

Reg. No. :

Name :

IMPROVEMENT / SUPPLEMENTARY EXAMINATION, JANUARY – 2022

Part – III

Time : 2 Hours

PHYSICS

Cool-off time : 20 Minutes

Maximum : 60 Scores

General Instructions to Candidates :

- There is a 'Cool-off time' of 20 minutes in addition to the writing time.
- Use the 'Cool-off time' to get familiar with questions and to plan your answers.
- Read questions carefully before answering.
- Read the instructions carefully.
- Calculations, figures and graphs should be shown in the answer sheet itself.
- Malayalam version of the questions is also provided.
- Give equations wherever necessary.
- Electronic devices except non-programmable calculators are not allowed in the Examination Hall.

വിദ്യാർത്ഥികൾക്കുള്ള പൊതുനിർദ്ദേശങ്ങൾ :

- നിർദ്ദിഷ്ട സമയത്തിന് പുറമെ 20 മിനിറ്റ് 'കൂൾ ഓഫ് ടൈം' ഉണ്ടായിരിക്കും.
- 'കൂൾ ഓഫ് ടൈം' ചോദ്യങ്ങൾ പരിചയപ്പെടാനും ഉത്തരങ്ങൾ ആസൂത്രണം ചെയ്യാനും ഉപയോഗിക്കുക.
- ഉത്തരങ്ങൾ എഴുതുന്നതിന് മുമ്പ് ചോദ്യങ്ങൾ ശ്രദ്ധാപൂർവ്വം വായിക്കണം.
- നിർദ്ദേശങ്ങൾ മുഴുവനും ശ്രദ്ധാപൂർവ്വം വായിക്കണം.
- കണക്ക് കൂട്ടലുകൾ, ചിത്രങ്ങൾ, ഗ്രാഫുകൾ, എന്നിവ ഉത്തരപേപ്പറിൽ തന്നെ ഉണ്ടായിരിക്കണം.
- ചോദ്യങ്ങൾ മലയാളത്തിലും നല്കിയിട്ടുണ്ട്.
- ആവശ്യമുള്ള സ്ഥലത്ത് സമവാക്യങ്ങൾ കൊടുക്കണം.
- പ്രോഗ്രാമുകൾ ചെയ്യാനാകാത്ത കാൽക്കുലേറ്ററുകൾ ഒഴികെയുള്ള ഒരു ഇലക്ട്രോണിക് ഉപകരണവും പരീക്ഷാഹാളിൽ ഉപയോഗിക്കുവാൻ പാടില്ല.

Questions from 1 to 5 carry 1 score each. Answer any THREE questions. (3 × 1 = 3)

1 The study of electric and magnetic phenomena associated with charged and magnetic bodies is named as _____.

- (i) Optics (ii) Electrodynamics
(iii) Thermodynamics (iv) Mechanics

2 Linear velocity (v) is related to angular velocity (ω), through the radius (r) of the circle as

- (i) $\vec{\omega} = \vec{r} \times \vec{v}$ (ii) $\vec{r} = \vec{\omega} \times \vec{v}$
(iii) $\vec{v} = \vec{\omega} \times \vec{r}$ (iv) $\vec{\omega} = (\vec{r})^2 \times \vec{v}$

3. The limiting value of static friction is

- (i) proportional to area of contact
(ii) inversely proportional to area of contact
(iii) proportional to square of area of contact
(iv) independent of area of contact

4. Write the equation for the pressure of an ideal gas based on kinetic theory of gases.

5 Write any two fundamental forces in nature.

Questions from 6 to 16 carries 2 scores each. Answer any FIVE questions. (5 × 2 = 10)

6. Fill in the blanks in the table below :

Quantity	SI Unit	Symbol of SI unit
Time	second
Electric current	A
.....	steradian	sr
.....	mole	mol

