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MATHEMATICS PRELIMINARY EXAMINATION

PAPER II 2020

ANALYSIS SHEET

Examination number (please fill in):

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Name and Surname (please DO NOT fill in – for examiner's use only):

<u>Question</u>	<u>Topic</u>	<u>Mark obtained</u>
1	Analytical Geometry [15]	
2	Data Handling [9]	
3	Trigonometric functions [11]	
4	Trigonometry [19]	
5	Euclidean Geometry [13]	
6	Proportionality [6]	
TOTAL SECTION A [73]		
7	Analytical Geometry [19]	
8	Trigonometry [22]	
9	Data Handling [9]	
10	Geometry [16]	
11	Problem solving [11]	
TOTAL SECTION B [77]		

TOTAL: $\frac{\quad}{150} = \quad \%$

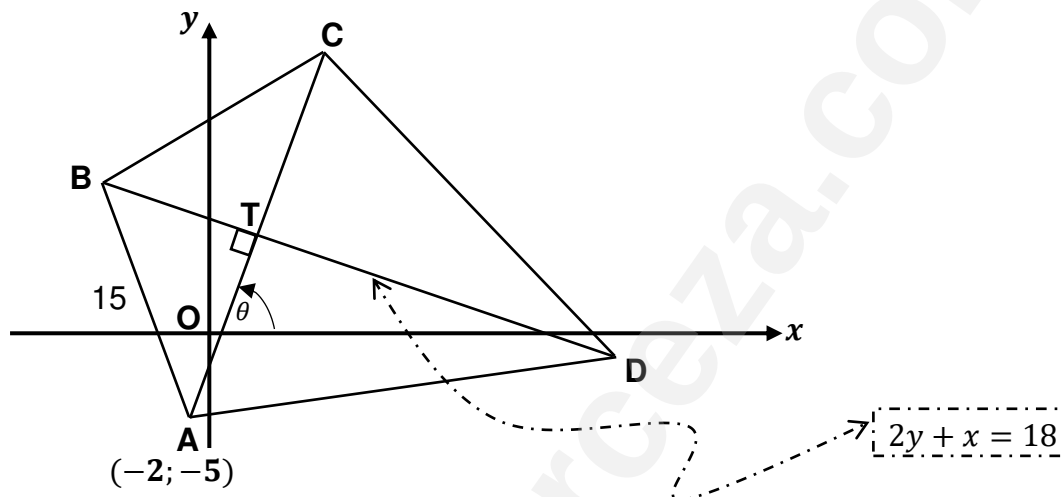
SECTION A

QUESTION 1

In the diagram below, (NOT drawn to scale), $A(-2; -5)$, B, C and D are the vertices of quadrilateral ABCD such that diagonal AC is perpendicular to diagonal BD at T.

The equation of line BT is given by $2y + x = 18$ and $AB = 15$ units.

[Note: AC does NOT pass through the origin]



(a) Determine

(1) the gradient of line AC. (2)

(2) θ , the inclination of line AC, rounded to the nearest whole number. (2)

(b) Determine the equation of line AC in the form $y = mx + c$. (2)

(c) Calculate the co-ordinates of point T. (3)

(d) If ABCD is a kite with $AB = BC$ and T is the midpoint of AC:

(1) Determine the coordinates of C. (2)

(2) Calculate the length of line BT. Leave your answer as a surd. (4)

[15]

QUESTION 2

The energy saving lightbulb, also known as a compact fluorescent light bulb (CFL), is a type of fluorescent lamp that fits into a standard light bulb socket. An energy saving lightbulb uses far less wattage to produce the same amount of light as a regular incandescent light bulb (IL).

