SAMPLE PAPER

MENTORS TALENT SEARCH EXAMINATION

FOR STUDENTS IN CLASS XI AND GOING TO CLASS TO XII

Time : 3 hours **Maximum Marks: 240**

INSTRUCTIONS

(A) General :

1. This Question paper contains **THREE** parts (Physics, Chemsitry and Mathematics). Each part containing 2 section (**Section-A and Section-B)**.
2. This Question Paper contains 12 pages, other than the OMR.
3. This Question Paper contains total **60 questions, 20 questions each** in **Physics, Chemistry and Mathematics**.
4. The Question Paper has blank spaces at the bottom of each page for rough work.No additional sheets will be provided for rough work.
5. Blank papers, clip boards, log tables, slide rule, calculators, cellular phones, pagers and electronic gadgets, in any form, are **NOT** allowed.
6. This booklet also contains the **OMR** answer sheet (i.e., A machine gradable Response Sheet).

(B) Answering on the OMR:

7. Each question will have **4 choices** in both the Sections, out of which **only one choice is correct**.
8. Fill the bubble with **Ball Pen (Blue or Black) ONLY.**

(C) Filling – Name and Registration No.

9. On the **OMR sheet**, write your Name and Registration No. using ball pen. Also, put your signature in the appropriate box using ball pen.

(D) Marking Scheme:

10. (a) For each question, you will be awarded **4 marks** if you have darkened only one bubble corresponding to the right answer.
    (b) In case you have not darkened any bubble, you will be awarded 0 mark for that question.
    (c) In all other cases, you will be awarded **–1 mark**.

DO NOT BREAK THE SEALS ON THIS BOOKLET, AWAIT INSTRUCTIONS FROM THE INVIGILATOR.

SEAL

Name :.....

Registration No.: ☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐

Head Office : Jugeshwar Bhawan, Plot # 4, Main Boring Road, Patna - 800001

PART-I : PHYSICS

SECTION – A

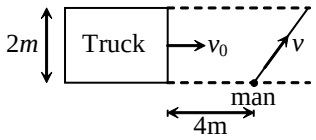
(Single Correct Answer Type)

This section contains **12 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The angle which a vector $\hat{i} - \hat{j} + \sqrt{2}\ \hat{k}$ makes with *y*-axis is

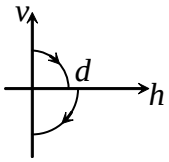
(A) 60° (B) 120° (C) 150° (D) $\tan^{-1}(-\frac{1}{2})$

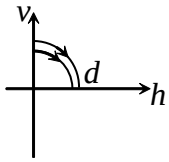
2. A 2m wide truck is moving with a uniform speed v_0 = 8 m/s along a straight horizontal road. A pedestrian starts to cross the road with a uniform speed *v* when the truck is 4 m away from him. The minimum value of *v* so that he can cross the road safely is

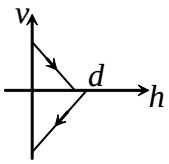


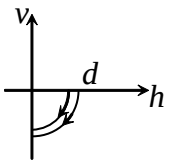
(A) 2.62 m/s (B) 4.6 m/s (C) 3.57 m/s (D) 1.414 m/s

3. A ball is dropped vertically from a height *d* above the ground. It hits the ground and bounces up vertically to a height *d*/2. Neglecting subsequent motion and air resistance, its velocity *v* varies with the height *h* above the ground as

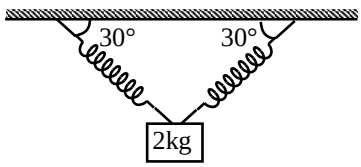
(A) 

(B) 

(C) 

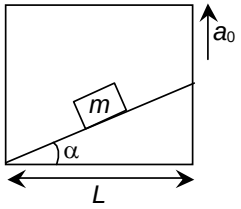
(D) 

4. A block of mass 2 kg is hanging with two identical massless springs as shown in figure. The acceleration of the block just at the moment, the right spring breaks is (g = 10 m/s²)



(A) 10 m/s² (B) 5 m/s² (C) 25 m/s² (D) 4 m/s²

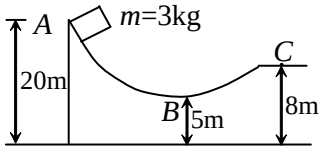
5. A particle slides down a smooth inclined plane of elevation α fixed in the elevator going up with an acceleration a_0 as shown in figure. The base of the incline has a length L. The time taken by the particle to reach the bottom is



