9/04/2023

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CODE

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MM : 99 Pattern Classes Scholarship Test **:** Phase 1 Objective) **Time : 1 Hr.**

(for LACHIT -35 Selection)
PCM (ENGINEERING Section)

Instructions :

(i) Attempt only 11 questions from each section of Physics, chemistry, Mathematics i.e, A total of 33 Questions.

(ii) **Pattern of the questions are as under:**

(i) The question paper consists of 3 parts (**Physics, Chemistry and Mathematics**). Each part has 2 sections.

(ii) **Section-1:** This section contains 10 multiple choice questions which have one or more than one options correct type. Each question carries **+3 marks** each for correct answer. There are no negative marks in this section.

(iii) **Section-2:** This section contains 10 questions. The answer to each of the question is a single-digit integer, ranging from 0 to 9 (both inclusive). Each question carries **+3 marks** for correct answer. There is no negative marks in this section.

PHYSICS

Choose the correct answer :

1. A block of mass 5 kg is moving with a speed of 8 m/s along east. If the force of 10 N is applied on it for 3 s along north, then the final speed of the block will be

(1) 20 m/s (2) 10 m/s

(3) 30 m/s (4) 5 m/s

2. The magnitude of change in velocity of a particle having speed v is v during a time interval Δt while moving in a uniform circular motion. The magnitude of acceleration of the particle is

(1) $\frac{v}{2\Delta t}$

(2) $\frac{v}{\Delta t}$

(3) $\frac{\pi v}{3\Delta t}$

(4) $\frac{\pi v}{2\Delta t}$

3. A particle moves in the $x - y$ plane under the influence of a force such that its linear momentum is $p(t) = \left[\hat{i}\cos(\alpha t) - j\sin(\alpha t)\right]\beta$, where α and β are constants. The angle between the force and the momentum is

(1) 0° (2) 45°

(3) 60° (4) 90°

4. A body of mass m moving with a velocity v in the x-direction collides with another body of mass M moving in the y-direction with a velocity V. They coalesce into one body during collision. The direction of the momentum of the composite body with x-axis is.

(1) $\tan^{-1}\left(\frac{mV}{Mv}\right)$ (2) $\tan^{-1}\left(\frac{MV}{mv}\right)$

(3) $\tan^{-1}\left(\frac{M}{M+m}\right)$ (4) $\tan^{-1}\left(\frac{M+m}{M}\right)$

PART - I (PHYSICS)

SECTION - 1

One or More Than One Options Correct Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE are correct**.

1. A particle moves in verticle x-y plane with y-axis along upward vertical, such that its position coordinates are co-related as $y = ax - bx^2$. Taking acceleration due to gravity along vertical downward direction, equal to 'g', the velocity of particle at origin of coordinate system at $t = 0$ is

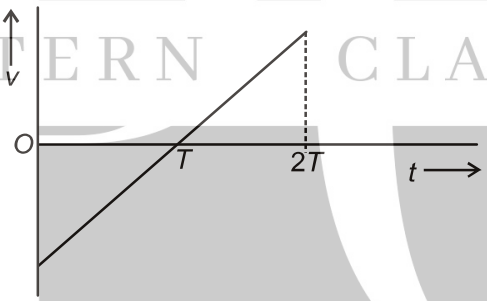
   (A) $\sqrt{\frac{g}{2b}(1+a^2)}$

   (B) $\sqrt{\frac{g}{a}}$

   (C) $\sqrt{\frac{g}{b}}$

   (D) $\sqrt{g\left(1+\frac{a}{b}\right)}$

2. The graph shown represents velocity of a particle moving along a straight line, for the time interval 0 to $2T$ seconds. For this duration we can say



   (A) The particle changes its direction of motion at some point

   (B) The acceleration of the particle remains constant

   (C) The displacement of the particle is zero

   (D) The initial and final speeds of the particle are same

3. A body starts moving on a horizontal circular road of radius r, with a constant tangential acceleration a_t. The coefficient of friction between the body and the road surface is μ. It begins to slip when its speed is v, then, (g = acceleration due to gravity)

