Roll No. _____

Code : 112021 PH–A

Please check that this question paper contains 33 questions and 12 printed pages.

CLASS–XI
PHYSICS
ANNUAL EXAM (2020-21)

Time allowed : 3 hours ***Maximum Marks : 70***

General Instructions :

(1) All questions are compulsory. There are 33 questions in all.

(2) This question paper has five sections : Section A, Section B, Section C, Section D and Section E.

(3) Section A contains ten very short answer questions and four Assertion-Reasoning MCQs of 1 mark each, Section B has two case-based questions of 4 marks each. Section C contains nine short answer questions of 2 marks each, Section D contains five short answer questions of 3 marks each and Section E contains three long answer questions of 5 marks each.

(4) There is no overall choice. However, internal choice is provided. You have to attempt only one of the choice in such questions.

(5) Fifteen minutes time has been allotted to read this question paper. During this time you will only read the question paper and will not write anything in the answer script.

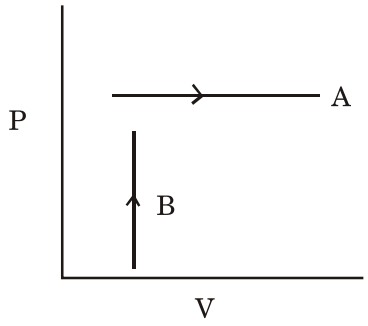
Section-A

1. State the number of significant figures in 0.07800.

2. What is the net force acting on a drop of rain falling down with a constant velocity?

3. Write the value of $\hat{i} \cdot \left(\hat{i} \times \hat{j}\right)$.

4. Two thermodynamic processes, A and B are represented through their P-V diagrams as shown below. Identify these two thermodynamic processes.



OR

Write the value of the specific heat capacity of a gas when it undergoes an isothermal change.

5. Two sound waves are having a phase difference of 60°. Calculate the path difference between these two waves.

OR

Write the expression for the minimum value of d (d = distance between the reflecting surface and the source of sound), in terms of v and Δt, for which a clear echo of the given sound can be heard.

(Here v = velocity of sound in air

Δt = Time for which a given sound can persist on the human ear).

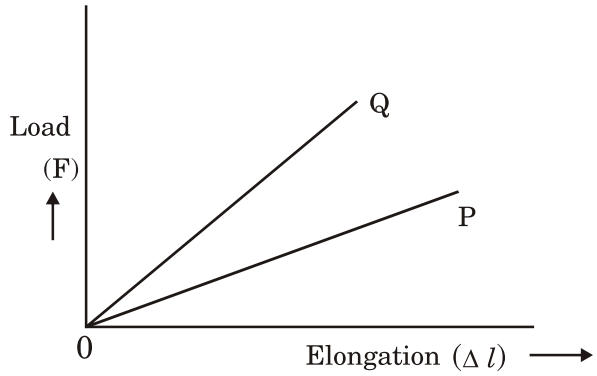
6. State the law of equipartition of energy.

7. A simple harmonic motion is described by $A = -4x$, where A is its instantaneous acceleration and x is its instantaneous displacement. Calculate its time period.

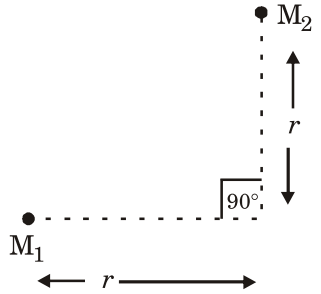
8. Write the value of Young's modulus for an ideal perfectly rigid body.

OR

The load versus elongation graphs for two wires, of the same lengths and made from the same material, are as shown in the figure. Which of these two wires (P or Q) is the thinner of the two ?



9. Write the expression for the gravitational potential energy of the masses M_1 and M_2, kept as shown in the figure.



OR

Define the term gravitational potential for a gravitational field.

10. Why do we prefer to use a screw driver having a long arm ?

For question numbers 11, 12, 13 and 14, two statements are given – one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) & (d) as given below :

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

(b) Both A and R are true but R is NOT the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is false.

11. **Assertion (A) :** The specific heat capacity of a gas at constant pressure is greater than its specific heat capacity at constant volume.

Reason (R) : At constant pressure, some additional heat is needed for doing work due to the expansion of the gas.

12. **Assertion (A) :** The excess pressure, in a bubble (of radius r) of a gas in a liquid is given by $^{2S}/_{r}$ where S is the surface tension of the liquid-gas interface.

