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UIMO
Unified International Mathematics Olympiad

UNIFIED INTERNATIONAL MATHEMATICS OLYMPIAD

CLASS - 09

Question Paper Code : 40109

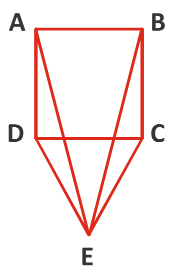
KEY

1	2	3	4	5	6	7	8	9	10
D	C	C	C	D	A	B	C	C	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	A	B	D	A	D	C	D	A	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	C	D	B	C	C	B	C	C
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A,B,C	A,B,D	A,B,C,D	B,C,D	A,B,D	A	D	D	D	A
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
C	A	B	C	A	C	C	A	B	A

SOLUTIONS

MATHEMATICS - 1

01. (D) It is give that ΔCDE is a an equiliateral triangle



$\angle CDE = \angle CED = \angle DEC = 60°$

It is also given that ABCD is a square

$\angle ADC = \angle BCD = 90°$

Now, $\angle ADE = \angle ADC + \angle CDE = 90° + 60° = 150°$ ...... (i)

and $\angle BCE = \angle BCD + \angle DCE = 90° + 60° = 150°$ ...... (i)

Thus, in Δs ADE and BCE, we have

AD = BC [Sides of same square]

DE = CD [Sides of an equilateral triangle]

and $\angle ADE = \angle BCE$ [from (i)]

So, by using SAS congruence congrience critertion, we obtain

$\Delta ADE \cong \Delta BCE$

$\angle ADE = 90° + 60° = 150°$

In ΔADE, AD = DE

$\therefore$ $x + x + 150° = 180°$

$2x = 30°$

$x = \frac{30°}{2} = 15°$

$\therefore$ $\angle BEC = 15°$

But $\angle DEC = 60°$

$x + \angle AEB + x = 60°$

$15° + \angle AEB + 15° = 60°$

$\angle AEB = 60° - 30°$

$\angle AEB = 30°$

02. (C) $x = \frac{9}{4}$

$$\frac{1}{\sqrt{6}+\sqrt{5}-\sqrt{11}} = \frac{1}{\left(\sqrt{6}+\sqrt{5}\right)-\sqrt{11}}$$

$$\times \frac{\left(\sqrt{6}+\sqrt{5}\right)+\sqrt{11}}{\left(\sqrt{6}+\sqrt{5}\right)+\sqrt{11}}$$

$$= \frac{\left(\sqrt{6}+\sqrt{5}+\sqrt{11}\right)}{\left(\sqrt{6}+\sqrt{5}\right)^2-\left(\sqrt{11}\right)^2}$$

$$= \frac{\left(\sqrt{6}+\sqrt{5}+\sqrt{11}\right)}{6+5+2\sqrt{6}\times\sqrt{5}-11}$$

$$= \frac{\left(\sqrt{6}+\sqrt{5}+\sqrt{11}\right)}{2\sqrt{30}} \times \frac{\left(\sqrt{30}\right)}{\sqrt{30}}$$

$$= \frac{\sqrt{6}\times\sqrt{30}+\sqrt{5}\times\sqrt{30}+\sqrt{11}\times\sqrt{30}}{2\times 30}$$

$$= \frac{6\sqrt{5}+5\sqrt{6}+\sqrt{330}}{60}$$

03. (C) Given the sides ratio = 3 : 4 : 5 = $3x : 4x : 5x$

$\therefore$ a = $3x$, b = $4x$ & c = $5x$

Given a + b + c = 156 m

$3x + 4x + 5x = 156$ m

$12x = 156$ m

$x = \frac{\cancel{156}^{13}}{\cancel{12}_{1}}$ m

$\therefore$ a = $3x$ = 3 × 13m = 39 m

b = $4x$ = 4 × 13m = 52m

c = $5x$ = 5 × 13m = 65 m

$c^2 = a^2 + b^2$

$\therefore$ a, b, c are the sides of a right angled triangle

$\therefore$ Area

$$= \frac{1}{2}\times ab = \frac{1}{\cancel{2}_1}\times 39 \times \cancel{52}^{26}\ m^2 = 1014\ cm^2$$