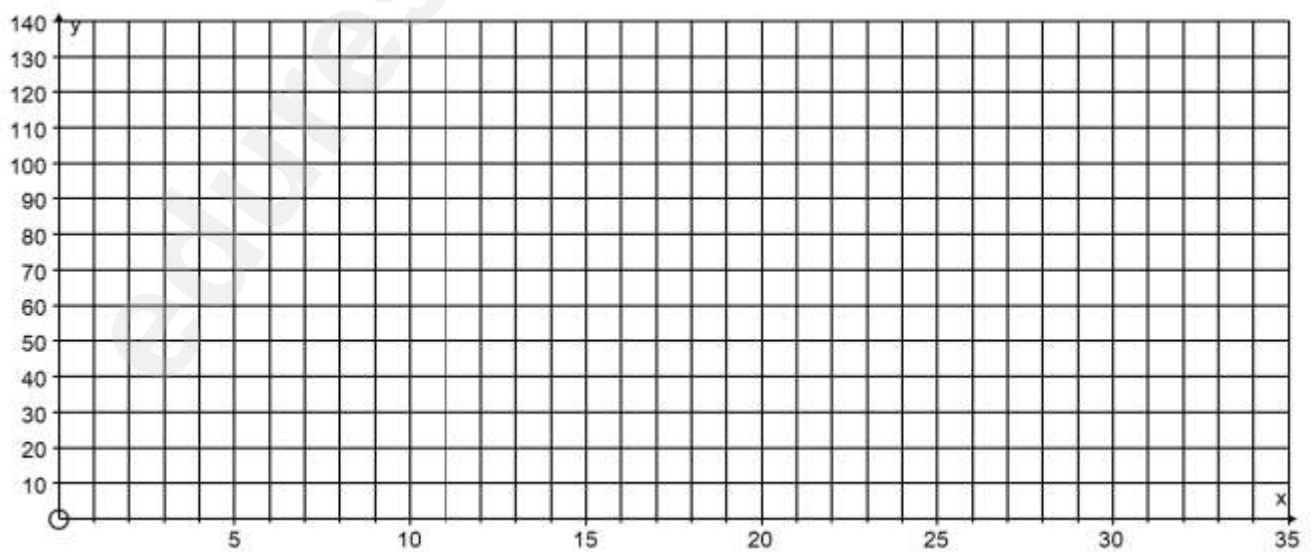
The table below compares the wattage of a CFL bulb to an IL bulb:

CFL (watts) (x)	IL bulb (watts) (y)
5	25
10	40
13	60
19	75
26	90
32	125



(a) Plot the information given in the table on the axes below:

(3)



Round off all answers to 2 decimal places

(b) Use your calculator to find the:

(1) equation of the line of best fit through this data. (2)

(2) correlation coefficient. (1)

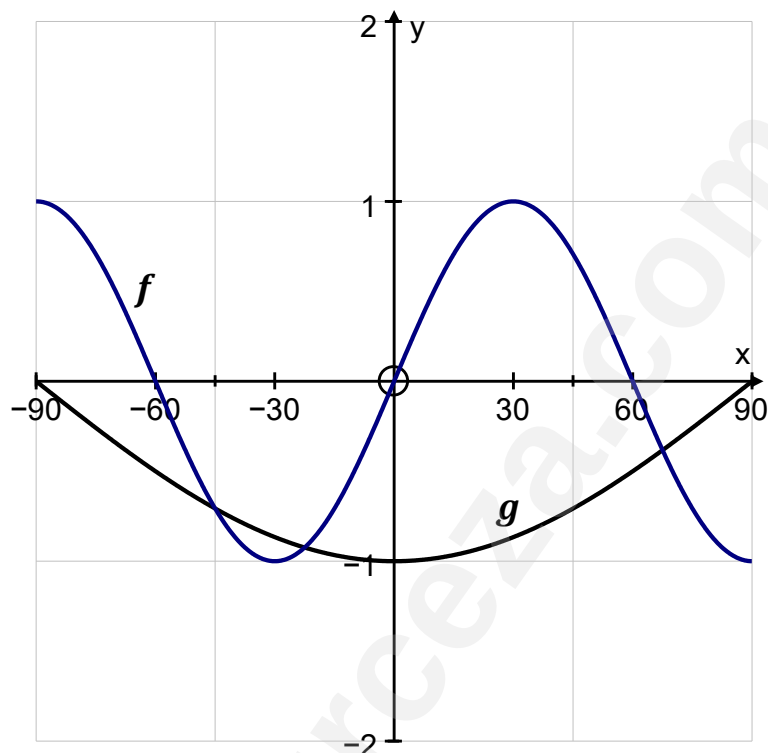
(c) Determine the equivalent IL wattage for a 35 Watt CFL lightbulb. (2)

(d) Comment on the validity of your answer in (c) above. (1)

[9]

QUESTION 3

In the diagram below, the graphs of $f(x) = \sin bx$ and $g(x) = -\cos x$ are drawn for $-90^\circ \leq x \leq 90^\circ$.



