

Roll No. \_\_\_\_\_

Code : 11201819PH-A

Please check that this question paper contains 27 questions and 8 printed pages.

**Class : XI**  
**PHYSICS (THEORY)**

Time Allowed : 3 Hours

Maximum Marks : 70

**General Instructions :**

1. All the questions are compulsory. There are 27 questions in all.
2. The question paper has four sections : Section A, Section B, Section C and Section D.
3. Section A (Q. No. 1 to 5) has five questions of one mark each.  
Section B (Q. No. 6 to 12) has seven questions of two marks each.  
Section C (Q. No. 13 to 24) has twelve questions of three marks each.  
Section D (Q. No. 25 to 27) has three questions of five marks each.
4. There is no overall choice. However an internal choice has been provided in two questions of one mark each, two questions of two marks each, four questions of three marks each and all the three questions of five marks weightage. You have to attempt only one of the choices in these questions.
5. Fifteen minutes time has been allotted to read this question paper. During this time, the students will only read the question paper and will not write any answer on the answer script.

**SECTION - A**

1. The length of a string tied to two rigid support is L. Write the value of the maximum wavelength of stationary waves that can be produced in it. 1
2. State the condition (in terms of scalar / vector products) under which two vectors : 1
  - (i)  $\vec{A}$  and  $\vec{B}$ , are parallel to each other.
  - (ii)  $\vec{P}$  and  $\vec{Q}$  are perpendicular to each other.
3. Two circular discs of same mass and same radius are shaped like a convex and a concave lens, respectively. If both are rotated about an axis perpendicular to their planes and passing through their centres, which one will have a greater moment of inertia? Give reason.

**OR**

For a planet orbiting the Sun in a (nearly) circular orbit, give the magnitude of the torque acting on the planet due to the (gravitational) force exerted on it by the Sun. Give reason for your answer. 1

4. Write the SI unit for the universal gravitational constant (G). 1

5. State the reason for the reddish appearance of the Sun at sunrise.

**OR**

State the reason for keeping the refractive index of the core of an optical fibre more than the refractive index of its cladding. 1

**SECTION - B**

6. A given container, maintained at a temperature T, has three types of molecules : A, B and C with masses  $m_A > m_B > m_C$ . 2

Compare the

(a) average kinetic energy

(b) rms speed

of the three types of molecules.

7. A physical quantity P, depends on four observables a, b, c and d as per the relation : 2

$$P = \frac{a^3 b^2}{(\sqrt{c})d}$$

If the percentage errors, in the measurements of a, b, c and d, are w%, x%, y% and z%, respectively, obtain the formula for the percentage error in the quantity P.

8. An object 2 cm high is placed at a distance of 10 cm from a concave mirror of radius of curvature 40 cm. Find the position and the size of the image formed. 2

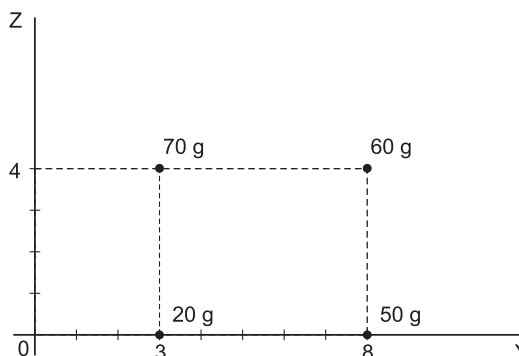
9. A projectile, of mass 50g is projected with a velocity of  $10 \text{ ms}^{-1}$  from the ground at an angle of  $45^\circ$  with the horizontal. Find the magnitude of the change in its momentum between 'leaving' and 'arriving back' to the ground.

OR

Show that a given gun will shoot three times as high when elevated at an angle of  $60^\circ$  as compared with firing at an angle of  $30^\circ$ .

2

10. Find the co-ordinates of the centre of mass of a system of four particles, located as shown in the  $(y, z)$  plane



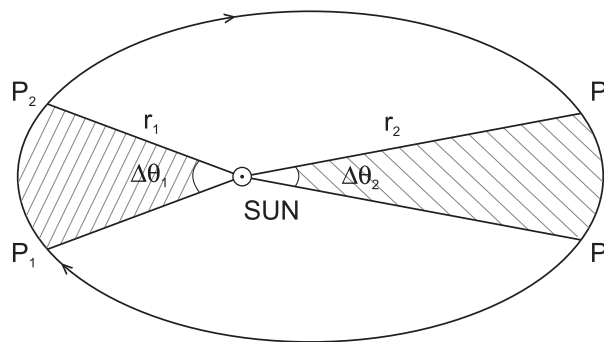
2

11. The acceleration due to gravity, at a depth  $d$  below the surface of the earth, equals  $g_d$ . Obtain the formula for the ratio  $(g_d/g_e)$  where  $g_e$  is the acceleration due to gravity on the surface of the earth.

OR

A given planet takes the same time (say,  $\Delta t$ ), in going from point  $P_1$  to point  $P_2$  in its orbit, as it takes in going from point  $P_3$  to  $P_4$ .

Find the (approximate) value of the ratio  $\left(\frac{r_1}{r_2}\right)$  in terms of  $\Delta\theta_1$  and  $\Delta\theta_2$ .



2

12. The speed of a particle of mass  $m$ , moving in a circle of radius  $r$ , is changing at a constant rate  $a_T \text{ ms}^{-2}$ .

Write the expression for the magnitude of its instantaneous resultant acceleration.