Reason (R) : There is only one liquid surface in this case.

13. **Assertion (A) :** Sound waves cannot propagate through vacuum but light waves can.

Reason (R) : Sound waves, unlike light waves, are known to be transverse waves.

14. **Assertion (A) :** The acceleration of a satellite, moving in a circular orbit around the earth, has to be zero.

Reason (R) : The linear velocity ($v = r\omega$) of the satellite remains constant throughout its orbital motion.

Section-B

Questions 15 and 16 are case study based questions and are compulsory. Attempt any 4 sub-parts from each question. Each sub-part carries 1 mark.

15. While playing the game of basketball, an experienced player often uses the concepts of projectile motion. Such a player knows that she/he should properly adjust the angle of projection (θ) of the ball when the ball is released with a certain velocity, u. This adjustment has to be done so that the vertical distance, travelled by the ball, in a time t_0, equals the vertical separation between the basket and the point of projection. Also, in the time t_0, the ball should travel a horizontal distance equal to the horizontal separation between the basket and the point of projection.

(1) For a given speed of projection, the horizontal distance, covered by the ball, has its maximum value when the angle of projection equals :

(a) $45°$ (b) $90°$

(c) $30°$ (d) $60°$

(2) The time, T, taken by the ball to reach the point of maximum height above its point of projection equals :

(a) $\frac{u \sin\theta}{g}$ (b) $u\, g \sin\theta$

(c) $\frac{g \sin\theta}{u}$ (d) $\frac{gu}{\sin\theta}$

(3) For a given speed of projection, the maximum horizontal distance, covered by the ball, is the same when its angle of projection is either :

(a) 45° or 75°

(b) 15° or 75°

(c) 30° or 75°

(d) 60° or 75°

(4) The maximum height H_{max}, reached by the ball equals :

(a) $\frac{u^2 \sin^2 \theta}{2g}$

(b) $\frac{2u^2 \sin^2 \theta}{g}$

(c) $\frac{2u \sin \theta}{g}$

(d) $\frac{u^2 \sin^2 \theta}{2g}$

(5) During its 'flight' after being released by the player, the trajectory of the ball is :

(a) an arc of a circle

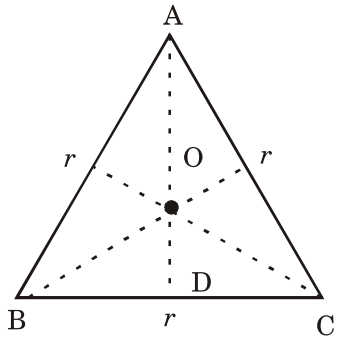
(b) a straight line

(c) a parabolic path

(d) a part of an ellipitical path

16. It is well known that each and every mass produces a gravitatonal field of its own in the surrounding region. The magnitude of this gravitational field, at any point, is taken as a measure of the gravitational intensity (of its gravitational field) at that point.

Consider a system of three identical point masses, each of mass m, located at the three vertices of an equilateral triangle of side r. Each of these three point masses will exert a gravitational force on the other two point masses. The magnitudes and directions of all these forces is given by Newton's law of gravitation.



(1) The magnitude of the net gravitational force, on any one body, due to other two bodies, is equal to :

(a) $\frac{G\,m^2}{r^2}$ (b) $\frac{2G\,m^2}{r^2}$

(c) $\frac{3G\,m^2}{r^2}$ (d) $\frac{\sqrt{3}\,G\,m^2}{r^2}$

(2) The electrical force, between two charged particles can be attractive or repulsive in nature. It is an inverse square force, i.e., it varies as the inverse of the square of the distance between the two charges.

The gravitational force, between two particles :

(a) can also be attractive or repulsive and is also an 'inverse square' force.

(b) is always an attractive force and is also an inverse square force.

(c) is always a repulsive force and is also an inverse square force.

(d) is always an attractive force but it is not an 'inverse square' force.

