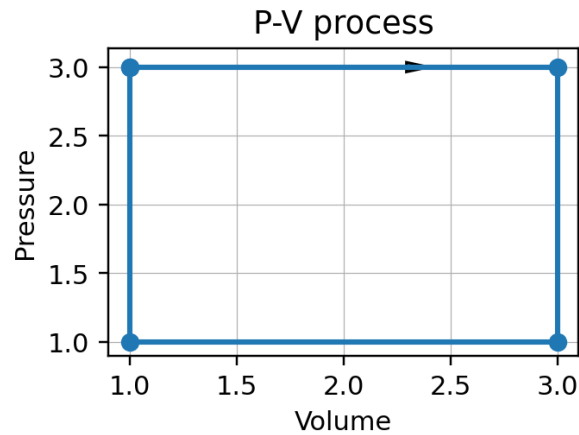
Q45. Case Study: Water in a cylindrical container of radius 0.50 m is spun at angular speed 10 rad/s. The free surface becomes parabolic.

Q45. How much higher is the rim than the centre?

- A. 0.98 m
- B. 1.28 m
- C. 1.52 m
- D. 1.75 m

Q46. Case Study: A Carnot engine operates between a hot reservoir at 500 K and a cold reservoir at 300 K. It absorbs 1200 J heat per cycle.

Q46. How much work does it perform per cycle?



- A. 360 J
- B. 480 J
- C. 600 J
- D. 720 J

Q47. Case Study: At 300 K and 1 atm, estimate the mean free path of nitrogen molecules. Molecular diameter $d = 0.37$ nm. Use $k = 1.38 \times 10^{-23}$ J/K and $p = 1.01 \times 10^5$ Pa.

Q47. Which value is closest?

- A. 4.0×10^{-8} m
- B. 6.7×10^{-8} m
- C. 1.0×10^{-7} m
- D. 2.0×10^{-7} m

Q48. Case Study: A 0.50 kg mass on a spring of force constant 200 N/m experiences linear damping with $b = 5$ kg/s.

Q48. What is the damped-oscillation period?

- A. 0.295 s
- B. 0.325 s
- C. 0.360 s
- D. 0.400 s

Q49. Case Study: A wave in a dispersive medium has relation $\omega = \alpha k^2$, where $\alpha = 1.0 \times 10^{-4} \text{ m}^2/\text{s}$.

Q49. What is the group velocity at $k = 50 \text{ m}^{-1}$?

- A. 0.005 m/s
- B. 0.010 m/s
- C. 0.020 m/s
- D. 0.025 m/s

Q50. Case Study: A disk of moment of inertia 0.05 kg m^2 is attached to a cylindrical rod of length 1.0 m, radius 0.01 m, and shear modulus $G = 7.9 \times 10^{10} \text{ Pa}$. For the rod, $J = \pi r^4/2$.

Q50. What is the torsional-oscillation period?

- A. 0.025 s
- B. 0.040 s
- C. 0.055 s
- D. 0.070 s

Answer Key

Q.No.	Ans.	Q.No.	Ans.	Q.No.	Ans.	Q.No.	Ans.	Q.No.	Ans.
1	C	11	C	21	C	31	A	41	B
2	B	12	B	22	C	32	A	42	B
3	C	13	C	23	C	33	D	43	B
4	C	14	B	24	C	34	A	44	B
5	C	15	B	25	C	35	A	45	B
6	D	16	C	26	C	36	A	46	B
7	C	17	C	27	B	37	A	47	B
8	B	18	D	28	B	38	A	48	B
9	C	19	C	29	C	39	A	49	B
10	B	20	C	30	B	40	D	50	B

