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Class: 11
Subject: Math's
Topic: Quadratic Equations
No. of Questions: 25

1. The number of solutions of $\sqrt{4-x}+\sqrt{x+9}=5$ is

A. 0
B. 1
C. 2
D. 3

Sol. C

$\sqrt{4-x}+\sqrt{x+9}=5$ (1)

Note that $4-x \geq 0$ and $x+9 \geq 0 \Rightarrow -9 \leq x \leq 4$.

We can write (1) as $\sqrt{x+9} = 5 - \sqrt{4-x}$

Squaring both the sides we get

$$x+9 = 25 - 10\sqrt{4-x} + 4 - x$$

$\Rightarrow \quad 10\sqrt{4-x} = 20 - 2x \quad \Rightarrow \quad 5\sqrt{4-x} = 10 - x$

Squaring both the sides we get

$25(4-x) = 100 - 20x + x^2 \quad \Rightarrow \quad x^2 + 5x = 0$

$\Rightarrow \quad x(x+5) = 0 \quad \Rightarrow \quad x = 0$ or $x = -5$

Both $x = 0$ and $x = -5$ satisfy (1).

2. The value of a for which one root of the quadratic equation, $(a^2 - 5a + 3)x^2 + (3a - 1)x + 2 = 0$ is twice as large as other, is

A. 2/3
B. 1/3
C. 1/3
D. 2/3

Sol. D

$(a^2 - 5a + 3)x^2 + (3a - 1)x + 2 = 0$ (1)

Let α and 2α be the roots of (1), then

$$(a^2 - 5a + 3)\alpha^2 + (3a - 1)\alpha + 2 = 0 \quad (2)$$

and $(a^2 - 5a + 3)(4\alpha^2) + (3a - 1)(2\alpha) + 2 = 0$ (3)

Multiplying (2) by 4 and subtracting it from (3) we get

$$(3a - 1)(2\alpha) + 6 = 0$$

Clearly $a \neq 1/3$. Therefore, $\alpha = -3/(3a - 1)$

Putting this value in (2) we get

$$(a^2 - 5a + 3)(9) - (3a - 1)^2(3) + 2(3a - 1)^2 = 0$$

$$\Rightarrow \quad 9a^2 - 45a + 27 - (9a^2 - 6a + 1) = 0$$

$$\Rightarrow \quad -39a + 26 = 0$$

$$\Rightarrow \quad a = 2/3.$$

For $a = 2/3$, the equation becomes $x^2 + 9x + 18 = 0$, whose roots are $-3, -6$.

3. If $f(x) = x^2 + 2bx + 2c^2$ and $g(x) = -x^2 - 2cx + b^2$ are such that min f(x) > max g(x), then the relation between b and c, is

A. no relation
B. $0 < c < b/2$
C. $|c| < \frac{|b|}{\sqrt{2}}$
D. $|c| > \sqrt{2}|b|$

Sol. D

$f(x) = (x + b)^2 + 2c^2 - b^2$

$\Rightarrow \quad \min f(x) = 2c^2 - b^2$

Also $\quad g(x) = -x^2 - 2cx + b^2 = b^2 + c^2 - (x + c)^2$

$\Rightarrow \quad \max g(x) = b^2 + c^2$

As min $f(x) >$ max $g(x)$, we get $2c^2 - b^2 > b^2 + c^2$

$\Rightarrow \quad c^2 > 2b^2 \Rightarrow |c| > \sqrt{2}\,|b|$

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4. Let p and q be the roots of $x^2 - 2x + A = 0$ and let r and s be the roots of $x^2 - 18x + B = 0$. If $p < q < r < s$ are in an A.P. then the ordered pair (A, B) is equal to

A. (– 3, 77)
B. (77, – 3)
C. (– 3, – 77)
D. None of these

Sol. A

We have $p + q = 2, pq = A$ (1)

and $r + s = 18, rs = B$ (2)

As p, q, r, s are in AP, we take

$$p = a - 3d,\ q = a - d,\ r = a + d,\ s = a + 3d.$$

As $p < q < r < s$, we have $d > 0$

Now, $2 = p + q = 2a - 4d$

and $18 = r + s = 2a + 4d$

Solving above equations, we get $a = 5$ and $d = 2$

$\therefore$ $p = -1, q = 3, r = 7$ and $s = 11$

Thus, $A = pq = -3$ and $B = rs = 77$.