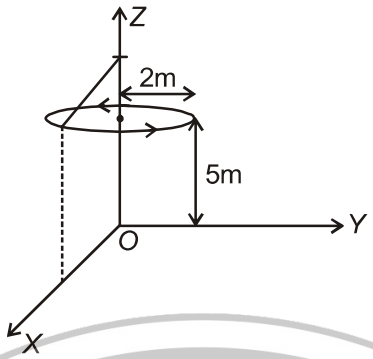
   (A) $v = \mu rg$

   (B) $\mu_g = \frac{v^2}{r} + a_t$

   (C) $\mu^2 g^2 = \frac{v^4}{r^2} + a_t^2$

   (D) The force of friction makes an angle $\tan^{-1}\left(\frac{v^2}{a_t\, r}\right)$ with the direction of motion at the point of slipping

4. The upper end of the string of a simple pendulum is fixed to a vertical z-axis, and set in motion such that the bob moves along a horizontal circular path of radius 2 m parallel to the xy plane, 5 m above the origin as shown. The bob has a constant speed of 3 m/s. The string breaks when the bob is vertically above the x-axis, and it lands on the xy plane at a point $p(x, y)$. Then, (g = 10 m/s^2)



(A) x = 2 m (B) x > 2 m

(C) y = 3 m (D) y = 5 m

5. A ball of mass m is attached to the lower end of a light vertical spring of force constant k. The upper end of the spring is fixed. The ball is released from rest with the spring at its normal (unstretched) length and comes to rest again after descending through a distance x. Then

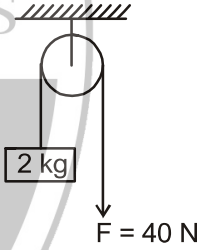
(A) $x = mg/k$

(B) $x = 2mg/k$

(C) The ball will have no acceleration at the position where it has descended through $x/2$

(D) The ball will have an upward acceleration equal to g at its lowermost position

6. A block of mass 2 kg is hanging over a smooth and light pulley through a light string. The other end of the string is now pulled by a constant force F = 40 N. The kinetic energy of the block becomes 40 J in a given interval of time. Then : (g = 10 m/s^2)



(A) Tension in the string is 40 N

(B) Displacement of the block in the given interval of time is 2 m

(C) Work done by gravity is –20 J

(D) Work done by tension is 80 J

7. A man of mass m is stationary on a stationary flat car. The car can move without friction along horizontal rails. The man starts walking with velocity v relative to the car. Work done by him

(A) Is less than $\frac{1}{2}mv^2$, if he walks along the rails

(B) Is equal to $\frac{1}{2}mv^2$, if he walks normal to rails

(C) Can never be less than $\frac{1}{2}mv^2$

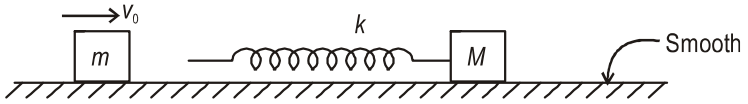
(D) Is greater than $\frac{1}{2}mv^2$, if he walks along the rails

8. A particle of mass m = 1 kg which can move on x-axis experiences a force given by law $F = x(3x - 2)$ N, where x is the x-coordinate of the particle in meters. The points on x-axis where the particle is in equilibrium are (Neglect all other forces)

(A) x = 0 (B) $x = \frac{1}{3}$

(C) $x = \frac{2}{3}$ (D) x = 1

9. A block of mass m moving with a velocity v_0 collides with system of a stationary block of mass M, at the back of which a spring of spring constant k is attached, as shown in the figure. Select the correct alternatives.



(A) The velocity of centre of mass is $\left(\frac{m}{m+M}\right)v_0$

(B) The initial kinetic energy of the system in the centre of mass frame is $\frac{1}{4}\left(\frac{mM}{M+m}\right)v_0^2$

(C) The maximum compression in the spring is $v_0\sqrt{\frac{mM}{m+M}\cdot\frac{1}{k}}$

(D) When the spring is in the state of maximum compression the kinetic energy in the centre of mass frame is zero

10. A block of mass 1.2 kg moving with a speed of 20 cm/s collides head on with a similar block kept at rest. The coefficient of restitution is $\frac{3}{5}$. Then