Can we say that the direction of this instantaneous resultant acceleration would be along the instantaneous (inward) radial direction?

2

### SECTION - C

13. Derive the expression for the rise of liquid in capillary tube. Hence show that the height of the liquid column supported is inversely proportional to the radius of the capillary tube.

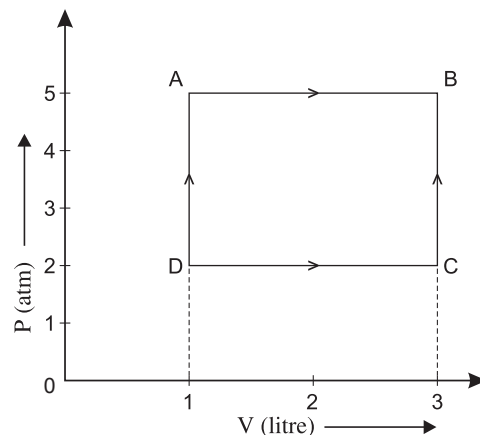
OR

A rectangular iron bar (coefficient of thermal conductivity =  $K_1$ ) and a rectangular brass bar (coefficient of thermal conductivity =  $K_2$ ) are soldered end to end. The length of the iron bar is double that of the brass bar while its area of cross section is half that of the brass bar.

If the free ends of the iron bar and the brass bar are maintained at temperatures of  $T_1$  and  $T_2$ , respectively, obtain an expression for the (equilibrium) temperature of the junction of the two bars. 3

14. Define the term 'escape speed'. Obtain an expression for the 'escape speed' of an object for a planet of mass  $M$  and radius  $R$ . 3
15. (a) Draw a labelled ray diagram for a (refracting type) astronomical telescope kept in its normal adjustment position.
- (b) Give two advantages of reflecting type of (astronomical) telescopes over refracting type of such telescopes. 3

16. One mole of an ideal gas undergoes a cyclic change ABCD where the  $(P, V)$  co-ordinates are  $A(5, 1)$ ,  $B(5, 3)$ ,  $C(2, 3)$  and  $D(2, 1)$ . The 'units' of  $P$  and  $V$  are as indicated in the diagram. Calculate the work done along each of the segments  $AB$ ,  $BC$ ,  $CD$  and  $DA$ . Also find the net work done in the process. (Given  $1 \text{ atm} = 1.01 \times 10^5 \text{ Nm}^{-2}$ )



3

17. A particle is executing simple harmonic motion. Write the equation for the instantaneous displacement ( $x$ ) of this particle from the origin.

Use this equation to obtain the relations between the (i) instantaneous velocity ( $v$ ) and (ii) instantaneous acceleration( $a$ ), in terms of the instantaneous displacement( $x$ ) of the particle.

**OR**

When do we observe the phenomenon of beats?

A given sitar string is observed to produce beats when sounded with a given standard source of frequency 'N'. It is given that 'N' is greater than the frequency of the note being produced by the sitar string.

The tension of this sitar string is slightly increased.

Will the beat frequency increase or decrease? Justify your answer.

3

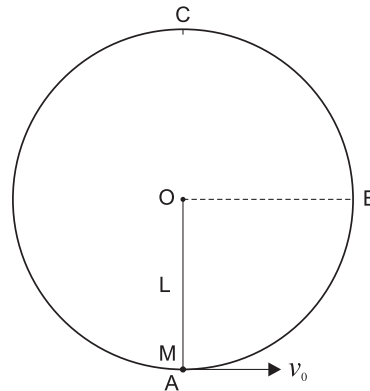
18. Define the term 'spring constant' for an ideal spring. Write its SI unit.

A block, attached to a spring, rests on a smooth horizontal surface.

Find the work done (i) by the spring force and (ii) by the external force when the block is moved from an initial displacement  $x_i$  to a final displacement  $x_f$  (from its equilibrium position).

**OR**

A bob 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, such that it completes a semicircular trajectory in the vertical plane with the string becoming slack only on reaching the topmost point C. Obtain an expression for  $v_0$  in terms of L.



3

19. (a) A body is moving along a straight line with a uniform negative acceleration. Draw the shape of its displacement vs time graph.

(b) The displacement of a body is given to be proportional to the cube of time elapsed. How does the acceleration of this body change with time? 3

20. For a thermodynamic system, define the terms :

(i) isothermal process

(ii) isochoric process

(iii) isobaric process

(iv) adiabatic process

In which of these processes is the work done by the gas zero and why?

**OR**

Write (any one) statement of the second law of thermodynamics.

Draw a diagram showing the schematic representation of a heat engine.

Write the formula for the efficiency of a heat engine. 3

21. State the law of equipartition of energy. Use it to obtain the value of  $\gamma (= C_p/C_v)$  for a monoatomic gas. 3

22. An object of mass  $M$ , moving with a velocity  $V$ , makes a head-on elastic collision with a body of mass  $m$ , initially at rest. After the collision, the velocity of the object of mass  $M$ , along its original direction, equals  $V/n$ . 3

Obtain an expression for the ratio  $m/M$ .