5. Suppose a, b, c are three non-zero real numbers. The equation $x^2 + (a + b + c)x + (a^2 + b^2 + c^2) = 0$ has

A. two negative real roots
B. two positive real roots
C. two real roots with opposite signs
D. no real roots

Sol. D

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$x^2 + (a + b + c)x + (a^2 + b^2 + c^2) = 0$ (1)

Discriminant D of (1) is given by

$$D = (a+b+c)^2 - 4(a^2+b^2+c^2)$$
$$= -\{(b^2+c^2-2bc)+(c^2+a^2-2ca)+(a^2+b^2-2ab)+(a^2+b^2+c^2)\}$$
$$= -[(b-c)^2+(c-a)^2+(a-b)^2+(a^2+b^2+c^2)] < 0$$

Thus, (1) cannot have real roots.

6. The equation $(\cos p - 1)x^2 + (\cos p)x + \sin p = 0$ in variable x has real roots, if p belongs to the interval

A. $(0, 2\pi)$
B. $(-\pi, 0)$
C. $(-\pi/2, \pi/2)$
D. $(0, \pi)$

Sol. D

$(\cos p - 1)x^2 + (\cos p)x + \sin p = 0$ (1)

Discriminant of (1) is given by

$$D = \cos^2 p - 4(\cos p - 1)\sin p$$
$$= \cos^2 p + 4(1 - \cos p)\sin p$$

Note that

$\cos^2 p \geq 0$, $1 - \cos p \geq 0$. Thus, $D \geq 0$ if $\sin p \geq 0$ i.e. if $p \in (0, \pi)$.

7. If a, b are two real numbers satisfying the relations $2a^2 - 3a - 1 = 0$ and $b^2 + 3b - 2 = 0$ and $ab \neq 1$, then the value of $\frac{ab + a + 1}{b}$ is

A. 1
B. 0
C. 1
D. 2

Sol. C

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$$b^2 + 3b - 2 = 0 \Rightarrow 1 + \frac{3}{b} - \frac{2}{b^2} = 0$$

$$\Rightarrow \quad \frac{2}{b^2} - \frac{3}{b} - 1 = 0$$

Thus, a and $1/b$ are roots of $2x^2 - 3x - 1 = 0$

$$\therefore \quad a + \frac{1}{b} = \frac{3}{2} \text{ and } \frac{a}{b} = \frac{-1}{2}$$

Now, $$\frac{ab + a + 1}{b} = a + \frac{1}{b} + \frac{a}{b} = \frac{3}{2} - \frac{1}{2} = 1$$

8. Suppose a, b, c are the lengths of three sides of a $\triangle$ABC, a > b > c, 2b = a + c and b is a positive integer. If $a^2 + b^2 + c^2 = 84$, then the value of b is

A. 7
B. 6
C. 5
D. 4

Sol. C

We have

$$ac = \frac{1}{2}[(a+c)^2 - (a^2 + c^2)] = \frac{1}{2}[4b^2 - (84 - b^2)]$$

$$= 5b^2/2 - 42$$

Thus, a and c are the roots of the equation

$$x^2 - 2bx + (5b^2/2 - 42) = 0$$

As a and c are distinct real numbers the discriminant of the above must be positive, that is, $4b^2 - 4(5b^2/2 - 42) > 0$

$\Rightarrow \quad 6b^2 < 168$ or $b^2 < 28$.

Also, $ac > 0 \Rightarrow 5b^2 > 84$.

$\therefore \quad 84/5 < b^2 < 28$.

As b is a positive integer, we get $b = 5$.