Use the diagram to answer the following questions:

(a) Write down the period of f . (1)

(b) Determine the value of b . (1)

(c) The general solutions of the equation $\sin bx = -\cos x$ are:

$$x = 67,5^\circ + k \cdot 90^\circ \text{ or } x = 135^\circ + k \cdot 180^\circ \text{ where } k \in \mathbb{Z}.$$

Determine the x -values of the points of intersection of f and g for the given domain. (3)

(d) Write down the values of x for which $\sin bx + \cos x < 0$ for the given domain. (4)

(e) Explain the transformation(s) from $g(x)$ to $h(x)$ if $h(x) = \cos(x - 30^\circ)$. (2)

[11]

QUESTION 4

(a) Simplify fully: $\frac{\cos(90^\circ - \theta) - \sin(180^\circ + \theta)}{\sin 2\theta}$ (4)

(b) (1) Prove: $\sin(540^\circ - x) \cdot \sin(-x) - \sin(90^\circ + x) \cdot \cos(180^\circ - x) = \cos 2x$ (5)

(2) Hence determine the general solution to: (3)

$$\sin(540^\circ - x) \cdot \sin(-x) - \sin(90^\circ + x) \cdot \cos(180^\circ - x) = -1$$

(c) Prove that: $\tan\theta + \frac{\cos\theta}{\sin\theta} = \frac{2}{\sin 2\theta}$ (4)

(d) Given that $\tan\theta = k$ in any right angled triangle, show, by the use of a sketch

that: $\sin 2\theta = \frac{2k}{k^2+1}$ (3)

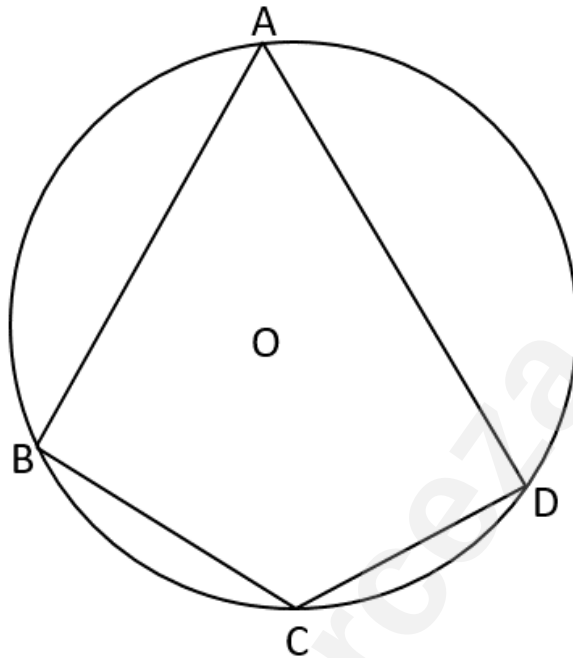
Sketch:



[19]

QUESTION 5

(a) Prove the theorem which states that “ *the opposite angles of a cyclic quadrilateral are supplementary*”.