(A) Velocity of first block after collision is 4 cm/s

(B) Velocity of the second block after the collision is 16 cm/s

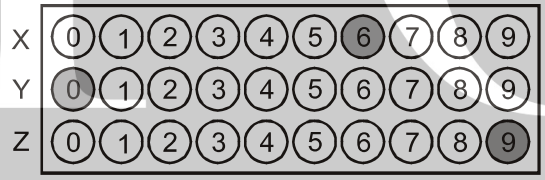
(C) Loss in kinetic energy is 7.7×10^{-3} J

(D) Loss in kinetic energy is 1.5×10^{-3} J

SECTION - 2

One Integer Value Correct Type

This section contains 10 questions. The answer to each of the question is a single digit integer, ranging from 0 to 9 (both inclusive). The appropriate bubbles corresponding to the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y and Z (say) are 6, 0 and 9, respectively, then the correct darkening of bubbles will look like the following :



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11. A wire has length l = (6 ± 0.06) cm, radius r = (0.5 ± 0.005) cm and mass m = (0.3 ± 0.003) gm. Then maximum percentage error in density is.

12. A stone is dropped from a certain height which can reach the ground in 5 second. If the stone is stopped after 3 second of its fall and then allowed to fall again from rest, then the time taken by the stone to reach the ground for the remaining distance is. (g = 10 m/s^2).

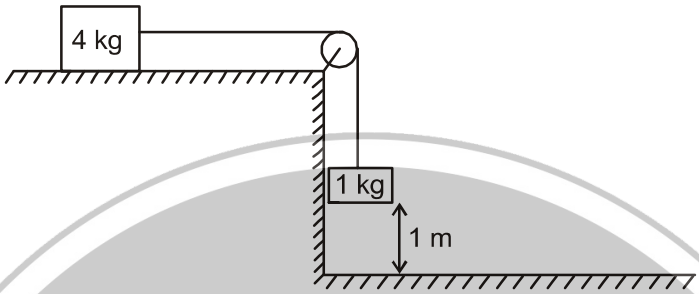
13. An astronaut present on a strange planet observes that he can jump a maximum horizontal distance of 2 m, if his initial speed is 6 m/s. The acceleration due to gravity (m/s^2) on the planet is 9x, find x.

14. The string of a simple pendulam is initially kept horizontal. The mass of the bob is m. Now the bob is released. The tension in the string in the lowest position of bob is k mg. Find the value of k.

15. A heavy particle of weight W_1 attached to a fixed point by a light inextensible string describes a circle in a vertical plane. The tension in the string has the values mW and nW respectively when the particle is at the highest and lowest points in the path. Then $n–m$ will be

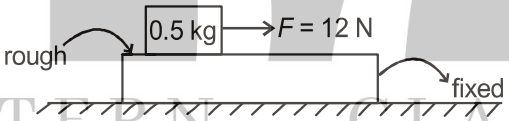
16. A particle of mass 2 kg was initially at rest. Now a variable force is applied on the particle which gives it power $P = \frac{3t^2}{2}$ watt, and it moves along a straight line. Then its velocity at t = 2s, in m/s will be

17. A 4 kg block is placed on a smooth horizontal table. The block is connected to a second block of mass 1 kg by a massless string that passes over a massless pulley as shown in figure. The 1 kg block is 1 m above the floor. The two blocks are released from rest. With what speed (in m/s) does the 1 kg block hit the ground? (g = 10 ms^2)

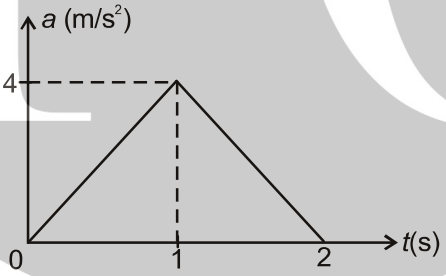


18. A block of mass 0.5 kg is pulled by 12 N force on a fixed block as shown. Speed of block is constant.

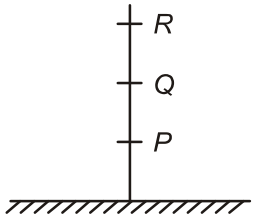
The total contact force (in N) applied by lower block on upper block is $\frac{26}{n}$ N. The value of n is.



19. The acceleration-time graph of a particle moving in a straight line is as shown in figure. The velocity of the particle at time t = 0 is 2 m/s. The velocity (in m/s) after 2 seconds will be. (Acceleration acts in the direction of initial velocity)



20. A stone, projected vertically upwards with a velocity v, reaches points P, Q, R in its path with velocities $\frac{v}{\sqrt{2}}, \frac{v}{\sqrt{3}}, \frac{v}{\sqrt{4}}$ respectively. The value of $\frac{PQ}{QR}$ is.