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9. Let p and q be real numbers such that $p \neq 0$, $p^3 \neq q$ and $p^3 \neq -q$. If α and β are non-zero complex numbers satisfying $\alpha + \beta = -p$ and $\alpha^3 + \beta^3 = q$, then a quadratic equation having $\frac{\alpha}{\beta}$ and $\frac{\beta}{\alpha}$ as its roots is

A. $(p^3 + q)x^2 - (p^3 + 2q)x + (p^3 + q) = 0$
B. $(p^3 + q)x^2 - (p^3 - 2q)x + (p^3 + q) = 0$
C. $(p^3 - q)x^2 - (5p^3 - 2q)x + (p^3 - q) = 0$
D. $(p^3 - q)x^2 - (5p^3 + 2q)x + (p^3 - q) = 0$

Sol. B

$$q = \alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$$

$$= -p^3 + 3\alpha\beta p$$

$$\Rightarrow \quad \alpha\beta = \frac{p^3 + q}{3p}$$

We have

$$\frac{\alpha}{\beta} + \frac{\beta}{\alpha} = \frac{\alpha^2 + \beta^2}{\alpha\beta}$$

$$= \frac{(\alpha + \beta)^2 - 2\alpha\beta}{\alpha\beta} = \frac{(\alpha + \beta)^2}{\alpha\beta} - 2$$

$$= \frac{p^2}{(p^3 + q)/3p} - 2$$

$$= \frac{3p^3 - 2p^3 - 2q}{p^3 + q} = \frac{p^3 - 2q}{p^3 + q}$$

and $\quad \frac{\alpha}{\beta} \cdot \frac{\beta}{\alpha} = 1$

Thus, required quadratic equation is

$$x^2 - \frac{(p^3 - 2q)}{p^3 + q}x + 1 = 0$$

or $\quad (p^3 + q)x^2 - (p^3 - 2q)x + (p^3 + q) = 0$

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10. If a is the minimum root of the equation $x^2 - 3|x| - 2 = 0$, then the value of $-1/a$ is

A. $(\sqrt{17} - 3)/4$
B. $(\sqrt{17} + 3)/4$
C. 2
D. 3

Sol. A

$x^2 - 3|x| - 2 = 0$ can be written as $|x|^2 - 3|x| - 2 = 0$

$\Rightarrow \quad |x| = \frac{1}{2}\left(3 \pm \sqrt{17}\right)$

As $\quad |x| \geq 0$, we get $|x| = \frac{1}{2}\left(3 + \sqrt{17}\right)$

$\Rightarrow \quad x = \pm \frac{1}{2}\left(3 + \sqrt{17}\right)$

$\therefore \quad a = -\frac{1}{2}\left(3 + \sqrt{17}\right) \Rightarrow -\frac{1}{a} = \frac{2}{\sqrt{17} + 3} = \frac{\sqrt{17} - 3}{4}$

11. Let α, β be the roots of $x^2 - x + p = 0$ and γ, δ be the roots of $x^2 - 4x + q = 0$. If $\alpha, \beta, \gamma, \delta$ are in a G.P. then the integral values of p and q respectively, are

A. 2, – 32
B. 2, 3
C. 6, 3
D. 6, – 32

Sol. A

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We have

$$\alpha + \beta = 1,\ \alpha\beta = p,$$
$$\gamma + \delta = 4,\ \gamma\delta = q$$

Let r be the common ratio of the GP $\alpha, \beta, \gamma, \delta$. Then

$$\alpha + \beta = 1 \Rightarrow \alpha + \alpha r = 1 \Rightarrow \alpha(1 + r) = 1$$
$$\gamma + \delta = 4 \Rightarrow \alpha r^2 + \alpha r^3 = 4$$
$$\Rightarrow \quad \alpha r^2 (1 + r) = 4$$

Thus, $\dfrac{\alpha r^2(1+r)}{\alpha(1+r)} = 4 \Rightarrow r^2 = 4 \Rightarrow r = \pm 2$

When $r = 2$,

we get $\alpha(1 + r) = 1 \Rightarrow \alpha = 1/3$

In this case $p = \alpha\beta = \alpha(\alpha r) = \alpha^2 r$

$$= \frac{1}{9}(2) = \frac{2}{9}$$

which is not an integer.

Thus, $r = -2$. In this case, $\alpha(1 + r) = 1 \Rightarrow \alpha = -1$.

