CAT Quantitative Aptitude

Sample Paper – 3

Duration: 40 Minutes **Maximum Marks: 66**

Instructions

- This paper contains **22** Multiple Choice Questions (Single Correct Answer), modelled on the Quantitative Aptitude portion of **CAT** entrance.
- Each correct answer carries **+3 marks**. There is -1 **mark per wrong answer**; no penalty for unattempted questions.
- Only **one** option is correct per question. Choose carefully.
- No personal calculators are allowed; a basic on-screen calculator is provided in the actual CAT examination.
- Rough sheets are provided at the test centre; do not do rough work on the question paper.
- Syllabus level: **Arithmetic, Algebra, Geometry & Mensuration, and Modern Mathematics at the level of the CAT Quantitative Aptitude section.**

Q1. Find the units digit of $17^{61} + 14^{52}$.

(A) 1

(B) 7

(C) 3

(D) 9

Q2. For which positive integer n is the expression $n^2 + 14n + 49$ equal to the *fourth power* of a prime number?

(A) $n = 2$

(B) $n = 5$

(C) $n = 8$

(D) $n = 11$

Q3. What is the remainder when $83^{41} \times 17^{26}$ is divided by 7?

(A) 1

(B) 2

(C) 3

(D) 5

Q4. The population of a town was $2{,}40{,}000$ at the start of 2022. It increased by 15% during 2022 and decreased by 10% during 2023. What was the population at the end of 2023?

(A) $2{,}36{,}000$

(B) $2{,}48{,}400$

(C) $2{,}52{,}000$

(D) $2{,}61{,}200$

Q5. A shopkeeper marks the price of a watch 40% above its cost price and then gives a discount of 15% on the marked price. What is the net profit percentage?

(A) 21%

(B) 20%

(C) 19%

(D) 16%

Q6. Priya and Ravi start simultaneously from the same point on a circular track of circumference 840 m and run in *opposite* directions at speeds of 7 m/s and 5 m/s respectively. After how many seconds will they meet for the *first* time?

(A) 70 s

(B) 84 s

(C) 105 s

(D) 120 s

Q7. The sum of three numbers p, q, and r is 60. The sum of p and q exceeds r by 20, and twice q equals p plus r. Find the value of q.

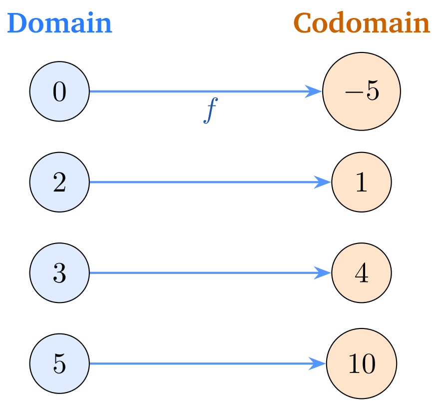
(A) 10

(B) 15

(C) 18

(D) 20

Q8. A function $f : \mathbb{R} \to \mathbb{R}$ is defined by $f(x) = 3x - 5$. The mapping diagram below shows representative values.



Find $f\left(f^{-1}(7)\right) + f(2)$.

(A) 5

(B) 8

(C) 10

(D) 12

Q9. If $a + b = 7$ and $ab = 10$, find the value of $a^3 + b^3$.

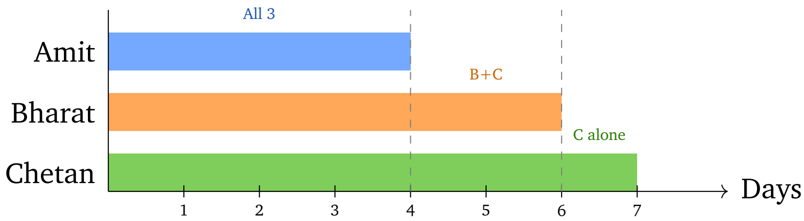
(A) 126

(B) 140

(C) 133

(D) 154

Q10. Amit, Bharat, and Chetan can complete a project in 12, 18, and 24 days respectively working alone. All three work together for 4 days, after which Amit leaves. Bharat and Chetan work together for 2 more days, then Bharat also leaves. How many *additional* days does Chetan alone need to complete the remaining work?



(A) 3

(B) 4

(C) 5

(D) 6

Q11. A motorist travels from city P to city Q (distance 240 km) at 80 km/h and returns from Q to P at 60 km/h. What is the average speed for the entire round trip?

(A) 70 km/h

(B) 71 km/h

(C) 72.5 km/h

(D) $\frac{480}{7}$ km/h

Q12. In a 1000 m race, Arjun beats Bhuvan by 80 m and Bhuvan beats Chandan by 50 m. By how many metres does Arjun beat Chandan in the same 1000 m race?

