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AUGUST PRACTICE QUESTIONS 2021
SECONDARY 4 EXPRESS
SECONDARY 5 NORMAL ACADEMIC

ELEMENTARY MATHEMATICS   **4048/01**

Specimen Paper

Date: **10 AUGUST 2021**   **Duration: NIL**

Candidates answer on separate writing paper

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READ THESE INSTRUCTIONS FIRST

Answer all questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures.
Give answers in degrees to one decimal place.
For π, use either your calculator value of 3.142, unless the question requires the answer in terms of π.

Topic names will be listed above each question for your benefit and revision

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Upon completion of solutions:

Each candidate have exactly 3 weeks to submit their solutions
Take a picture or send the digital version of your solutions to me (Kaiwen) via Telegram (**@kaiwen_tutor**) or WhatsApp (**90583779**)
Ensure that all workings are clear and legible
Solutions will be marked based on your presentation, accuracy and completeness of your solutions
A markers' report and the full solutions will be provided at the end of the month

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Setter: Ong Kai Wen

This question paper consists of <u>34</u> printed pages including the cover page

<u>Content Covered</u>

Numbers and Algebra	Geometry and Measurement	Statistics and Probability
Numbers & their Operations	Angles, Triangles & Polygons	Data Analysis
Ratio & Proportion	Congruence & Similarity	Data Handling
Percentage	Properties of Circles	Probability
Rate & Speed	Pythagoras' Theorem	
Algebraic Expression & Formulae	Trigonometry	
Functions & Graphs	Mensuration	
Equations & Inequalities	Coordinate Geometry	
Set Language & Notation	Vectors	
Matrices		
Problems in Real World Context		

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All questions are sourced and selected based on the known abilities of students sitting for the 'O' Level E-Math Examination. If questions are sourced from respective sources, credit will be given when appropriate

Question Source:

All questions compiled here are from **2011 – 2020 School Mid-Year / Prelim Papers**. Questions are categorised into the various topics and range from varying difficulties. School's name, paper and year is credited after every question

How to read:

[S4 VS P1/2011 PRELIM Qn 1]

Secondary 4, Victoria School, Paper 1, 2011, PRELIM, Question 1

<u>Topic: Numbers & their Operations</u>

A set of numbers is given below

$$-0.4, \qquad \frac{1}{3}, \qquad \sqrt[3]{3}, \qquad \frac{\pi}{7}, \qquad 0.\dot{6}\dot{6}, \qquad -\sqrt{4}$$

(a) Write down the set of numbers in descending order
(b) Write down the irrational numbers(s) from the given set

[S4 HIHS P1/2017 PRELIM Qn 2]

Given that $6^x = 9$, where x is a positive integer, find the value of
(a)
$$6^{-x}$$
(b)
$$6^{\frac{x}{2}}$$
(c)
$$6^{3x+1}$$

[S4 JYSS P1/2017 PRELIM Qn 14]

Show that for all p, where p is a positive integer, is divisible by **15**

$$(7p - 3)^2 - 4p(p - 3) + 6$$

[S4 PHSS P1/2017 MYE Qn 5]

Find the value of n given the following

$$4^{\frac{1}{2n}} \div 64^{-2} = 2^5$$

[S4 SST P1/2018 PRELIM Qn 5]

(a) Find the value of w given that

$$8^{12} \div 4^{2w} = \left(\frac{1}{2}\right)^{3w-2}$$

(b) Simplify the following, leaving your answers in positive index notation

$$\frac{2ab^2}{(2bc^0)^{-2}} \div \frac{8}{\sqrt{ab^2}}$$

[S4 FHSS P1/2016 PRELIM Qn 3]

(a) The highest common factor and the lowest common multiple of three numbers are **12** and **2376** respectively. If two of the numbers are **108** and **72**, find the smallest possible integer value of the third number