23. The equation of a plane progressive wave is  $y = 10 \sin 2\pi (t - 0.005x)$  where  $y$  and  $x$  are in cm and  $t$  is in seconds. Find the amplitude, frequency, wavelength and velocity of this wave. 3

24. The engine of a car, moving with a speed of  $36 \text{ kmh}^{-1}$ , is switched off as it reaches an inclined road, inclined at  $30^\circ$  with the horizontal. If the coefficient of friction, between the road surface and the wheels of the car is  $1/\sqrt{3}$ , find the distance travelled by the car on this inclined road before it comes to rest. 3  
(Take  $g = 10 \text{ ms}^{-2}$ )

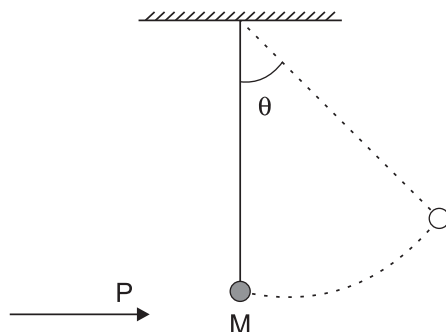
## SECTION - D

25. When is a particle (in mechanics) said to be in a state of (translational) equilibrium?

Why do we say that a particle, in equilibrium, need not necessarily be at rest?

A particle of mass  $M$ , is suspended vertically from an inextensible light string of length  $L$ . When a horizontal force  $P$  acts on the particle, it comes to equilibrium with the string inclined at an angle  $\theta$  to its original position.

Obtain the expression for  $\theta$ .



OR

A vehicle is moving on a circular road of radius  $R$  that has been banked at an angle  $\theta$ .

Obtain a formula for the maximum safe speed of the car. It is given that the coefficient of static friction, between the car wheels and the road, is  $\mu_s$ .

Draw a graph, showing the dependence of the maximum (safe) speed on  $\sqrt{\tan\theta}$ , when  $\mu_s = 0$ .

5

26. A point object  $O$ , lies on the principle axis of a convex spherical surface, of radius of curvature  $R$ . This surface separates a rarer medium of refractive index  $\mu_1$  from a denser medium of refractive index  $\mu_2$ . The point object (at distance  $u$ ) is so placed that its real image gets formed in the denser medium (at a distance  $v$ ). Derive the relation between the refractive indices, object distance, image distance and radius of curvature of spherical surface.

OR

Define the term 'angle of deviation' for a ray of light incident on an equilateral prism of angle  $A$ .

Draw a graph showing the dependence of the angle of deviation on the angle of incidence.

Use the relevant ray diagram to obtain a formula for the refractive index of the material of an equilateral prism in terms of the angle ( $A$ ) of the prism and the angle ( $\delta_m$ ) of minimum deviation.

5

27. Prove that the sum of the 'pressure head', 'velocity head' and the 'gravitational head' remains constant during the stream line flow of an ideal liquid.

**OR**

- (a) Define Young's modulus of elasticity. Give its unit and dimensions.
- (b) With the help of stress vs strain graph, depict the changes that happen when a load on a metal wire, suspended from a rigid support, is gradually increased. Mark the different regions of the graph.

5



Roll No. \_\_\_\_\_

Code : 11-201718PY-A

Please check that this question paper contains **26** questions and **7** printed pages.

**CLASS–XI**  
**SUBJECT–PHYSICS (THEORY)**

**Time allowed : 3 Hrs.**

**M.Marks : 70**

***General Instructions :***

1. *All questions are compulsory. There are 26 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 five questions of one mark each. Section B contains five questions of two marks each. Section C contains twelve questions of three marks each. Section D contains one value based question of four marks and Section E contains three questions of five marks each.*
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**Section-A**

1. Write the name of the SI unit of 'luminous intensity'.
2. A body is initially at rest. It undergoes one-dimensional motion with a constant acceleration. How does its displacement(s) depend on time (t) ?

3. Say 'yes' or 'no' :
- (i) Average speed of an object always equals the magnitude of its average velocity.
  - (ii) Instantaneous speed of an object always equals the magnitude of its instantaneous velocity.
4. A box contains equal number of molecules of hydrogen and oxygen. If there is a fine hole in the box, which gas will leak out more rapidly ?
5. From the following three, name the factor/factors on which the average kinetic energy of a gas molecule depends :

nature of gas, temperature, volume

### **Section-B**

6. The escape velocity 'v' of a body depends upon (i) the acceleration due to gravity (g) of the planet and (ii) the radius (R) of the planet.  
Use the method of dimensions to obtain a relation between v, g and R.
7. Derive an expression for the variation of acceleration due to gravity with height 'h' from the surface of the earth.
8. (a) Write the mathematical form of the first law of thermodynamics.  
(b) Hence obtain its corresponding forms for an
- (i) adiabatic process
  - (ii) isothermal process

**OR**

- (a) State the zeroth law of thermodynamics.

- (b) For two systems in thermal equilibrium, name the physical quantity that :
- (i) has the same value for the two systems
  - (ii) does not get exchanged between the two systems.
9. The lower face of an aluminium cube, of side 10 cm, is riveted to the floor. A shearing force of 1000 N is applied on the upper face. Given that the shear modulus of aluminium is  $25 \times 10^9 \text{ N m}^{-2}$ , find the displacement of the upper edge of the cube.
10. Which of the following examples represent (nearly) simple harmonic motion and which represent periodic, but not simple harmonic, motion?
- (i) The rotation of earth about its axis.
  - (ii) Motion of an oscillating mercury column in a u-tube.
  - (iii) Motion of a ball bearing inside a smooth curved bowl, when released from a point slightly above the lower most point.
  - (iv) General vibrations of a polyatomic molecule about its equilibrium position.