PART - II (CHEMISTRY)

SECTION - 1

One or More Than One Options Correct Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE are correct**.

21. 100 ml 0.1 M phosphorus acid can be completely neutralised by

(A) 150 ml, 0.1 M lime water

(B) 50 ml, 0.4 M caustic soda solution

(C) 100 ml, 0.1 M baryta water

(D) 40 ml, 0.5 M caustic potash solution

22. If the molarity of sulphuric acid solution in the following reaction :

$$H_2SO_4 + Al(OH)_3 \rightarrow Al(OH)(SO_4) + 2H_2O$$

is 0.5 M and density of sulphuric acid solution is 1.2 g/ml, then select the correct statement(s)

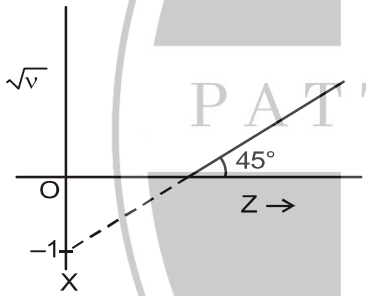
(A) Molality of H_2SO_4 solution = 0.43

(B) Normality of H_2SO_4 solution = 1.0

(C) Mole fraction of water in H_2SO_4 solution = 0.9922

(D) Molarity of hydrogen ions in the sulphuric acid solution is 1.0

23. As per Moseley's law if square root of X-ray frequency emitted by atom is plotted against atomic number of respective atoms as given in the following plot



then the correct statement regarding the graph is/are

(If the atomic number of element is 51)

(A) Value of constant 'a' in Moseley's equation is 1

(B) Value of constant 'b' in Moseley's equation is 1

(C) Element of lower atomic number do not emit X-ray

(D) Element of higher atomic number emit X-ray

24. An electron in an atom of hydrogen jumps from 6th excited state to ground state, then

(A) Maximum number of lines in the spectrum can be 21

(B) Maximum number of spectral lines can be 6

(C) Minimum of one line can be observed in the spectrum

(D) Maximum number of spectral lines in the Balmer series can be only 1

25. Which of the following species (atomic no. given) belongs to p-block?

(A) Z = 84

(B) Z = 33

(C) Z = 38

(D) Z = 52

26. Shape around one of the central atom in which of the following species is correctly matched?

(A) I_2Cl_6 – Square planar

(B) Al_2Cl_6 – Tetrahedral

(C) B_2H_6 – Tetrahedral

(D) IF_6^- – Distorted octahedral

27. Which of the following molecule(s) is/are non polar?

(A) PCl_3F_2

(B) PF_3Cl_2

(C) XeF_4

(D) XeF_2

28. Which of the following is/are typical transition metals?

(A) Os

(B) Rh

(C) Co

(D) Cr

29. Which of the following is/are correct statement(s)?

(A) Bohr's atomic model is wave quantum mechanical model of atom

(B) Number of α-particles undergoing scattering per unit surface area of screen per unit time in Rutherford's α-scattering experiment is inversely proportional to $\sin^4\theta$, where θ is angle of scattering

(C) Number of s-electrons in Cr (atomic number = 24) is 7

(D) Minimum number of electrons with $s = +\frac{1}{2}$, in Fe^{2+} (atomic number = 26) is 10

30. 0.8 mole of a mixture of CO and CO_2 requires exactly 40 g of NaOH in solution for complete conversion of all CO_2 into Na_2CO_3. How much more amount of NaOH would it require for conversion into Na_2CO_3, if the mixture (0.8 mole) is completely oxidised to CO_2?

(A) 0.6 mole

(B) 24 g

(C) 1.2 g-equivalents

(D) 0.4 mole

SECTION - 2

One Integer Value Correct Type

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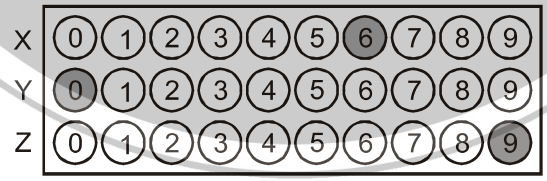

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31. 100 cm^3 of a solution of an acid (molar mass = 98) containing 29.4 g of the acid per litre were completely neutralized by 90 cm^3 of aq. NaOH solution containing 20 g NaOH per 500 cm^3. The basicity of the acid is _____ .

