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UIMO
Unified International Mathematics Olympiad

UNIFIED INTERNATIONAL MATHEMATICS OLYMPIAD

CLASS - 10
Question Paper Code : UN40109

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C	B	C	D	B	C	A	D	C	D

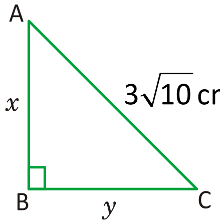
SOLUTIONS

MATHEMATICS - 1

01. (D) Given in ΔABC

$\angle B = 90^\circ$ & $AC = 3\sqrt{10}$ cm

Let AB = x & BC = y



$\therefore x^2 + y^2 = \left(3\sqrt{10}\right)^2 = 90 \rightarrow (1)$

Given $(3x)^2 + (2y)^2 = \left(9\sqrt{5}\right)^2$

$\Rightarrow 9x^2 + 4y^2 = 405 \rightarrow (2)$

eq (2) – eq (1) × 4 $\Rightarrow (9x^2 + 4y^2) - (4x^2 + 4y^2) = 405 - 4 \times 90$

$5x^2 = 45$

$x^2 = \frac{45}{5} = 9$

$x = \sqrt{9} = 3$

$9 + y^2 = 90 \rightarrow (1)$

$y^2 = 90 - 9 = 81$

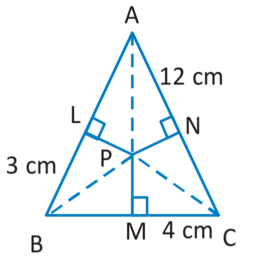
$y = \sqrt{81} = 9$

$x + y = 3 + 9 = 12$ cm

02. (C) Construction :- Join PA, PS & PC

$AL^2 + BM^2 + CN^2 = AP^2 - PL^2 + BP^2 - PM^2 + CP^2 - PN^2$

$= BP^2 - PL^2 + CP^2 - PM^2 + AP^2 - PN^2$



$= BL^2 + CM^2 + AN^2 = (3\text{ cm})^2 + (4\text{ cm})^2 + (12\text{ cm})^2$

$= 9\text{ cm}^2 + 16\text{ cm}^2 + 144\text{ cm}^2 = 169\text{ cm}^2$

03. (B) 6 m 5 cm = 605 cm

20 m 35 cm = 2035 cm

HCF of 2035 cm and 605 cm

```
605)2035(3
    1815
    ----
     220)605(2
         440
         ---
          55)220(4
             220
             ---
             (0)
```

```
55)1100(20
   1100
   ----
   (0)
```

HCF = 55 cm

04. (C) $(x^2 - 4x + 4)(x + 3) = (x - 2)^2 (x + 3)$

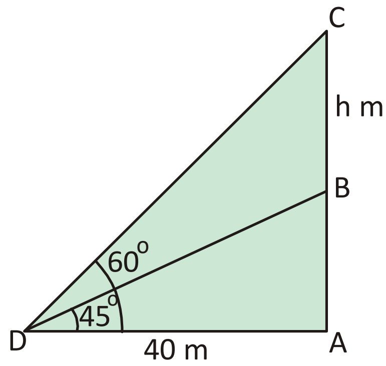
$= (x - 2)(x - 2)(x + 3)$

$(x^2 + 2x - 3)(x - 2) = (x + 3)(x - 1)(x - 2)$

∴ Common factors are $(x - 2)(x + 3)$.

∴ H.C.F. of given polynomals are $(x - 2)(x + 3)$.