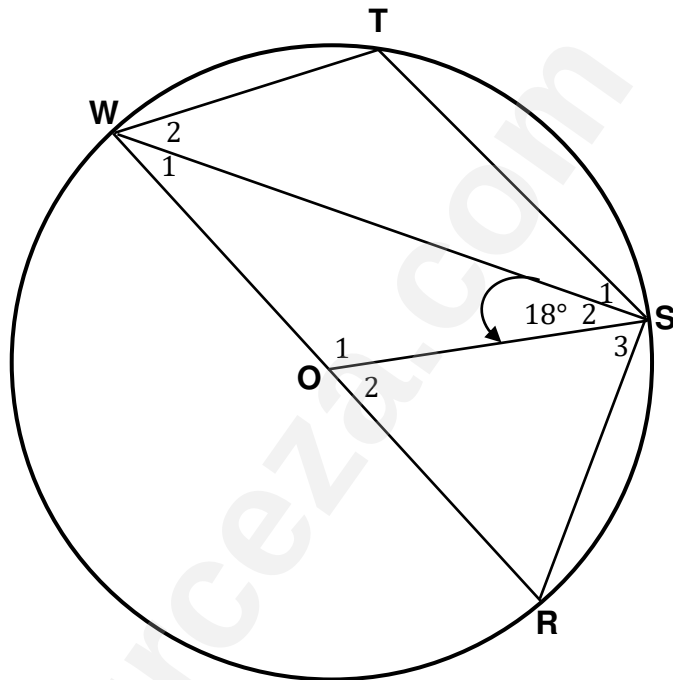


(5)

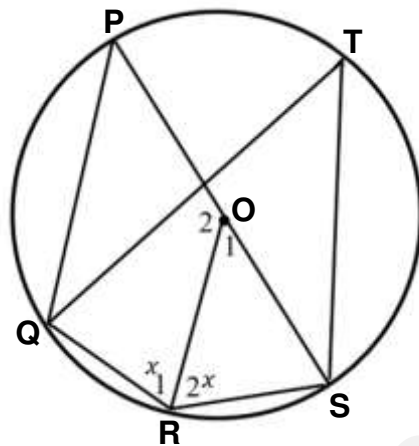
[illegible]

- (b) In the diagram, O is the centre of the circle and WR is the diameter. R, S, T and W are points on the circle and $\hat{S}_2 = 18^\circ$.

Calculate, giving reasons, the size of $\hat{T}$. (4)



(c) Given circle centre O and $\hat{R}_1 = \hat{R}_2 = x$. Prove, with reasons, that: $\hat{O}_1 = \hat{T} = \hat{P}$. (4)

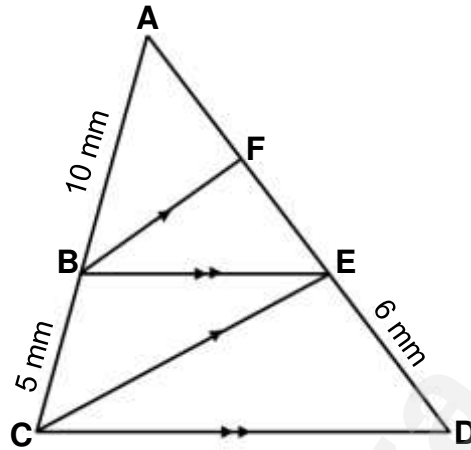


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[13]

QUESTION 6

In the diagram, $BE \parallel CD$ and $BF \parallel CE$. $AB = 10$ mm, $BC = 5$ mm and $DE = 6$ mm.



Calculate, giving reasons, the length of EF.

[6]