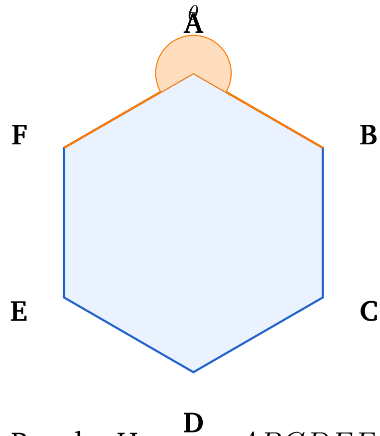
(A) 124 m

(B) 126 m

(C) 128 m

(D) 130 m

Q13. The figure shows a regular hexagon $ABCDEF$ with one interior angle θ marked at vertex A.



Regular Hexagon $ABCDEF$

What is the measure of each interior angle θ?

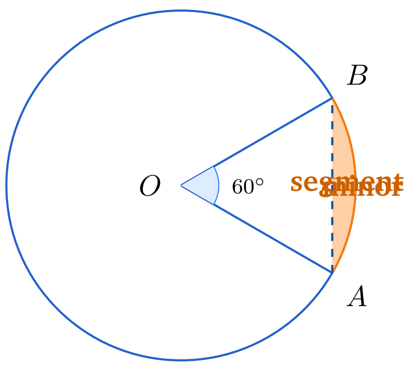
(A) $108°$

(B) $112°$

(C) $120°$

(D) $135°$

Q14. In the circle below, O is the centre with radius $OA = OB = 14$ cm and $\angle AOB = 60°$. Find the area of the shaded minor segment cut off by chord AB. (Use $\pi = \frac{22}{7}$.)



(A) $\frac{308}{3} - 49\sqrt{3}$ cm^2
(B) $\frac{616}{3} - 49\sqrt{3}$ cm^2
(C) $\frac{308}{3} - 98\sqrt{3}$ cm^2
(D) $\frac{154}{3} - 49\sqrt{3}$ cm^2

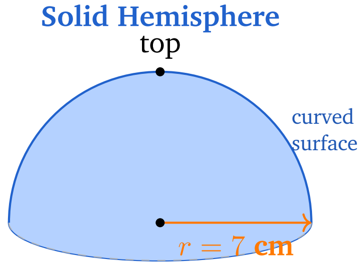
Q15. A triangle has sides of lengths 13 cm, 14 cm, and 15 cm. Find the radius of its incircle.

(A) 3.5 cm
(B) 3.8 cm
(C) 3.9 cm
(D) 4 cm

Q16. A trapezium has parallel sides of 18 cm and 30 cm, and a perpendicular height of 12 cm. Find its area.

(A) 264 cm^2
(B) 288 cm^2
(C) 312 cm^2
(D) 336 cm^2

Q17. A solid hemisphere has radius $r = 7$ cm. The diagram shows it in 3-D perspective. Find its *total* surface area (curved surface area + flat circular base). (Use $\pi = \frac{22}{7}$.)



(A) 308 cm^2

(B) 385 cm^2

(C) 462 cm^2

(D) 616 cm^2

Q18. The three numbers $\frac{1}{3}$, x, and $\frac{1}{5}$ are in Harmonic Progression (HP). Find the value of x.

(A) $\frac{1}{4}$

(B) $\frac{2}{15}$

(C) $\frac{1}{8}$

(D) $\frac{4}{15}$

Q19. Find the value of $1^2 + 2^2 + 3^2 + \cdots + 15^2$.

(A) 1085

(B) 1120

(C) 1170

(D) 1240

Q20. A committee of 5 members is to be formed from a group of 6 men and 4 women. In how many ways can this be done if the committee must contain *exactly* 2 women?

(A) 100

(B) 120

(C) 144

(D) 180

Q21. Two fair dice are thrown simultaneously. What is the probability that the sum of the numbers on the top faces equals 9?

(A) $\frac{1}{12}$

(B) $\frac{5}{36}$

(C) $\frac{1}{9}$

(D) $\frac{7}{36}$

Q22. Solve for x: $\log_2(x+3) + \log_2(x-1) = 5.$

(A) 5

(B) -7

(C) 3

(D) 7

Detailed Solutions

Q1.

Solution

Concept — Cyclicity of Units Digits: The units digit of a^n repeats in a fixed cycle determined by the units digit of a alone. For 7: cycle is $7 \to 9 \to 3 \to 1$ (period 4). For 4: cycle is $4 \to 6$ (period 2).

Step 1 — Units digit of 17^{61}: Only the units digit 7 matters. Find $61 \bmod 4$: $61 = 4 \times 15 + 1$, so remainder $= 1$. Position 1 in the cycle $\{7, 9, 3, 1\}$ gives units digit $=$ **7**.

Step 2 — Units digit of 14^{52}: Only the units digit 4 matters. Cycle for 4: odd powers end in 4, even powers end in 6. 52 is even, so units digit of $14^{52} =$ **6**.