05. (D) Let AB be the height of the incomplete tower and suppose it has been raised by h m. Then,



$\tan 45° = \frac{AB}{40}$ or AB = 40 m

$\tan 60° = \frac{h + AB}{40}$

$\Rightarrow h = 40\sqrt{3} - AB = 40\left(\sqrt{3} - 1\right)$m

06. (D) Let P(2, 5) divides the Join of A(8, 2) and B(–6, 9) in the ratio $m_1 : m_2$

$\therefore\ P(2,5) = \left(\frac{m_1(-6) + m_2 \times 8}{m_1 + m_2}, \frac{9m_1 + 2m_2}{m_1 + m_2}\right)$

$\therefore\ \frac{-6m_1 + 8m_2}{m_1 + m_2} = 2 \Rightarrow -6m_1 + 8m_2 = 2m_1 + 2m_2$

$-6m_1 - 2m_1 = 2m_2 - 8m_2$

$\cancel{-}8m_1 = \cancel{-}6m_2$

$\frac{m_1}{m_2} = \frac{6}{8} = \frac{3}{4}$

$\therefore\ m_1 : m_2 = 3 : 4$

07. (A) Given PQ = PR

$\sqrt{(h+2)^2 + 16} = \sqrt{(h-4)^2 + 16}$

$\Rightarrow h^2 + 4h + 20 = h^2 - 8h + 32$

$\Rightarrow 12h = 12$

$\Rightarrow h = 1$

08. (B) Given $\Delta ADE \sim \Delta ABC \Rightarrow \frac{AD}{AB} = \frac{DE}{BC} = \frac{AE}{AC}$

$$\Rightarrow \frac{1.2\text{cm}}{BC} = \frac{\cancel{3\text{cm}}^{2}}{\cancel{7.5\text{cm}}_{5}}$$

$$\Rightarrow BC = \frac{\cancel{1.2}^{0.6}\ \text{cm} \times 5}{\cancel{2}_{1}}$$

= 3 cm

09. (B) The two-digit number is of the form 7n + 3

First two-digit number will be for n = 1

i.e., 7 × 1 + 3 = 10

Last two-digit number will be for

n = 13

i.e., 7 × 13 + 3 = 94

No. of terms = 13

Sum of all 13 terms

$= \frac{13}{2}$ (10 + 94)

= 13 × 52 = 676

10. (C) secθ + tanθ = θ

$\frac{1}{\cos\theta} + \frac{\sin\theta}{\cos\theta} = p$ 1 + sinθ = p cosθ

sin θ + tan θ = p,

$\frac{1}{\cos\theta} + \frac{\sin\theta}{\cos\theta} = p$ or 1 + sinθ = p cosθ

⇒ $(\sin\theta + \tan\theta)^2 = p^2$,

⇒ $\sec^2 + \tan^2\theta + 2\sec\theta\tan\theta = p^2$

⇒ $p^2 + 1 = \sec^2 + 1 + \tan^2\theta + 2\sec\theta\tan\theta$

⇒ $p^2 + 1 = 2\sec^2\theta + 2\sec\theta\tan\theta$

⇒ $p^2 + 1 = 2\sec^2\theta(\sec\theta + \tan\theta)$

⇒ $p^2 + 1 = 2\sec^2\theta(p) + 2\sec\theta\tan\theta$

⇒ $\frac{p^2+1}{2p} = \sec\theta$

⇒ $\cos\theta = \frac{2p}{p^2+1}$

11. (C) Volume of the vessel

$= \frac{1}{2} \times \frac{4}{3}\pi(R^3 - r^3)$

$= \frac{2}{3} \times \frac{22}{7}\left[\left(\frac{21}{2}\right)^3 - 7^3\right]\text{cm}^3$

$= 44\left(\frac{21^2}{8} - \frac{49}{3}\right)$

$= 44 \times \frac{931}{24}\text{cm}^3 = \frac{10241}{6}\text{cm}^3$

∴ Weight of the vessel

$= \frac{10241}{6} \times 10\text{g}$

$= \frac{10241 \times 10}{6 \times 1000}$ kg = 17.07 k

12. (B) Let co-ordinates of Q be (x, y).

$\frac{x-2}{2} = 4$; $\frac{y+9}{2} = 3$

$x = 10$; y = – 3

∴ (10, –3) are the co-ordinates of Q.