(A) $\left[\frac{L}{g\sin\alpha\cos\alpha}\right]^{1/2}$ (B) $\left[\frac{2L}{(g+a_0)\sin\alpha\cos\alpha}\right]^{1/2}$

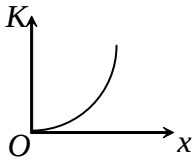
(C) $\left[\frac{L}{(g+a_0)\sin 2\alpha}\right]^{1/2}$ (D) $\left[\frac{(g+a_0)\sin\alpha\cos\alpha}{L}\right]^{1/2}$

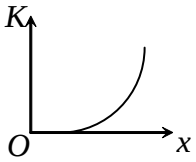
6. A block of mass 3 kg slides down a rough curved path from point *A* as shown. If it stops at *C*, the work done by friction is (g = 10 ms^{-2})

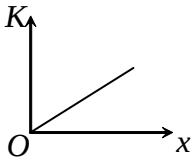


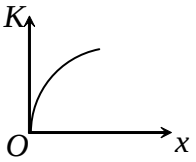
(A) –360 J (B) –240 J (C) –600 J (D) –450 J

7. A body moves from rest with a constant acceleration. Which one of the following graph represents the variation of its kinetic energy *K* with the distance travelled *x* ?

(A) 

(B) 

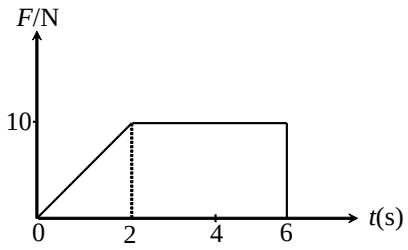
(C) 

(D) 

8. A particle of mass m moving eastward with a speed v collides with another particle of same mass moving northward with same speed v. The two particles coalesce on collision. The new particle of mass 2m will move in the north-east direction with a velocity of

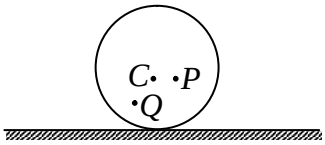
(A) $v\sqrt{2}$ (B) $\frac{v}{\sqrt{2}}$ (C) $\frac{v}{2}$ (D) v

9. A body of mass 3 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is given by (given initial momentum = 0)



(A) zero (B) 5 Ns (C) 30 Ns (D) 50 Ns

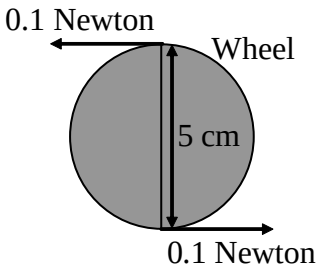
10. A disc is rolling without slipping with angular velocity ω. *P* and *Q* are two points equidistant from the centre *C*. The order of magnitude of velocity is



(A) $V_Q > V_C > V_P$ (B) $V_P > V_C > V_Q$

(C) $V_P > V_C$, $V_Q = V_C / 2$ (D) $V_P < V_C > V_Q$

11. Two constant parallel forces act on a wheel provided in a transistor for tunning as shown in the figure. If the wheel rotates then the work done per rotation will be



(A) 0.05 joule (B) 0.0015 joule (C) 0.031 joule (D) 0.062 joule

12. A particle of mass m is projected with a velocity v making an angle of 45º with horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height h is

(A) $m\sqrt{2gh^2}$ (B) $\frac{mv^3}{\sqrt{2}g}$ (C) $\frac{mv^3}{4\sqrt{2}g}$ (D) zero

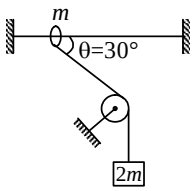
SECTION – B

(Comprehension Type)

This section contains **3 paragraphs**. Based upon the first and second paragraph 3 multiple choice questions and based upon the third paragraph 2 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Passage-1

A smooth ring of mass *m* can slide on a fixed horizontal rod. A massless string tied to the ring passes over a fixed smooth pulley of mass *m* and carries a block of mass 2*m* as shown in figure. At an instant the string between ring and pulley makes an angle $\theta = 30°$ with the horizontal.