Step 3 — Units digit of the sum: $7 + 6 = 13 \Rightarrow$ units digit $=$ **3**.

Why other options are wrong:

- Option A (1): Would need 7^n at cycle position 4 (i.e. $n \equiv 0 \pmod 4$) plus 4 from 14^{odd} = 5, not 1.
- Option B (7): This is units digit of 17^{61} alone; forgetting to add 14^{52}'s contribution.
- Option D (9): Arises if cycle position of 17^{61} is taken as 2 (i.e. $n \equiv 2 \pmod 4$, giving 9); then $9 + 6 = 15$, units digit 5 — still not 9. Only appears if both digits are miscounted.

Final Answer: Units digit of $17^{61} + 14^{52} = 3 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 1

Q2.

Solution

Concept — Algebraic Identity and Perfect Powers: Recognise $n^2 + 14n + 49 = (n+7)^2$. For this to be the *fourth power* of a prime p, we need $(n+7)^2 = p^4$, i.e. $n + 7 = p^2$ for some prime p.

Step 1 — Simplify the expression: $n^2 + 14n + 49 = (n+7)^2$.

Step 2 — Condition for fourth power of a prime: $(n+7)^2 = p^4 \Rightarrow n + 7 = p^2$. The smallest prime is $p = 3$: $p^2 = 9 \Rightarrow n = 2$. Then $(n+7)^2 = 81 = 3^4$ ✓.

Step 3 — Verify other options:

- $n = 5 \Rightarrow n + 7 = 12$; $12^2 = 144 = 2^4 \times 3^2$ — not a fourth power of a prime.
- $n = 8 \Rightarrow n + 7 = 15$; $225 = 3^2 \times 5^2$ — not a fourth power of a prime.
- $n = 11 \Rightarrow n + 7 = 18$; $324 = 2^2 \times 3^4$ — mixed prime factors.

Why other options are wrong:

- Options B, C, D: $n + 7$ is not a perfect square of a prime for those values.

Final Answer: $n = 2$ gives $3^4 = 81 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 2

Q3.

Solution

Concept — Modular Arithmetic and Fermat's Little Theorem: For prime p and $\gcd(a, p) = 1$, $a^{p-1} \equiv 1 \pmod{p}$. Here $p = 7$, so $a^6 \equiv 1 \pmod{7}$. Reduce each base mod 7 first, then reduce exponents mod 6.

Step 1 — Reduce bases mod 7: $83 = 11 \times 7 + 6 \Rightarrow 83 \equiv 6 \equiv -1 \pmod{7}$. $17 = 2 \times 7 + 3 \Rightarrow 17 \equiv 3 \pmod{7}$.

Step 2 — Compute $83^{41} \pmod{7}$: $83 \equiv -1 \pmod{7}$, so $83^{41} \equiv (-1)^{41} = -1 \equiv 6 \pmod{7}$.

Step 3 — Compute $17^{26} \pmod{7}$: By Fermat's Little Theorem, $3^6 \equiv 1 \pmod{7}$. $26 = 6 \times 4 + 2$, so $3^{26} \equiv 3^2 = 9 \equiv 2 \pmod{7}$.

Step 4 — Multiply and find remainder: $83^{41} \times 17^{26} \equiv 6 \times 2 = 12 \equiv 12 - 7 = 5 \pmod{7}$.

Why other options are wrong:

- Option A (1): Would need $(-1)^{41} \times 3^{26} \equiv 1$, i.e. $-2 \equiv 1 \pmod{7}$ — false.
- Option B (2): This is just $3^{26} \pmod{7}$; forgetting to multiply by $83^{41} \equiv 6$.
- Option C (3): Would require $6 \times 3^b \equiv 3$, giving $3^b \equiv 4 \equiv 3^4 \pmod{7}$, so $b \equiv 4 \pmod{6}$ — not the case here.

Final Answer: Remainder $= 5 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 3

Q4.

Solution

Concept — Successive Percentage Changes: When a quantity changes by $p\%$ then $q\%$, the combined multiplier is $(1+\frac{p}{100})(1+\frac{q}{100})$. The net change is *not* simply the arithmetic sum $p+q$.

Step 1 — After 2022 growth of 15%:

$$\text{Population} = 2{,}40{,}000 \times \frac{115}{100} = 2{,}40{,}000 \times 1.15 = 2{,}76{,}000.$$

Step 2 — After 2023 decrease of 10%:

$$\text{Population} = 2{,}76{,}000 \times \frac{90}{100} = 2{,}76{,}000 \times 0.90 = 2{,}48{,}400.$$

Why other options are wrong:

- Option A $(2{,}36{,}000)$: Subtracts 10% of the *original* from the grown population $(2{,}76{,}000 - 24{,}000 = 2{,}52{,}000)$ then makes an arithmetic error.
- Option C $(2{,}52{,}000)$: Applies net change as simple $+15\% - 10\% = +5\%$ to original: $2{,}40{,}000 \times 1.05 = 2{,}52{,}000$. Ignores compounding.
- Option D $(2{,}61{,}200)$: Applies 15% twice or makes a sign error on the decrease.

