

2017

PHYSICS

( Theory )

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks for the questions

General Instructions :

- (i) All questions are compulsory.
- (ii) Marks for each question are indicated against it.
- (iii) There is no overall choice. However, an internal choice has been provided in two questions of two marks each, two questions of three marks each and two questions of five marks.
- (iv) Use of ordinary calculator is allowed.
- (v) Mobile phones are not allowed in the Examination Hall.
- (vi) Use the following values of physical constants wherever necessary:

Mass of the earth,  $M = 6.00 \times 10^{24}$  kg

Radius of the earth,  $R_e = 6.4 \times 10^6$  m

Acceleration due to gravity,  $g = 9.8$  m/s<sup>2</sup>

Gravitational constant,  $G = 6.673 \times 10^{-11}$  Nm<sup>2</sup>/kg<sup>2</sup>

Universal gas constant,  $R = 8.314$  J/mole/K

Mechanical equivalent of heat,  $J = 4.186$  J/cal

Avogadro number,  $N = 6.022 \times 10^{23}$  /mole

Boltzmann constant,  $k = 1.381 \times 10^{-23}$  J/mole/K

GROUP —A

( Multiple choice type questions )

Choose and write the correct answer in the answer script.

$$\frac{1}{2} \times 8 = 4$$

1. Which of the following physical quantity have the same dimensional formula as work.

 $\frac{1}{2}$ 

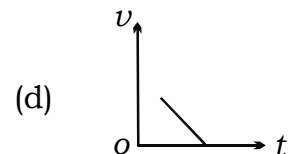
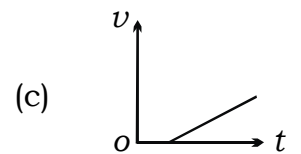
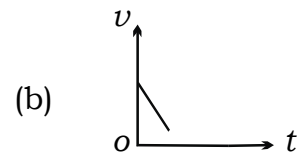
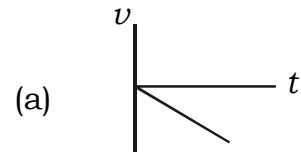
- (a) Power
- (b) Angle
- (c) Torque
- (d) Stress

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2. The number of significant figures in the express 0.0824 is  $\frac{1}{2}$

- (a) 3
- (b) 4
- (c) 5
- (d) 2

3. Velocity – time graph for the motion of a body falling freely under gravity is  $\frac{1}{2}$



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4. The angle between two vectors  $\vec{A} = \hat{i} + 2\hat{j} + \hat{k}$  and  $\vec{B} = -\hat{i} - 2\hat{j} - \hat{k}$  is  $\frac{1}{2}$

- (a)  $0^\circ$
- (b)  $45^\circ$
- (c)  $180^\circ$
- (d)  $90^\circ$

5. If a carpet is beaten with a stick, the fibers of the carpet come in motion and hence move forward, but the dust particles remain at rest and fall down. This is due to  $\frac{1}{2}$

- (a) inertia of motion
- (b) force
- (c) inertia of rest
- (d) inertia of direction.

6. The maximum force of static friction which comes into play before a body just starts to slide is called  $\frac{1}{2}$

- (a) static friction
- (b) limiting friction
- (c) sliding friction
- (d) kinetic friction

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7. The relation between torque, position vector and force is 1/2
- (a)  $\vec{\tau} = \vec{r} \times \vec{F}$
- (b)  $\vec{F} = \vec{r} \times \vec{\tau}$
- (c)  $\vec{r} = \vec{\tau} \times \vec{F}$
- (d)  $\vec{F} = \vec{r} \cdot \vec{F}$
8. A thin wire of mass 1kg and length 2m is bent to form a circular ring. The moment of inertia of this ring about its axis is 1/2
- (a)  $\frac{1}{\pi^2} \text{ kg m}^2$
- (b)  $\frac{\pi^2}{4^2} \text{ kg m}^2$
- (c)  $\frac{3}{\pi^2} \text{ kg m}^2$
- (d)  $\frac{5}{\pi^2} \text{ kg m}^2$

GROUP – B

( Very short answer type questions )

Answer the following questions in a few words / sentences.

