Exam ID: 100

National Level ScienceX Olympiads

ScienceX Physics Olympiad (SPO)

Name: _____

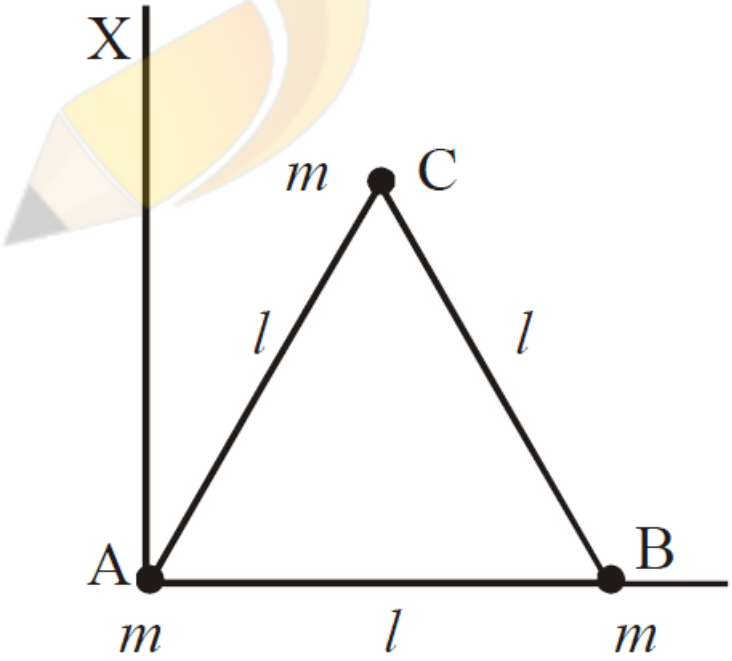
Date: _____

Exam Instructions

1. The timer has been set for the exam, and a countdown will display the remaining time. When the timer runs out, the exam will end automatically. No further action will be required after that.
2. You can flag any question that you want.
3. If you don't want to submit any of your provided answers, you can clear them.
4. If you choose to drop this exam, it will not be submitted, and no result will be generated.
5. Once you finish the exam, you cannot resume it.

Question: 1 of 50 QID: 117 Marks: 4

Three particles, each of mass **m** gram, are situated at the vertices of an equilateral triangle ABC of side ***l*** cm (as shown in the figure). The moment of inertia of the system about a line AX perpendicular to AB and in the plane of ABC, in gram-cm^2 units will be



Please mark (✓) for the correct answer.

- A. $\frac{3}{4}ml^2$
- B. $\frac{5}{4}ml^2$
- C. $2ml^2$
- D. $\frac{3}{2}ml^2$

Question: 2 of 50 QID: 151 Marks: 4

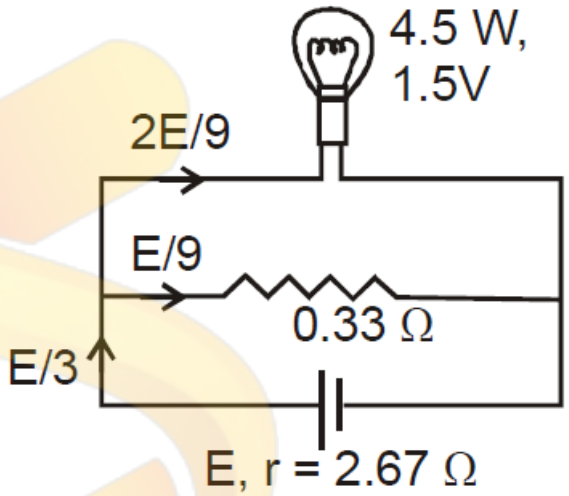
What is the energy of photon whose wavelength is 6840 Å?

Please mark (✓) for the correct answer.

- **A.** 12.1 eV
- **B.** 1.81 eV
- **C.** –13.6 eV
- **D.** 3.6 eV

Question: 3 of 50 QID: 140 Marks: 4

A torch bulb rated as 4.5 W, 1.5 V is connected as shown in fig. The e.m.f. of the cell, needed to make the bulb glow at full intensity is



Please mark (✓) for the correct answer.

- **A.** 1.5V
- **B.** 4.5V
- **C.** 2.67V
- **D.** 13.5V

Question: 4 of 50 QID: 132 Marks: 4

A particle is executing a simple harmonic motion. Its maximum acceleration is α and maximum velocity is β. Then its time period of vibration will be :

Please mark (✓) for the correct answer.