Detailed Explanations

<p>Q1. Answer: C. From $F = Gm_1m_2/r^2$, $G = Fr^2/(m_1m_2)$. Therefore $[G] = [M L T^{-2}][L^2]/[M^2] = [M^{-1} L^3 T^{-2}]$.</p>
<p>Q2. Answer: B. For addition, the answer is rounded to the least number of decimal places. 4.1 has one decimal place, so $3.26 + 4.1 = 7.36$ is reported as 7.4 m.</p>
<p>Q3. Answer: C. Velocity is $dx/dt = 6t^2 - 6t$. At $t = 2$ s, $v = 6(4) - 12 = 12$ m/s.</p>
<p>Q4. Answer: C. Crossing time = width/cross-river speed = $600/4 = 150$ s. Drift = current speed x time = $3 \times 150 = 450$ m.</p>
<p>Q5. Answer: C. Range $R = u^2 \sin(2\theta)/g = 400 \times \sin 60^\circ / 10 \approx 400 \times 0.866/10 = 34.6$ m.</p>
<p>Q6. Answer: D. Centripetal acceleration $a = v^2/r = 10^2/5 = 20$ m/s².</p>
<p>Q7. Answer: C. For upward acceleration, $N - mg = ma$, so $N = m(g+a) = 60(10+2) = 720$ N.</p>
<p>Q8. Answer: B. Friction = $\mu mg = 0.2 \times 5 \times 10 = 10$ N. Net force = $20 - 10 = 10$ N. Acceleration = $10/5 = 2$ m/s².</p>
<p>Q9. Answer: C. Work = integral from 0 to 4 of $5x dx = (5/2)x^2$ from 0 to 4 = 40 J.</p>
<p>Q10. Answer: B. Spring energy = $(1/2)kx^2 = 0.5 \times 200 \times (0.10)^2 = 1.0$ J.</p>
<p>Q11. Answer: C. $\Delta K = (1/2)m(v^2 - u^2) = 1 \times (100 - 16) = 84$ J.</p>
<p>Q12. Answer: B. Work = $mgh = 50 \times 10 \times 2 = 1000$ J. Power = work/time = $1000/5 = 200$ W.</p>

Q13. Answer: C. $x_{cm} = (2 \times 0 + 3 \times 5)/(2+3) = 15/5 = 3 \text{ m}$.

Q14. Answer: B. Torque $\tau = rF \sin 90^\circ = 0.50 \times 20 = 10 \text{ N m}$.

Q15. Answer: B. For a hoop, $I = MR^2 = 2 \times (0.50)^2 = 0.50 \text{ kg m}^2$.

Q16. Answer: C. For a low circular orbit, $v \approx \sqrt{gR} = \sqrt{9.8 \times 6.4 \times 10^6} \approx 7.9 \times 10^3 \text{ m/s} = 7.9 \text{ km/s}$.

Q17. Answer: C. Stress = $F/A = 100/(1.0 \times 10^{-4}) = 1.0 \times 10^6 \text{ Pa}$. Young's modulus = stress/strain = $10^6/10^{-3} = 10^9 \text{ Pa}$.

Q18. Answer: D. Equal pressure is transmitted: $F_2/A_2 = F_1/A_1$. $F_2 = 400 \times (1.00/0.02) = 20,000 \text{ N}$.

Q19. Answer: C. Gauge pressure $p = \rho gh = 1000 \times 10 \times 5 = 5.0 \times 10^4 \text{ Pa}$.

Q20. Answer: C. Torricelli's theorem gives $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20 \text{ m/s}$.

Q21. Answer: C. $\Delta L = L\alpha\Delta T = 2 \times 1.2 \times 10^{-5} \times 50 = 0.0012 \text{ m} = 1.20 \text{ mm}$.

Q22. Answer: C. $Q = mc\Delta T = 0.5 \times 4200 \times 60 = 126,000 \text{ J}$.

Q23. Answer: C. For a fixed amount of gas, T is proportional to PV. New $PV = (2P)(V/2) = PV$, so temperature remains unchanged.

Q24. Answer: C. First law: $\Delta U = Q - W = 500 - 200 = 300 \text{ J}$.

Q25. Answer: C. $\eta = 1 - T_c/T_h = 1 - 300/600 = 0.5 = 50\%$.

Q26. Answer: C. v_{rms} is proportional to \sqrt{T} . If T becomes 4T, v_{rms} becomes 2 times.

Q27. Answer: B. $T = 2\pi\sqrt{m/k} = 2\pi\sqrt{0.50/200} \approx 2\pi(0.05) = 0.314 \text{ s}$.