### **Section-C**

11. A ball, initially at rest, is released from the top of a tower of height 27 metres. It takes "T" seconds to reach the ground. Find the height of the ball, above the ground, at  $t = \frac{T}{3}$ .
12. A projectile is thrown upward at an angle  $\theta$  with the horizontal, with an initial velocity  $u$ . Obtain the equation of its trajectory and state its nature.

13. Draw the following graphs for the motion of a object (initially at rest) under 'free fall'. Neglect air resistance.

(i) Variation of position with respect to time

(ii) Variation of velocity with respect to time

(iii) Variation of acceleration with respect to time.

14. Why does a cyclist lean inwards while negotiating a curve ? Explain with a diagram.

Obtain an expression for the angle which a cyclist will have to make with the vertical (for 'safe' negotiation), while taking a circular turn.

**OR**

Two masses  $M$  and  $m$  ( $M > m$ ) are connected at the two ends of an inextensible string. The string passes over a smooth frictionless pulley. Obtain the acceleration of the masses and the tension in the string.

15. A helicopter, of mass 1000 kg, rises with a vertical acceleration of  $15 \text{ ms}^{-2}$ . The crew and the passengers weigh 300 kg. Give the magnitude and direction of :

(i) force on the floor by the crew and passengers.

(ii) action of the rotor of the helicopter on the surrounding air.

(Take  $g \cong 10 \text{ ms}^{-2}$ )

16. (a) State theorem of parallel axes for the moment of inertia of a body.

(b) Determine the moment of inertia of a thin ring (of mass  $m$  and radius  $r$ ) about a tangential axis in the plane of the ring.

17. A circular ring of radius 2 m weighs 100 kg. It rolls along a horizontal floor so that its centre of mass has a speed of  $20 \text{ cm s}^{-1}$ . How much work has to be done to stop it ?

18. Define the term : 'gravitational potential energy of a body'.

Obtain an expression for it, for a body of mass 'm' lying at distance 'r' ( $r > R$  where  $R =$  radius of earth) from the centre of the earth.

19. Why do we say that there is always an excess pressure on the concave side of the meniscus of a liquid.

Obtain the expression for the excess pressure inside a liquid drop.

20. With the help of a block diagram, write the working principle of a refrigerator and obtain the expression for its coefficient of performance.

21. A given vessel contains two non-reacting gases : neon (mono atomic) and oxygen (diatomic). The ratio of their partial pressures is 3 : 2. Estimate the ratio of (i) number of molecules and (ii) mass of neon and oxygen in the vessel.

Atomic mass of Neon = 20.2 units                      molecular mass of  $\text{O}_2 = 32.0$  units

22. State the effect of (i) change of pressure only (ii) change of density only and (iii) change of temperature only on the speed of sound. Justify your answers.

### Section-D

23. Ravi was very interested in athletics, specially in Javelin throw. He used to watch it on television and imagined himself playing the same. His friends encouraged him to do practice in the fields instead of just dreaming. He started practising daily but his range of throwing didn't increase much. He then approached his PTI who patiently listened to his problem. He advised Ravi that he should aim to throw the javelin at an angle of  $45^\circ$  with the horizontal. Ravi did the same and his range of throw started improving day by day. He soon started participating in competitions.

- (i) State the values shown by Ravi and his PTI.
- (ii) Why did the PTI advise Ravi to throw the javelin at an angle of  $45^\circ$  with the horizontal direction ?

### Section-E

24. (a) Prove that the magnitude of the ratio of the difference in speeds after collision, to the difference in speeds before collision, for a one-dimensional elastic collision, equal to one.
- (b) A particle of mass  $m$  is moving in a horizontal circle of radius  $r$ , under a centripetal force equal to  $\left(\frac{-k}{r^2}\right)$ , where  $k$  is a constant. Obtain the expression for the total energy of the particle.

**OR**

- (a) One end of a block (of mass  $m$ ), resting on a smooth horizontal surface, is attached to one end of an ideal spring. The other end of this spring is attached to a rigid wall.

Find an expression for the work done by the spring force if the block is moved from an initial displacement  $x_i$  to a final displacement  $x_f$ .  
Hence show that this spring force is conservative in nature.

- (b) The above block is extended from the 'equilibrium position' through a distance  $x_m$  and then released from rest. Find the maximum speed of the block.

25. Name and prove the principle which states :

“When a liquid is in a streamline flow through a pipe of non-uniform cross section, the sum of its kinetic energy, potential energy and pressure energy per unit volume remain constant”.

Write any two of its applications.

**OR**

The oil rises in the wick through the narrow spaces between the threads of the wick. Name the phenomenon associated.

Derive an expression for the rise of liquid in a narrow tube and show that the height of the liquid column supported is inversely proportional to the density of liquid and radius of the tube.

26. Explain Doppler effect in sound. Obtain an expression for apparent frequency of sound when source and observer are :

- (a) both approaching each other  
(b) both moving away from each other

**OR**

State the condition for the formation of stationary waves.

Obtain an expression for the stationary waves formed by two sinusoidal waves travelling along the same path in opposite directions. Obtain the positions of the nodes and the antinodes.

□□□

Roll No. \_\_\_\_\_

Code : 112017-042-A

Please check that this question paper contains **26** questions and **7** printed pages.

**CLASS-XI  
PHYSICS**

**Time Allowed : 3 Hours**

**Maximum Marks : 70**

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**Section-A**

- 1. Define the term 'systematic errors'.
- 2. Particles of masses  $m_1, m_2, \dots, m_n$ , are present at points defined by position vectors  $\vec{r}_1, \vec{r}_2, \dots, \vec{r}_n$ . Write the expression for the position of the centre of mass of this  $n$ -particle system.



