

## ***Mathematical Formulae***

### *Compound interest*

$$\text{Total amount} = P \left( 1 + \frac{r}{100} \right)^n$$

### *Mensuration*

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4 \pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3} \pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2} a b \sin C$$

$$\text{Arc length} = r \theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2} r^2 \theta, \text{ where } \theta \text{ is in radians}$$

### *Trigonometry*

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2 b c \cos A$$

### *Statistics*

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left( \frac{\sum fx}{\sum f} \right)^2}$$

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Answer **all** the questions.

1. (a) Express  $\frac{2}{9a^2-16} - \frac{3}{4-3a}$  as a single fraction in its simplest form. [3]
- (b) Given that  $y$  is inversely proportional to the square of  $x$ , find the percentage decrease in  $y$  when the value of  $x$  is doubled. [3]
- (c) Given that  $x = \frac{3y+2}{x-1}$ , express  $x$  in terms of  $y$ . [3]
- 2 In 2015, Mr Rajoo earned \$7600 per month and received additional  $2\frac{1}{2}$  months of salary as bonus. He lived with his wife, his four children and his parents. The table shows the income tax reliefs for Mr Rajoo.

Type of Tax relief	Amount
Earned Income	\$1000
Wife Relief	\$2000
Child Relief	\$4000 each
Parents (living with income earner)	\$7000 each
Parents (not living with income earner)	\$4500 each
CPF Contributions	\$22040

- (a) Calculate the income tax reliefs that Mr Rajoo qualifies for. [2]
- (b) What is his chargeable income, given that he worked all 12 months of 2015? [2]
- (c) Based on the table of income tax rates shown below, calculate the amount of income tax that Mr Rajoo had to pay for 2015. [3]

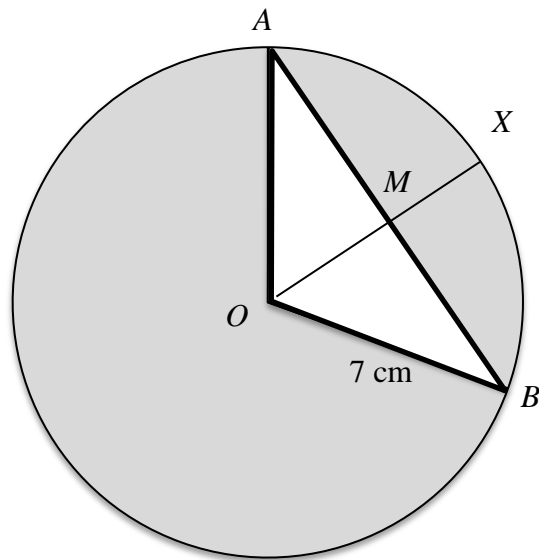
	Chargeable Income (\$)	Rate (%)	Gross Tax Payable (\$)
On the first...	20000	0	0.00
On the next...	10000	3.5	350.00
On the first...	30000	-	350.00
On the next...	10000	5.5	550.00
On the first...	40000	-	900.00
On the next...	40000	8.5	3400.00
On the first...	80000	-	4300.00
On the next...	80000	14	11200.00

- (d) What was Mr. Rajoo's chargeable income for the previous year 2014 if the payable income tax based on that year was \$3280? [2]

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3. Two girls, Pauline and Ivy, started together at the same constant speed of  $x$  km/h on a 5 km walk. After 3 km, Pauline increased her speed by 1.5 km/h and walked the remaining 2 km. Ivy walked at a constant speed  $x$  km/h all the way.
- (a) Write down the speed, in terms of  $x$ , that Pauline used to walk the remaining 2 km. [1]
- (b) Write down and simplify an expression for the time taken, in terms of  $x$ , to complete the 5 km walk by
- (i) Ivy. [1]
- (ii) Pauline. [1]
- (c) Pauline finished the journey 20 minutes earlier than Ivy.  
Write down an equation in  $x$  and show that it reduces to  $2x^2 + 3x - 18 = 0$ . [2]
- (d) Solve the equation  $2x^2 + 3x - 18 = 0$ , giving your answers correct to 3 decimal places. [2]
- (e) Hence find
- (i) the time taken, to the nearest minute, for Pauline to complete the journey. [2]
- (ii) the average speed, in km/h, of Pauline for the whole journey. [2]

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4.