13. (D) $X = \left(\frac{m_1x_2 + m_2x_1}{m_1 + m_2}, \frac{m_1y_2 + m_2y_1}{m_1 + m_2}\right)$

$= \left(\frac{(2\times -3) + 3\times 7}{5}, \frac{2\times 6 + 4\times 3}{5}\right)$

$= \left(\frac{-6+21}{5}, \frac{12+12}{5}\right)$

$= \left(\frac{\cancel{15}^{3}}{\cancel{5}}, \frac{24}{5}\right)$

$= \left(3, \frac{24}{5}\right)$

14. (B) LHS = $3(\sin\theta - \cos\theta)^4 + 6(\sin\theta + \cos\theta)^2 + 4(\sin^6\theta + \cos^6\theta)$

$= 3(\sin^2\theta + \cos^2\theta - 2\sin\theta\cos\theta)^2 + 6(\sin^2\theta + \cos^2\theta + 2\sin\theta\cos\theta) + 4[(\sin^2\theta + \cos^2\theta)^3 - 3\sin^2\theta\cos^2\theta(\sin^2\theta + \cos^2\theta)]$

$= 3(1 - 2\sin\theta\cos\theta)^2 + 6(1 + 2\sin\theta\cos\theta) + 4(1 - 3\sin^2\theta\cos^2\theta)$

= 3 (1 + 4 $\sin^2\theta\cos^2\theta$ – 4$\sin\theta\cos\theta$) + 6 + 12 $\sin\theta\cos\theta$ + 4 – 12 $\sin^2\theta\cos^2\theta$

$= 3 + 12\sin^2\theta\cos^2\theta - 12\sin\theta\cos\theta + 10 + 12\sin\theta\cos\theta - 12\sin^2\theta\cos^2\theta$

= 13

15. (A) Given $\Delta PQR \sim \Delta DEF$

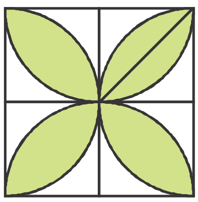
$\frac{PQ}{DE} = \frac{QR}{EF} = \frac{PR}{DF}$

$\Rightarrow \frac{3.6\text{ cm}}{2.4\text{ cm}} = \frac{PR}{5.4\text{ cm}}$

$PR = \frac{3.6}{2.4} \times 5.4$

= 8.1 cm

16. (B) Radius = 14 cm ÷ 2 = 7 cm



Area of a  $= \frac{1}{4} \times \frac{22}{7} \times 7\text{ cm} \times 7\text{ cm} = 38.5\text{ cm}^2$

Area of a  $= \frac{1}{2} \times 7\text{ cm} \times 7\text{ cm} = 24.5\text{ cm}^2$

Area of a  $= 38.5\text{ cm}^2 - 24.5\text{ cm}^2 = 14\text{ cm}^2$

Area of shaded region = $14\text{ cm}^2 \times 8 = 112\text{ cm}^2$

17. (C) Given $2\pi rh = 264\text{ m}^2$ & $\pi r^2 h = 924\text{ m}^3$

$\therefore \frac{\pi r^2 h}{2\pi r h} = \frac{924^{7}\text{ m}^3}{264_{2}\text{ m}^2}$

$\therefore r = 7\text{ m}$

$2 \times \frac{22}{7} \times 7 \times h = 264\text{ m}^2$

$h = \frac{264^{132^{12^{6}}}\text{ m}^2}{2 \times 22_{2_1}\text{ m}} = 6\text{m}$