(b) **(i)** Express **6468** as a product of its prime factors
   (ii) Find the smallest possible integer k such that $\sqrt{6468k}$ is an integer

[S4 AHS P1/2020 PRELIM Qn 5]

Topic: Ratio & Proportion
A map is drawn to a scale of $1:50\,000$
(a) Calculate the actual distance, in kilometres, represented by **1 cm** on the map
(b) Two towns are **20 km** apart. Calculate, in centimeters, their distance apart on the map
(c) Calculate, in square kilometres, the actual area of a housing estate which has an area of **50 cm²** on the map

[S4 GESS P1/2016 MYE Qn 6]

y is inversely proportional to x^3. x has a certain value if $y = 5$. Find the value of y when x is doubled

[S4 BNSS P1/2020 PRELIM Qn 8]

The area of a 8 km^2 park is represented on a map by an area of 200 cm^2
(a) If the map has a scale of $1:n$, find the value of n
(b) If the perimeter of the park on the map is 13 cm, calculate the actual perimeter in kilometres
(c) A renovation was done on the park and its area on the map is now represented by the following parallelogram $ABCD$, with $AB = 25\text{ cm}$, $AD = 13\text{ cm}$ and $5DO = DC$. Find the percentage change in the area of the park
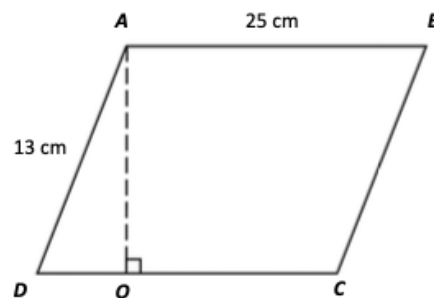
[S4 CCHS(M) P1/2020 PRELIM Qn 6]

<u>Topic: Percentage</u>

The body mass index (BMI) of a person is defined as

$$\text{BMI} = \frac{\text{mass}}{\text{height}^2}$$

Over one year, David's mass decreased by 0.5% and his height increased by 10%. Find the percentage change in David's BMI

[S4 SCSS P1/2017 PRELIM Qn 7(b)]

Employees of a company are offered a salary increase based on one of these schemes:

Scheme A: An increase of 12% of their present salary
Scheme B: An increase of $\$90$ plus 10% of their present salary

Gwendolyn finds that both schemes will give her the same salary increase. Given that her present salary is $\$x$, form an equation in terms of x and hence find her present salary
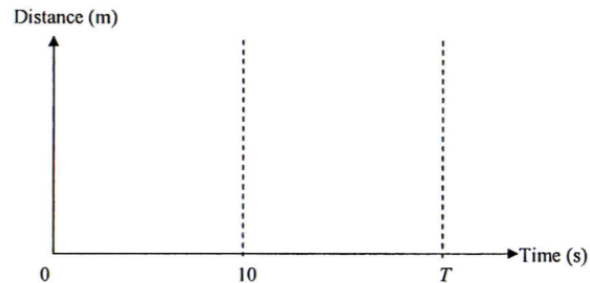
[S4 MSS P1/2020 PRELIM Qn 5]

Connor has 6 litres of a 10% alcohol solution. How much water must he add to reduce the concentration of alcohol to 8%?

[S4 MGS P1/2020 PRELIM Qn 10]

<u>Topic: Rate & Speed</u>
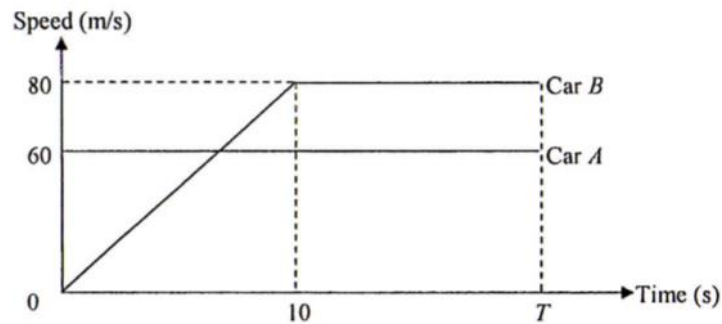
The diagram below shows Car *A* travelling at a uniform speed of **60 m/s**. Car *B* accelerated uniformly from rest to reach a speed of **80 m/s** in **10 sec**. Find
(a) the time when both cars were travelling at the same speed
(b) the time when Car *B* overtook Car *A*
(c) On the axes given below, sketch the distance-time graph of Car *B*