13. Acceleration of block is

(A) $\frac{3}{5}g$ (B) $\frac{g}{3}$ (C) $\frac{2\sqrt{3}}{5}g$ (D) none of these

14. Acceleration of ring is

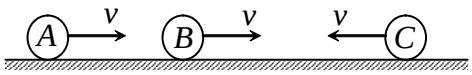
(A) $\frac{3}{5}g$ (B) $\frac{g}{3}$ (C) $\frac{2\sqrt{3}}{5}g$ (D) none of these

15. Normal force due to ring on the rod is

(A) $\frac{4mg}{5}$ (B) mg (C) $\frac{2mg}{5}$ (D) none of these

Paragraph-2

Two spheres A and B are moving on a smooth horizontal surface with same velocity v having some separation between them. A third sphere C is moving in opposite direction on same surface with same speed. All the spheres are of equal mass. The collisions are elastic. Let v_{cm} represents the centre of mass velocity of all the three spheres.



16. If A and B are connected to each other by a massless rigid rod, then the value of v_{cm} after all the possible collisions have occurred will be

(A) $\frac{v}{3}$ (B) $\frac{2v}{3}$ (C) v (D) $\frac{3v}{3}$

17. If A and B are connected to each other by a massless rigid rod, then during all the possible collisions

(A) momentum of A and B is conserved (B) momentum of B and C is conserved

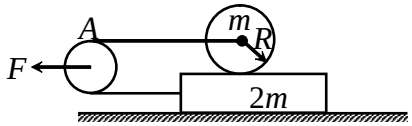
(C) momentum of B and C is not conserved (D) momentum of A will remain constant

18. After all collision are completed, the total number of collisions will be

(A) 1 (B) 2 (C) 3 (D) 4

Paragraph-3

A solid cylinder of mass *m* and radius *R* is kept at rest on a plank of mass 2*m* lying on a smooth horizontal surface. Massless and inextensible string connecting cylinder to the plank is passing over a massless pulley. The friction between the cylinder and the plank is sufficient to prevent slipping. Pulley *A* is pulled with a constant horizontal force *F*.



19. Acceleration of cylinder with respect to earth is

(A) $\frac{5F}{21m}$ (B) $\frac{F}{7m}$ (C) $\frac{3F}{7m}$ (D) $\frac{2F}{7m}$

20. Acceleration of plank with respect to earth is

(A) $\frac{5F}{21m}$ (B) $\frac{F}{7m}$ (C) $\frac{3F}{7m}$ (D) $\frac{2F}{7m}$

PART-II: CHEMISTRY

SECTION – A
(Single Correct Answer Type)

This section contains **12 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

21. Statement-1 : The dipole moment of C_3O_2 and CO_2 are zero.

Statement-2 : Two more electronegative ends are in diametrically opposite direction in both cases.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true

22. An electron, a proton and an alpha particle have K.E. of 16E, 4E and E respectively. What is the qualitative order of their de-Broglie wavelengths :

(A) $\lambda_e > \lambda_p = \lambda_\alpha$ (B) $\lambda_p = \lambda_\alpha > \lambda_e$ (C) $\lambda_p < \lambda_e < \lambda_\alpha$ (D) $\lambda_\alpha < \lambda_e = \lambda_p$

23. Which of the following represents kinetic energy of an an electron in Bohr's orbit of H-atom.

(A) $\frac{-Rhc}{n^2}$ (B) $\frac{Rhc}{n^2}$ (C) $\frac{-2Rhc}{n^2}$ (D) $\frac{2Rhc}{n^2}$

24. Bond distance C–F in (CF_4) & Si–F in (SiF_4) are respective 1.33Å & 1.54 Å. C–Si bond is 1.87 Å. Calculate the covalent radius of F atom ignoring the electronegativity differences.

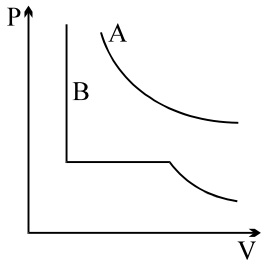
(A) 0.64 Å (B) $\frac{1.33+1.54+1.8}{3}$ Å (C) 0.5 Å (D) $\frac{1.54}{2}$ Å

25. pH of a mixture of 0.75 M CH_3COOH and 0.25 M $(CH_3COO)_3Al$

[pK_a (CH_3COOH) = 4.74; $\log_{10}3$ = 0.477]

(A) 4.26 (B) 9.74 (C) 4.74 (D) 9.26

26. For two gases A and B, P v/s V isotherms are drawn at T K as shown. T_A & T_B are critical temperatures of A & B respectively.