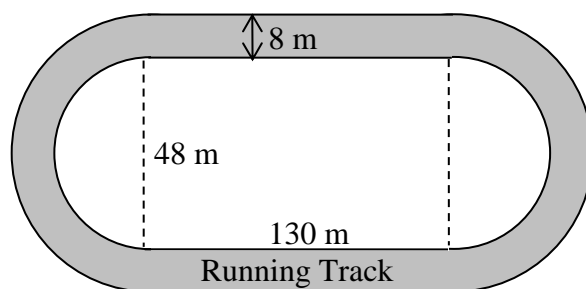


The diagram shows the sector of a circle,  $AOB$ , of radius 7 cm.

The area of the shaded sector is  $120 \text{ cm}^2$ .

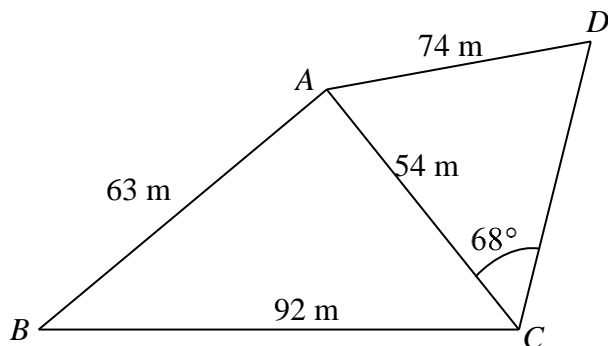
- (a) Calculate reflex angle  $AOB$  in radians. [2]
- (b) Calculate the perimeter of the major sector  $AOB$ . [2]
- (c) Calculate the area of the segment  $AMBX$ . [3]
- (d) Calculate the length  $MX$ . [2]

5. The diagram shows a running track surrounding a field. It is made up of a rectangular area 130 m by 48 m, and two semi-circular areas of radius 24 m. A running track 8 m wide surrounds it.



- (a) Find the area of the running track. Give your answer in the form  $a + b\pi$ . [2]
- (b) The track is divided into 8 lanes of equal width. Lane 1 is innermost and nearest to the field while Lane 8 is outermost and furthest from the field. A woman runs in the exact centre of Lane 3 for 6 rounds. Assuming that she runs in the centre of Lane 3 throughout her run, what is the total distance that she covered during her run? Give your answer in kilometres correct to 3 significant figures. [3]
- (c) A man runs at an average speed of 12.2 m/s in the exact centre of Lane 3. It takes him 2 min 35 s to complete his run. What is the number of laps that he ran? Give your answer to 1 decimal place. [2]
6. The sum of the ages of both Shawn and Jasper is 35. Five years ago, Shawn was four times as old as Jasper.
- (a) If Shawn's age is  $x$  years, write down an algebraic expression for Shawn's age five years ago. [1]
- (b) If Jasper's age is  $y$  years, write down an algebraic expression for Jasper's age five years ago. [1]
- (c) Write down an algebraic equation to show the relationship between Shawn and Jasper's ages five years ago. [1]
- (d) Write down an algebraic equation to show the relationship between Shawn and Jasper's present ages. [1]
- (e) Solve the 2 simultaneous equations in (c) and (d) to determine Shawn and Jasper's present ages. [3]

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7. Four points  $A, B, C, D$  lie on a horizontal field as shown in the diagram. Given that  $AB = 63$  m,  $AC = 54$  m,  $AD = 74$  m and  $\angle ACD = 68^\circ$ .  $B$  is 92 m west of  $C$ .