$\therefore$ The ratio of height and diameter

$= 6^3 : 14^7 = 3:7$

18. (C) $\sqrt{3}x^2 + 10x - 8\sqrt{3} = 0$

$\sqrt{3}x^2 + 12x - 2x - 8\sqrt{3} = 0$

$\sqrt{3}x(x + 4\sqrt{3}) - 2(x + 4\sqrt{3}) = 0$

$(x + 4\sqrt{3})(\sqrt{3}x - 2) = 0$

$x + 4\sqrt{3} = 0$ (or) $\sqrt{3}x - 2 = 0$

$x = -4\sqrt{3}$ (or) $x = \frac{2}{\sqrt{3}}$

19. (C) $\cos\theta = \frac{10}{20} = \frac{1}{2} \Rightarrow \theta = 60°$

$\angle PLK = 180° - 90° - 60° = 30°$

$\angle NLM = 180° - 90° - 30° = 60°$

$\cos\angle NLM = \cos 60° = \frac{NL}{LM} = \frac{NL}{6}$

$\Rightarrow \frac{1}{2} = \frac{NL}{6} \Rightarrow NL = 3\text{ cm}$

$\therefore$ $MN = \sqrt{ML^2} = \sqrt{6^2 - 3^2} = \sqrt{27}$

Hence, MN = $3\sqrt{3}$ cm

20. (C) Join O to P and Q. Join P to R. Draw SP $\perp$ OQ.

Now SP = QR, as they are opposite sides of rectangle PRQS.

OP = 8 cm + 4 cm = 12 cm

OS = 8 cm – 4 cm = 4 cm

$\therefore$ $SP = \sqrt{OP^2 - OS^2}$

$= \sqrt{12^2 - 4^2}\text{ cm} = 8\sqrt{2}\text{ cm}$

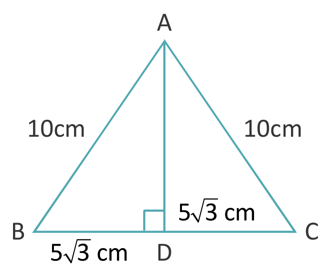
$\therefore$ $QR = 8\sqrt{2}$ cm

21. (D) The required distance =

$\sqrt{\left[(\sqrt{3}+1)-(\sqrt{3}-1)\right]^2 + \left[(\sqrt{2}-1)-(\sqrt{2}+1)\right]^2}$

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

22. (D) Construct AD $\perp$ BC



$BD = DC = \frac{BC}{2} = 5\sqrt{3}\text{ cm}$

$\sin\angle BAD = \frac{5\sqrt{3}\text{ cm}}{10\text{ cm}} = \frac{\sqrt{3}}{2} = \sin 60°$

$\therefore$ $\angle BAC = 2\angle BAD = 120°$

23. (C) $\alpha + \beta = \frac{-b}{a} = \frac{-(-14)}{1} = 14$,

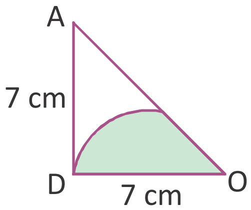
$\alpha^2\beta + \alpha\beta^2 = \alpha\beta(\alpha + \beta)$

$= 1(14)$

14

$\alpha\beta = \frac{c}{a} = \frac{1}{1} = 1$

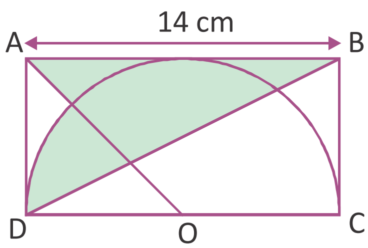
24. (B) Area of unshaded region of isosceles right angled $\Delta ADO = \frac{1}{2}\times 7\times 7\text{cm}^2$



$-\frac{45°}{360°}\times\frac{22}{7}\times 7\times 7\text{cm}^2$

$= 24.5\text{ cm}^2 - 19.25\text{ cm}^2$

$= 5.25\text{ cm}^2$ $\rightarrow$ (1)



$\therefore$ Area of shaded region

= Area of ΔABD – eq (1)

$= \frac{1}{2}\times 7\times 14\text{cm}^2 - 5.25\text{cm}^2$

$= 43.75\text{ cm}^2$

25. (B) Let the usual speed of plane = x km/hr

The increased speed of the plane = km/hr

$\Rightarrow y = (x + 250)$ km/hour. ... (1)

Distance = 1500 km.