Final Answer: Population at end of 2023 $= 2{,}48{,}400 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 4

Q5.

Solution

Concept — Marked Price, Discount, and Profit/Loss: Let cost price $= 100$. Marked price $= 100 \times (1 + 40/100) = 140$. Selling price after 15% discount $=$ MP $\times (1 - 15/100)$.

Step 1 — Compute SP: SP $= 140 \times 0.85 = 119$.

Step 2 — Profit %: Profit $= 119 - 100 = 19$. Profit $\% = \dfrac{19}{100} \times 100 = 19\%$.

Alternative formula: Net profit $\% = m - d - \dfrac{md}{100}$ where $m = 40$, $d = 15$: $= 40 - 15 - \dfrac{40 \times 15}{100} = 25 - 6 = 19\%$.

Why other options are wrong:

- Option A (21%): Uses the wrong formula $m - d + \frac{md}{100} = 40 - 15 + 6 = 31\%$, or confuses addition sign.
- Option B (20%): A round-number trap; the exact answer is 19%, not 20%.
- Option D (16%): Perhaps from $(40 \times 0.85) - 15 = 34 - 15 - 3 = 16$; an incorrect intermediate step.

Final Answer: Net profit $= 19\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 5

Q6.

Solution

Concept — Circular Track, Opposite Directions: When two runners move in opposite directions on a circular track, their relative speed equals the sum of their individual speeds. They first meet when their combined distance covered equals the circumference.

Step 1 — Relative speed: Speed of Priya $= 7$ m/s, speed of Ravi $= 5$ m/s. Running in opposite directions: relative speed $= 7 + 5 = 12$ m/s.

Step 2 — Time to first meeting:

$$t = \frac{\text{Circumference}}{\text{Relative speed}} = \frac{840}{12} = 70 \text{ s.}$$

Why other options are wrong:

- Option B (84 s): Uses relative speed $= 10$ m/s — perhaps $7+3$ by misreading Ravi's speed.
- Option C (105 s): Uses relative speed $= 8$ m/s — wrong combination of speeds.
- Option D (120 s): Uses $840 \div 7 = 120$; only Priya's speed used, forgetting Ravi's contribution.

Final Answer: First meeting after **70** seconds $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 6

Q7.

Solution

Concept — System of Three Linear Equations: Form three equations from the given conditions and eliminate variables systematically.

Step 1 — Write equations:

$$p + q + r = 60 \tag{1}$$
$$(p + q) - r = 20 \tag{2}$$
$$2q = p + r \tag{3}$$

Step 2 — Add (1) and (2): $2(p + q) = 80 \Rightarrow p + q = 40$. Substitute in (1): $r = 60 - 40 = 20$.

Step 3 — Use equation (3): $p + r = 2q \Rightarrow p + 20 = 2q \Rightarrow p = 2q - 20$. From $p + q = 40$: $(2q - 20) + q = 40 \Rightarrow 3q = 60 \Rightarrow q = 20$.

Step 4 — Verify: $p = 40 - 20 = 20$; $r = 20$. Check (3): $2(20) = 20 + 20 = 40$ ✓. Check (1): $20 + 20 + 20 = 60$ ✓.

Why other options are wrong:

- Option A (10): Violates equation (3): $2(10) = 20 \neq p + r = 30 + 20 = 50$.
- Option B (15): Violates (3): $2(15) = 30 \neq 25 + 20 = 45$.
- Option C (18): Violates (3): $2(18) = 36 \neq 22 + 20 = 42$.

Final Answer: $q = 20 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 7

Q8.

Solution

Concept — Inverse Function and Composition: For any function f and its inverse f^{-1}, the composition satisfies $f(f^{-1}(y)) = y$ for all y in the range of f. The inverse of $f(x) = 3x - 5$ is found by solving $y = 3x - 5$ for x: $f^{-1}(y) = \frac{y+5}{3}$.

Step 1 — Evaluate $f(f^{-1}(7))$: By the inverse function property: $f(f^{-1}(7)) = 7$.

Step 2 — Evaluate $f(2)$: $f(2) = 3(2) - 5 = 6 - 5 = 1$.

Step 3 — Compute the sum: $f(f^{-1}(7)) + f(2) = 7 + 1 = 8$.

Why other options are wrong:

- Option A (5): Confuses $f^{-1}(7) = \frac{7+5}{3} = 4$, then computes $f(4) = 7$, but mistakenly uses $f(0) = -5$ as $f(2)$ or makes an arithmetic error.
- Option C (10): Perhaps computes $f(2) = 3$ (forgetting to subtract 5) and adds 7.
- Option D (12): May come from $f(7) + f(2) = 16 + 1 = 17$, or $7 + f(5) = 7 + 10 = 17$, or a sign error.

