Quadratic Equations

Free Response Questions

Q: 1 In the figure below, two concentric circles have centre O. Their radii are R and (R + 6) [5] --- cm respectively.



(Note: The figure is not to scale.)

Find the lengths of the chords AB and CD. Show your work.

Q: 2 Vitthal went on a long cycling round trip from his home to a nearby hill and back. The [5] journey to the hill started with a 40 km flat road and then a 25 km uphill slope.

While going uphill, his average speed reduced by 10 km/hr compared to the flat road leading to an extra half-hour of travel time. However, he maintained the same average speed on the flat road in both directions.

i) Find the time taken by Vitthal to reach the end of 65 km stretch in the uphill direction.

ii) If he took 2 $\frac{1}{2}$ hrs to reach home from the hill, find his average speed on the slope while descending.

Show your work.

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Case Study

Study the given information and answer the questions that follow.

Bangalore city corporation is building parks in residential areas across the city. Shown below is one such park. The rectangular park consists of various components like walking track, kids play area, open gym, pond etc.



(Note: The image is not to scale.)

Q: 3 Gate 3 has been placed exactly opposite to gate 1 on the boundary of the park. The [2] distance between gate 3 and gate 2 is 1 m more than the distance between gate 3 and gate 2.

The shortest distance between gates 1 and 2 is 29 m, find the width of the park. Show your work.

Q: 4 The caretaker of the park is attempting to plant saplings in the form of a square. That [2] is, number of rows of saplings is the same as the number of columns of saplings. On arranging the saplings, he found that 24 saplings were still left with him. When he increased the number of rows and columns by 1, he found that he was short of 25 saplings.

Find the number of saplings available with him. Show your work.

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Q: 5 The city corporation is planning to install a rectangular sand table as shown below, for [1] the kids in the play area. The carpenter is asked to design a rectangular table whose length is thrice its width and the area is 108 sq m.



(Note: The image is not to scale.)

Determine whether such a table can be made. Show your steps.

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Q.No	What to look for	Marks
1	Writes that a perpendicular from the centre to a chord bisects the chord, hence:	0.5
	$AP = \frac{1}{2} \times AB = (R - 9) \text{ cm}$	
	Uses the pythagoras theorem in A AOP and writes the equation:	0.5
	$(R)^{2} = (R - 8)^{2} + (R - 9)^{2}$	
	Solves the above equation to find the value of R as 5 cm and 29 cm.	1.5
	Replaces the values obtained of R in (2R - 18) cm and discards the value 5 cm because it gives negative value of AB. Finds AB = 40 cm considering R = 29 cm.	1
	Finds OQ = (29 - 1) = 28 cm and OC = (29 + 6) = 35 cm.	0.5
	Uses the pythagoras theorem in $f \Delta$ COQ and writes the equation for CQ as:	1
	$CQ = \sqrt{[(35)^2 - (28)^2]} = 21 \text{ cm}$	
	Finds the value of CD as $21 \times 2 = 42$ cm using the same logic as step 1.	
2	i) Assumes Vitthal's average speed on the 40 km flat road to be <i>s</i> km/hr and the time taken by him to cover it as <i>t</i> hrs.	1
	Thus, finds the speed on the 25 km slope uphill as (s - 10) km/hr and the time taken to cover it as ($t + \frac{1}{2}$) hrs.	
	Frames the equations:	
	$s = \frac{40}{t}$ and	
	$(s - 10) = 25 \div (t + \frac{1}{2})$	
	Substitutes the value of <i>s</i> from the first equation into the second equation as:	1.5
	$\frac{40}{t}$ - 10 = 25 ÷ (t + $\frac{1}{2}$)	
	Simplifies the above equation to frame quadratic equation in t as:	
	$t^2 - t - 2 = 0$	

Q.No	What to look for	Marks
	Factorises and solves the above equation to find the value of <i>t</i> as (-1) and 2.	1
	Rejects (-1) and thus finds t as 2 hrs and ($t + \frac{1}{2}$) as 2 $\frac{1}{2}$ hrs.	
	Finds the time taken by Vitthal to reach the end of 65 km stretch in the uphill direction as:	0.5
	$2 + 2\frac{1}{2} = 4\frac{1}{2}$ hrs.	
	ii) Writes that, Vitthal took 2 hrs to cover cover the flat road and hence finds the time taken to descend the 25 km slope as:	0.5
	$2\frac{1}{2} - 2 = \frac{1}{2}$ hrs	
	Finds the speed on the slope while descending as:	0.5
	25 ÷ $\frac{1}{2}$ = 50 km/hr	
3	Takes the distance between gates 1 and 3 as 'x' m. Writes that the distance between gates 2 and 3 is ($x + 1$) m.	1
	Applies Pythagoras theorem to the triangle formed by gates 1, 2 and 3 and frames a quadratic equation as:	
	x^{2} + (x + 1) ² = 29 ² or x^{2} + x - 420 = 0	
	Solves the above quadratic equation and finds the value of x as 20m.	1
	Concludes that the width of the park is 20m.	
4	Takes the former number of rows and columns of saplings as x and finds the number of saplings available as $x^2 + 24$.	0.5
	Takes the latter number of rows and columns of saplings as $(x + 1)$ and finds the number of saplings available as $(x + 1)^2 - 25$.	0.5
	Equates the above two quadratic expressions and solves for x as:	0.5
	$x^{2} + 24 = x^{2} + 1 + 2 x - 25$ => x = 24	

Q.No	What to look for	Marks
	Finds the number of saplings available with the caretaker as $24^2 + 24 = 600$.	0.5
5	Assumes the width as x, length as 3 x and uses the given area to write the quadratic equation as:	0.5
	$3x^2 = 108 \text{ or } x^2 - 36 = 0$	
	Finds the discriminant as 0^2 - (4)(1)(-36) = 144 > 0 and concludes that it is possible to make such a table.	0.5
	(Award full marks if the equation is solved to obtain $x = 6$ m instead of using the concept of discriminant.)	

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