04. (C)

$$\begin{array}{r|l|l}
3x-4 & 12x^3 + 76x^2 + 155x + 100 & 4x^2 + 20x + 25 \\
 & 12x^3 + 16x^2 & \\
 & (-) \quad (-) & \\ \hline
 & \quad 60x^2 + 155x & \\
 & \quad 60x^2 + 80x & \\
 & \quad (-) \quad (-) & \\ \hline
 & \qquad 75x + 100 & \\
 & \qquad 75x + 100 & \\
 & \qquad (-) \quad (-) & \\ \hline
 & \qquad\quad 0) &
\end{array}$$

$$\therefore \sqrt{\frac{12x^3+76x^2+155x+100}{3x+4}}$$

$$= \sqrt{4x^2+20x+25}$$

$$= \sqrt{(2x)^2+2(2x)(5)+5^2}$$

$$= \sqrt{(2x+5)^2} = (2x+5)$$

05. (D) $\frac{1}{3-\sqrt{8}}=\frac{1}{3-\sqrt{8}}\times\frac{3+\sqrt{8}}{3+\sqrt{8}}=\frac{3+\sqrt{8}}{3^2-\left(\sqrt{8}\right)^2}$

$=\frac{3+\sqrt{8}}{9-8}=3+\sqrt{8}$

$\frac{1}{\sqrt{8}-\sqrt{7}}=\frac{1}{\sqrt{8}-\sqrt{7}}\times\frac{\sqrt{8}+\sqrt{7}}{\sqrt{8}+\sqrt{7}}$

$=\frac{\sqrt{8}+\sqrt{7}}{\left(\sqrt{8}\right)^2-\left(\sqrt{7}\right)^2}=\left(\sqrt{8}+\sqrt{7}\right)$

$\therefore \text{LHS}=\left(3+\sqrt{8}\right)-\left(\sqrt{8}+\sqrt{7}\right)+\left(\sqrt{7}+\sqrt{6}\right)$
$-\left(\sqrt{6}+\sqrt{5}\right)+\left(\sqrt{5}+2\right)$

$=3+\sqrt{8}-\sqrt{8}-\sqrt{7}+\sqrt{7}+\sqrt{6}-\sqrt{6}$
$-\sqrt{5}+\sqrt{5}+2=5$

06. (A) Given diagonal of a cube = diameter of a sphere

$\therefore$ $\sqrt{3}a$ = 2 cm

$\therefore$ $a=\frac{2\text{cm}}{\sqrt{3}}$

Volume of cube = a^3 = $\left(\frac{2}{\sqrt{3}}\text{cm}\right)^3$

= $\frac{8}{3\sqrt{3}}\text{cm}^3$

07. (B) s = $\frac{91\text{ cm} + 80\text{ cm} + 109\text{ cm}}{2}$

= $\frac{280\text{ cm}}{2}$

= 140 cm

Area of D = $\sqrt{s(s - a)(s - b)(s - c)}$

= $\sqrt{140\text{ cm} \times 49\text{ cm} \times 60\text{ cm} \times 31\text{ cm}}$

= $\sqrt{12759600}$ cm^2

3	12759600	3572.0
	9	
65	375	
	325	
707	5096	
	4949	
7142	14500	
	14284	
71420	31600	
	0	
	31600	

= 3,572 cm^2

But $\frac{1}{2}$ × h × 109 cm = 3,572 cm^2

$\therefore$ h = $\frac{3{,}572\text{ cm}^2 \times 2}{109\text{ cm}}$

h = 65.54 cm

08. (C) $\frac{(32)^{0.2}+(81)^{0.25}}{(256)^{0.5}-(121)^{0.5}}=\frac{\left(2^3\right)^{1/5}+\left(3^4\right)^{1/4}}{\left(2^8\right)^{1/2}-\left(11^2\right)^{1/2}}$