- **A.** $\frac{\beta^2}{\alpha}$
- **B.** $\frac{2\pi\beta}{\alpha}$
- **C.** $\frac{\beta^2}{\alpha^2}$
- **D.** $\frac{\alpha}{\beta}$

Question: 5 of 50 QID: 106 Marks: 4

if force and length units are raised four times. The energy unit

Please mark (✓) for the correct answer.

- **A.** is increased by 8 times
- **B.** is increased by 4 times
- **C.** remains unchanged
- **D.** is increased by 16 times

Question: 6 of 50 QID: 135 Marks: 4

Select the ***incorrect*** statements from the following.

I. Polar molecules have permanent electric dipole moment.
II. CO_2 molecule is a polar molecule.
III. H_2O is a non-polar molecule.

Please mark (✓) for the correct answer.

- **A.** II and III
- **B.** I and III
- **C.** I and II
- **D.** I, II and III

Question: 7 of 50 QID: 119 Marks: 4

Which of the following statements is/are ***true***?
I. Water is more elastic than air
II. Modulus of elasticity is more for steel than that of copper.
III. Young's modulus of elasticity for a perfectly rigid body is infinite

Please mark (✓) for the correct answer.

- **A.** I, II and III
- **B.** I and II only
- **C.** II only
- **D.** I only

Question: 8 of 50 QID: 122 Marks: 4

A man stands at one end of a boat which is stationary in water. Neglect water resistance. The man now moves to the other end of the boat and again becomes stationary. The centre of mass of the *'man plus boat'* system will remain stationary with respect to water

Please mark (✓) for the correct answer.

- **A.** only if the man moves without acceleration on the boat
- **B.** in all cases
- **C.** only if the man and the boat have equal masses
- **D.** only when the man is stationary initially and finally

Question: 9 of 50 QID: 134 Marks: 4

The rate of transfer of energy in a wave depends

Please mark (✓) for the correct answer.

- **A.** directly on the wave amplitude and square of the wave frequency
- **B.** directly on the square of the wave amplitude and root of the wave frequency
- **C.** directly on the square of the wave amplitude and square of the wave frequency
- **D.** None of these

Question: 10 of 50 QID: 115 Marks: 4

What will be the final pressure if an ideal gas in a cylinder is compressed adiabatically to 1/3rd of its volume?

Please mark (✓) for the correct answer.

- **A.** Final pressure will be three times less than initial pressure.
- **B.** Change in pressure will be less than three times the initial pressure.
- **C.** Change in pressure will be more than three times the initial pressure.
- **D.** Final pressure will be three times more than initial pressure.

Question: 11 of 50 QID: 137 Marks: 4

An electric dipole is placed at an angle of 30° with an electric field of intensity 2×10^5 NC^{-1}, It experiences a torque of 4 Nm. Calculate the charge on the dipole if the dipole length is 2 cm.

Please mark (✓) for the correct answer.

- **A.** 8μC
- **B.** 4mC
- **C.** 8mC
- **D.** 2mC

Question: 12 of 50 QID: 114 Marks: 4

On a railway curve the outside rail is laid higher than the inside one so that resultant force exerted on the wheels of the rail car by the tops of the rails will

Please mark (✓) for the correct answer.

- **A.** equilibriate the centripetal force
- **B.** be decreased
- **C.** have a horizontal inward component
- **D.** be vertical

Question: 13 of 50 QID: 131 Marks: 4

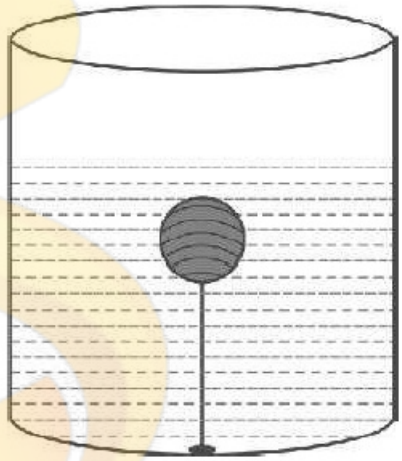
A particle is executing SHM along a straight line. Its velocities at distances x_1 and x_2 from the mean position are V_1 and V_2, respectively. Its time period is

Please mark (✓) for the correct answer.

- **A.** $2\pi\sqrt{\frac{x_2^2-x_1^2}{V_1^2-V_2^2}}$
- **B.** $2\pi\sqrt{\frac{V_1^2+V_2^2}{x_1^2+x_2^2}}$
- **C.** $2\pi\sqrt{\frac{V_1^2-V_2^2}{x_1^2-x_2^2}}$
- **D.** $2\pi\sqrt{\frac{x_1^2-x_2^2}{V_1^2-V_2^2}}$

Question: 14 of 50 QID: 123 Marks: 4

A solid sphere of density η (>1) times lighter than water is suspended in a water tank by a string tied to its base as shown in fig. If the mass of the sphere is m, then the tension in the string is given by



Please mark (✓) for the correct answer.