7. State whether the following statements are true or false :
- The magnitude of displacement may or may not be equal to the path length traversed by an object.
 - During motion, the magnitude of the displacement may be zero but the corresponding path length is not zero.
8. (a) Select the scalar quantity from the list below :
“linear momentum, angular momentum, power, force”
- (b) Two vectors are said to be equal, only if they have same _____ and _____.
9. An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and completes 7 revolutions in 100 s. What is the linear speed of the motion ?
10. State whether the work done in the following situations are zero, positive or negative :
- Work done by friction
 - Work done by the applied force in lifting an object
 - Work done by centripetal force in circular motion
 - Work done by gravitational force in a freely falling body
11. Prove work – energy theorem for a variable force.
12. State Newton’s law of gravitation.
13. Define the terms : (i) tensile stress and (ii) longitudinal strain.
14. Draw a typical stress – strain curve for a metal and mark the proportional limit.
15. Draw the schematic diagram of a heat engine.
16. Derive an equation for the work done in an isothermal process.

Questions from 17 to 24 carries 3 scores each. Answer any FOUR questions. ($4 \times 3 = 12$)

17. (a) Define average velocity. (2)

(b) Draw the position – time graph of an object moving with constant positive velocity. (1)

18. State Newton's second law of motion and derive the equation $\vec{F} = m \vec{a}$.

19. The angular momentum (\vec{l}) is related to linear momentum (\vec{p}) as $\vec{l} = \vec{r} \times \vec{p}$. Show that the rate of change of angular momentum of a particle is equal to the external torque acting on it.

20. Centripetal force (F) depends on mass (m) of the object, its velocity (v) and radius (R) of the circle. Using the method of dimensions derive an equation for centripetal force.

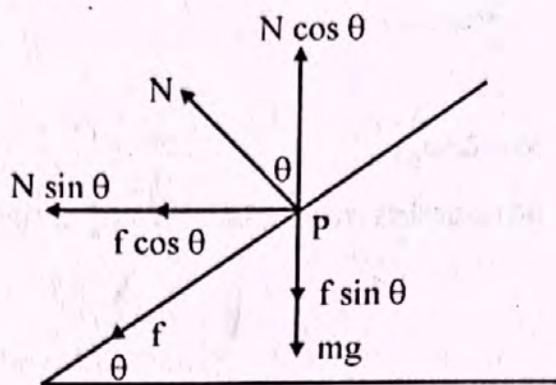
21. In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 Å. Find the approximate location of the centre of mass of the molecule, given that a chlorine atom is about 35.5 times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus.

22. Using kinetic theory of gases, prove that the average kinetic energy of a gas molecule is proportional to the absolute temperature of the gas.

23. Show that acceleration due to gravity at a depth d below the surface of earth is given by

$$g_{(d)} = g \left(1 - \frac{d}{R} \right) \text{ where } g \text{ is the acceleration due to gravity at the surface of earth.}$$

24. The various forces acting on a car (P) on a banked road are shown in the figure.



- (a) Name the forces labelled N and f. (2)
- (b) The sum of the forces _____ and _____ provides the necessary centripetal force for the car. (1)

Questions from 25 to 35 carries 4 scores each. Answer any FIVE questions. ($5 \times 4 = 20$)

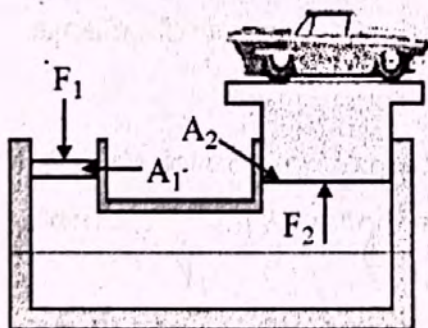
25. (a) What is the shape of the trajectory followed by a projectile? (1)
- (b) Derive an expression for the maximum height attained by a projectile. (3)
26. A cricket ball is thrown at a speed of 28 ms^{-1} in a direction of 30° above the horizontal. Value of acceleration due to gravity at the place is 9.8 ms^{-2} .
- (a) Calculate the time of flight. (2)
- (b) Calculate the horizontal range. (2)
27. (a) State Newton's third law of motion. (1)
- (b) Two billiard balls each of mass 0.05 kg moving in opposite directions with speed 6 ms^{-1} collide and rebound with the same speed. What is the impulse imparted to each ball due to the other? (3)
28. State and prove the law of conservation of mechanical energy in the case of a freely falling object.