$=\frac{2^{5\times\frac{1}{5}}+3^{4\times\frac{1}{4}}}{2^{8\times\frac{1}{2}}-11^{2\times\frac{1}{2}}}=\frac{2+3}{2^4-11}=\frac{5}{16-11}$

$=\frac{5}{5}=1$

09. (C) $\angle$TSR = 80°

$\angle$OST = $\angle$OST = $\frac{180° - 50°}{2}$ = 65°

$x°$ = 80° – 65° = 15°

10. (C) $\angle$BAD = $\frac{1}{2}\angle$BOD

$=\frac{1}{2}\times 140^\circ = 70^\circ$

$\angle$DCP = $\angle$BAD [Since exterior angle of a cyclic quadrilateral is equal to the interior opp.angle.]

$\therefore$ $\angle$DCP = $\angle$BAD = 70°

11. (B) Given $\angle A = \angle B + \angle C$ In ΔABC

But $\angle A + \angle B + \angle C = 180°$

$\Rightarrow$ $\angle A + \angle A = 180°$

$[\therefore \angle B + \angle C = \angle A]$

$\angle A = 90°$

12. (A) Gives P lies $x = -5$ line & $y = 1$ line

$\therefore$ P = (–5, 1)

13. (B) $x^2 - z^2 + y^2 - p^2 + 2pz - 2xy$

$= (x - y)^2 - (p - z)^2$

$= (x - y + p - z)(x - y - p + z)$

14. (D) Let 'k' to be added to $(x^{46} - 3x^{35} + 2x^{24} + 5)$

So, that it is exactly divisible by $(x + 1)$

$\therefore$ $p(x) = x^{46} - 3x^{35} + 2x^{24} + 5 + k$ and $p(-1) = 0$

$p(-1) = (-1)46 - 3(-1)35 + 2(-1)2 + 5 + k = 0$

$1 - 3(-1) + 2 + 5 + k = 0$

$1 + 3 + 7 + k = 0$

$k = -11$

15. (A) Given $2x + 1^o + 4x - 10^o + x + 15^o + x + 10^o = 360^o$

$8x + 16^o = 360^o$

$8x = 344^o$

$x = 43^o$

16. (D) $S = \pi r l = \pi r\sqrt{r^2 + h^2}$

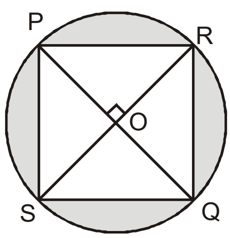
$V = \frac{1}{3}\pi r^2 h$

$\therefore$ $3\pi Vh^3 + 9V^2 - S^2h^2 = 3\pi \times \frac{1}{3}\pi r^2h \times h^3 + 9 \times \frac{1}{9}\pi^2r^4h^2 - \pi^2r^2(r^2 + h^2)h^2$

$= \pi^2r^2h^4 + \pi^2r^4h^2 - \pi^2r^4h^2 - \pi^2r^2h^4$

$= 0$

17. (C) Let the diagonals meet at O as shown in the figure



$\angle POS = \angle ROQ = 90°$

Also OP = OQ = OS = OR, i.e., the diagonals are equal and bisect at right angles. Clearly, PRQS is a square

18. (D) $\angle y + \angle G = 180°$ ....(Linear pair axiom)

or $\angle y + \angle 125° = 180°$

$\therefore$ $\angle y = 180° - 125° = 55°$

AB || DE and BD cuts them

$\therefore$ $\angle D = \angle B$ .....(Alt. $\angle$s)

or $\angle D = 65°$ ......(i)

Apain BD || FG and DF cuts them

$\therefore$ $\angle F = \angle D$ .... (Alt. $\angle$s)

$= 65°$ Using (i) .....(ii)

In Δ EFG, EG is produced

$\therefore$ $\angle x + \angle F = \angle G = 125°$

$\therefore$ $\angle x + 65° = 125°$ [Using (ii)]

or $\angle x = 125° - 65° = 60°$

Hence $\angle x = 60°$ and $\angle x = 55°$

$\angle x - \angle y = 60° - 55° = 5°$

19. (A) Given in ΔABC, $AB = AC \Rightarrow \angle C = \angle B = 35°$

In ΔABD and ΔACD

$\overline{AB} = \overline{AC}$ ($\because$ side & given)