- **A.** $(\frac{\eta-1}{\eta})mg$
- **B.** $(\frac{mg}{\eta-1})$
- **C.** ηmg
- **D.** $(\eta-1)mg$

Question: 15 of 50 QID: 111 Marks: 4

A mass is suspended from a spring balance that is maintained in a lift. The lift goes up. The readings of the spring balance will indicate in its reading

Please mark (✓) for the correct answer.

- **A.** an increase
- **B.** a change depending on its velocity
- **C.** a decrease
- **D.** no change

Question: 16 of 50 QID: 109 Marks: 4

A body is thrown vertically upwards with a velocity u. Select the incorrect statements from the following.
I. Both velocity and acceleration are zero at its highest point
II. Velocity is maximum and acceleration is zero at the highest point.
III. Velocity is maximum and acceleration is g downwards at its highest point.

Please mark (✓) for the correct answer.

- **A.** I and III
- **B.** II and III
- **C.** I, II and III
- **D.** I and II

Question: 17 of 50 QID: 124 Marks: 4

Two soap bubbles each with radius r_1 and r_2 coalesce in vacuum under isothermal conditions to form a bigger bubble of radius R. Then R is equal to

Please mark (✓) for the correct answer.

- **A.** r_1-r_2
- **B.** $\sqrt{r_1^2 - r_2^2}$
- **C.** $\sqrt{r_1^2 + r_2^2}$
- **D.** $\frac{\sqrt{r_1^2 + r_2^2}}{2}$

Question: 18 of 50 QID: 139 Marks: 4

In household electric circuit
I. all electric appliances drawing power are joined in parallel
II. a switch may be either in series or in parallel with the appliance which it controls
III. if a switch is in parallel with an appliance, it will draw power when the switch is in the 'off' position (open)
IV. if a switch is in parallel with an appliance, the fuse will blow (burn out) when the switch is put 'on' closed.

Which of the above statements are ***correct***?

Please mark (✓) for the correct answer.

- **A.** I, III and IV
- **B.** II, III and IV
- **C.** I and IV
- **D.** I, II and IV

Question: 19 of 50 QID: 125 Marks: 4

A solid ball of metal has a spherical cavity inside it. The ball is heated. The volume of cavity will

Please mark (✓) for the correct answer.

- **A.** increase
- **B.** remain unchanged
- **C.** decrease
- **D.** have its shape changed

Question: 20 of 50 QID: 153 Marks: 4

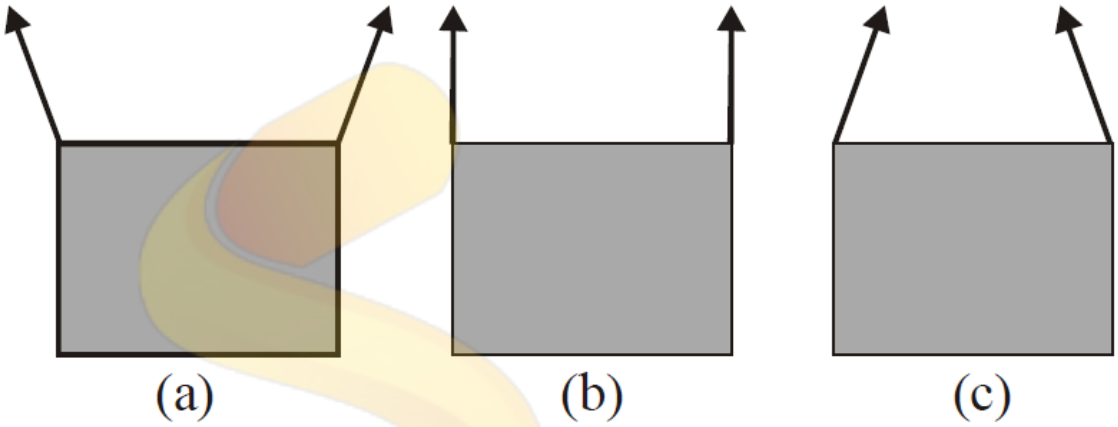
At 0 K temperature, a p-type semiconductor

Please mark (✓) for the correct answer.

- **A.** has equal number of holes and free electrons
- **B.** does not have any charge carriers
- **C.** has few holes and few free electrons
- **D.** has few holes but no free electrons

Question: 21 of 50 QID: 120 Marks: 4

A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports . It can be done in one of the following three ways



The tension in the strings will be

Please mark (✓) for the correct answer.

