Annual Examination, 2020-2021
PHYSICS

Grade: 11   **Time: 3 Hours**
Date: 07.02.2021   **Max. 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 choices in such questions.
You may use the following values of physical constants wherever necessary:

$c = 3 \times 10^8 \text{ ms}^{-1}$	$h = 6.626 \times 10^{-34} \text{ J s}$
$e = 1.602 \times 10^{-19} \text{ C}$	$K_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$
$N_A = 6.023 \times 10^{23} \text{ mole}^{-1}$	$\mu_O = 4\pi \times 10^{-7} \text{ T m A}^{-1}$
$m_e = 9.1 \times 10^{-31} \text{ kg}$	$m_n = 1.675 \times 10^{-27} \text{ kg}$
Radius of earth = 6400 km	$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$

Section – A
All questions are compulsory. In case of internal choices, attempt any one of them.

1. Can a moving body have relative velocity zero with respect to another body? Give an example .   **1**

2. At which point of the trajectory is the speed of motion minimum?   **1**

(OR)

At what angle of projection the horizontal range will be maximum?

3. Name the physical quantity whose SI unit is kg m s $^{-1}$.   **1**

4. What is angle between frictional force and instantaneous velocity of the body moving over a rough surface?   **1**

(OR)

What is the angle of friction between two surfaces in contact, if coefficient of friction is $\sqrt{3}$?

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5. What is the velocity of center of mass if two identical particles move towards each other with velocity 2v and v respectively? **1**

<div align="center">**(OR)**</div>

Two equal and opposite forces act on a rigid body. Under what conditions will the body (i) rotate (ii) not rotate?

6. Should the value of escape velocity be less or more on the surface of moon as compared to earth? Justify **1**

7. Arrange copper, steel and rubber in the order of increasing coefficient of elasticity. **1**

8. What is the change in internal energy of an ideal gas which is compressed/expanded isothermally? **1**

<div align="center">**(OR)**</div>

Write the expression for the specific heat capacity at constant volume for a monoatomic gas.

9. Water boils at 100^0C and is converted into vapour. Which thermodynamic process involves in this statement? **1**

10. A body oscillates with SHM according to the equation $X = 5 \cos(\pi t + \pi/4)$ m. What is the maximum amplitude of oscillation? **1**

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) and (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 also false

11. **Assertion:** A thermodynamic system performs work without taking heat from an external source. **1**

   Reason: The source of energy of the work is the internal energy of the system.

12. **Assertion:** Two accidents are happened. The first one with water at 100^0C and the second one with steam at 100^0C. The burn due to water at 100^0C is dangerous. **1**

   Reason: Heat content in water at 100^0C is very high compared to steam at 100^0C

13. **Assertion:** There are two springs, one delicate and another stout. The frequency of oscillation will be more for the stout spring.

    1

    Reason: For the delicate spring, extension is greater for the mass m. Hence its period of oscillation is greater and so, its frequency of oscillation is less

14. **Assertion:** Rubber is more elastic than steel

    1

    Reason: Young's modulus of rubber is more than that of steel.

Section – B

Questions 15 and 16 are Case Study based questions and are compulsory. Attempt any 4 sub parts from each question. Each question carries 1 mark.

15. A metal sphere is falling through castor oil as shown in the following figure. As the ball falls through the viscous liquid, its velocity gradually increases and attains terminal velocity

    4

1. The force which is not acting on the metal sphere

(a) elastic   (b) viscous   (c) weight   (d) upthrust

2. Which of the the forces acting on the metal sphere change

(a) weight   (b) viscous   (c) elastic   (d) upthrust

3. At terminal velocity the magnitude of acceleration is

(a) 9.8 m/s^2 (b) 10 m/s^2 (c) 0 m/s^2 (d) none of the above

4. Which of the following statements is correct?

(a) No change in viscous force as velocity remains constant during its fall.

(b) Change in upthrust as velocity is not constant during its fall

(c) Change in viscous force as the velocity is not constant during its fall

(d) No change in upthrust as velocity is constant during its fall.