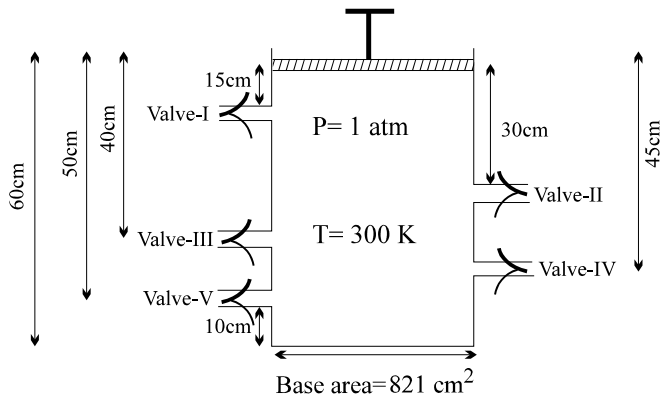


Which of following is true?

(A) $T_A < T < T_B$ (B) $T_A > T > T_B$ (C) $T_A > T_B > T$ (D) None of above

27. A container fitted with frictionless massless piston consist of five valves–I, II, III, IV and V. These valves open automatically if pressure exceed over 1.5, 2.2, 2.5, 4.4 and 4.8 atm respectively. Under the given initial conditions (mentioned in given diagram) system is in state of equilibrium. Piston is now pressed in downward direction very slowly.

[Note: Consider the diameter of valve tube negligible and temperature remain constant.]



Which of the following is correct :

(I) Valve –II will be opened first

(II) As the piston crosses the valve which will be opened first, the remaining number of moles in container are $\frac{5}{3}$.

(III) Valve–V will be the second valve which open

(IV) Number of moles will zero as piston crosses Valve–V

(A) (I) & (II) (B) (II) & (III) (C) (I) & (IV) (D) (III) & (IV)

28. One mole mixture of CH_4 & air (containing 80% N_2 20% O_2 by volume) of a composition such that when underwent combustion gave maximum heat (assume combustion of only CH_4). Then which of the statement is correct, regarding composition of initial mixture. (X presents mole fraction)

(A) $X_{CH_4} = \frac{1}{11}, X_{O_2} = \frac{2}{11}, X_{N_2} = \frac{8}{11}$ (B) $X_{CH_4} = \frac{3}{8}, X_{O_2} = \frac{1}{8}, X_{N_2} = \frac{1}{2}$

(C) $X_{CH_4} = \frac{1}{6}, X_{O_2} = \frac{1}{6}, X_{N_2} = \frac{2}{3}$ (D) Data insufficient

29. According to hybridisation theory maximum s-character is found in bond formed by (*) atom.

(A) $\overset{*}{C}H_4$ (B) $\overset{*}{S}F_6$ (C) $\overset{*}{X}eO_6^{4-}$ (D) $\overset{*}{S}F_4$

30. $C_6H_5OH\ (g) + O_2\ (g) \longrightarrow CO_2\ (g) + H_2O\ (l)$

Magnitude of volume change if 30 ml of C_6H_5OH (g) is burnt with excess amount of oxygen, is

(A) 30 ml (B) 60 ml (C) 20 ml (D) 10 ml

31. When pure water is saturated with $CaCO_3$ and CaC_2O_4, the concentration of calcium ion in the solution under equilibrium is 8.426×10^{-5} M. If the ratio of the solubility product of $CaCO_3$ to that of CaC_2O_4 is 2.087, what is the solubility product of $CaCO_3$ in pure water?

(A) 4.80×10^{-8} (B) 9.60×10^{-9} (C) 9.60×10^{-8} (D) 4.80×10^{-9}

32. 'y' ml of 'y' volume H_2O_2 solution completely reacts with 'x' ml of 'y' M $KMnO_4$ solution in acidic medium. The value of x/y is

(A) 0.036 (B) 28

(C) 0.057 (D) cannot be calculated

SECTION – B

(Comprehension Type)

This section contains **2 paragraphs**. Based upon the first & second paragraph **3** multiple choice questions and based upon the third paragraph **2** multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph-1

Nature of bond can be predicted on the basis of electronegativity of bonded atoms, greater difference in electronegativity (X), more will be the polarity of bond, and polar bond are easily broken in polar solvent like water. For hydroxy acids $X_O - X_A$ difference predict the nature of oxide formed by the element A.