- **A.** least in (c)
- **B.** least in (b)
- **C.** the same in all cases
- **D.** least in (a)

Question: 22 of 50 QID: 152 Marks: 4

Radioactive nuclei that are injected into a patient collected at certain sites within its body, undergoing radioactive decay and emitting electromagnetic radiation. These radiations can then be recorded by a detector. This procedure provides an important diagnostic tools called

Please mark (✓) for the correct answer.

- **A.** Gamma ray spectroscopy
- **B.** Gamma camera
- **C.** Radiotracer technique
- **D.** CAT scan

Question: 23 of 50 QID: 133 Marks: 4

What type of vibrations are produced in a sitar wire ?

Please mark (✓) for the correct answer.

- **A.** Progressive longitudinal
- **B.** Progressive transverse
- **C.** Stationary transverse
- **D.** Stationary longitudinal

Question: 24 of 50 QID: 149 Marks: 4

What change occurs, if the monochromatic light used in Young's double slit experiment is replaced by white light ?

Please mark (✓) for the correct answer.

- **A.** all the bright fringes are coloured between violet and red.
- **B.** only the central fringe is white and all other fringes are observed coloured.
- **C.** all the bright fringes become white.
- **D.** no fringes are observed.

Question: 25 of 50 QID: 145 Marks: 4

The oscillating electric and magnetic vectors of an electromagnetic wave are oriented along

Please mark (✓) for the correct answer.

- **A.** the same direction and are in phase
- **B.** mutually perpendicular directions and are in phase
- **C.** mutually perpendicular directions and differ in phase by 90°
- **D.** the same direction but differ in phase by 90°

Question: 26 of 50 QID: 118 Marks: 4

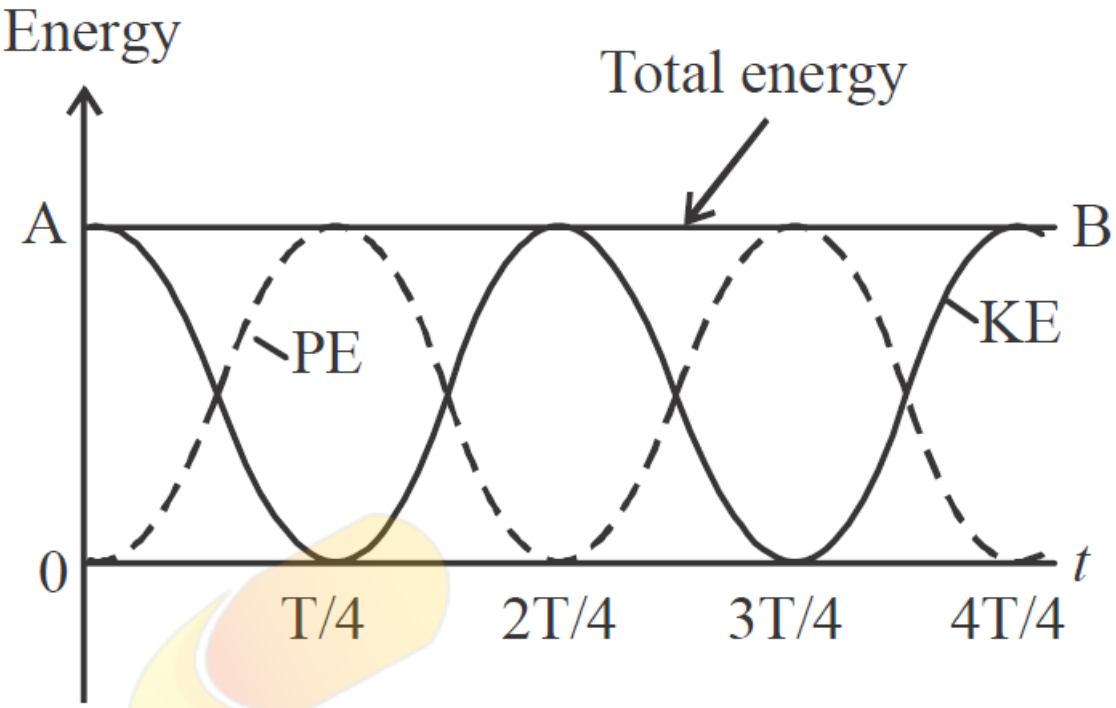
For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is

Please mark (✓) for the correct answer.

- **A.** 2
- **B.** $\sqrt{2}$
- **C.** $\frac{1}{2}$
- **D.** $\frac{1}{\sqrt{2}}$

Question: 27 of 50 QID: 130 Marks: 4

What do you conclude from the graph about the frequency of KE, PE and SHM ?



Please mark (✓) for the correct answer.