5. At terminal velocity

(a) Upthrust is balanced by weight of the metal sphere and viscous force

(b) Weight of the metal sphere is balanced by viscous force and upthrust

(c) Viscous force is balanced by weight of the metal sphere and upthrust

(d) Unbalanced force is maximum

16. A car of mass 2000 kg is lifted up a distance of 30 m by a crane A in 1 minute as shown in the figure given below. The second crane B does the same job in 2 minutes. (g = 9.8 m/s^2) **4**

Crane A   Crane B

1. Work done by the

(a) crane A is more than that of B

(b) crane A is less than that of B

(c) crane A is equal to that of B

(d) none of the above

2. Power supplied by crane A is

(a) 9.8 kW   (b) 19.6 kW

(c) 26.8 kW   (d) 99.4 kW

3. Power supplied by crane B is

(a) 1.8 kW   (b) 4.9 kW

(c) 16.4 kW   (d) 29.6 kW

4. If the efficiency of crane A is 55%, its input power is

(a) 7.81 kW   (b) 9.46 kW   (c) 17.82 kW   (d) 72.85 kW

5. The amount of work done to move an object in closed vertical circle on the surface of the earth is zero, because

(a) work done by or against a conservative force depends only on the initial and final positions of the body.

(b) work done by or against a conservative force depends upon the nature of the path between initial and final positions of the body.

(c) work done by or against a conservative force in a round trip is not equal to zero

(d) work done by a conservative force is not completely recoverable.

SECTION – C

All questions are compulsory. In case of internal choices, attempt anyone.

17. Check the correctness of the relation: **2**

$$F = \frac{mV^2}{r},$$

where F – force , v – velocity and r – radius of the circle

18. Show that vectors $\bar{F} = \hat{\imath} - 5\hat{\jmath}$ and $\bar{r} = 2\hat{\imath} - 10\hat{\jmath}$ are parallel to each other.   **2**

(OR)

Two cricket balls are colliding each other. Name the collision. Does the law of conservation of energy hold good in this case? Give reason for your answer.

19. Calculate the mean free path of molecule, if number of molecules per cm³ is   **2**
3 x 10¹⁹ and diameter of each molecule is 2 x 10⁻¹⁰ m.

(OR)

Consider a cubical box of side l which contains N molecules, each of mass m, all moving horizontally with speed, u at right angles to one of the walls. When a molecule hits a wall, it bounces off with no loss of speed and travels in the opposite direction. Deduce

(i) the momentum of a molecule just before a collision with the wall

(ii) the change in momentum of a molecule when it collides with the wall.

(iii) the time taken by one molecule between collisions with wall.

20. The terminal velocity of a copper ball of radius 2.0 mm falling through a tank of oil **2** at 20°C is 6.5 cm s^{-1}. Compute the viscosity of the oil at 20°C. Density of oil is 1.5 ×10^3 kg m^{-3}, density of copper is 8.9 × 10^3 kg m^{-3}.

21. Give reason for the following: **2**

    (a) Soap helps in cleaning the clothes.

    (b) The field is ploughed before sowing.

22. Two vessels made of two different metals are identical in all respects. They are **2** completely filled with ice at 0°C. The ice in one is melted in 30 minutes and another in 10 minutes by heat coming from outside. Compare the thermal conductivities of metals.

23. A grindstone has moment of inertia of 6 kgm^2 about its axis. A constant torque is **2** applied and the grindstone is found to acquire an angular speed of 5 π rad / s in 10 seconds after starting from rest. Calculate torque.

24. Show that the total angular momentum of a rotating system remains constant if no **2** torque acts on the system

(OR)

A disk of moment of inertial I$_1$ is rotating freely with angular speed ω$_1$. A second non – rotating disk with moment of inertia I$_2$ is dropped on it as shown in the figure. The two then rotates as one unit. Find the angular speed of the system.
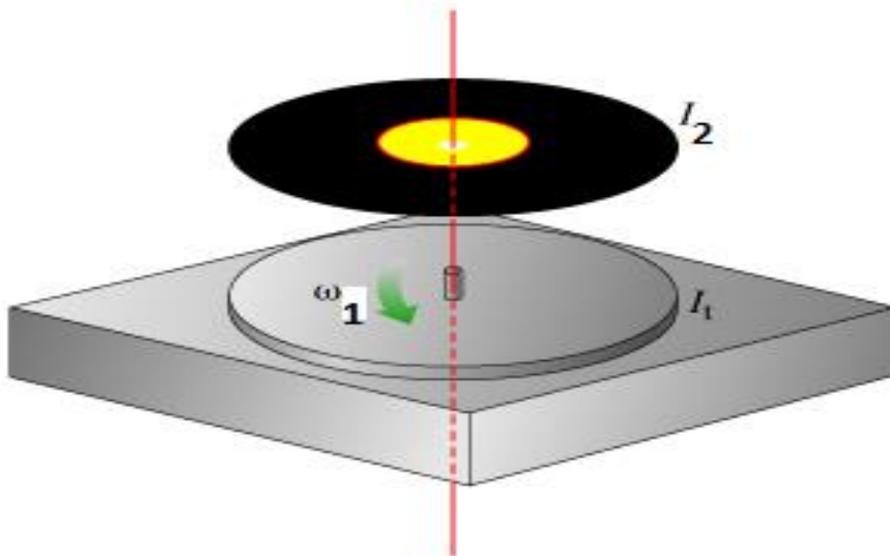
25. The difference between C_p and C_v is always a constant. Give a mathematical proof. **2**

<div align="center">

(OR)

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A sample of hydrogen gas of mass 6 g is allowed to expand isothermally at 27^0C till its volume doubled.