3. Given that Boltzmann's constant =  $K_B$  and Absolute temperature =  $T$ , show, on a graph, the dependence of the average translational Kinetic Energy ( $E$ ) of a gas molecule, on the absolute temperature of the gas.
4. Name the physical quantity that remains constant for a given system during an adiabatic process. For a given gas, the ratio  $\frac{C_p}{C_v} = r$ . Write the relation, between pressure ( $p$ ) and volume ( $v$ ), for this gas, during an adiabatic change.
5. In which liquid water or honey, the terminal velocity, of a given object, has a lower value ?

### Section-B

6. A constant force,  $\vec{F}$ , acting on a body of mass 20 kg, changes its velocity from  $(2\hat{i})_{\text{ms}^{-1}}$  to  $(6\hat{i})_{\text{ms}^{-1}}$  in 40s. Find the magnitude and direction of the force.
7. A particle, of mass 0.5 kg, moves along the  $x$ -axis, with a velocity  $V = kx^{3/2}$  where  $k = (\text{S})\text{m}^{-1/2}\text{s}^{-1}$ . Find the work done by the net force, acting on it, during its displacement from  $x = 0$  to  $x = 2\text{m}$ .
8. How much below the surface of the earth does the acceleration due to gravity becomes 99% of its value at the earth's surface ? (Radius of earth = 6400 km).
9. Show, on a diagram, the fundamental mode of vibration, of the air-column, in (i) an open tube (ii) a closed tube. If the frequencies of vibration are equal in the two tubes, find the ratio of their lengths.

### OR

A source, S, of sound, having a natural frequency  $n$ , first approaches, and then moves fast, a stationary observer O. The source moves with a constant velocity  $V_s$  of sound, in air, is  $V$ .

Find the magnitude of change ( $\Delta n$ ) in the apparent frequency of the source, at the instant it goes past O.

10. Two bodies, M and N, of Equal masses, are suspended from two separate mass less springs of spring constants  $k_1$  and  $k_2$  respectively. If these two bodies, when made to oscillate, vertically, have equal values for their maximum velocities find the ratio of their oscillation amplitudes of M to that of N.

### Section-C

11. (a) Check the correctness of the relation :

$$V = \sqrt{\frac{2 GM}{R}}$$

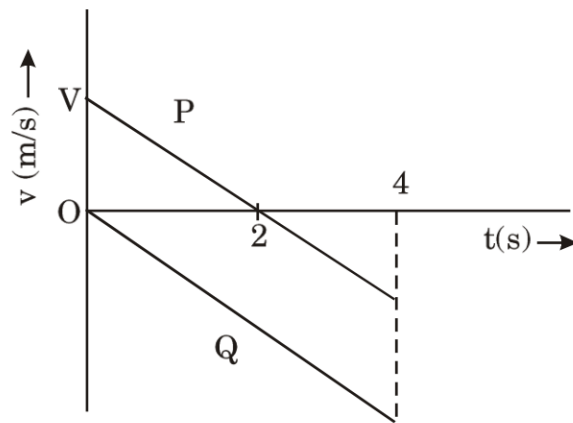
(V = velocity, M = mass R = Radius, G = universal gravitational constant)

- (b) A physical quantity P is related to four observables  $a$ ,  $b$ ,  $c$  and  $d$  as follows :-

$$P = \frac{a^3 b^2}{\sqrt{cd}}$$

If the percentage errors of measurement in  $a$ ,  $b$ ,  $c$  and  $d$  are 1%, 3%, 4% and 2% respectively, find the percentage error in the quantity P ?

12. (a) Two particles P and Q move vertically under gravity the graphs, in the figure\* show the upward velocity V (in m/s) of the particles at time  $t$  (in s) for  $0 \leq t \leq 4$ . P starts with velocity V (in m/s) and Q starts from rest. Taking  $g \approx 10 \text{ ms}^{-2}$ , find the value of v.



(b) Given that Q reaches the ground, when  $t = 4s$ . Find the speed with which Q reaches the ground and its height above the ground, at  $t = 0$ .

13. A fighter plane, flying horizontally at an altitude (H) metre, with a speed  $v$  ( $\text{ms}^{-1}$ ), passes directly overhead an anti aircraft gun. At what angle from the vertical should the gun be fired so that the shell fired with a muzzle speed  $(U)\text{ms}^{-1}$ , hits the plane ? At what minimum altitude should the pilot fly the plane to avoid being hit ?

14. (a) State the triangle law of vector addition.

(b) Two vectors  $\vec{A}$  and  $\vec{B}$  are inclined to each other at an angle Q. Using triangle law of vector addition, find the magnitude of their resultant.

15. Check the correctness, or otherwise of the following statements :

(a) It is comparatively difficult to put an object into motion than to maintain its motion.

(b) Friction is a conservative force.

(c) A single isolated force can exist in nature.

16. Find the potential energy of a system of four particles placed at the vertices of a square of side L. Also obtain the potential at the centre of the square.