- (a) Calculate
- (i)  $\angle ADC$ , [2]
  - (ii)  $\angle ABC$ , [3]
  - (iii) the bearing of  $B$  from  $A$ . [2]
  - (iv) area of the quadrilateral field  $ABCD$ . [2]
- (b) Emily is walking on a trail along  $B$  to  $C$ . How far has she walked from  $B$  when she is nearest to  $A$ . [2]
- (c) A bird is perched on a vertical tower  $AF$  at  $A$ . The angle of elevation of the bird's vantage point at  $F$  from  $B$  is  $42^\circ$ . Calculate the height of the tower  $AF$ . [2]

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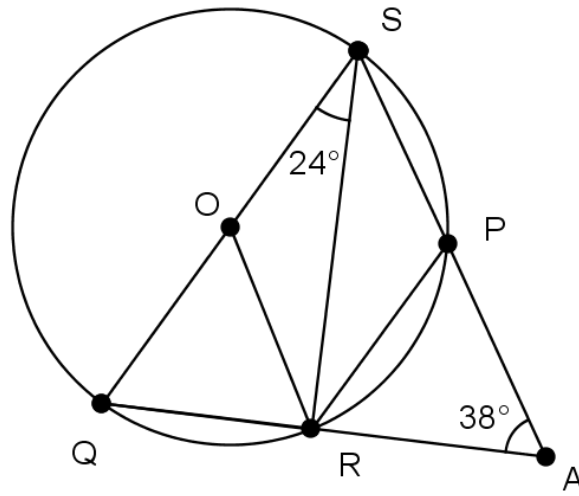
8. **Answer the whole of this question on a sheet of graph paper.**

The variables  $x$  and  $y$  are connected by the equation  $y = x - 2 + \frac{8}{x}$ . The table below shows some corresponding values of  $x$  and  $y$ . The values of  $y$  are given correct to one decimal place where appropriate.

$x$	1	1.5	2	3	4	5	6	7	8	9
$y$	7.0	4.8	4.0	3.7	4.0	4.6	5.3	$k$	7.0	7.9

- (a) Calculate the value of  $k$ , giving your answer correct to 1 decimal place. [1]
- (b) Taking 2 cm to represent 1 unit on both  $x$ -axis and  $y$ -axis, draw the graph of  $y = x - 2 + \frac{8}{x}$  for  $1 \leq x \leq 9$ . [3]
- (c) Use your graph to estimate
- (i) the value of  $x$  for which  $y$  is a minimum, [1]
- (ii) the of values of  $x$  for which  $y = 5$ . [1]
- (d) By drawing a tangent, find the gradient of the curve at  $x = 3.5$ . [2]
- (e) By drawing a suitable straight line on the same axes, solve the equation  $4\left(x - 2 + \frac{8}{x}\right) = x + 20$ . [3]

9. In the diagram,  $QS$  is a diameter of the circle, centre  $O$ .  $AQR$  and  $APS$  are straight lines. Given that  $\angle QSR = 24^\circ$  and  $\angle QAP = 38^\circ$ ,