$|X_O - X_A| > |X_O - X_H|$ then A–O–H show basic nature (NaOH)

$|X_O - X_A| < |X_O - X_H|$ then A–O–H show acidic nature (H–O–Cl)

With the help of EN values [$EN_A = 1.8$, $EN_B = 2.6$, $EN_C = 1.6$, $EN_D = 2.8$, $EN_O = 3.44$, $EN_H = 2.26$] answer the following questions for the compounds HAO, HBO, HCO, HDO.

33. Compounds whose aqueous solution is acidic and order of their acidic strength

(A) AOH, COH ; AOH < COH (B) HDO, HBO ; HDO > HBO

(C) AOH, COH ; AOH > COH (D) HDO, HBO ; HDO < HBO

34. Compounds whose aqueous solution is basic and order of their basic strength

(A) AOH, COH ; AOH < COH (B) HDO, HBO ; HDO > HBO

(C) AOH, COH ; AOH > COH (D) HDO, HBO ; HDO < HBO

35. Which of the following bond is most polar

(A) AB (B) BC (C) CD (D) AD

Paragraph-2

Equilibrium constants are given (in atm) for the following reactions at 0° C:

$$SrCl_2 \cdot 6H_2O(s) \rightleftharpoons SrCl_2 \cdot 2H_2O(s) + 4H_2O(g) \qquad K_p = 5 \times 10^{-12}$$

$$Na_2HPO_4 \cdot 12\,H_2O(s) \rightleftharpoons Na_2HPO_4 \cdot 7\,H_2O(s) + 5H_2O(g) \qquad K_p = 2.43 \times 10^{-13}$$

$$Na_2SO_4 \cdot 10\,H_2O(s) \rightleftharpoons Na_2SO_4(s) + 10\,H_2O(g) \qquad K_p = 1.024 \times 10^{-27}$$

The vapor pressure of water at 0°C is 4.56 torr.

36. Which is the most effective drying agent at 0°C?

(A) $SrCl_2 \cdot 2H_2O$ (B) $Na_2HPO_4 \cdot 7\ H_2O$ (C) Na_2SO_4 (D) all equally

37. At what relative humidities will $Na_2SO_4 \cdot 10H_2O$ be efflorescent (release moisture) when exposed to air at 0°C ? $[10^{0.3} \approx 2]$

(A) above 33.33% (B) below 33.33 % (C) above 66.66% (D) below 66.66%

38. At what relative humidities will Na_2SO_4 be deliquescent (i.e. absorb moisture) when exposed to the air at 0°C?

(A) above 33.33% (B) below 33.33 % (C) above 66.66% (D) below 66.66%

Paragraph-3

If we know the equilibrium constant for a particular reaction, we can calculate the concentrations in the equilibrium mixture from the initial concentrations. Commonly only the initial concentration of reactants are given.

39. In a study of equilibrium

$$H_2(g) + I_2(g) \rightleftharpoons 2HI\ (g)$$

1 mol of H_2 and 3 mol of I_2 gave rise at equilibrium to x mol of HI.

Addition of a further 2 mol of H_2 gave an additional x mol of HI. What is x?

(A) 0.5 (B) 1 (C) 1.5 (D) None of these

40. In above problem, what is K_p at the temperature of the experiment.

(A) 1 (B) 2 (C) 4 (D) None of these

PART-III : MATHEMATICS

SECTION – A
(Single Correct Answer Type)

This section contains **12 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

41. The circumcentre of the triangle formed by the lines $xy + 2x + 2y + 4 = 0$ and $x + y + 2 = 0$ is

(A) (0, 0) (B) (– 2, – 2)

(C) (– 1, – 1) (D) (– 1, – 2)

42. A point P(x, y) moves such that the sum of its distances from the lines $x + y = 0$ and $y – x = 0$ is 3. The area of the region bounded by the locus of P is

(A) 18 (B) 19 (C) 20 (D) 30

43. The locus of the centre of the circles such that the point (2, 3) is the midpoint of the chord $5x + 2y = 16$ is

(A) $2x – 5y + 11 = 0$ (B) $2x + 5y – 11 = 0$

(C) $2x + 5y + 11 = 0$ (D) none of these

44. If the lines $(y – b) = m_1 (x + a)$ and $y – b = m_2 (x + a)$ are the tangents to $y^2 = 4ax$, then

(A) $m_1 + m_2 = 0$ (B) $m_1 m_2 = 1$ (C) $m_1 + m_2 = 1$ (D) $m_1 m_2 = –1$

45. If $(x-2)^2 + (y-2)^2 = 1$, then the maximum value of x + y, is

(A) $4 + \sqrt{2}$ (B) $9 + 4\sqrt{2}$ (C) $\sqrt{2}$ (D) $4 - \sqrt{2}$

46. If $\phi_1(x) = x^2 + (k-29)x - k$ and $\phi_2(x) = 2x^2 + (2k-43)x + k$, both the factors of a cubic polynomial p(x) with leading coefficient 2, then value of p(0) can be