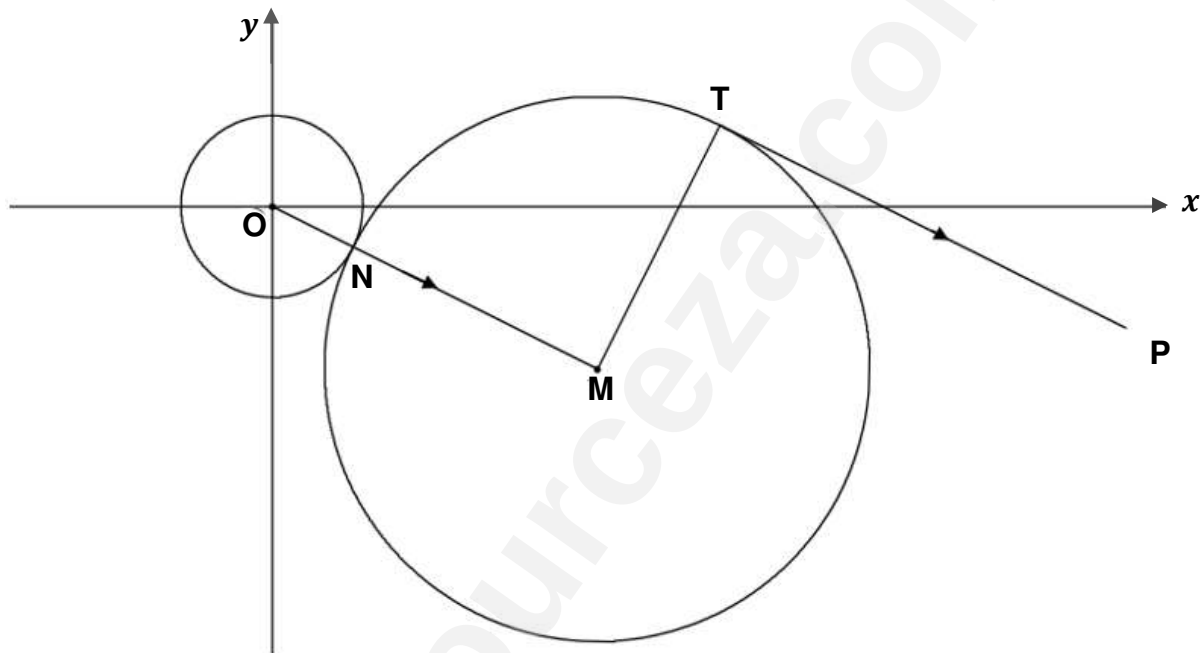
73 Marks

SECTION B

QUESTION 7

In the diagram below, the equation of the circle with centre M is given by the equation: $(x - 8)^2 + (y + 4)^2 = 45$

PT is a tangent to this circle at T and PT is parallel to OM. Another circle, having centre O, touches the circle having centre M at N.



- (a) Write down the coordinates of M. (1)

- (b) Calculate the length of OM. Leave your answer in simplest surd form. (2)

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(c) Calculate the length of ON. Leave your answer in simplest surd form. (3)

(d) Calculate, giving reasons, the size of $\widehat{OMT}$. (2)

(e) Determine the equation of line MT in the form $y = mx + c$. (5)

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(6)

This image shows a blank sheet of white paper with horizontal blue ruling lines. A diagonal watermark with the text "Sourceza.com" is visible across the center of the page. The watermark is light gray and semi-transparent. There are approximately 20 horizontal lines spaced evenly down the page.

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QUESTION 8

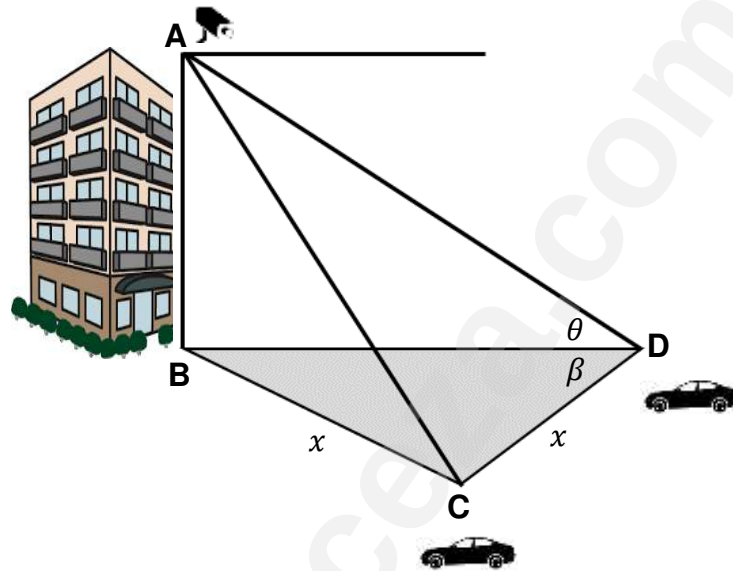
- (a) Simplify without the use of a calculator: $\frac{\sin 104^\circ (2 \cos^2 15^\circ - 1)}{\tan 38^\circ \cdot \sin^2 412^\circ}$ (7)

- (b) (1) Show that $\tan x = 2 \sin x$ can be written as $\sin x = 0$ or $\cos x = \frac{1}{2}$ (5)

- (2) Hence, write the general solution of the equation: $\tan x = 2 \sin x$ (2)

- (c) A surveillance camera, A, at the top of a building, shows 2 cars parked outside a building (B). The angle of elevation of A from D is θ . Car C is equidistant from Car D and the building B.

$$BC = DC = x \text{ and } \angle CDB = \beta.$$



- (1) Find BD in terms of x and $\cos 2\beta$. (3)

- (2) Prove that $AB = 2x \cos \beta \tan \theta$ (5)

[22]

QUESTION 9

What is Parkrun? It is a 5km run - it's you against the clock.