32. A mixture of NH_4NO_3 and $(NH_4)_2HPO_4$ contains 30.40% mass percent of nitrogen. The mass ratio of NH_4NO_3 to $(NH_4)_2HPO_4$ in the mixture is _____ .

33. Maximum number of electrons in Fe(at. no. = 26) satisfying the condition m + l = 1, is _____ .

34. Assume that 2×10^{-17} J of light energy is needed by the interior of human eye to see an object. If the number of photons of yellow light with λ = 598.2 nm that are needed to generate this minimum energy is 20 x, then what is the value of x?

35. An ionic compound of iron has a magnetic moment (μ) of 4.9 BM. If the iron ion in the compound is present as Fe^{x+}, then the least value of 'x' is _____ .

36. In how many of the compounds, $p_\pi - d_\pi$ back bonding is possible?

$(SiH_3)_2O$, Cl_2O, $(CH_3)_2O$, $N(SiH_3)_3$, $Ni(CH_3)_3$, H_3BO_3, BF_3, $B_3N_3H_6$, $K[B(OH)_4]$, PF_3

37. Number of 109° 28′ bond angles in $Si(CH_3)_4$ molecule is _____ .

38. Total number of paramagnetic species among the following is/are (if s-and p-orbital mixing is not considered)

O_2^-, O_2^+, N_2, C_2, B_2, B_2^-

39. How many of the following elements are less electronegative than nitrogen?

F, Br, O, S, P, As

40. If spin quantum number has 3 possible values and if maximum number of elements in 5th period of periodic table is 3x, then value of x is _____.

PART - III (MATHEMATICS)

SECTION - 1

One or More Than One Options Correct Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE are correct**.

41. If the equation $f(x) = 2x^3 + 3x^2 - 12x + C$, $C \in R$, then

(A) $f(x) = 0$, has two equal roots and one distinct root when $C = -7$

(B) $f(x) = 0$, has two equal roots and one distinct root when $C = -20$

(C) $f(x) = 0$, has three solutions when $C \in (-7, 20)$

(D) $f(x) = 0$, has three solutions and only one is positive, when $C \in (-20, 0)$

42. $f(x) = 3 + 2\sin x + 2\cos^2 x$, then

(A) Minimum value of $f(x)$ is 5 in the interval $\left[0, \frac{2\pi}{3}\right]$

(B) Minimum value of $f(x)$ is 1 in the interval $\left[0, \frac{7\pi}{6}\right]$

(C) Maximum value of $f(x)$ is $\frac{11}{2}$ in the interval $\left[\pi, \frac{11\pi}{6}\right]$

(D) Maximum value of $f(x)$ is 5 in the interval $\left[\pi, \frac{11\pi}{6}\right]$

43. If a, b and c are the sides of a triangle with usual notations such that $a^4 + b^4 + c^4 = a^2c^2 + 2a^2b^2 + 2b^2c^2$ then

(A) Angle opposite to the side b is $\frac{\pi}{6}$

(B) Angle opposite to the side b is $\frac{5\pi}{6}$

(C) Angle opposite to the side a may be $\frac{\pi}{3}$

(D) Angle opposite to the side a may be $\frac{2\pi}{3}$

44. If $10a + 4b + 2c = 0$ and equations $ax^2 + bx + c = 0$, $a \neq 0$, $a, b, c \in R$, then

(A) One root lies in the interval (1, 3)

(B) One root in the interval (2, 3)

(C) Both roots are real

(D) Both roots are not real

45. The number of solution(s) of the equation $|\sin 3x| = e^{-|3x|}$ is

(A) 4 for $x \in [0, \pi]$ (B) 6 for $x \in [-\pi, 0]$

(C) 8 for $x \in [-\pi, \pi/3]$ (D) 8 for $x \in [-2\pi/3, 2\pi/3]$

46. The number of solution(s) of the equation $\sin^3 x + \sin^2 x (\cos x - 2) + 4 = 2 (\sin x + \cos x)$

(A) Is 1 in the interval $[0, \pi]$

(B) Is 0 in the interval $[0, \pi/2]$

(C) Is 0 in the interval $[0, \pi]$

(D) Is 2 in the interval $[0, 2\pi]$

47. Let $a > 1$, $b > 1$ and $\log_{10} a^2 + 8 \cdot \log_{b^2} 10 + \log_{a^2} b^2 \leq |6 \cdot \sin\theta|$. If equations $x^2 - 2\sin\theta\, x + (4\cos^2\theta + 5) = 0$ and $x^2 + qx + r = 0$ have a common root, then