- **A.** Frequency of KE and PE is double the frequency of SHM
- **B.** Frequency of KE and PE is four times the frequency SHM.
- **C.** Frequency of KE and PE is equal to the frequency of SHM.
- **D.** Frequency of PE is double the frequency of K.E.

Question: 28 of 50 QID: 116 Marks: 4

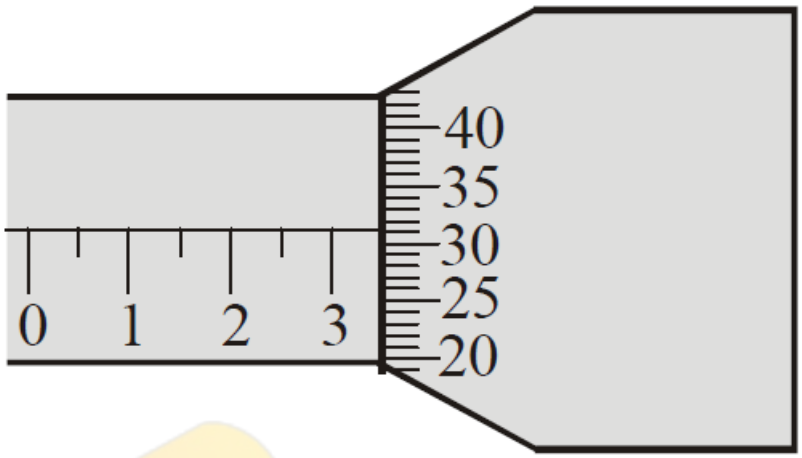
A particle is moving in a circle of radius r under the action of a force $F = ar^2$ which is directed towards centre of the circle. Total mechanical energy (kinetic energy + potential energy) of the particle is (take potential energy = 0 for r = 0)

Please mark (✓) for the correct answer.

- **A.** $\frac{1}{2}ar^3$
- **B.** $\frac{5}{6}ar^3$
- **C.** ar^3
- **D.** $\frac{4}{3}ar^3$

Question: 29 of 50 QID: 105 Marks: 4

A screw gauge is shown in the accompanying diagram. There are a total of fifty divisions in the circular scale and millimetres in the linear scale. When the circular scale completes two full revolutions and the screw moves by 1 mm, the instrument's least count and reding in the figure are, respectively.



Please mark (✓) for the correct answer.

- **A.** 0.02 mm and 3.70 mm
- **B.** 1.0 mm and 5.37 mm
- **C.** 0.01 mm and 3.82 mm
- **D.** 0.11 mm and 4.57 mm

Question: 30 of 50 QID: 146 Marks: 4

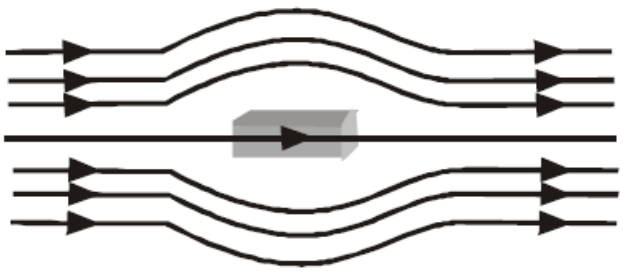
A rod of length 10 cm lies along the principal axis of a concave mirror of focal length 10 cm in such a way that its end closer to the pole is 20 cm away from the mirror. The length of the image is

Please mark (✓) for the correct answer.

- **A.** 5 cm
- **B.** 2.5 cm
- **C.** 10 cm
- **D.** 15 cm

Question: 31 of 50 QID: 142 Marks: 4

The given figure represents a material which is



Please mark (✓) for the correct answer.

- **A.** none of these
- **B.** ferromagnetic
- **C.** paramagnetic
- **D.** diamagnetic

Question: 32 of 50 QID: 154 Marks: 4

Carbon, Silicon and Germanium atoms have four valence electrons each. Their valence and conduction bands are separated by energy band gaps represented by $(E_g)_C$, $(E_g)_{Si}$ and $(E_g)_{Ge}$ respectively.

Which one of the following relationship is ***true*** in their case?

Please mark (✓) for the correct answer.

- **A.** $(E_g)_C < (E_g)_S$
- **B.** $(E_g)_C < (E_g)_{Ge}$
- **C.** $(E_g)_C = (E_g)_S$
- **D.** $(E_g)_C > (E_g)_S$

Question: 33 of 50 QID: 110 Marks: 4

Two equal vectors have a resultant equal toeither of them, then the angle between them will be

Please mark (✓) for the correct answer.