$1 \times 8 = 8$

9. Name the weakest and strongest force in nature. 1/2 + 1/2 = 1

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10. Can a body have zero velocity and still be accelerating? Give example. 1/2 + 1/2 = 1
11. What is absolute error in measurement? 1
12. What is impulse? Give its expression. 1/2 + 1/2 = 1
13. What is periodic motion? 1
14. State work-energy theorem. 1
15. What is constructive interference of waves pulse? 1
16. A note produces 4 beats per second with a tuning fork of frequency 512 Hz and 6 beats per second with a tuning fork of 514 Hz. Find the frequency of the note. 1

GROUP — C

( Short answer type –I questions )

Answer the following questions within 30 words each:

$2 \times 8 = 16$

17. A stone tied to the end of string 80 cm is whirled in a horizontal circle with a constant speed. If the stone makes 14 revolution in 25s, what is the magnitude and direction of the acceleration of the stone? 2

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18. Define radius of gyration. Give its expression.  $1 + 1 = 2$
19. A particle moves from position  $(3\hat{i} + 2\hat{j} - 6\hat{k})$  to a position  $(14\hat{i} + 13\hat{j} + 9\hat{k})$  in metres and a constant force  $(4\hat{i} + 2\hat{j} + 3\hat{k})$  newton acts on it. Calculate the work done by the force. 2
20. State Kepler's second and third laws of planetary motion. 2
21. Define, degrees of freedom. Write the perfect gas equation for  $n$  moles of a gas.  $1 + 1 = 2$
- Or
- State two assumptions of kinetic theory of gases.  $1 + 1 = 2$
22. State Bernoulli's theorem. Write its mathematical form.  $1 + 1 = 2$
23. What are isothermal and isobaric processes?  $1 + 1 = 2$
24. A body oscillate with simple harmonic motion according to the following equation  $x = 0.40 \cos (0.70 t - 0.30)$ m  
Find the  $1 + 1 = 2$
- (a) amplitude
- (b) frequency

Or

Draw the graphical representation of kinetic energy and potential energy versus displacement of S.H.M. What is the value of K.E. and P.E. at the extreme positions?

$$1 + \frac{1}{2} + \frac{1}{2} = 2$$

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GROUP — D

( Short answer type – II questions )

Answer the following questions in 30 to 40 words each :

$$3 \times 9 = 27$$

25. Derive the relation between linear speed and angular speed of a body undergoing circular motion. 3
26. (a) State the law of conservation of linear momentum. 1
- (b) A 3.5 kg rifle fires a 10 g bullet with a velocity of  $850 \text{ ms}^{-1}$ . What is the recoil velocity of the rifle? 2
27. (a) Find the expression for the potential energy stored in a spring. 2
- (b) What is coefficient of restitution? 1
28. Derive graphically the relation  $v^2 - v_0^2 = 2aS$  where the symbols have their usual meanings. 3
29. (a) Give one point of difference between heat and temperature.  $\frac{1}{2} + \frac{1}{2} = 1$
- (b) What is the result of mixing of 5 gm of ice at  $-5^\circ\text{C}$  with 10 gm of water at  $20^\circ\text{C}$  (sp. heat of ice is  $0.5 \text{ cal/gm/}^\circ\text{C}$ ) 2

Or

Derive Newton's law of cooling. 2

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30. Show that the centre of mass of a two particle system if their masses are equal in vector form is 3

$$\vec{R}_{C.M.} = \frac{\vec{r}_1 + \vec{r}_2}{2}$$

31. Obtain an expression for orbital velocity of a satellite. Find the expression for its time period when it is orbiting very close to the earth. 2 + 1 = 3

32. (a) What is the change in internal energy of a gas in an isothermal process? 1

- (b) The source temperature of a Carnot engine is 127°C. It takes 500 cal of heat from the source and reject 400 cal to the sink during each cycle. What is the temperature of the sink? 2

33. Derive an expression for the rise of a liquid in a capillary tube. (ascent formula). 3

Or

- State the law of equipartition of energy. Using the concept of kinetic theory of gas, derive the relation between average kinetic energy and temperature of a gas. 1 + 2 = 3

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GROUP — E

( Long Answer type questions )

Answer the following questions in 70 to 80 words each :

5 × 3 = 15

34. An object is projected with a velocity 'V<sub>0</sub>' making an angle 'θ' with the horizontal. Find expression for its (i) time of flight. (ii) Maximum height attained.

Is it possible that for two different angle of projection the horizontal range is same for a given velocity.

2 + 2 + 1 = 5

35. State Pascal's law With the help of a labelled diagram describe the construction and working of a hydraulic brake. 1 + 4 = 5

Or

What is Reynold's number? What is its physical significance. A small sphere falling from rest through a large column of a viscous fluid. Show that the terminal velocity of the sphere is 1 + 1 + 3 = 5

$$v_T = \frac{2}{9} \frac{r^2(\rho - \sigma)g}{\eta}$$

Where  $r$  = radius of the sphere  
 $\rho$  = density of the material of the sphere  
 $\sigma$  = density of the fluid.

- 36.** What is Doppler effect? Derive an expression for the apparent frequency when the source moves away from stationary observer.

A source of sound of frequency 256 Hz is moving rapidly towards a wall with a velocity of 5 m/s. How many beats per second will be heard if sound travels at a speed of 330 m/s.

$$1 + 2 + 2 = 5$$

*Or*

Show that the motion of simple pendulum is simple harmonic. Obtain an expression for its time period.

What is second's pendulum?

$$4 + 1 = 5$$

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