$\overline{BD} = \overline{DC}$ ($\because$ side & given)

$\overline{AD} = \overline{AD}$ ($\because$ side & common)

$\therefore$ $\Delta ABD \cong \Delta ACD$ [$\because$ SSS congruency]

$\therefore$ $\angle BDA = \angle CDA$ [$\because$ CPCT]

But $\angle BDA + \angle CDA = 180°$

$\angle BDA + \angle BDA = 180°$

$2\angle BDA = 180°$

$\angle BDA = \frac{180°}{2} = 90°$

In ΔBAD, $35° + 90° + \angle BAD = 180°$

$125° + \angle BAD = 180°$

$\angle BAD = 180° - 125°$

$\angle BAD = 55°$

20. (D) a + b – c = a + b – c + c – c

= a + b + c – 2c

= 2s – 2c

= 2(s – c)

Similarly (a – b + c) = 2(s – b)

(b + c – a) = 2(c – a)

∴ (a + b + c) (a + b – c) (a – b + c)

(b + c – a) = 2s × 2(s – a) × 2(s – b) × 2(s – c)

= 16 3(s – a)(s –b)(s – c)

$= 16\left(\sqrt{s(s-a)(s-b)(s-c)}\right)^2$

$= 16\Delta^2$

21. (A) Given h = r

Volumes ratio of cone, hemisphere and

cylinder $= \frac{1}{3}\pi r^2 h : \frac{2}{3}\pi r^3 : \pi r^2 h$

$= \frac{1}{3}\pi r^2(r) : \frac{2}{3}\pi r^3 : \pi r^2(r)$

$= \frac{\not{\pi r^3}^{\,1}}{3} : \frac{2}{3}\not{\pi r^3} : \not{\pi r^3}^{\,1}$

$= \frac{1}{3} \times 3 : \frac{2}{3} \times 3 : 1 \times 3$

= 1 : 2 : 3

22. (B) In ΔABC, 40° + 90° +ΔB = 180°

∠B = 180° – 130° = 50°

In ΔBDE, ∠B + ∠D + ∠BED = 180°

50° + x + 100° = 180°

x = 180° – 150°

x = 30°

23. (C) Long division method: In this method, we first divide $x^3 + 13x^2 + 32x + 20$ by $(x + 2)$ to obtain the quotient as a quadratic in x and then we factorize the quotient by the methods discussed earlier.

$$x + 2 \,\big)\; x^3 + 13x^2 + 32x + 20 \;\big(\; x^2 + 11x + 10$$
$$x^3 + 2x^2$$
$$- \quad -$$
$$\overline{\quad 11x^2 + 32x \quad}$$
$$11x^2 + 22x$$
$$- \quad -$$
$$\overline{\quad 10x + 20 \quad}$$
$$10x + 20$$
$$- \quad -$$
$$\overline{\quad 0 \quad}$$

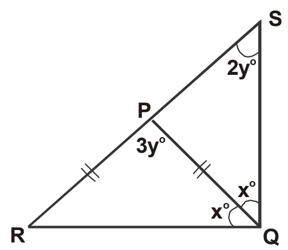
$x^3 + 13x^2 + 32x + 20 = (x + 2)(x + 1)(x + 10) = (x + 2)(x^2 + 11x + 10)$

$= (x + 2)(x^2 + x + 10x + 10) = (x + 2)\{(x^2 + x) + (10x + 10)\}$

$= (x + 2)\{x(x + 1) + 10(x + 1)\} = (x + 2)(x + 1)(x + 10)$

Hence, $x^3 + 13x^2 + 32x + 20 = (x + 2)(x + 1)(x + 10)$

24. (D) Given, PR = PQ = ∠PRQ = ∠RPQ = $x°$



$\Rightarrow x° + x° + 3y° = 180°$

$\Rightarrow 2x + 3y = 180°$ .... (i)

and $3y° = 2y° + x°$

$\Rightarrow x° = y°$ .... (ii)