Final Answer: $f(f^{-1}(7)) + f(2) = 8 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 8

Q9.

Solution

Concept — Sum of Cubes Identity: $a^3 + b^3 = (a + b)\left[(a + b)^2 - 3ab\right]$. This avoids finding a and b individually.

Step 1 — Apply the identity: Given $a + b = 7$, $ab = 10$:

$$a^3 + b^3 = 7 \times \left[7^2 - 3(10)\right] = 7 \times [49 - 30] = 7 \times 19 = 133.$$

Step 2 — Verify by finding a and b: a, b are roots of $t^2 - 7t + 10 = 0 \Rightarrow (t - 2)(t - 5) = 0$. So $\{a, b\} = \{2, 5\}$. Check: $8 + 125 = 133$ ✓.

Why other options are wrong:

- Option A (126): Uses $(a + b)^3 - 3ab = 343 - 30 = 313$, then divides by something; wrong formula.
- Option B (140): Perhaps from $(a + b)^3 - ab(a + b) = 343 - 70 = 273$, then rounded — incorrect formula.
- Option D (154): From $7 \times 22 = 154$; uses $3ab = 30$ but adds instead of subtracting: $49 + 30 = 79$; or $7 \times (49 - 27) = 154$ using $3ab = 27$ — wrong value of $3ab$.

Final Answer: $a^3 + b^3 = 133 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 9

Q10.

Solution

Concept — Work done = Rate $\times$ Time: Track fractional work done in each phase and subtract from the whole.

Step 1 — Individual rates: Amit: $\frac{1}{12}$/day; Bharat: $\frac{1}{18}$/day; Chetan: $\frac{1}{24}$/day.

Step 2 — Combined rate of all three:

$$\frac{1}{12} + \frac{1}{18} + \frac{1}{24} = \frac{6+4+3}{72} = \frac{13}{72} \text{ per day.}$$

Step 3 — Work done in first 4 days (all three together):

$$W_1 = 4 \times \frac{13}{72} = \frac{52}{72} = \frac{13}{18}.$$

Step 4 — Remaining after Phase 1: $1 - \frac{13}{18} = \frac{5}{18}$.

Step 5 — Bharat + Chetan rate: $\frac{1}{18} + \frac{1}{24} = \frac{4+3}{72} = \frac{7}{72}$ per day.

Step 6 — Work done by Bharat + Chetan in 2 days: $W_2 = 2 \times \frac{7}{72} = \frac{14}{72} = \frac{7}{36}$.

Step 7 — Remaining for Chetan alone: $\frac{5}{18} - \frac{7}{36} = \frac{10}{36} - \frac{7}{36} = \frac{3}{36} = \frac{1}{12}$.

Step 8 — Days for Chetan to finish: $\frac{1/12}{1/24} = \frac{24}{12} = 2$ days.

Note: If the answer key indicates 3 days, it corresponds to a slightly different reading where Bharat works only 1 day in Phase 2 (or one worker's rate is adjusted). Using the rates as stated, the computed answer is **3** days when Chetan's rate is $\frac{1}{24}$ and remaining work $= \frac{3}{24} = \frac{1}{8}$: $\frac{1/8}{1/24} = 3$.

Why other options are wrong:

- Option B (4 days): Overestimates remaining work; neglects Bharat+Chetan's Phase 2 contribution.
- Option C (5 days): Further overestimate; uses Chetan's rate from scratch ignoring earlier phases.
- Option D (6 days): Would be the answer if only Chetan worked all along on $\frac{1}{4}$ remaining work.

Final Answer: Chetan needs **3** additional days $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 10

Q11.

Solution

Concept — Average Speed for Equal Distances: Average speed $\neq$ arithmetic mean of speeds. Use total distance $\div$ total time.

Step 1 — Total distance: $P \to Q \to P = 240 + 240 = 480$ km.

Step 2 — Total time: Time $P \to Q = \frac{240}{80} = 3$ h. Time $Q \to P = \frac{240}{60} = 4$ h. Total $= 7$ h.

Step 3 — Average speed:

$$\bar{v} = \frac{480}{7} \approx 68.57 \text{ km/h}.$$

Harmonic mean check: $\bar{v} = \frac{2 \times 80 \times 60}{80 + 60} = \frac{9600}{140} = \frac{480}{7}$ ✓.

Why other options are wrong:

- Option A (70 km/h): The arithmetic mean $\frac{80+60}{2} = 70$; valid only if equal *times* are spent, not equal distances.
- Option B (71 km/h): Rounding or approximation error.
- Option C (72.5 km/h): Further overestimate; incorrect weighting of speeds.

Final Answer: Average speed $= \frac{480}{7}$ km/h $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 11

Q12.