- **A.** 150°
- **B.** 110°
- **C.** 60°
- **D.** 120°

Question: 34 of 50 QID: 150 Marks: 4

Light of wavelength 4000 Å is incident on a metal plate whose work function is 2eV. What is maximum kinetic energy of emitted photoelectron?

Please mark (✓) for the correct answer.

- **A.** 1.1 eV
- **B.** 1.5 eV
- **C.** 2.0 eV
- **D.** 0.5 eV

Question: 35 of 50 QID: 148 Marks: 4

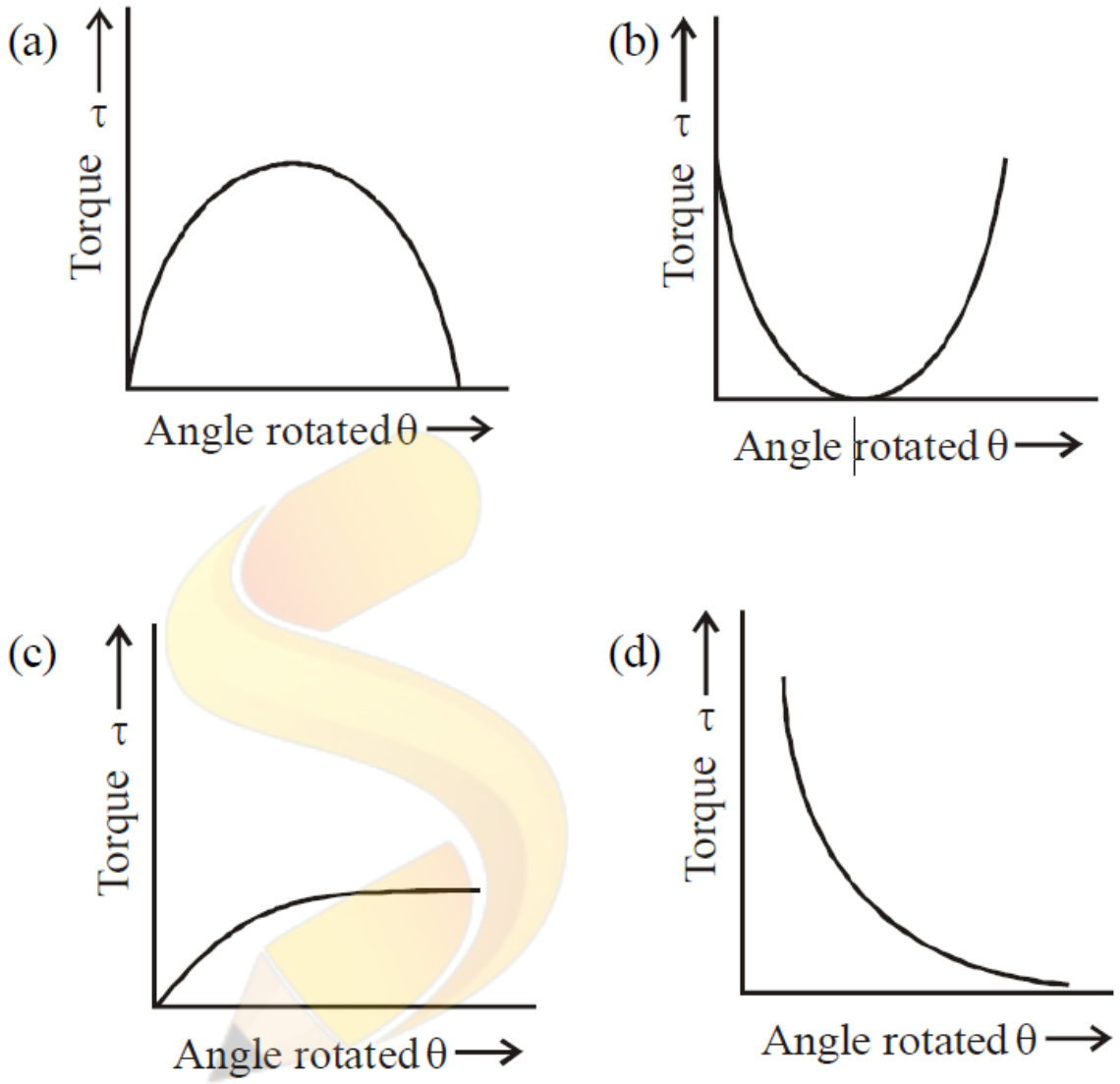
A concave mirror having the focal length 15 cm, forms an image having twice of the linear dimensions of the object. If the image is virtual, then the position of the object will be :

Please mark (✓) for the correct answer.