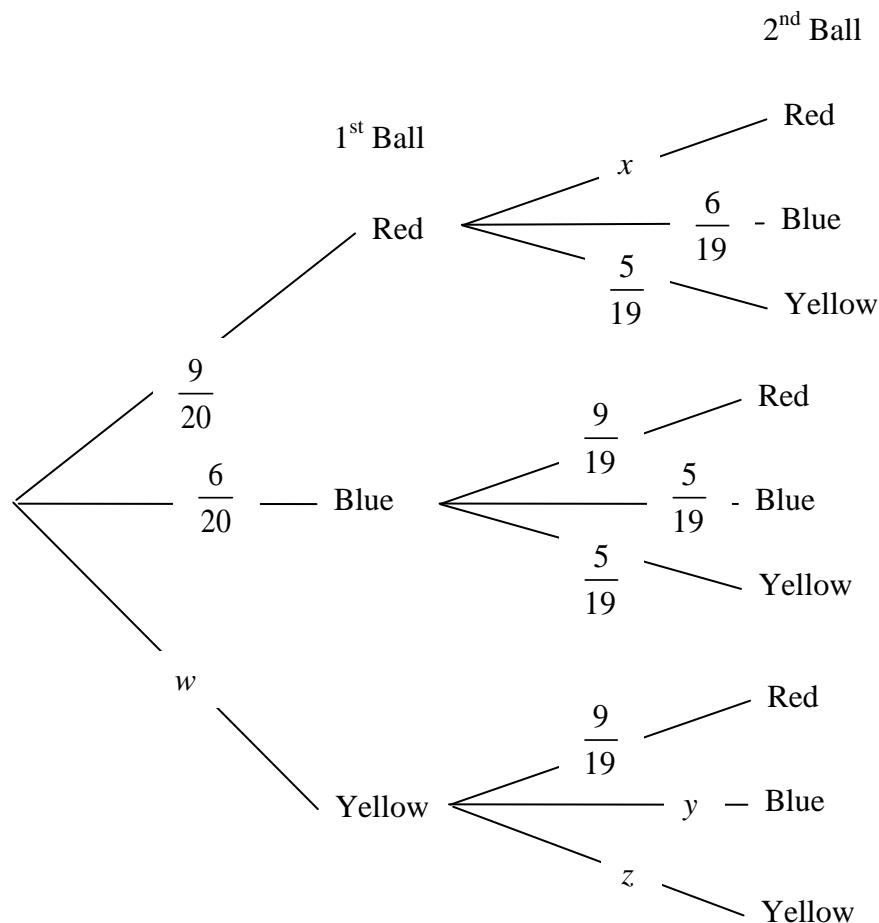


Stating clearly your reasons, find

- |     |                |     |
|-----|----------------|-----|
| (a) | $\angle SQR$ , | [1] |
| (b) | $\angle ROS$ , | [1] |
| (c) | $\angle SPR$ , | [2] |
| (d) | $\angle PRQ$ , | [3] |
| (e) | $\angle PRO$ . | [1] |



10. A bag contains 20 balls of three colours. There are 9 red, 6 blue and 5 yellow balls. The child picks a ball at random and it is not replaced. A second ball is picked at random and it is also not replaced. The tree diagram below shows the possible outcomes and some of their probabilities.



- (a) Calculate the values of  $w$ ,  $x$ ,  $y$ , and  $z$  as shown on the tree diagram. [2]
- (b) Expressing your answers as a fraction in its lowest term, calculate the probability that
- (i) both balls would be the same colour, [2]
- (ii) both balls are of different colours, [1]
- (iii) one ball is red and the other blue. [1]
- (c) A third ball is now picked at random. Calculate the probability that none of the three balls are yellow. [2]

11. Here is some information about a portable vertical storage tank for bulk powder products.

Capacity	$62.3 \text{ m}^3 \#$
Capacity (Cement)	$96\,000 \text{ kg}^*$

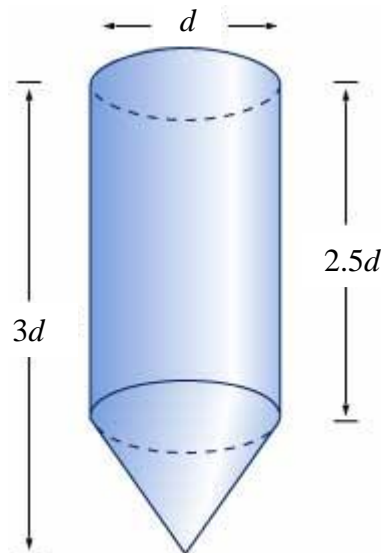
#Safety Information: The capacity of the tank is 90% of the total volume of the interior of the tank.

\*Cement can weigh between  $1\,410 - 1\,506 \text{ kg/m}^3$  depending on how aerated it is.



(Image taken from: <http://www.cementsilos.com>)

- (a) Mass of one such empty storage tank should not be more than one-third the mass of its contents. What is the maximum possible mass of an empty storage tank? [1]
- (b) In this question the interior of the storage tank can be modelled as a cylinder with an inverted cone at the bottom with diameter  $d$  m. Given that the height of the cylinder is 2.5 times the diameter  $d$  and the total height of the tank is thrice the diameter  $d$ , work out the value of  $d$ . [4]



- (c) Ali wants to fill the tank with  $96\,000 \text{ kg}$  of cement. Comment on whether this is possible and whether it is advisable. Justify your comment with calculations. [3]