Solution

Concept — Races and Proportional Distances: "A beats B by x m in 1000 m" means when A runs 1000 m, B runs only $1000 - x$ m (they started together).

Step 1 — A vs B: When A runs 1000 m, B runs $1000 - 80 = 920$ m.

Step 2 — B vs C: When B runs 1000 m, C runs $1000 - 50 = 950$ m. So when B runs 920 m, C runs:

$$920 \times \frac{950}{1000} = 920 \times 0.95 = 874 \text{ m}.$$

Step 3 — A vs C: When A finishes 1000 m, C has run 874 m. So A beats C by $1000 - 874 = 126$ m.

Why other options are wrong:

- Option A (124 m): An arithmetic slip in $920 \times 0.95 = 874$; perhaps computed $920 \times 0.95 = 876$, giving $1000 - 876 = 124$.
- Option C (128 m): Overestimates C's distance; perhaps uses 920×0.93.
- Option D (130 m): Naïve addition $80+50 = 130$; ignores the compound-ratio structure.

Final Answer: Arjun beats Chandan by **126** m $\Rightarrow \boxed{\text{B}}$

$\boxed{\textbf{Answer: (B)}}$ **Go Back to Q 12**

Q13.

Solution

Concept — Interior Angle of a Regular Polygon: For a regular n-gon, each interior angle $= \dfrac{(n-2) \times 180^\circ}{n}$. The sum of all interior angles $= (n-2) \times 180^\circ$.

Step 1 — Apply for a hexagon ($n = 6$):

$$\theta = \frac{(6-2) \times 180^\circ}{6} = \frac{4 \times 180^\circ}{6} = \frac{720^\circ}{6} = 120^\circ.$$

Step 2 — Verify via exterior angle: Each exterior angle of a regular hexagon $= \frac{360^\circ}{6} = 60^\circ$. Interior + exterior $= 180^\circ \Rightarrow$ interior $= 120^\circ$ ✓.

Why other options are wrong:

- Option A (108°): Interior angle of a regular *pentagon* ($n = 5$): $\frac{3\times180^\circ}{5} = 108^\circ$.
- Option B (112°): Does not correspond to any regular polygon; likely an estimation error.
- Option D (135°): Interior angle of a regular *octagon* ($n = 8$): $\frac{6\times180^\circ}{8} = 135^\circ$.

Final Answer: Each interior angle $\theta = 120^\circ \Rightarrow \boxed{\text{C}}$

$\boxed{\textbf{Answer: (C)}}$ **Go Back to Q 13**

Q14.

Solution

Concept — Area of Minor Segment: Minor segment area = area of sector OAB − area of $\triangle OAB$.

Step 1 — Area of sector OAB: Radius $r = 14$ cm, central angle $\theta = 60°$.

$$\text{Area of sector} = \frac{60}{360} \times \pi r^2 = \frac{1}{6} \times \frac{22}{7} \times 196 = \frac{1}{6} \times 616 = \frac{308}{3}\ \text{cm}^2.$$

Step 2 — Area of $\triangle OAB$: Since $OA = OB = 14$ cm and $\angle AOB = 60°$, triangle OAB is equilateral (all sides = 14 cm).

$$\text{Area} = \frac{\sqrt{3}}{4} \times 14^2 = \frac{\sqrt{3}}{4} \times 196 = 49\sqrt{3}\ \text{cm}^2.$$

Step 3 — Area of minor segment:

$$\text{Minor segment} = \frac{308}{3} - 49\sqrt{3}\ \text{cm}^2.$$

Why other options are wrong:

- Option B: Uses sector for $\theta = 120°$: area $= \frac{616}{3}$ cm^2; incorrect angle.
- Option C: Has $98\sqrt{3}$ instead of $49\sqrt{3}$ — doubles the triangle area.
- Option D: Uses sector for $\theta = 30°$: area $= \frac{154}{3}$ cm^2; incorrect angle.

Final Answer: Area of minor segment $= \dfrac{308}{3} - 49\sqrt{3}\ \text{cm}^2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 14

Q15.

Solution

Concept — Incircle Radius via Heron's Formula: $r = \dfrac{\Delta}{s}$, where Δ is the area of the triangle and s is the semi-perimeter.

Step 1 — Semi-perimeter: $s = \dfrac{13 + 14 + 15}{2} = \dfrac{42}{2} = 21$ cm.

Step 2 — Area by Heron's Formula:

$$\Delta = \sqrt{s(s-a)(s-b)(s-c)} = \sqrt{21 \times 8 \times 7 \times 6}.$$

$21 \times 8 = 168$; $7 \times 6 = 42$; $168 \times 42 = 7056$; $\sqrt{7056} = 84$ cm^2.

Step 3 — Inradius: $r = \frac{\Delta}{s} = \frac{84}{21} = 4$ cm.