According to the question,

(Scheduled time) – (time in increasing the speed) = 30 minutes

$\frac{1500}{x} - \frac{1500}{y} = \frac{1}{2}$ ... (2)

$\left[\text{Time} = \frac{\text{Distance}}{\text{Speed}}\right]$

$\frac{1500}{x} - \frac{1500}{x+250} = \frac{1}{2}$ [$\therefore$ From (1)]

$\Rightarrow \frac{1500x + 375000 - 1500x}{x(x+250)} = \frac{1}{2}$

$\Rightarrow x(x + 250) = 750000$

$\Rightarrow x^2 + 250x - 750000 = 0$

$\Rightarrow x^2 + 1000x - 750x - 750000 = 0$

$\Rightarrow x(x + 1000) - 750(x + 1000) = 0$

$\Rightarrow (x - 750)(x + 1000) = 0$

$\Rightarrow x = 750$ or $x = -1000$

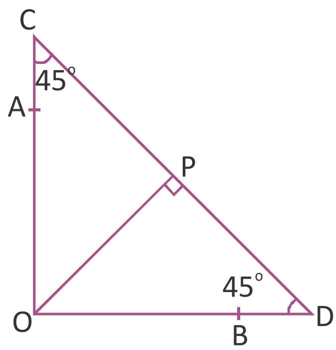
But speed can never be negative

Hence, the usual speed = 750 km/hr

26. (D) The first 'n' even numbers are 2, 4, 6, ..., 2n

$\therefore S_n = \frac{n}{2}(2 + 2n) = n(n + 1)$

27. (A) OC = OD and OA = OP = OB



OP = 1 m

PC = 1m

$OC = \sqrt{2}$ m

$\therefore$ AC = OC – OA

$= (\sqrt{2} - 1)$ m

and $AC + AP = (\sqrt{2} - 1) + 1$

$= \sqrt{2} = 1.414$ m

28. (D) a and b are the roots of $x^2 + px + 1 = 0$

$\Rightarrow \alpha + \beta = -p, \alpha\beta = 1$

γ and δ are the roots of $x^2 + qx + 1 = 0$

$\Rightarrow \gamma\delta = 1$

$\gamma^2 + q\gamma + 1 = 0 \Rightarrow \gamma^2 + 1 = -q\gamma$

$\delta^2 + q\delta + 1 = 0 \Rightarrow \delta^2 + 1 = -q\delta$

$(\alpha - \gamma)(\beta - \gamma)(\alpha + \delta)(\beta + \delta)$

$= [\alpha\beta - \gamma(\alpha + \beta) + \gamma^2]$

$[\alpha\beta + \delta(\alpha + \beta) + \delta^2]$

$= (1 + p\gamma + \gamma^2)(1 - p\delta + \delta^2)$

$= (-q\gamma + p\gamma)(-p\delta - q\delta)$

$= -\gamma(q - p) \times \delta(p + q)$

$= \gamma\delta(q^2 - p^2)$

$= (q^2 - p^2)$

29. (A) sin 0°+ cos30° – tan45°

+ cosec 60° + cot90°

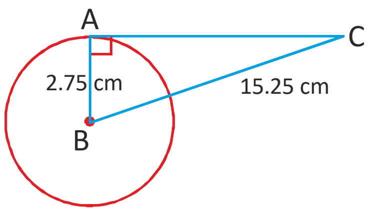
$= 0 + \frac{\sqrt{3}}{2} - 1 + \frac{2}{\sqrt{3}} + 0$

$= \frac{3 - 2\sqrt{3} + 4}{2\sqrt{3}}$

$= \frac{7 - 2\sqrt{3} \times \sqrt{3}}{2\sqrt{3} \times \sqrt{3}}$

$= \frac{7\sqrt{3} - 6}{6}$

30. (C)



In ΔABC, $\angle$BAC = 90°

[$\because$ A tangent is perpendicular to radius]

$AC^2 = \sqrt{BC^2 - AB^2}$

$= \sqrt{(15.25)^2 - (2.75)^2}$

$= \sqrt{232.5625 - 7.5625}$

$= \sqrt{225}$ cm

= 15 cm

MATHEMATICS - 2

31. (B, C)

In ΔABC, DE||BC

$\Rightarrow \frac{AD}{BC} = \frac{AE}{CE} \Rightarrow \frac{3x - 2}{7x - 5} = \frac{5x - 4}{5x - 3}$