- **A.** 30 cm
- **B.** 40 cm
- **C.** 7.5 cm
- **D.** 22.5 cm

Question: 36 of 50 QID: 136 Marks: 4

Which of the following graphs shows the correct variation in magnitude of torque on an electric dipole rotated in a uniform electric field from stable equillibrium to unstable equillibrium?



Please mark (✓) for the correct answer.

- **A.** (b)
- **B.** (c)
- **C.** (d)
- **D.** (a)

Question: 37 of 50 QID: 141 Marks: 4

The galvanometer cannot as such be used as an ammeter to measure the value of current in a given circuit. The following reasons are
I. galvanometer gives full scale deflection for a small current.
II. galvanometer has a large resistance.
III. a galvanometer can give inaccurate values.
The correct reasons are:

Please mark (✓) for the correct answer.

- **A.** I, II and III
- **B.** II and III
- **C.** I and III
- **D.** I and II

Question: 38 of 50 QID: 128 Marks: 4

In a diatomic molecules, the rotational energy at a given temperature

Please mark (✓) for the correct answer.

- **A.** equals the translational kinetic energy for each molecule.
- **B.** obeys Maxwell's distribution
- **C.** None of these
- **D.** have the same volue for all molecules

Question: 39 of 50 QID: 126 Marks: 4

Which of the following statements is ***correct*** for any thermodynamic system ?

Please mark (✓) for the correct answer.

- **A.** Internal energy and entropy are state functions
- **B.** The change in entropy can never be zero
- **C.** The internal energy changes in all processes
- **D.** The work done in an adiabatic process is always zero.

Question: 40 of 50 QID: 143 Marks: 4

Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon
I. relative position and orientation of the two coils
II. the materials of the wires of the coils
III. the rates at which currents are changing in the two coils

Which of the above statements is/are ***correct***?

Please mark (✓) for the correct answer.

- **A.** I and III
- **B.** I only
- **C.** II only
- **D.** II and III

Question: 41 of 50 QID: 113 Marks: 4

A conveyor belt is moving at a constant speed of 2m/s. A box is gently dropped on it. The coefficient of friction between them is $\mu = 0.5$. The distance that the box will move relative to belt before coming to rest on it taking $g = 10\ ms^{-2}$, is

Please mark (✓) for the correct answer.

- **A.** 0.6 m
- **B.** zero
- **C.** 1.2 m
- **D.** 0.4 m

Question: 42 of 50 QID: 129 Marks: 4

Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will.

Please mark (✓) for the correct answer.

- **A.** decrease for some and increase for others
- **B.** increase
- **C.** remains the same
- **D.** decrease

Question: 43 of 50 QID: 107 Marks: 4

One centimetre on the main scale of a vernier callipers is divided into 10 equal parts. If 10 divisions of vernier coincide with 8 small divisions of the main scale, the least count of vernier callipers is

Please mark (✓) for the correct answer.

- **A.** 0.05 cm
- **B.** 0.005 cm
- **C.** 0.01 cm
- **D.** 0.02 cm

Question: 44 of 50 QID: 144 Marks: 4

In an LR circuit f = 50 Hz, L = 2H, E = 5 volts, R = 1 Ω then energy stored in inductor is

Please mark (✓) for the correct answer.

- **A.** None of these
- **B.** 100J
- **C.** 50J
- **D.** 25J

Question: 45 of 50 QID: 127 Marks: 4

Choose the ***false*** statement(s) from the following.

I. Specific heat of a substance depends on the mass of substance.
II. Specific heat of substance depends on the temperature of the substance.
III. Specific heat depends on the nature of material.

Please mark (✓) for the correct answer.

- **A.** II only
- **B.** I only
- **C.** I and II
- **D.** I, II and III

Question: 46 of 50 QID: 112 Marks: 4

In a train compartment about to halt at a railway station, a youngster sitting on the top tier throws an apple at a distance of two metres, aiming it reach his brother's open palm, which is vertically below his own. The apple will fall

Please mark (✓) for the correct answer.

- **A.** slightly away from the hand of his brother in the direction of motion of the train
- **B.** slightly away from the hand of his brother opposite to the direction of motion of the train
- **C.** in the hand of his brother
- **D.** None of the above

Question: 47 of 50 QID: 108 Marks: 4

If the capacitance of a nanocapacitor is measured in terms of a unit 'u' made by combining the electric charge 'e', Bohr radius 'a_0', Planck's constant 'h' and speed of light 'c' then

Please mark (✓) for the correct answer.

- **A.** $u = \frac{hc}{e^2 a_o}$
- **B.** $u = \frac{e^2 a_o}{hc}$
- **C.** $u = \frac{e^2 c}{h a_o}$
- **D.** $u = \frac{e^2 h}{a_o}$

Question: 48 of 50 QID: 138 Marks: 4

A parallel plate capacitor is charged and then isolated. What is the effect of increasing the plate separation on charge, potential, capacitance, respectively?