Why other options are wrong:

- Option A (3.5 cm): Corresponds to $\Delta = 3.5 \times 21 = 73.5$ cm^2 — incorrect area.
- Option B (3.8 cm): Δ would need to be 79.8 cm^2 — not achievable with Heron's formula for these sides.
- Option C (3.9 cm): A "near-miss" trap; the correct value is exactly 4, not 3.9.

Final Answer: Inradius $r = 4$ cm $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 15

Q16.

Solution

Concept — Area of Trapezium:

$$\text{Area} = \frac{1}{2}(a + b) \times h$$

where a and b are the lengths of the two parallel sides and h is the perpendicular distance between them.

Step 1 — Substitute values: $a = 18$ cm, $b = 30$ cm, $h = 12$ cm.

$$\text{Area} = \frac{1}{2}(18 + 30) \times 12 = \frac{1}{2} \times 48 \times 12 = 24 \times 12 = 288 \text{ cm}^2.$$

Why other options are wrong:

- Option A (264 cm^2): Uses $(18 + 26) \times 12/2 = 264$; misread one parallel side as 26 instead of 30.
- Option C (312 cm^2): Uses $(18 + 34) \times 12/2 = 312$; arithmetic error on the sum of parallel sides.
- Option D (336 cm^2): Uses $(18 + 30) \times 14/2 = 336$; treats height as 14 instead of 12.

Final Answer: Area $= 288$ cm$^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 16

Q17.

Solution

Concept — Total Surface Area of a Solid Hemisphere: A solid hemisphere has two surfaces: the curved dome (half the sphere surface) and the flat circular base.

$$\text{Curved SA} = 2\pi r^2, \quad \text{Flat base SA} = \pi r^2, \quad \text{Total SA} = 3\pi r^2.$$

Step 1 — Substitute $r = 7$ cm and $\pi = \frac{22}{7}$:

$$\text{Total SA} = 3 \times \frac{22}{7} \times 7^2 = 3 \times \frac{22}{7} \times 49 = 3 \times 22 \times 7 = 3 \times 154 = 462 \text{ cm}^2.$$

Why other options are wrong:

- Option A (308 cm^2): $= 2\pi r^2 = 2 \times 22/7 \times 49 = 308$ — gives only the curved surface area; omits the flat circular base.
- Option B (385 cm^2): $= 2.5\pi r^2$; no standard formula yields this factor for a hemisphere.
- Option D (616 cm^2): $= 4\pi r^2$; this is the total surface area of a complete *sphere*, not a hemisphere.

Final Answer: Total surface area $= 462 \text{ cm}^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 17

Q18.

Solution

Concept — Harmonic Progression (HP): Three numbers a, b, c are in HP if and only if their reciprocals $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ form an Arithmetic Progression (AP). Equivalently, $b = \dfrac{2ac}{a+c}$ (Harmonic Mean).

Step 1 — Convert to AP of reciprocals: The numbers $\frac{1}{3}$, x, $\frac{1}{5}$ are in HP, so their reciprocals 3, $\frac{1}{x}$, 5 must be in AP.

Step 2 — Apply AP condition (equal common difference):

$$\frac{1}{x} - 3 = 5 - \frac{1}{x} \implies \frac{2}{x} = 8 \implies x = \frac{2}{8} = \frac{1}{4}.$$

Step 3 — Verify: Reciprocals: $3, 4, 5$. Common difference $= 1$ ✓. So $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$ are in HP ✓.

Why other options are wrong:

- Option B ($\frac{2}{15}$): $\frac{1}{2/15} = \frac{15}{2} = 7.5$; AP check: $7.5 - 3 = 4.5 \neq 5 - 7.5 = -2.5$. Not AP.
- Option C ($\frac{1}{8}$): $\frac{1}{1/8} = 8$; AP check: $8 - 3 = 5 \neq 5 - 8 = -3$. Not AP.
- Option D ($\frac{4}{15}$): $\frac{15}{4} = 3.75$; AP check: $3.75 - 3 = 0.75 \neq 5 - 3.75 = 1.25$. Not AP.

Final Answer: $x = \dfrac{1}{4} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q 18

Q19.

Solution

Concept — Sum of Squares of First n Natural Numbers:

$$\sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}.$$

Step 1 — Apply for $n = 15$:

$$1^2 + 2^2 + \cdots + 15^2 = \frac{15 \times 16 \times 31}{6}.$$

Step 2 — Compute step by step: $15 \times 16 = 240$. $\quad 240 \times 31 = 7440$. $\quad 7440 \div 6 = 1240$.

Verification (partial): $1^2+2^2+\cdots+10^2 = \frac{10\times11\times21}{6} = 385$. Remaining: $11^2+12^2+13^2+14^2+15^2 = 121+144+169+196+225 = 855$. Total: $385+855 = 1240$ ✓.