$\therefore \quad p = \alpha^2 r = (-1)^2(-2) = -2$

and $\quad q = \gamma\delta = (\alpha r^2)(\alpha r^3) = \alpha^2 r^5 = -32$

Hence, $\quad p = -2,\ q = -32.$

12. If α and β ($\alpha < \beta$) are the roots of the equation $x^2 + bx + c = 0$, where $c < 0 < b$, then

A. $0 < \alpha < \beta$
B. $\alpha < 0 < \beta < |\alpha|$
C. $\alpha < \beta < 0$
D. $\alpha < 0 < |\alpha| < \beta$

Sol. B

We have $\alpha + \beta = -b,\ \alpha\beta = c$

As $c < 0,\ b > 0$, we get $\alpha < 0 < \beta$

Also, $\quad \beta = -b - \alpha < -\alpha = |\alpha|$

Thus, $\quad \alpha < 0 < \beta < |\alpha|$

13. If the roots of the equation $x^2 - 2ax + a^2 + a - 3 = 0$ are real and less than 3, then

A. $a < 2$
B. $2 \leq a \leq 3$
C. $3 < a \leq 4$
D. $a > 4$

Sol. A

We can write the given equation as

$$(x - a)^2 = 3 - a \qquad (1)$$

As x and a are real, $(x - a)^2 \geq 0 \Rightarrow 3 - a \geq 0$ or $a \leq 3$.
Equation (1) implies

$$x - a = \pm\sqrt{3 - a} \Rightarrow x = a \pm \sqrt{3 - a}$$

Both the roots of (1) will be less than 3, if the larger of the two roots is less than 3, that is,

$$a + \sqrt{3 - a} < 3 \Rightarrow \sqrt{3 - a} - (3 - a) < 0$$

$$\Rightarrow \sqrt{3 - a}\left(1 - \sqrt{3 - a}\right) < 0$$

$$\Rightarrow \sqrt{3 - a} > 0 \text{ and } 1 - \sqrt{3 - a} < 0$$

$$\Rightarrow \quad a < 3 \text{ and } 1 < \sqrt{3 - a}$$

$$\Rightarrow \quad a < 3 \text{ and } 1 < 3 - a$$

$$\Rightarrow \quad a < 3 \text{ and } a < 2 \Rightarrow a < 2.$$

14. If $4^x - 3^{x - 1/2} = 3^{x + 1/2} - 2^{2x - 1}$, then the value of x is equal to

A. 5/2
B. 2
C. 3/2
D. 1

Sol. C

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$$4^x - 3^{x-1/2} = 3^{x+1/2} - 2^{2x-1}$$

$$\Rightarrow \quad 4^x + 2^{2x-1} = 3^{x+1/2} + 3^{x-1/2}$$

$$\Rightarrow \quad 4^x + \frac{4^x}{2} = 3x\sqrt{3} + \frac{3^x}{\sqrt{3}}$$

$$\Rightarrow \quad \left(\frac{3}{2}\right)4^x = \left(\frac{4}{\sqrt{3}}\right)3^x$$

$$\Rightarrow \quad \left(\frac{4}{3}\right)^x = \frac{2}{3} \times \frac{4}{\sqrt{3}} = \frac{8}{3\sqrt{3}} = \left(\frac{2}{3^{1/2}}\right)^3 = \left(\frac{4}{3}\right)^{3/2}$$

$$\Rightarrow \quad x = 3/2$$

15. The number of solutions of $\sqrt{x+1} - \sqrt{x-1} = 1$, ($x \in$ R) is

A. 1
B. 2
C. 4
D. Infinite

Sol. A

For the equation to make sense we must have
$x + 1 \geq 0$ and $x - 1 \geq 0 \Rightarrow x \geq -1, x \geq 1$ i.e. $x \geq 1$.
We rewrite equation as

$$\sqrt{x+1} = 1 + \sqrt{x-1}$$

and square both the sides to obtain

$$x + 1 = 1 + x - 1 + 2\sqrt{x-1}$$

$$\Rightarrow \quad \frac{1}{2} = \sqrt{x-1} \Rightarrow \frac{1}{4} = x - 1 \text{ or } x = \frac{5}{4}$$

Also, $x = 5/4$ satisfies the given equation.