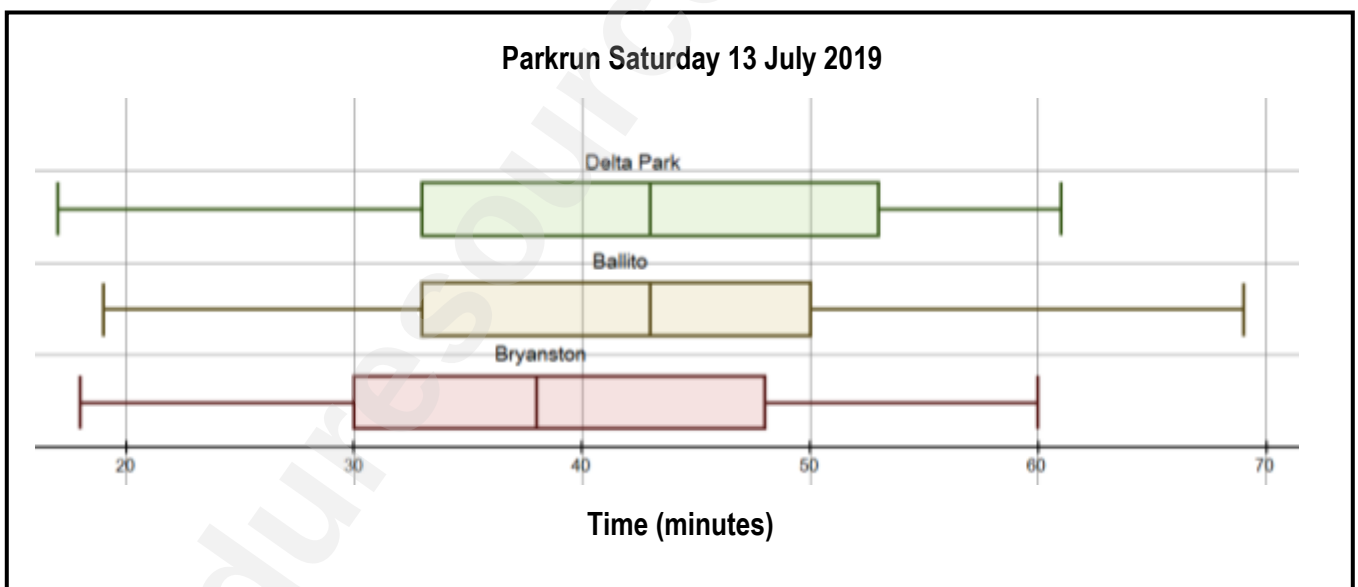
When is it? Every Saturday at 8:00am.

How fast do I have to be? We all run for our own enjoyment. Please come along and join in whatever your pace!



- Bryanston is a very large residential suburb in Sandton, Johannesburg.
- Delta Park is situated in Victory Park, a leafy suburb of Johannesburg. It is described as one of the oldest and trendier suburbs.
- Ballito is a holiday town located on the Dolphin Coast in Kwa-Zulu Natal.

The box and whisker plots below represent the times (in minutes) that participants completed the Parkrun in.



The following additional information was calculated.