$\Rightarrow x = 1$ or $\frac{7}{10}$

32. (A, C)

$$
\begin{array}{r|l}
x + 1) & x^3 - 3x - 2\,(x^2 - x - 2 \\
 & x^3 + x^2 \\ \hline
 & -x^2 - 3x - 2 \\
 & -x^2 - x \\ \hline
 & -2x - 2 \\
 & -2x - 2 \\ \hline
 & 0
\end{array}
$$

$x^3 - 3x - 2 = (x + 1)(x^2 - x - 2)$

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

33. (A, C)

Given $\text{Sin}(A + B) = \frac{\sqrt{3}}{2} = \text{Sin}60°$

$\therefore$ A + B = 60° $\rightarrow$ (1)

Given $\text{Cos}(A - B) = \frac{\sqrt{3}}{2} = \text{Cos}30°$

$\therefore$ A – B = 30° $\rightarrow$ (2)

eq $(1) + (2) \Rightarrow A + \cancel{B} + A - \cancel{B} = 60° + 30° = 90°$

2A = 90° $\Rightarrow \angle$A = 45°

45° + B = 60°

B = 60° – 45°

B = 15°

34. (B, C)

The given relation can be written as

$(m + 2)\tan\theta + (2m - 1) = (2m + 1)\sec\theta$

$\Rightarrow (m + 2)^2 \tan^2\theta + 2(m + 2)(2m - 1)\tan\theta + (2m - 1)^2$

$= (2m + 1)^2 (1 + \tan^2\theta)$

$\Rightarrow [(m + 2)^2 - (2m + 1)^2] \tan^2\theta + 2(m + 2)$

$(2m - 1)\tan\theta + (2m - 1)^2 - (2m + 1)^2 = 0$

$\Rightarrow 3(1 - m^2)\tan^2\theta + (4m^2 + 6m - 4)\tan\theta - 8m = 0$

$\Rightarrow (3 \tan\theta - 4)\,[(1 - m^2)\tan\theta + 2m] = 0$

which is true if $\tan\theta = \frac{4}{3}$ or $\tan\theta$

$= 2m/(m^2 - 1)$

35. (A, B, C, D)

ABCD is a cyclic quadrilateral

$\therefore \angle A + \angle C = 180^\circ$ & $\angle B + \angle D = 180^\circ$

$2x - 3^\circ + 2y + 17^\circ = 180^\circ$

$y + 7^\circ + 4x - 9^\circ = 180^\circ$

$2x + 2y + 14^\circ = 180^\circ$

$4x + y = 182^\circ \rightarrow 2$

$2x + 2y = 180^\circ - 14^\circ$

$2(x + y) = 166^\circ$

$$x + y = \frac{166^\circ}{2} = 83^\circ \rightarrow (1)$$

Solving eq (1) & (2) we get $x = 33^\circ$ & $y = 50^\circ$

$\therefore \angle A + \angle B = 2x - 3^\circ + y + 7^\circ = 63^\circ + 50^\circ + 7^\circ = 120^\circ$

$\angle A = 2x - 3 = 2 \times 33^\circ - 3^\circ = 66^\circ - 3^\circ = 63^\circ$

$\angle B = y + 7^\circ = 50^\circ + 7^\circ = 57^\circ$

$\angle C = 2y + 17^\circ = 100^\circ + 17^\circ = 117^\circ$

$\angle D = 180^\circ - \angle B = 180^\circ - 57^\circ = 123^\circ$

$\angle A + \angle D = 63^\circ + 123^\circ = 186^\circ$

$\angle A + \angle B = 63^\circ + 57^\circ = 120^\circ$

$\angle B + \angle C = 57^\circ + 117^\circ = 174^\circ$

REASONING

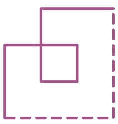
36. (B)

$$P \xrightarrow{+2} R \xrightarrow{+2} T \xrightarrow{+2} V \xrightarrow{+2} X$$

$$3 \xrightarrow{+2} 5 \xrightarrow{+3} 8 \xrightarrow{+4} 12 \xrightarrow{+5} 17$$

$$C \xrightarrow{+3} F \xrightarrow{+3} I \xrightarrow{+3} L \xrightarrow{+3} O$$