16. The equation $\sqrt{x+1} - \sqrt{x-1} = \sqrt{4x-1}, (x \in R)$ has

A. no solution
B. one solution
C. two solutions
D. more than two solutions

Sol. A

The given equation is valid if $x + 1 \geq 0$, $x - 1 \geq 0$ and $4x - 1 \geq 0$ i.e. if $x \geq 1/4$.
Squaring both the sides we get

$$x + 1 + x - 1 - 2\sqrt{(x+1)(x-1)} = 4x - 1$$

$$\Rightarrow \quad 1 - 2x = 2\sqrt{(x+1)(x-1)}$$

Squaring again, we get

$$1 - 4x + 4x^2 = 4(x^2 - 1)$$

$$\Rightarrow \quad 4x = 5 \text{ or } x = 5/4.$$

Putting this value of x in the given equation, we get

$$\sqrt{\frac{5}{4}+1} - \sqrt{\frac{5}{4}-1} = \sqrt{4\left(\frac{5}{4}\right)-1}$$

$$\Rightarrow \quad \frac{3}{2} - \frac{1}{2} = 2 \text{ or } 1 = 2$$

which is not true.
Thus, the given equation has no solution.

17. If c, d are roots of $x^2 - 10ax - 11b = 0$ and a, b are roots of $x^2 - 10cx - 11d = 0$, then the value of $a + b + c + d$ is

A. 1210
B. 1
C. 2530
D. 11

Sol. A

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$$c + d = 10a \quad (1)$$
$$a + b = 10c \quad (2)$$

Subtracting (1) from (2) we get

$$(a - c) + (b - d) = 10\ (c - a)$$
$$\Rightarrow \quad b - d = 11(c - a) \quad (3)$$

As c is a root of $x^2 - 10ax - 11b = 0$,
we get

$$c^2 - 10ac - 11b = 0 \quad (3)$$

Similarly, $a^2 - 10ac - 11d = 0$ (4)

Subtracting (4) from (3), we get

$$c^2 - a^2 = 11(b - d)$$
$$\Rightarrow \quad (c - a)\ (c + a) = (11)11(c - a)$$
$$\Rightarrow \quad c + a = 121$$
$$\therefore \quad a + b + c + d = 10(a + c) \quad \text{[from (1) and (2)]}$$
$$= 10(121) = 1210$$

18. If the sum of the roots of the quadratic equation $ax^2 + bx + c = 0$, is equal to the sum of the squares of their reciprocals, then

A. ab^2, ca^2, bc^2 are in A.P.
B. ab^2, bc^2, ca^2 are in A.P.
C. ab^2, bc^2, ca^2 are in G.P.
D. none of these

Sol. A

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Let α, β be the roots of $ax^2 + bx + c = 0$, then

$\alpha + \beta = -b/a$ and $\alpha\beta = c/a$.

We are given $\alpha + \beta = \dfrac{1}{\alpha^2} + \dfrac{1}{\beta^2} \Rightarrow \alpha^2\beta^2(\alpha + \beta) = \alpha^2 + \beta^2$

$\Rightarrow \quad (\alpha\beta)^2(\alpha + \beta) = (\alpha + \beta)^2 - 2\alpha\beta$

$\Rightarrow \quad \dfrac{c^2}{a^2}\left(\dfrac{-b}{a}\right) = \dfrac{b^2}{a^2} - \dfrac{2c}{a}$

$\Rightarrow \quad -bc^2 = ab^2 - 2a^2c$

$\Rightarrow \quad 2a^2c = ab^2 + bc^2$

$\Rightarrow \quad ab^2, ca^2, bc^2$ are in A.P.

19. If a and b are the non-zero distinct roots of $x^2 + ax + b = 0$, then the least value of $x^2 + ax + b$ is

A. 2/3
B. 9/4
C. 9/4
D. 1

Sol. C

We have $a + b = -a,\ ab = b$

As $\quad b \neq 0$, we get $a = 1$

$\therefore \quad 1 + b = -1 \Rightarrow b = -2$

Thus, $\quad x^2 + ax + b = x^2 + x - 2$

$= \left(x + \dfrac{1}{2}\right)^2 - \dfrac{9}{4} \geq -\dfrac{9}{4}$

$\therefore$ least value of $x^2 + ax + b$ is $-9/4$ which is attained at $x = -1/2$.