(3) The work that needs to be done, by an external agency in taking any one of the point masses very very far away from the other two point masses, equals :

(a) $\frac{-Gm^2}{r}$ (b) $\frac{Gm^2}{r}$

(c) $\frac{2Gm^2}{r}$ (d) $\frac{-2Gm^2}{r}$

(4) Magnitude of the net gravitational field (due to all the three masses), at the mid point D of arm BC of triangle ABC, is :

(a) $\frac{Gm^2}{r^2}$ (b) $\frac{Gm}{3r^2}$

(c) $\frac{3Gm}{r^2}$ (d) $\frac{4Gm}{3r^2}$

(5) The S.I. unit of the intensity of gravitational field is :

(a) newton / kilogram (b) kilogram / newton

(c) newton.kilogram (d) newton / $_{(\text{kilogram})^2}$

Section-C

17. '*x*' joule of work is done on a gas to reduce it volume by compressing it. If this change is done under adiabatic condition, calculate the :

(a) change in internal energy of the gas

(b) amount of heat absorbed by the gas

18. Name the physical quantity that corresponds to force for rotational motion. Write the relation of this physical quantity with the moment of inertia of the body on which it acts.

19. A copper vessel of mass 300 g contains 1 kg of water. Calculate the amount of heat needed to raise the temperature of water from 15°C to 85°C.

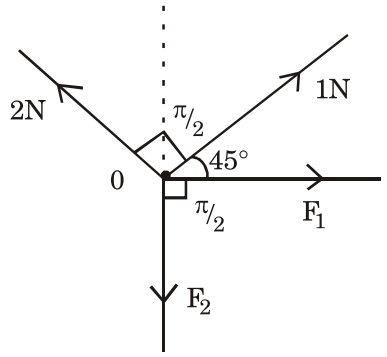
(given : specific heat capacity of water = 4200 J / (kg °C) and specific heat capacity of copper = 378 J/$_{(\text{kg °C})}$.

OR

Determine the temperature at which the root mean square speed of CO_2 gas molecule will be equal to 1 km s^{-1}. (Given that molecular mass of CO_2 = 44)

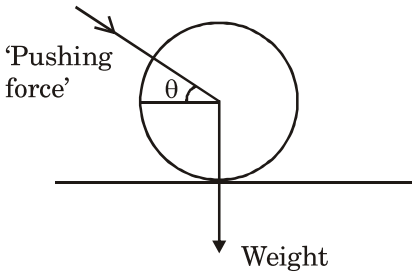
20. A force of 6.4 N stretches a vertical spring by 0.1 m. Find the mass that must be suspended from the spring so that its simple harmonic oscillations have a time period of $\left(\frac{\pi}{4}\right)$ second.

21. Four forces acting at a point mass kept at O, when acting in the way as shown in the figure, keep it in equilibrium. Find the forces F_1 and F_2.

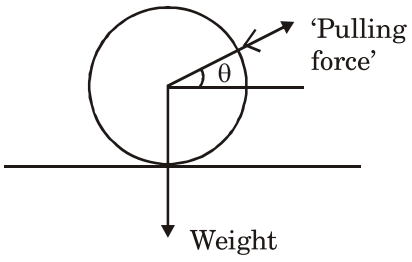


OR

The diagrams (a) and (b), drawn here show a lawn roller being (i) pushed (ii) pulled by applying a force on it. Use these diagrams to justify why 'pulling' is easer than 'pushing'.



(a)



(ii)

22. A body moving with a uniform acceleration describes 12 m in third second of its motion and 20 m in the fifth second. Find the initial velocity and acceleration of the body.

23. Let (C) represent the root mean square speed of molecule in a gas and let (V) the speed of sound waves in that gas. Show that the ratio $\left(\frac{C}{V}\right)$ is constant for a given gas.

24. The rotational kinetic energy of a body is given by $E = \frac{1}{2} I \omega^2$, where ω is the angular velocity and I is the moment of inertia of the body. By using this equation obtain dimensional formula for moment of inertia (I).

OR

Force (F) and displacement (x) are related as

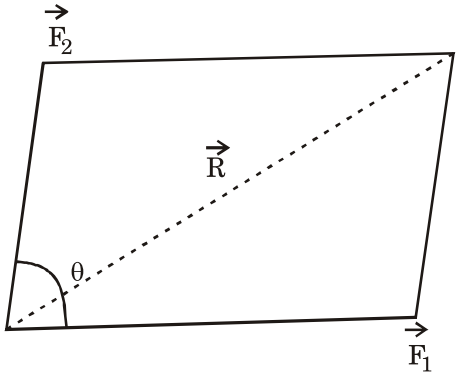
$$F = \frac{\alpha}{\beta + \sqrt{x}}$$

where α and β are dimensional constants. Find dimensions of α and β.