(a) Calculate the number of moles.

(b) What is the final temperature of the H_2 ?

<div align="center">

Section -D

All questions are compulsory. In case of internal choices, attempt any one.

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26. Derive Stoke's law formula for the viscous force acting on a spherical ball moving through a viscous fluid. The viscous force F acting on the sphere depends on **3**

(i) η, the viscosity of the liquid

(ii) r, the radius of the sphere

(iii) v, the velocity of the sphere. (given K = 6 π)

27. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string. A horizontal force F = 600 N is applied to (i) A, (ii) B along the direction of string. What is the tension in the string in each case? **3**

<div align="center">

(OR)

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Two blocks 8 kg and 12 kg are connected at the two ends of a light inextensible string that goes over a frictionless pulley. Find the acceleration of the blocks, and the tension in the string when the blocks are released.

28. A nucleus is at rest. All of a sudden it splits into two small nuclei. What is the angle at which these two nuclei fly apart? **3**

<div align="center">

(OR)

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Show that angle of repose is equal to the angle of friction using a labelled diagram

29. The velocity time graph represents the journey of a train P travelling along a **3** straight horizontal track between two stations which are 1.5 km apart. The train P leaves the first station, accelerating uniformly from rest for 300 m until it reaches a speed of 30 m/s. The train then maintains this speed for T sec before decelerating uniformly at 1.25 m/s², coming to rest at the next station.
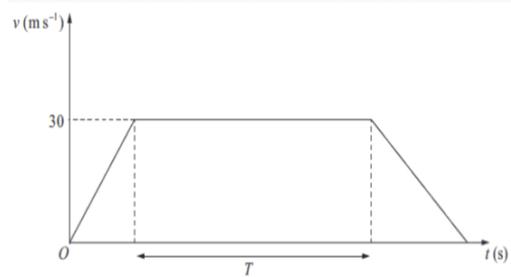
1. Find the acceleration of P during the first 300 m of its journey.

2. Find the value of T

30. The speed of a wave along a stretched string depends only on the tension and **3** linear mass density of the string and does not depend on the frequency of the wave.

(a) Give the equation of speed of transverse wave along a stretched string.

(b) Why the speed does not depend on the frequency of the wave?

(c) A steel of wire 0.72 m long has a mass of 5×10^{-3} kg. If the wire is under a tension 60 N , what is the speed of transverse wave on the wire?

Section – E

All questions are compulsory. In case of internal choices, attempt any one.

31. (a) Derive an expression for (i) displacement (ii) velocity and (iii) acceleration of a **5** particle executing Simple harmonic motion.

(b) The displacement in mm of a harmonic oscillator is represented by $X = 0.25 \cos(6280t - \pi/3)$, where t is in second. Find the (i) initial phase in radian (ii) frequency in Hz

(OR)

(a) Is oscillation of a mass suspended by a spring simple harmonic?

(b) Write the expression for the period of oscillation of the spring

(c) Two springs of unequal length and of same material are loaded with same load, which one will have large value of time period? Give reason for your answer.

(d) Write the condition for simple harmonic motion.

32. (a) Obtain an expression for acceleration due to gravity at a certain height h above **5** the surface of the earth using a labelled diagram

(b) At what height above the earth's surface the value of g is the same as in a mine 100 km deep.

(OR)

(a) Obtain an expression for escape velocity

(b) An elephant and an ant are to be projected from earth into space. Whether the velocity is same or different in doing so? Justify your answer.

33. (a) A particle is projected with a velocity u in a direction making an angle θ with the horizontal. Find (i) the maximum height (ii) time of flight. **5**

(b) Prove that the time of flight T and the horizontal range R of a projectile are connected by the equation $g\,T^2 = 2\,R\tan\theta$.

(OR)

A stone tied to the end of a string is whirled in a horizontal circle with constant speed

(a) What is the direction of velocity of the stone at any instant?

(b) Give the direction of acceleration of the stone at any instant.

(c) What is the angle between velocity vector and acceleration vector in uniform circular motion?

(d) Draw a figure which shows the direction of acceleration (change in velocity of the stone)

(e) Name the force that provides centripetal force when earth revolving around the sun.