From (i) and (ii) we get

$x° = y° = 36°$

∴ ∠RPQ = 3y° = 3 × 36° = 108°

25. (B) Sum of the shaded angles = 5 × sum of the angles of a triangle

$- \frac{\text{Complete angle}}{2}$

$= 5 \times 180° - \frac{360°}{2}$

= 900° – 180°

= 720°

26. (C) Given $x - \frac{1}{x} = (3 + 2\sqrt{2})$

Cubing on both sides

$$x^3 - \frac{1}{x^3} - 3\cancel{x} \times \frac{1}{\cancel{x}}(x - \frac{1}{x}) = (3 + 2\sqrt{2})^3$$

$$x^3 - \frac{1}{x^3} - 3(3 + 2\sqrt{2}) = 3^3 + 3 \times 3^2(2\sqrt{2}) + 3 \times 3(2\sqrt{2})^2 + (2\sqrt{2})^3$$

$$x^3 - \frac{1}{x^3} - 9 - 6\sqrt{2} = 27 + 54\sqrt{2} + 72 + 16\sqrt{2}$$

$$x^3 - \frac{1}{x^3} - 99 + 70\sqrt{2} + 9 + 6\sqrt{2}$$

$$= 108 + 76\sqrt{2}$$

27. (C) Length of each edge of the cube = 44 cm

Volume of the cube = $(44 \times 44 \times 44)\ cm^3$

Radius of each bullet, r = 2 cm

Volume of each bullet = $\left(\frac{4}{3}\pi r^3\right) cm^3$

$$= \left(\frac{4}{3} \times \frac{22}{7} \times 2 \times 2 \times 2\right) cm^3 = \frac{704}{21} cm^3$$

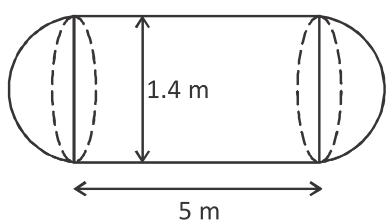
Number of bullets formed =

$$\frac{\text{volume of the cube in } cm^3}{\text{Volume of each bullet in } cm^3}$$

$$= \left(44 \times 44 \times 44 \times \frac{21}{704}\right) = 2541$$

Hence, the number of bullets formed is 2541

28. (B) We have, Diameter of the cylinder = 1.4 m



$$r = \text{Radius of the cylinder} = \frac{1.4m}{2} = 0.7m$$

and h = Length of the cylinder = 5 m

∴ S_1 = Surface area of the cylinder = $2\pi rh$

Clearly, Radius of the hemisphere = r.

∴ S_2 = Surface area of two hemi-spheres = $2 \times 2\pi r^2 = 4\pi r^2$

Let S be the total surface area of storage tank. Then,

$$S = S_1 + S_2 = 2\pi rh + 4\pi r^2 = 2\pi r(h + 2r)$$

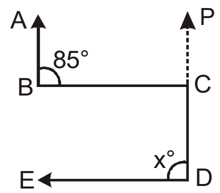
$$S = 2 \times \frac{22}{7} \times 0.7(5 + 2 \times 0.7)$$

$$= 2 \times 22 \times 0.1 \times 6.4 = 28.16\ m^2$$

Rate of painting = Rs. 10 per square metre.

∴ Cost of painting = Rs.(10 × 28.16) = Rs. 281.60

29. (C) Extend the line DC to a point P, such that AB | | CP,



Then $\angle BCP = \angle EDC = x°$ (Corresponding angles)

Also, $\angle ABC + \angle BCP = 180°$

⇒ $\angle BCP = 95°$

and $\angle BCP = \angle EDC = 95°$

30. (C) $\angle ACD = \angle BAC + \angle B = 30° + 40° = 70°$

$x = \angle ACD + 50° = 70° + 50°$

$x = 120°$

MATHEMATICS - 2

31. (A, B, C)