(A) 75 (B) – 150 (C) – 75 (D) none of these

47. Number of integral values of x for which the inequality $\log_{10}\left(\frac{2x-2007}{x+1}\right) \le 0$ holds true, is

(A) 1004 (B) 1005 (C) 2012 (D) 2014

48. The point of intersection of common tangents of $y^2 = 4ax$ $(a > 0)$ and $x^2 + y^2 – 6ax + a^2 = 0$ is

(A) (a, 0) (B) (– a, 0) (C) (– a, – a) (D) (– 2a, 0)

49. Consider the two functions $f(x) = x^2 + 2bx + 1$ and $g(x) = 2a(x + b)$, where the variable x and the constants a and b are real numbers. Each such pair of the constants a and b may be considered as a point (a, b) in an ab plane. Let S be the set of all such points (a, b) for which the graphs of y = f(x) and y = g(x) do not intersect (in the xy plane). The area of S is

(A) 1 (B) π (C) 4 (D) 4π

50. A variable straight line with slope $m (m \neq 0)$ intersects the hyperbola $xy = 1$ at two distinct points. Then the locus of the point which divides the line segment between these two points in the ratio 1 : 2 is

(A) An ellipse (B) A hyperbola (C) A circle (D) A parabola

51. The length of the major axis of the ellipse $(5x-10)^2+(5y+15)^2=\frac{(3x-4y+7)^2}{4}$ is

(A) 10 (B) $\frac{20}{3}$ (C) $\frac{20}{7}$ (D) 4

52. A(1, x), B(x, 2) and C(1, x^2) are the vertex of a triangle, then minimum area of the triangle A, B, C

(A) $2\sqrt{5}$ (B) $4\sqrt{5}$ (C) $5\sqrt{5}$ (D) none of these

SECTION – B

(Comprehension Type)

This section contains **2 paragraphs**. Based upon the first & second paragraph **3** multiple choice questions and based upon the third paragraph **2** multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph-1

If both the equation $bx^2 - ax + 1 = 0$, $ax^2 - bx + 1 = 0$ have rational roots

53. If given equations also have atleast a common root, then minimum value of $2(a^2 + b^2)$ is

(A) 1 (B) 1/2 (C) 2 (D) none of these

54. If both equation have no common roots and $a,b \in N$, then a + b is

(A) 6 (B) 10 (C) 8 (D) 11

55. If both the equation have atleast one root common and $a,b \in N$, then |a + b| is

(A) 6 (B) 10 (C) 8 (D) 1

Paragraph-2

To the circle $x^2 + y^2 = 4$ two tangents are drawn from P(– 4, 0), which touches the circle at A and B and a rhombus PA P'B is completed.

56. Circumcentre of the triangle PAB is at

(A) (– 2, 0) (B) (2, 0) (C) $\left(\frac{\sqrt{3}}{2},0\right)$ (D) none of these

57. Ratio of the area of triangle PAP' to that of P'AB is

(A) 2 : 1 (B) 1 : 2 (C) $\sqrt{3}:2$ (D) none of these

58. If P is taken to be at (h, 0) such that P' lies on the circle, the area of the rhombus is

(A) $6\sqrt{3}$ (B) $2\sqrt{3}$ (C) $3\sqrt{3}$ (D) none of these

Paragraph-3

Consider an isosceles triangle ABC with base BC = 8 units and $\angle B = \angle C$. A lines cuts the base externally at D such that it make angle θ with base and bisects the side which is nearer to D.

59. If $\angle B$ = 45°, then the area of quadrilateral which the striaght line cuts from the given triangle is

(A) $\frac{3+\tan\theta}{1+\tan\theta}$ (B) $\frac{3+5\tan\theta}{1+\tan\theta}$ (C) $\frac{2(3+5\tan\theta)}{1+\tan\theta}$ (D) $\frac{4(3+5\tan\theta)}{1+\tan\theta}$

60. If $\angle B = 45°$, then length of portion of straight line inside the triangle may lie in the range

(A) (2, 4) (B) $(2\sqrt{2},4)$ (C) $(\sqrt{2},2)$ (D) none of these