	Bryanston	Ballito	Delta Park
n	1173	324	1224
Q_2 (median)	38,03	42,48	43,25
$\bar{x}$	39,00	42,42	43,46
σ	10,23	11,63	11,55

Using the information given, answer the questions which follow:

- (a) What percentage of people participating in the Bryanston Parkrun, run longer than 30 minutes? (1)

- (b) How many people ran faster than 43,25 minutes at Delta Park? (2)

- (c) Suggest a reason for the large range at the Ballito Parkrun. (1)

- (d) A runner has a personal best of 20,00 minutes. At which run would he get the best place finish? Justify your answer. (2)

A measure of skewness can be calculated by using the following formula:

$$Skewness = \frac{3(\bar{x} - Q_2)}{\sigma}$$

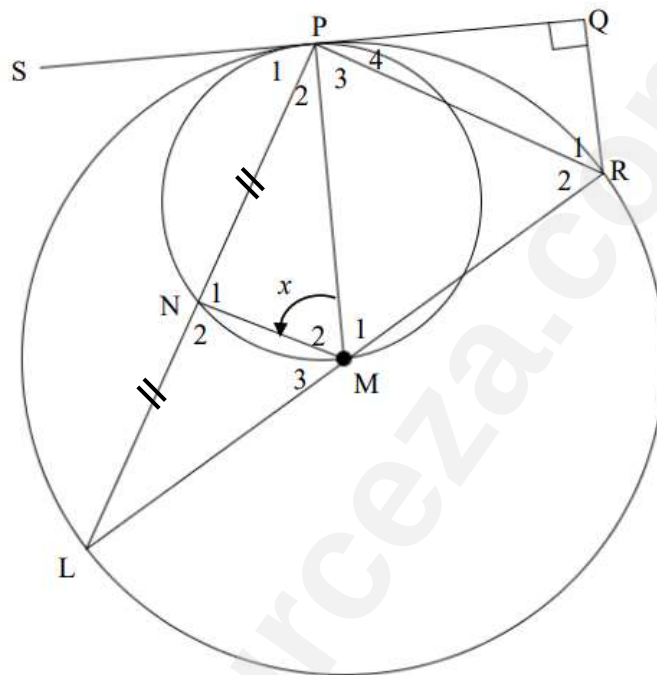
- (e) Using the formula given above, determine if the data at the Delta Parkrun is more skew than the data at the Bryanston Parkrun. Suggest a reason for your findings. (3)

[9]

QUESTION 10

SPQ is a common tangent for both circles. M is the centre of the bigger circle. PM is the diameter of the smaller circle.

RQ is perpendicular to PQ and $\widehat{PMN} = x$. It is also given that $LN = NP$.



(a) Prove, giving reasons, that PR bisects $\widehat{QL}$.

(4)

(b) Prove, giving reasons, that $\triangle PNM \parallel \triangle PQR$ (3)

If it is given that $PR = 30$ cm and $QR = 15$ cm, calculate, with reasons,

(c) The length of LR . (5)

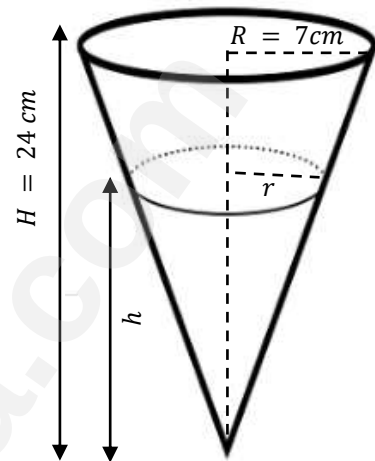
(d) The value of x . (4)

[16]

QUESTION 11

A sealed vertical inverted cone (i.e. vertex down) has a radius, R , of 7cm and height, H , of 24cm. Water is filled to one third of the cone's height.

$$V_{\text{cone}} = \frac{1}{3}(\text{base area})(\text{height})$$

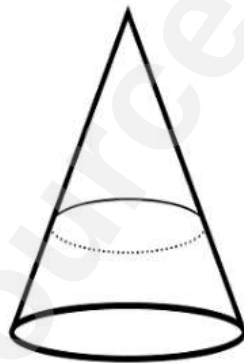


- (a) Determine the volume of the cone, leaving your answer in terms of π . (2)

- (b) Determine the height of the water, h , and the radius, r , of the water surface. (3)

(c) Determine the volume of air in the cone, leaving your answer in terms of π . (2)

(d) The cone is now turned upside down. Find the height of the water. (4)



[11]

77 Marks

EXTRA WORKING SPACE:

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