$\angle BCD = 36° + 30° = 66°$

∴ $\angle B = \angle BCD$

AB | | CD .... (1)

$\angle E + \angle ECD = 150° + 30° = 180°$

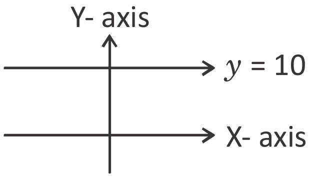
∴ EF | | CD .... (2)

From equation (1) and (2) AB | | EF

32. (A, B, D)

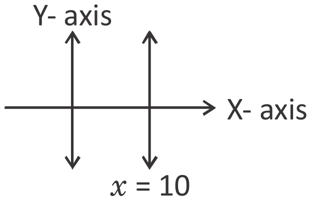
(0, 0) has on $x = y$ line.

$\therefore$ option 'A' is true



$y = 10$ line is perpendicular to y - axis

$\therefore$ option 'B' is true



$x = 10$ line is parallel to y - axis

$\therefore$ Option 'D' is correct

33. (A, B, C, D)

$$= \frac{1}{3}\pi r^2 h = 9856 \text{ cm}^3$$

$$= \frac{1}{3} \times \frac{22}{\cancel{7}_1} \times 14^2 \times 14 \times h \text{ cm}^3 = 9856 \text{ cm}^3$$

$$h = \cancel{9856}^{\cancel{448}\ \cancel{224}\ 16} \text{ cm}^3 \times 3 \times \frac{1}{\cancel{22}_1} \times \frac{1}{\cancel{2}_1} \times \frac{1}{\cancel{14}_1}$$

$$h = 48 \text{ cm}$$

$$l^2 = h^2 + r^2 = 48^2 + 14^2$$

$$= \sqrt{2304 + 196}$$

$$l = \sqrt{2500}$$

$$l = 50 \text{ cm}$$

CSA of a cone $= \pi r l$

$$= \frac{\cancel{22}}{\cancel{7}_1} \times \cancel{14}^2 \text{ cm} \times 50 \text{ cm}$$

$$= 2200 \text{ cm}^2$$

TSA of a cone $= \pi r l + \pi r^2$

$$= 2200 \text{cm}^2 + \frac{22}{\cancel{7}_1} \times \cancel{14}^2 \text{ cm} \times 14 \text{ cm}$$

$$= 2200 \text{ cm}^2 + 616 \text{ cm}^2$$

$$= 2816 \text{ cm}^2$$

34. (B, C, D)

$(x^2 - 4x)(x^2 - 4x - 1) - 20$

$= (x^2 - 4x)^2 - (x^2 - 4x) - 20$

$= y^2 - y - 20$, where $y = x^2 - 4x$

$= y^2 - 5y + 4y - 20$

$= (y^2 - 5y) + (4y - 20)$

$= y(y - 5) + 4(y - 5)$

$= (y - 5)(y + 4)$

$= (x^2 - 4x - 5)(x^2 - 4x + 4)$

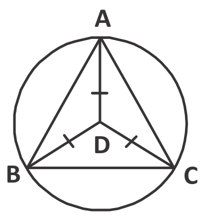
[Replacing y by $x^2 - 4x$]

$= (x^2 - 5x + x - 5)(x^2 - 2 \times x \times 2 + 2^2)$

$= \{x(x - 5) + (x - 5)\}(x - 2)^2 = (x - 5)(x + 1)(x - 2)^2$

35. (A, B, D)

'D' is equidistant from A, B, and C.



$\therefore$ 'D' is a circumcentre

$$\therefore \angle BAC = \frac{1}{2}\angle BDC = \frac{1}{2} \times 100^\circ$$

$$\angle BAC = 50^\circ$$

$$\angle BCA = \frac{1}{2}\angle BDA = \frac{1}{2} \times 144^\circ$$

$$\angle BCA = 72^\circ$$

$$\angle ABC = \frac{1}{2}\angle ADC = \frac{1}{\cancel{2}} \times \cancel{116^\circ}^{58^\circ}$$

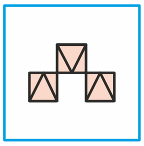
$$\angle ABC = 58^\circ$$

REASONING

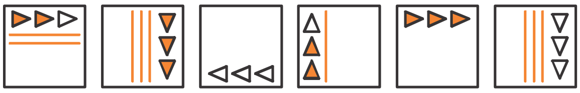
36. (A) Q RS T UVWXY Z ABCDEFG H I JKLMNOPQRS
2 5 7 10

Number of letters skipped between adjacent letters in the series is in the order of 2, 5, 7, 10.