25. Find the value of 'm' for which the vectors $\vec{A} = \left(2\hat{i} + m\hat{j} + \hat{k}\right)$ and $\vec{B} = \left(4\hat{i} - 2\hat{j} - 2\hat{k}\right)$ would be perpendicular to each other.

OR

Use the diagram given here to obtain an expression for the magnitude of the resultant $\vec{R}$ of the forces $\vec{F}_1$ and $\vec{F}_2$.



Section-D

26. A simple harmonic progressive wave of amplitude 1 cm and frequency 100 Hz is travelling along the positive x-direction with a velocity of 15 ms^{-1}. Calculate the :

(a) displacement and

(b) particle velocity

for this wave

at x = 180 cm and t = 5 s.

27. (a) State the law of conservation of angular momentum.

(b) Show that the rate of change of the angular momentum of particle is equal to the torque acting on it.

OR

(a) Three particles, of masses m_1, m_2, m_3 are located at the points (x_1, y_1); (x_2, y_2) (x_3, y_3) in the XY plane.

A net force $\vec{F}$ acts on this system of three particles.

(i) Write the expression for the co-ordinates x and y of the centre of mass of this system.

(ii) Find the acceleration, $\vec{a}$, of the centre of mass of this system.

(b) If $m_1 = m_2 = m_3 = m$ (say), show that the co-ordinates of the centre of mass are just the average of the co-ordinates of the points where the three mass particles are located.

28. The temperatures of equal masses of three different (non interacting) liquids X, Y and Z are 12°C, 19°C and 28°C, respectively. If liquids X and Y were to be mixed, the equilibrium temperature of the mixture would be 16°C. If liquids Y and Z were to be mixed, the equilibrium temperature of the mixture would be 23°C.

Find the ratio of the specific heat capacity of liquid X to that of liquid Z.

29. Show that terminal velocity (V) of a spherical object of radius r, density δ, falling vertically through a viscous fluid of density σ and coefficient of viscosity η is given by $V = \frac{2(\delta - \sigma) r^2 g}{9 \quad \eta}$

OR

(a) Define surface tension.

(b) Obtain an expression for the excess of pressure inside an air bubble in a liquid.

30. (a) State the relation between the 'force of limiting friction' and the 'normal reaction' for two bodies in contact with each other.

(b) Show that the coefficient of static friction equals the tangent of the angle of repose.

Section-E

31. (a) Explain the phenomenon of capillarity. Derive an expression for the rise of liquid in a capillary tube.

(b) What will happen, if the length of the capillary tube is smaller than the height to which the liquid rises ?

OR

(a) State Bernoulli's principle.

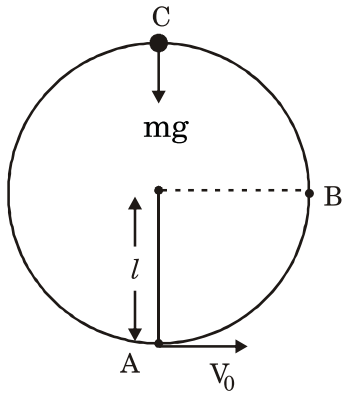
(b) What is likely to happen if an artery of the heart gets constricted due to the accumulation of plaque on its inner walls ?

32. A ball of mass (m) is suspended by a light string of length (l). It is imparted a horizontal velocity (V_0) at the lowest point A, so that it completes its circular trajectory in the vertical plane with the string becoming sleek only on reaching the top most point C. Obtain the expression for :

(a) horizontal velocity, V_0, imparted to the ball at the point A.

(b) the speeds of the ball at point B and C.

(c) the ratio of the kinetic energy of the ball at points B and C.



OR

(a) Define elastic and inelastic collisions.

(b) A body of mass (m) moving with velocity u collides elastically head-on with another identical body of mass (m) initially at rest. Show that the moving body will come at rest as a result of this collision.

33. (a) Obtain an expression for the maximum speed with which a vehicle can safely negotiate a curved road banked at an angle θ. The coefficient of friction between the wheel and the road is μ.

(b) Find the speed at which a car can take turn round a curve of 30 m radius on a level road, if the coefficient of friction between the tyres and the road is 0.4.

OR

(a) Obtain an expression for the acceleration of a body of mass 'm' moving with a uniform speed 'v' in a circular path of radius 'r'.

(b) A stone tied to an end of a string 80 cm long is whirled in a horizontal circle with a constant speed. If the stone makes an 14 revolutions in 25 seconds. Find the magnitude and direction of acceleration of the stone.

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