29. Power is the time rate at which work is done
- (a) Write an equation for power in terms of force and velocity. (1)
- (b) Power can not be expressed in the unit
- (i) Js^{-1} (ii) horse-power
- (iii) kilowatt hour (iv) watt (1)
- (c) The engine of a bus of mass 5000 kg accelerates the bus from 2 ms^{-1} to 20 ms^{-1} in 120 seconds. Calculate the power expended by the engine. (2)

30. (a) Define escape speed. (1)
- (b) Derive an expression for escape speed. (3)

31. Prove Bernoulli's principle.

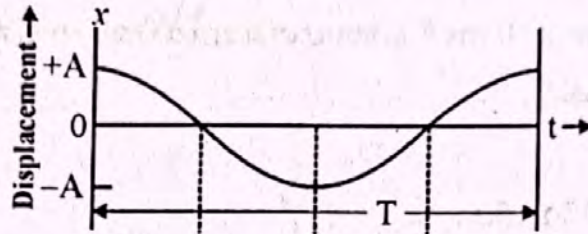
32. The schematic diagram of a machine is shown below.



- (a) Write the name of the machine. (1)
- (b) In the figure, mass of the car 3000 kg. The area of cross-section of the piston carrying the car is 425 cm^2 . What is the pressure on the smaller piston ?
($g = 9.8 \text{ ms}^{-2}$) (3)
33. A transition of matter from any one state to another is called a change of state.
- (a) The temperature at which the solid and the liquid states of a substance are in thermal equilibrium is called its _____ (1)

- (b) "Value of latent heat of a substance depends on its pressure." State whether this statement is true or false. (1)
- (c) 0.3 kg of ice melts completely by absorbing 10^5 J of heat. Calculate heat of fusion of ice. (2)

34. (a) The displacement – time relation of a simple harmonic motion is shown below.



Draw a graph showing the corresponding velocity – time relation. (2)

- (b) What is the length of a simple pendulum, which ticks seconds if value of acceleration due to gravity at the place is 9.8 ms^{-2} ? (2)

35. A harmonic wave of amplitude 'a' and angular frequency ' ω ' travels along positive x direction.

- (a) Write an equation for the displacement of this harmonic wave. (1)
- (b) Show that the ratio of angular frequency to angular wave number $\left(\frac{\omega}{k}\right)$ represents velocity of the wave. (3)

Questions from 36 to 40 carries 5 scores each. Answer any THREE questions. ($3 \times 5 = 15$)

36. "Physical quantities on both sides of an equation must have the same dimensions."

- (a) The above statement is in accordance with the principle of _____. (1)
- (b) Write a vector quantity and a scalar quantity having the same dimensions. (1)
- (c) Check whether the equation $\frac{1}{2}mv^2 = mgh$ is dimensionally correct. Here m is the mass, v the velocity, g the acceleration due to gravity and h is the height. (3)

37. An object is moving with uniform acceleration 'a'.
- (a) Write the equation connecting the velocity of the object with time. (1)
 - (b) Using a suitable velocity – time graph, derive the equation $x = v_0t + \frac{1}{2}at^2$. (4)
38. A car of mass m is taking a circular turn of radius R on a horizontal road. The coefficient of static friction between the tyres and the road is μ .
- (a) Derive an expression for the maximum possible safe speed of the car. (3)
 - (b) Let $\mu = 0.1$ and $R = 20$ m. If the car moves at a speed of 5 ms^{-1} , will the car slip while taking the turn? (2)
39. Moment of inertia depends on mass and distance to the axis of rotation.
- (a) Write the dimensional formula of moment of inertia. (1)
 - (b) State the theorem of perpendicular axes relating to moment of inertia. (2)
 - (c) The moment of inertia of a circular disc of mass M and radius R about an axis perpendicular to it and through its centre is $\frac{MR^2}{2}$. Determine the moment of inertia of the disc about a diameter. (2)
40. Acceleration due to gravity depends on mass and radius of the planet.
- (a) Write an equation for acceleration due to gravity in terms of mass and radius of the planet. (1)
 - (b) A body weighs 63 N on the surface of the earth. What is the gravitational force on it due to the earth at a height equal to half the radius of the earth? (4)