37. (D)



38. (D) Initially number of lines are equal to the number of dark triangles and then white triangle is equal to the number of lines.



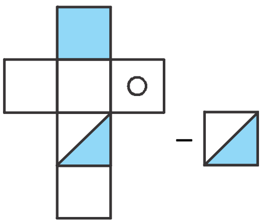
39. (D)
$3 \times 3 = 9$, $4 \times 4 = 16$] 916

$2 \times 2 = 4$, $6 \times 6 = 36$] 436

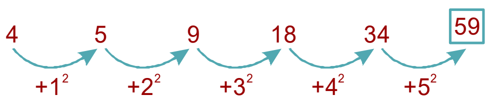
$1 \times 1 = 1$, $5 \times 5 = 25$] 125

40. (A) Only one cubes have only one face painted red.

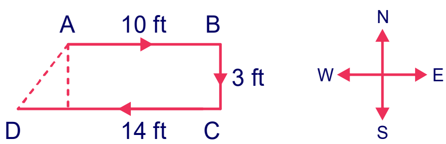
41. (C)



42. (A)



43 (B)

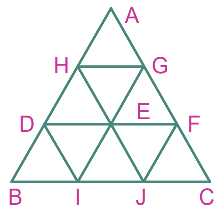


Required distance $AD = \sqrt{3^2 + (14-10)^2}$

$= \sqrt{9+16}$

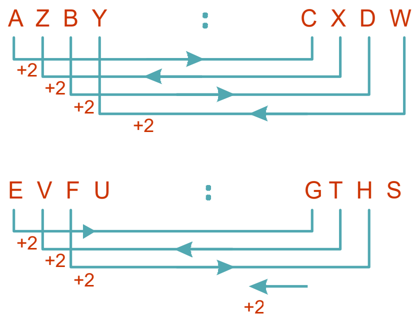
$= 5$ ft

44. (C) There are 15 parallelograms in the given figure.



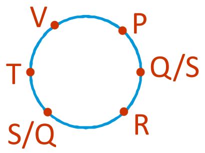
1.	BDEI	2.	EFJI
3.	DEJI	4.	EFCJ
5.	DEGH	6.	EFGH
7.	EGAH	8.	BHGI
9.	GHJC	10.	AGID
11.	AFJH	12.	DHEI
13.	EGFI	14.	DFJB
15.	DFCI		

45. (A)



CRITICAL THINKING

46. (C)



47. (C) House 17 is 6th from the right side. Now on the opposite lane houses start from number 23. 6th house from the right side on opposite lane would be 28th

44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

48. (A) In fig. (X), one of the dots lies in the region common to the square and the triangle only, another dot lies in the region common to the circle and the triangle only and the third dot lies in the region common to the triangle and the rectangle only. In fig. (2), there is no region common to the square and the triangle only. In fig. (3), there is no region common to the circle and the triangle only. In fig. (4) there is no region common to the triangle and the rectangle only. Only fig. (1) consists of all the three types of regions.

49. (B) The statement talks of Jade plants only and not “all plants with thick leaves”. So, I does not follow. Also, since Jade plants require little water, so they can be grown in places where water is not in abundance so, II follows.

50. (A) Because Mr. Sachin spends many hours during the weekend working in his vegetable garden, it is reasonable to suggest that he enjoys this work. There is no information to suggest that he does not like classical music. Although Mrs. Sanchez likes to cook, there is nothing that indicates she cooks vegetables (choice c). Mrs. Sachin likes to read, but there is no information regarding the types of books she reads (choice d).

The End