**OR**

The radius of a planet is double that of the earth but their average densities are the same. If the escape velocities at the planet and at the earth are  $V_P$  and  $V_E$ , respectively, show that  $V_P = 2V_E$

17. A brass rod, of length 50 cm and diameter 3.0 mm, is joined to a steel rod of same length and same diameter. Find is the change in length of the combined rod at  $250^\circ\text{C}$ , if the original lengths have been measured at  $40.0^\circ\text{C}$ . Is there a 'Thermal Stress' developed at the junction when the ends of the rod are free to expand ? (Coefficient of linear expansion of brass =  $2.0 \times 10^{-5}^\circ\text{C}^{-1}$  and that of steel =  $1.2 \times 10^{-5}^\circ\text{C}^{-1}$ ).

18. The Young's modulus, of the material of a given wire is  $Y$ . It is observed that the length of a given wire of this material is  $L_1$ , when the tension becomes  $T_2$ . Find the original length of the wire.
19. (a) Define the term "isothermal process".  
 (b) Derive an expression, for the work done, when an ideal gas undergoes a change in its state, isothermally, from  $(P_1, V_1)$  to  $(P_2, V_2)$ .
20. On the basis of kinetic theory, derive an expression, for the pressure exerted by an ideal gas, on the walls of the container, in terms of the root mean square velocity.
21. A particle, in SHM, is described by the displacement function.

$$x(t) = A \cos(\omega t + \phi), \quad \omega = \frac{2\pi}{T}$$

If the initial ( $t = 0$ ) position of the particle is at  $x = 1$  cm and its initial velocity is  $\pi$  cm/s, find its amplitude and its initial phase angle?

The angular frequency of the particle is  $(\pi) \text{ s}^{-1}$ .]

22. Justify (in brief) the correctness, or otherwise, of the following statements :
- (a) Solid can support both longitudinal and transverse waves, but-only longitudinal waves can propagate-through gases.
- (b) The shape of a pulse does not get distorted during its propagation in a dispersive medium.
- (c) A violin note and a sitar note may have the same frequency and amplitude; yet we can distinguish between two such notes.
23. A manufacturer wanted to display his products at a fair. He wanted to use a rotating turn table on which his products, as well as one of his sales person, could be present together. He also wanted that his sales person should be able to adjust the speed of rotation without having to step down from the table.

When he told his problem to his school day teacher, the teacher suggested him a very simple method for this purpose. The manufacturer checked the suggested method and found it working. He thanked his teacher profusely.

- (a) Write the likely simple suggestion that could have been given by the teacher.
- (b) Name the principle on which this suggestion is based.
- (c) State the values displayed by the (i) teacher (ii) manufacturer.

### **Section-F**

24. State the meaning of the term 'banking of roads'. Give the reason for 'banking a (curved) road. Obtain an expression for maximum speed with which a vehicle can safely negotiate a curved road, banked out an angle  $\theta$ . The coefficient of friction between the wheels and the road is  $\mu$ .

**OR**

Give the meaning of the term 'friction'? Distinguish between static friction, limiting friction and kinetic friction. Draw the relevant graph, showing how the force of friction,  $f$ , varies with the (externally) applied, force,  $F$ .

25. When is a collision, between two objects, said to be an elastic collision? Prove that in an elastic one-dimensional collision between two bodies, of masses  $m_1$ , and  $m_2$ , moving with velocities  $u_1$ , and  $u_2$ , the relative velocity of approach (before the collision), equals their relative velocity of recession, (after the collision).

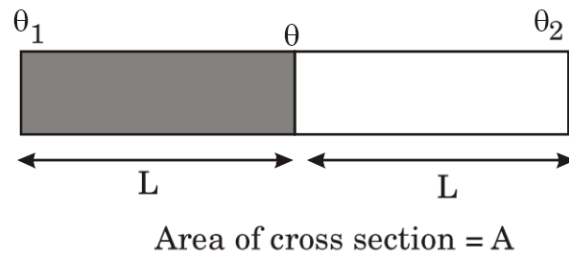
**OR**

State and demonstrate the Principle of conservation of total mechanical energy. Show that the total mechanical energy of a freely falling body remains constant throughout its fall.

26. State, and prove, Bernoulli's Principle for the flow of a non-viscous, incompressible fluid in a combined flow through a pipe of non-uniform cross-section.

**OR**

State the factors on which the rate of flow of heat, through a bar of uniform cross section, depends. Hence define the 'coefficient of thermal conductivity' for a given material. The two parts, of a composite rod, made up of two metals, have equal lengths and equal areas of cross section. The thermal conductivities, of the two materials, are  $k_1$  and  $k_2$ , respectively. Find an expression for the steady state temperature,  $\theta$ , of the junction when the two ends are maintained at temperatures  $\theta_1$  and  $\theta_2$  ( $\theta_1 > \theta_2$ )



Roll No. \_\_\_\_\_

Code : 112016-041-A

Please check that this question paper contains **26** questions and **4** printed pages.

**CLASS-XI**  
**MATHEMATICS**

**Time Allowed : 3 Hrs.**

**Maximum Marks : 100**

- *Please check that this question paper contains 4 printed pages.*
- *Please check that this question paper contains 26 questions.*
- *Please write down the serial number of the question before attempting it.*
- *There is reading time for 15 minutes. Students will read the question paper during this time and will not write any answer on the answer script during this period.*

**General Instructions :**

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Section A consists of 6 questions of 1 mark each.  
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**Section-A**

1. Evaluate :  $i^{141} + i^{142} + i^{143} + i^{144}$
2. Solve  $-8 \leq 5x - 3 < 7$  where  $x \in \mathbb{Z}$ .
3. Find the distance between the lines  
 $4x - 3y + 5 = 0$  and  $8x - 6y + 7 = 0$
4. Find the equation of the parabola with focus  $(0, -3)$  and directrix  $y = 3$ .
5. Write the contrapositive of the statement  
“If it is hot outside, then you feel thirsty”.
6. State whether the ‘or’ used in the statement is inclusive or exclusive. Give reason for your answer :  
“Two lines intersect at a point or are parallel.”