(A) $q + r$ may be 3 (B) $q + r$ may be 7

(C) $q^2 + r^2$ is 29 (D) $3q + r^2$ is 21

48. In a triangle ABC with usual notation, if $\frac{a}{R} + \frac{b}{R} + \frac{c}{R} = 3\sqrt{3}$, then $\frac{R}{r}$ is

(A) Less than 1 (B) Less than 2

(C) Less than 3 (D) Greater than 2

49. Let a function is $f(x) = |x| + |x - 2| + |x + 2|$, then number of solution(s) of $f(x) = ax + b$ is

(A) 1 if $a = 1$, $b = 3$ (B) 2 if $a = 2$, $b = 3$

(C) 1 if $a = 2$, $b = 3$ (D) 2 if $a = 1$, $b = 5$

50. Let $f(x) = \frac{2x^4 + 3x^2 + 2}{x^4 + 1}$ is a function for $x \in R$, then

(A) $f(x) > 1$ (B) $f(x) > 2$

(C) $f(x) \leq \frac{7}{2}$ (D) $f(x) \leq 4$

SECTION - 2

One Integer Value Correct Type

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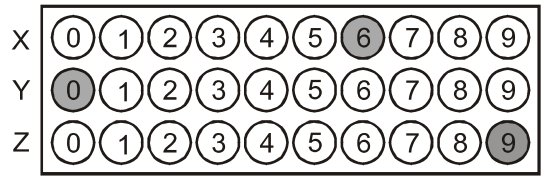

51. In a triangle ABC $\left(\angle B = \frac{\pi}{2}\right)$, P and Q are two points on side AB such that $\angle CAP = \alpha$, $\angle CPQ = 2\alpha$ and $\angle CQB = 3\alpha$. If $CQ < k.PQ$, then the value of k is _____.

52. If $f(x) = \{\log (x^2 + 4x + 5)\}^2 + 6 \cdot \log (x^2 + 4x + 5) + 4$, then minimum value of $f(x)$ is _____.

53. If $\sin A + \sin B = 1$ and $\cos A + \cos B = \sqrt{2}$, then the value of $\frac{12}{\pi}|A - B|$ is _____.

54. Let $\sec \theta_1$, $\sec \theta_2$, $\sec \theta_3$ are roots of $4x^3 - 24x + 47x - 30 = 0$, then the value of $\frac{47}{\sum \cos \theta_1} - 27$ is _____.

55. For $x \in \left(0, \frac{\pi}{3}\right)$, minimum value of $\sec^2 x + \text{cosec}^2 x - 5$ is k, then $|k| + 3$ is _____.

56. The number of solution of $\sin(\cos x) - \cos(\sin x) = \frac{\pi}{2}$ in the interval $[0, 2\pi]$ is _____.

57. The minimum number of elements that must be added to the relation $R = \{(a, b), (b, c)\}$ if $a, b, c \in N$. So that it is an equivalence relation is _____.

58. $f(x)$ is a function such that, $f(x) = 1 + 2x - 2[x - 5]$ ([.] denotes greatest integer function). If $P \in$ range of $f(x)$ and $P \in I$, then minimum number of power set of set A, if $P \in A$ is _____.

59. If $f(x) = 5 - 6x - 3x^2$ and $g(x) = \log_2 (x^2 - 4x + 36)$ are two functions. A is a set containing integers of range of $f(x)$ and B is a set containing integers of range of $g(x)$, then the number of elements common to each of the set $A \times B$ and $B \times A$ is k, then $|k - 9|$ is _____.

60. Set A and set B have 3 and 7 elements each. If a is minimum value of $n(A \cup B)$ and b is maximum value of $n(A \cap B)$, then $2a + b - 11$ is _____.

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PC
PATTERN CLASSES