20. If a < b < c < d, then the equation $3(x - a)(x - c) + 5(x - b)(x - d) = 0$ has

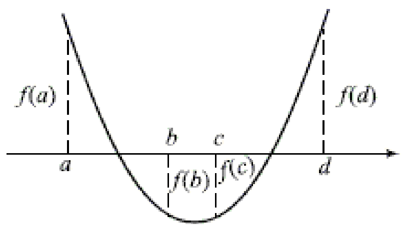
A. real and distinct roots
B. real and equal roots
C. purely imaginary roots
D. none of these

Sol. A

Let $f(x) = 3(x-a)(x-c) + 5(x-b)(x-d)$

Since f is a polynomial, f is continuous on **R**. Also, since $a < b < c < d$,

$$f(a) = 5(a-b)(a-d) > 0$$
$$f(b) = 3(b-a)(b-c) < 0$$
$$f(c) = 5(c-b)(c-d) < 0$$
$$f(d) = 3(d-a)(d-c) > 0$$



As f is continuous on ***R***, $y = f(x)$ crosses x-axis at least once between a and b and once between c and d.

Thus, f has two distinct real roots, one lying between a and b and one lying between c and d.

21. $\sqrt{x+3-4\sqrt{x-1}}+\sqrt{x+8-6\sqrt{x-1}}=1$. Solve for x.

(A) $\{5,10\}$ (B) $[1,\infty)$

(C) $[5,10]$ (D) none of these

Put $x - 1 = t^2$ in the given equation, we get

$$\sqrt{t^2+1+3-4t}+\sqrt{t^2+1+8-6t}=1$$

$|t-2| + |t-3| = 1$

$t \in [2, 3]$

$x \in [5, 10]$

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22. If the equation $x^2 + 5bx + 8c = 0$, does not have two distinct real roots, then minimum value of $5b + 8c$ is

(A) 1 (B) 2

(C) –2 (D) –1

Sol. Since the equation $x^2 + 5bx + 8c = 0$ does not have two distinct real roots and coefficient of x^2 is positive, hence $x^2 + 5bx + 8c \geq 0$

$\Rightarrow$ $5b + 8c \geq -1$. Hence the minimum value is –1.

23. Let a, b, c be real numbers with $a \neq 0$ and let α, β be the roots of the equation $ax^2 + bx + c = 0$. Then the roots of $a^3x^2 + abcx + c^3 = 0$ in terms of α, β are given by

(A) α, β (B) $\frac{c\alpha}{a}, \frac{c\beta}{a}$

(C) $a\alpha, c\beta$ (D) $c\alpha, a\beta$

Sol. Given equation $a^3x^2 + abcx + c + c^3 = 0$

written as $a\left(\frac{ax}{c}\right)^2 + b\left(\frac{ax}{c}\right) + c = 0$.

Clearly roots of this equation are $\frac{ax}{c} = \alpha, \beta$

$\Rightarrow$ $x = \frac{c\alpha}{a}, \frac{c\beta}{z}$

24. If a, b, c be the sides of ΔABC and equations $ax^2 + bx + c = 0$ and $5x^2 + 12x + 13 = 0$ have a common root, then $\angle C$ is

(A) 60° *(B) 90°*

(C) 120° *(D) 45°*

Solution: (B) Since $5x^2 + 12x + 13 = 0$ has imaginary roots as $D = 144 - 4 \times 5 \times 13 < 0$

So, both roots of $ax^2 + bx + c = 0$ and $5x^2 + 12x + 13 = 0$ will be common

$$\therefore \frac{a}{5} = \frac{b}{12} = \frac{c}{13} \Rightarrow a^2 + b^2 = c^2 \Rightarrow \angle C = 90°$$

25. *If $f(x) = (x - a_1)^2 + (x - a_2)^2 + \ldots\ldots\ldots(x - a_n)^2$ find x where f(x) is minimum.*

(A) ∞

(B) $\dfrac{a_1 + a_2 + \ldots\ldots\ldots a_n}{n}$

(C) $\dfrac{a_1 - a_2 - \ldots\ldots\ldots - a_n}{n}$

(D) $-\infty$

Solution: (B) minimum value of $f(x) = nx^2 - 2[a_1 + a_2 + \ldots\ldots a_n]\,x + a_1^2 + a_2^2 \ldots a_n^2$

exist at $x = -\dfrac{B}{2A} = \dfrac{a_1 + a_2 + \ldots\ldots\ldots a_n}{n}$.