### Section-B

7. Let A and B be sets. If  $A \cap X = B \cap X = \phi$  and  $A \cup X = B \cup X$  for some set X, show that  $A = B$ .
8. From amongst the 100 literate individuals of a city, 50 read newspaper A, 45 read newspaper B and 25 neither A nor B. How many individuals read both the newspapers A and B ?
9. Find the domain and range of the real function  $f(x) = \sqrt{25 - x^2}$
10. Find the general solution of  $3 \tan x + \cot x = 5 \operatorname{cosec} x$ ,  $x \neq n\pi$ .

**OR**

Prove that  $\cos 20^\circ \cos 40^\circ \cos 60^\circ \cos 80^\circ = \frac{1}{16}$

11.  $\alpha$  is divided into two parts such that the ratio of the tangents of parts is  $k$ . If  $x$  be the difference of two parts, prove that  $\sin x = \frac{k-1}{k+1} \cdot \sin \alpha$
12. Convert the complex number  $2 - 2i$  in the polar form. Also write its argument.

**OR**

Find the square root of the complex number  $4 - 4\sqrt{3}i$

13. Solve the following system of inequalities graphically :  
 $x - 2y \leq 3$ ;  $3x + 4y \geq 12$ ;  $x \geq 0$ ;  $x - y \geq 1$

14. Find  $n$  such that  $\frac{a^{n+1} + b^{n+1}}{a^n + b^n}$  may be the A.M. between  $a$  and  $b$ .

**OR**

The product of the first three terms of a G.P. is 1000. If we add 6 to its second term and 7 to its third term, the resulting three terms form an A.P. Find the terms of the G.P.

15. Find the equation of the circle passing through the point (6, 1) and having its centre on the mid point of the line segment joining the centres of the circles

$$(x - 2)^2 + (y - 4)^2 = 65$$

and  $(x - 4)^2 + (y - 6)^2 = 64$

**OR**



An equilateral triangle is inscribed in the parabola  $y^2 = 4ax$ , whose one vertex is at the vertex of the parabola. Find the length of a side of the triangle.

16. Using section formula, prove that the three points A  $(-2, 3, 5)$ , B  $(1, 2, 3)$  and C  $(7, 0, -1)$  are collinear. Also find the ratio in which point C divides the line segment AB.
17. Find the derivative of  $\tan(2x + 3)$  by first principle method.

18. Find the non-zero value of  $k$ , if

$$\lim_{x \rightarrow 1} \frac{x^4 - 1}{x - 1} = \lim_{x \rightarrow k} \frac{x^3 - k^3}{x^2 - k^2}$$

19. A box contains 10 bulbs, of which three are defective. If a random sample of 5 bulbs is drawn, find the probabilities that the sample contains
- exactly two defective bulbs
  - at the most one defective bulb.

### Section-C

20. By the principle of Mathematical Induction, prove that the sum of cubes of three consecutive natural numbers is divisible by 9.

**OR**

Using principle of Mathematical Induction, prove that

$$\frac{1}{2.5} + \frac{1}{5.8} + \frac{1}{8.11} + \dots + \frac{1}{(3n-1)(3n+2)} = \frac{n}{6n+4}, n \in \mathbb{N}$$

21. Find the sum of the following series upto  $n$  terms :

$$\frac{1^3}{1} + \frac{1^3 + 2^3}{1 + 3} + \frac{1^3 + 2^3 + 3^3}{1 + 3 + 5} + \dots$$

22. Show that the coefficient of the middle term in the expansion of  $(1 + x)^{2n}$  is equal to the sum of the coefficients of two middle terms in the expansion of  $(1 + x)^{2n-1}$ .
23. The mean and variance of 7 observations are 8 and 16 respectively. If 5 of the observations are 2, 4, 10, 12 and 14, find the remaining two observations.

24. One side of a rectangle lies along the line  $4x + 7y + 5 = 0$ . Two of its opposite vertices are  $(-3, 1)$  and  $(1, 1)$ . Find the equations of the other three sides.

**OR**

The line  $2x - 3y - 4 = 0$  is the perpendicular bisector of the line AB and co-ordinates of A are  $(-3, 1)$ . Find the co-ordinates of B.

25. In any  $\Delta ABC$ , prove that :  $\frac{\cos A}{a} + \frac{\cos B}{b} + \frac{\cos C}{c} = \frac{a^2 + b^2 + c^2}{2abc}$
26. Find the number of arrangements of the letters of the word 'REPUBLIC'. In how many of these arrangements :
- (i) does the word start with a vowel
  - (ii) all the vowels occur together
  - (iii) What is the significance of 'Republic Day' in our life ?

□□□

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**CLASS-XI**  
**MATHEMATICS**

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**Section-A**

1. Write the principal argument of  $Z = 3 + i\sqrt{3}$
2. An arc of length R units subtends an angle  $\theta$  at the centre of circle of radius R. Find the value of  $\theta$ .
3. Solve the following in-equation for  $x$ , where  $x$  is a natural number :  
 $5x - 2 < 3x + 3$
4. Evaluate :  $\lim_{x \rightarrow 0} \frac{\sqrt{1+x} - 1}{x}$   $x \neq 0, x > -1$
5. Find the derivative of  $f(x) = \cos x - \sin x$  at  $x = \frac{2\pi}{3}$
6. If  $10^{\text{th}}$  is the only middle term in the expansion of  $(1+x)^n$ ,  $n \in \mathbb{N}$ . Write its last term.