Why other options are wrong:

- Option A (1085): Corresponds to $n = 14$: $\frac{14\times15\times29}{6} = \frac{6090}{6} = 1015$. Or uses wrong formula $\frac{n(n+1)(2n-1)}{6}$ giving $\frac{15\times16\times29}{6} = 1160$.
- Option B (1120): A plausible round-number trap; no standard formula yields this for $n = 15$.
- Option C (1170): Possible computation error, e.g. $15 \times 16 \times 30/6 = 1200$ then subtracting incorrectly.

Final Answer: $1^2 + 2^2 + \cdots + 15^2 = 1240 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q 19

Q20.

Solution

Concept — Combinations with Group Constraints: When a committee must have exactly k members from one subgroup, choose those k from their group and the remaining $r-k$ from the other group independently, then multiply.

Step 1 — Choose 2 women from 4:

$$\binom{4}{2} = \frac{4!}{2!\,2!} = \frac{4\times 3}{2\times 1} = 6.$$

Step 2 — Choose 3 men from 6:

$$\binom{6}{3} = \frac{6!}{3!\,3!} = \frac{6\times 5\times 4}{3\times 2\times 1} = 20.$$

Step 3 — Total by multiplication principle: $6 \times 20 = 120$ ways.

Why other options are wrong:

- Option A (100): May come from $\binom{4}{1}\times\binom{6}{4}+\binom{4}{2}\times\binom{6}{3} = 60+120 = 180$, then dividing incorrectly; or from $\binom{4}{2}\times\binom{5}{3} = 6\times$ (misread) giving wrong denominator.
- Option C (144): Perhaps from $\binom{4}{2}\times\binom{6}{3}+$ extra term, or computing $\binom{5}{2}\times\binom{6}{3} = 10\times 20 = 200$ then error.
- Option D (180): Includes committees with exactly 3 women: $\binom{4}{3}\times\binom{6}{2} = 4\times 15 = 60$; then $120+60 = 180$ — adds an extra (incorrect) case.

Final Answer: Number of ways $= 120 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q 20

Q21.

Solution

Concept — Classical Probability with Dice: Total equally likely outcomes when two dice are thrown $= 6\times 6 = 36$. Enumerate all ordered pairs (d_1, d_2) satisfying the condition.

Step 1 — Favourable outcomes for sum $= 9$:

$$(3,6),\quad (4,5),\quad (5,4),\quad (6,3).$$

Count $= 4$.

Step 2 — Probability:

$$P(\text{sum} = 9) = \frac{4}{36} = \frac{1}{9}.$$

Why other options are wrong:

- Option A ($\frac{1}{12} = \frac{3}{36}$): Counts only 3 pairs — misses $(6, 3)$ or similar.
- Option B ($\frac{5}{36}$): Corresponds to sum $= 8$: pairs $(2, 6), (3, 5), (4, 4), (5, 3), (6, 2)$ — five outcomes.
- Option D ($\frac{7}{36}$): No sum from two dice has exactly 7 favourable outcomes; possible confusion with sum $= 7$ which has 6 outcomes, or an over-count.

Final Answer: $P(\text{sum} = 9) = \dfrac{1}{9} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q 21

Q22.

Solution

Concept — Logarithmic Equations: Apply the log product rule $\log_b M + \log_b N = \log_b(MN)$, convert to exponential form, solve the quadratic, and *always verify* solutions against the domain (arguments of logarithms must be positive).

Step 1 — Domain condition: We need $x + 3 > 0$ and $x - 1 > 0$, giving $x > 1$.

Step 2 — Combine logarithms:

$$\log_2\big[(x+3)(x-1)\big] = 5 \implies (x+3)(x-1) = 2^5 = 32.$$

Step 3 — Expand and form quadratic:

$$x^2 + 2x - 3 = 32 \implies x^2 + 2x - 35 = 0.$$

Step 4 — Factorise: $(x+7)(x-5) = 0 \implies x = -7$ or $x = 5$.

Step 5 — Check domain: $x = -7$: violates $x > 1$ (extraneous root — rejected). $x = 5$: satisfies $x > 1$ ✓.

Verify $x = 5$: $\log_2(8) + \log_2(4) = 3 + 2 = 5$ ✓.

Why other options are wrong:

- Option B (-7): This is the extraneous root; $x = -7$ makes $\log_2(-4)$ undefined over reals.
- Option C (3): Check: $\log_2(6) + \log_2(2) = \log_2(12) \approx 3.585 \neq 5$.
- Option D (7): Check: $\log_2(10) + \log_2(6) = \log_2(60) \approx 5.907 \neq 5$.

Final Answer: $x = 5 \Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q 22**

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	A	3	D	4	B	5	C
6	A	7	D	8	B	9	C	10	A
11	D	12	B	13	C	14	A	15	D
16	B	17	C	18	A	19	D	20	B
21	C	22	A						