Please mark (✓) for the correct answer.

- **A.** Constant, decreases, increases
- **B.** Constant, decreases, decreases
- **C.** Increases, decreases, decreases
- **D.** Constant, increases, decreases

Question: 49 of 50 QID: 121 Marks: 4

An air bubble of radius 1 cm rises with terminal velocity 0.21 cm/s in liquid column. If the density of liquid is 1.47×10^3 kg/m^3. Then the value of coefficient of viscosity of liquid ignoring the density of air, will be

Please mark (✓) for the correct answer.

- **A.** 1.78×10^4 poise
- **B.** 1.52×10^4 poise
- **C.** 1.82×10^4 poise
- **D.** 1.71×10^4 poise

Question: 50 of 50 QID: 147 Marks: 4

The critical angle for the material of a prism is 45°and its refracting angle is 30°. A monochromatic ray goes out perpendicular to the surface of emergence from the prism. Then the angle of incidence on the prism will be :

Please mark (✓) for the correct answer.

- **A.** 30°
- **B.** 75°
- **C.** 45°
- **D.** 60°

--- END OF QUESTION PAPER ---

Answer Key

No	Question Type	QID	Correct Answer
Question - 1	Multiple Choice (Radiobutton)	117	B
Question - 2	Multiple Choice (Radiobutton)	151	B
Question - 3	Multiple Choice (Radiobutton)	140	D
Question - 4	Multiple Choice (Radiobutton)	132	B
Question - 5	Multiple Choice (Radiobutton)	106	D
Question - 6	Multiple Choice (Radiobutton)	135	A
Question - 7	Multiple Choice (Radiobutton)	119	A
Question - 8	Multiple Choice (Radiobutton)	122	B
Question - 9	Multiple Choice (Radiobutton)	134	C
Question - 10	Multiple Choice (Radiobutton)	115	C
Question - 11	Multiple Choice (Radiobutton)	137	D
Question - 12	Multiple Choice (Radiobutton)	114	C
Question - 13	Multiple Choice (Radiobutton)	131	A
Question - 14	Multiple Choice (Radiobutton)	123	D
Question - 15	Multiple Choice (Radiobutton)	111	A
Question - 16	Multiple Choice (Radiobutton)	109	C
Question - 17	Multiple Choice (Radiobutton)	124	C
Question - 18	Multiple Choice (Radiobutton)	139	A
Question - 19	Multiple Choice (Radiobutton)	125	A
Question - 20	Multiple Choice (Radiobutton)	153	B
Question - 21	Multiple Choice (Radiobutton)	120	B
Question - 22	Multiple Choice (Radiobutton)	152	C
Question - 23	Multiple Choice (Radiobutton)	133	C
Question - 24	Multiple Choice (Radiobutton)	149	B
Question - 25	Multiple Choice (Radiobutton)	145	B
Question - 26	Multiple Choice (Radiobutton)	118	C
Question - 27	Multiple Choice (Radiobutton)	130	A
Question - 28	Multiple Choice (Radiobutton)	116	B
Question - 29	Multiple Choice (Radiobutton)	105	C
Question - 30	Multiple Choice (Radiobutton)	146	A
Question - 31	Multiple Choice (Radiobutton)	142	D
Question - 32	Multiple Choice (Radiobutton)	154	D
Question - 33	Multiple Choice (Radiobutton)	110	D
Question - 34	Multiple Choice (Radiobutton)	150	A
Question - 35	Multiple Choice (Radiobutton)	148	C
Question - 36	Multiple Choice (Radiobutton)	136	D
Question - 37	Multiple Choice (Radiobutton)	141	D
Question - 38	Multiple Choice (Radiobutton)	128	B
Question - 39	Multiple Choice (Radiobutton)	126	A
Question - 40	Multiple Choice (Radiobutton)	143	B
Question - 41	Multiple Choice (Radiobutton)	113	D
Question - 42	Multiple Choice (Radiobutton)	129	C
Question - 43	Multiple Choice (Radiobutton)	107	D

No	Question Type	QID	Correct Answer
Question - 44	Multiple Choice (Radiobutton)	144	A
Question - 45	Multiple Choice (Radiobutton)	127	B
Question - 46	Multiple Choice (Radiobutton)	112	A
Question - 47	Multiple Choice (Radiobutton)	108	B
Question - 48	Multiple Choice (Radiobutton)	138	D
Question - 49	Multiple Choice (Radiobutton)	121	B
Question - 50	Multiple Choice (Radiobutton)	147	C

--- END OF ANSWER KEY ---