Q28. Answer: B. $T = 2\pi\sqrt{l/g} = 2\pi\sqrt{1/10} \approx 1.99 \text{ s}$.

Q29. Answer: C. Wave speed $v = \sqrt{T/\mu} = \sqrt{100/0.01} = \sqrt{10000} = 100 \text{ m/s}$.

Q30. Answer: B. Change in level = $10 \log_{10}(I_2/I_1) = 10 \log_{10}(100) = 20 \text{ dB}$.

Q31. Answer: A. Dimensional consistency is required because only quantities with the same dimensions can be added, subtracted, or equated.

Q32. Answer: A. The acceleration due to gravity has no horizontal component, so horizontal velocity remains constant while vertical velocity changes.

Q33. Answer: D. Friction opposes relative motion/tendency, not necessarily the object's motion. For example, friction helps a walking person move forward.

Q34. Answer: A. The work-energy theorem states that net work equals change in kinetic energy; the reason describes the mechanism of mechanical energy transfer.

Q35. Answer: A. Since $\tau_{\text{ext}} = dL/dt$, if external torque is zero then angular momentum remains constant.

Q36. Answer: A. Hooke's law gives stress proportional to strain, and elastic energy density equals one-half stress times strain, so it is proportional to strain squared.

Q37. Answer: A. The relation $p = \rho gh$ directly shows that pressure increases linearly with depth h .

Q38. Answer: A. Carnot efficiency is $\eta = 1 - T_c/T_h$; it depends only on reservoir temperatures and follows from reversibility.

Q39. Answer: A. Kinetic theory gives $(1/2)mv_{\text{rms}}^2 = (3/2)kT$; hence v_{rms} is proportional to \sqrt{T} .

Q40. Answer: D. The assertion is false. Sound is a mechanical wave and needs a material medium, so the reason is true.

Q41. Answer: B. Vertical height $h = 5 \sin 30^\circ = 2.5$ m. Using energy, $mgh = (1/2)mv^2 + (1/2)I\omega^2 = (1/2)mv^2(1+2/5)$. Thus $v = \sqrt{2gh/(1.4)} = \sqrt{50/1.4} \approx 6.0$ m/s.

Q42. Answer: B. Using vis-viva equation, $v_p = \sqrt{\mu(2/r_p - 1/a)}$, where $r_p = 6671$ km and $a = (6671+7871)/2$ km = 7271 km. Substitution gives about 8.04×10^3 m/s.

Q43. Answer: B. For a polytropic ideal gas, $TV^{(n-1)} = \text{constant}$. $T_2 = T_1(V_1/V_2)^{(n-1)} = 300(5)^{0.3} \approx 486$ K.

Q44. Answer: B. $v = \sqrt{\gamma RT/M} = \sqrt{(5/3)(8.314)(300)/0.004} \approx 1019$ m/s.

Q45. Answer: B. For a rotating liquid, height difference $\Delta h = \omega^2 R^2 / (2g) = 10^2 \times 0.50^2 / (2 \times 9.8) \approx 1.28$ m.

Q46. Answer: B. Efficiency = $1 - 300/500 = 0.40$. Work = $\eta Q_h = 0.40 \times 1200 = 480$ J.

Q47. Answer: B. Mean free path $\lambda = kT/(\sqrt{2}\pi d^2 p)$. Substituting the values gives $\lambda \approx 6.7 \times 10^{-8}$ m.

Q48. Answer: B. $\omega_0 = \sqrt{k/m} = 20$ rad/s and $\beta = b/(2m) = 5$ rad/s. Damped angular frequency = $\sqrt{\omega_0^2 - \beta^2} = \sqrt{375} = 19.36$ rad/s. Period = $2\pi/19.36 \approx 0.325$ s.

Q49. Answer: B. Group velocity $v_g = d\omega/dk = 2\alpha k = 2 \times 10^{-4} \times 50 = 0.010$ m/s.

Q50. Answer: B. Torsional constant $\kappa = GJ/L = G\pi r^4/(2L) \approx 1240$ N m/rad. Period $T = 2\pi\sqrt{I/\kappa} = 2\pi\sqrt{0.05/1240} \approx 0.040$ s.