### Section-B

7. In an examination, 80% students passed in mathematics, 70% passed in science and 15% failed in both subjects. If 390 students passed in both subjects then find the total number of students who appeared in the examination.
8. Write the domain of  $f(x) = x^2 + 1$  and draw its graph. Also find the value of  $x$  for which  $f(x) = f(x + 1)$

**OR**

Draw the graph of  $f(x) = \begin{cases} 1 - x, & x < 0 \\ 1, & x = 0 \\ 1 + x, & x > 0 \end{cases}$ . Also write its range.

9. If in triangle ABC,  $\frac{\cos A}{a} = \frac{\cos B}{b}$ , prove that triangle is an isosceles triangle.

**OR**

In any triangle ABC, prove that  $2(a \sin^2 \frac{C}{2} + c \sin^2 \frac{A}{2}) = c + a - b$

10. Find the general solution of  $3 \tan x + \cot x = 5 \operatorname{cosec} x$ ,  $x \neq n\pi$ ,  $(2n + 1)\frac{\pi}{2}$  where  $n \in \mathbb{Z}$ .
11. If  $a + ib = \frac{c + i}{c - i}$ ,  $a, b, c \in \mathbb{R}$ ,  $a \neq 0$ ,  $c \neq \pm 1$ . Prove that  $a^2 + b^2 = 1$  and  $\frac{b}{a} = \frac{c}{c^2 - 1}$

**OR**

Find the square root of  $Z = 6 - 8i$

12. If the coefficient of  $(r - 5)^{\text{th}}$  term and  $(2r - 1)^{\text{th}}$  term in the expansion of  $(1 + x)^{34}$  are equal. Find the value of  $r$ .
13. If the first term of G.P. is ' $a$ ' and  $n$ th term is ' $b$ ' and P denotes the product of first  $n$  terms. Prove that  $P^2 = (ab)^n$ .

**OR**

If the sum of  $n$  terms of two A.P.'s are in the ratio  $3n + 8 : 7n + 15$ , find the ratio of their 12<sup>th</sup> terms.

14. Solve the following system of in-equations graphically :  
 $x - 2y \leq 0, 2x - y + 2 \geq 0, x \geq 0, y \geq 0$
15. Find the equation of ellipse whose foci are  $(0, \pm 6)$  and length of minor axis is 16 units. Also find the coordinates of the points where the ellipse cut  $y$  axis and its latus rectum.
16. Find the ratio in which line segment joining the points A  $(- 2, 4, 7)$  and B  $(3, - 5, 8)$  is divided by YZ plane. Also find the coordinates of point of division.
17. Find the derivative of  $\cos (5x + 2)$  w.r.t.  $x$  by first principle.
18. Write the converse and contra positive of following statement :  
 If two lines are parallel then they do not intersect in the same plane.
19. Two dice are thrown simultaneously. Let  $E_1$  denote getting a doublet,  $E_2$  denote getting sum of the numbers appearing on the dice to be at least 10.
- (i) Find  $P E_2$  or  $E_2$       (ii) Are  $E_1$  and  $E_2$  mutually exclusive ?

**Section-C**

20. Let  $U = \{x : x \leq 10, x \in \mathbb{N}\}$ ,  $A = \{x : x \text{ is a prime number } < 10\}$ ,  $B = \{3x : x \in \mathbb{N}, x < 4\}$  Verify that  $(A \cup B)' = A' \cap B'$   
 Represent the  $(A \cup B)'$  with the help of Venn diagram.

21. If  $x + y = z$  and  $\tan x = k \tan y$ , prove that  $\sin z = \frac{k + 1}{k - 1} \sin(x - y)$

**OR**

Prove that  $\sin^2 x + \sin^2(x + \frac{\pi}{3}) + \sin^2(x - \frac{\pi}{3}) = \frac{3}{2}$

22. Using principle of Mathematical Induction, prove that

$$1 \times 3 + 2 \times 3^2 + 3 \times 3^3 + \dots + n \times 3^n = \frac{(2n - 1)3^{n+1} + 3}{4}, \forall n \in \mathbb{N}$$

23. How many words with or without meaning can be formed using the letters of the word "DAUGHTER", if
- (i) All vowels are never together
- (ii) Vowels occupy odd places

**OR**

A polygon has 44 diagonals. If  $n$  denotes the number of vertices of polygon, find the value of  $n$ . Hence find the number of triangles that can be formed by joining these  $n$  points.

24. Two lines passing through point  $(2, 3)$  are inclined at an angle of  $45^\circ$  to each other. If the slope of one of the line is 2, find the slope and equation of the other line.

25. Find the sum of  $n$  terms of the series :

$$3 + 5 + 9 + 15 + 23 + \text{-----} n \text{ terms}$$

26. ABC is an educational organization which has 140 schools. It instructed the principals to organize 'BLOOD DONATION CAMP' in their respective schools. Following are the details of number of schools collecting the number of units of blood.

No. of units	0-10	10-20	20-30	30-40	40-50	50-60	60-70
No. of schools	9	17	32	23	40	18	1

Find the mean and variance of the above data.

What values are shown by the persons who donated blood ?