37. (C) The answer figure is as shown below:



Hence answer is (C)

38. (C) Column one : $4 \rightarrow 4(2)^2 = 416$

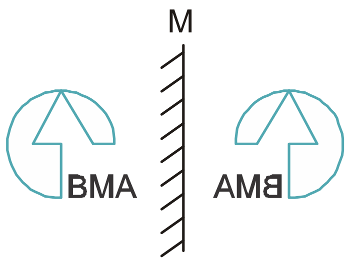
Column two : $7 \rightarrow 7(7)^2 = 749$

Column three : $3 \rightarrow 3(3)^2 = 309$

Column four : $2 \rightarrow 2(2)^2 = 204$

Hence correct answer is option (C)

39. (D)

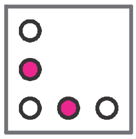


40. (A) The number of circles increase by one each time.

The shading of the new circle alternates from shading to unshaded.

When the circle is added, the remaining circles move around the edge of the box in an anti clock wise direction.

The missing box must look like the below



41. (C) There are 14 squares in the given figure.

1. AFMG	2. GHMN	3. BHNI
4. EFMI	5. KLMN	6. IJKN
7. CQKJ	8. LKQP	9. DELP
10. AHKE	11. GBJL	12. CPMI
13. DFNQ	14. ABCD.	

42. (B) Since the total number of dots on opposite face is always 7, therefore, 1 dot appears opposite 6 dots, 2 dots appear opposite 5 dots and 3 dots appear opposite 4 dots.

Fig. A, C, D are wrong since,

1 dot cannot appear adjacent to 6 dots.

3 dots cannot appear adjacent to 4 dots.

and 2 dots cannot appear adjacent to 5 dots.

43. (C) The new alphabet series after deleting every alternate letter starting from B is

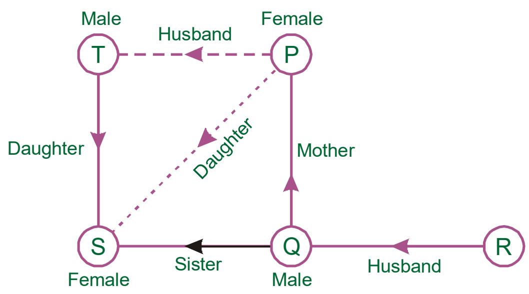
$\xrightarrow{\text{left}}$

A C E G I K (M) O Q S U W Y

Now 3 + 4 = 7 (left to right)

The seventh letter from the left is M.

44. (D)



45. (B) 10 : 99 :: 9 : 80

$10^2 - 1$ (100–1) ; $9^2 - 1$ (82–1)

CRITICAL THINKING

46. (C) Because the first two sentences are true, both John and David saw more movies than Suman. However, it is uncertain as to whether David saw more movies than John.

47. (A) All Fridays in March:

$1st \xrightarrow{+7} 8th \xrightarrow{+7} 15th \xrightarrow{+7} 22nd \xrightarrow{+7} 29th$

There are 31 days in March

Sat	Sun	Mon
30th	31st	1st

Since 1st April fell on Monday.

$1st \xrightarrow{+7} 8th \xrightarrow{+7} 15th$

15th April fell on a Monday in the same year.

48. (D) Closing the schools for a week and the parents withdrawing their wards from the local schools are independent issues, which must have been triggered by different individual causes.

49. (C)

Bench I [P] [T] (S)

Bench II [U] (Q)

Bench III [V] (R)

□ = Boy ○ = Girl

QRS are group of girls.

50. (D) The first sentence makes this statement true. There is no support for choice a. The passage tells us that the spa vacation is more expensive than the island beach resort vacation, but that doesn't necessarily mean that the spa is overpriced; therefore, choice b cannot be supported. And even though the paragraph says that the couple was relieved to find a room on short notice, there is no information to support choice c, which says that it is usually necessary to book at the spa at least six months in advance.

The End