[S4 SKSS P1/2017 PRELIM Qn 24]

Danny drove to his office located **14 km** away from home. In the first **9 km**, his average speed was **70 km/h**. He then took another **6 minutes** to reach his office. Find the average speed for his journey in **km/h**

[S4 HSS P1/2020 PRELIM Qn 4]

Topic: Algebraic Expressions & Formulae

The first four terms in a sequence of numbers $T_1, T_2, T_3, T_4, \ldots$ are given below

$$T_1 = 3^0 + 1 + 2^2 = 6$$
$$T_2 = 3^1 + 4 + 3^2 = 16$$
$$T_3 = 3^2 + 7 + 4^2 = 32$$
$$T_4 = 3^3 + 10 + 5^2 = 62$$

(a) Write down an expression for T_5 and show that $T_5 = 130$
(b) Write down the value of T_6
(c) Find an expression, in terms of n, for the nth term T_n of the sequence
(d) Show that

$$T_{n+1} - T_n = 2(3^{n-1} + n + 3)$$

[S4 CHS P2/2012 PRELIM Qn 5] (July)

The first three terms in a sequence of numbers, $T_1, T_2, T_3, \ldots$ are given below

$$T_1 = 1 \times 2 + 10 = 12$$
$$T_2 = 2 \times 3 + 6 = 12$$
$$T_3 = 3 \times 4 + 2 = 14$$

(a) Find T_4
(b) Show that

$$T_n = n^2 - 3n + 14$$

(c) Evaluate T_{50}
(d) Explain why every term in the sequence is even

[S4 ACS(B) P1/2017 PRELIM Qn 1]

(a) Simplify the following

$$\frac{x+1}{x^2 - 9} - \frac{2}{3 - x}$$

(b) Simplify the following, leaving your answer in positive indices

$$\frac{(abc^{-2})^3}{(a^{-4}b^{-1})^{-1}} \times \frac{a^{-6}b^{-7}}{(bc^2)^{-4}}$$

[S4 CHIJKC P1/2017 PRELIM Qn 1]

(a) Find the value of $\dfrac{4x}{15y}$ given that

$$4x^2 - 12xy + 9y^2 = 0$$

(b) Factorise the following completely

$$a^2 + 2ab + b^2 - 4b^2c^2$$

[S4 CCHS(M) P1/2018 PRELIM Qn 11]

Express the following as a single fraction

$$\frac{3}{4 - \dfrac{3}{\left(\dfrac{x+1}{x}\right)}} - \frac{5}{x+4}$$

[S4 ACS(I) P1/2016 PRELIM Qn 11]

Given that $1 < y < 2$, simplify and arrange the following expressions in ascending order of magnitude

$$\frac{1}{y^{-2}} \div \frac{1}{y^3}, \qquad \frac{1}{(y-3)^3} \times \frac{(y-3)^2}{1}, \qquad \frac{y^{-2}}{4y^{-3}}$$

[S4 DSS P1/2016 PRELIM Qn 11]

(a) The first **4** terms in a sequence are **78, 73, 68** and **63**

    (i) Find an expression, in terms of n, for the n**th** term, T_n, of this sequence

    (ii) Evaluate T_{21}

(b) Study the pattern below and answer the questions that follow based on the pattern

$$L_1 = \frac{1}{1} - \frac{1}{2} = \frac{1}{2}$$
$$L_2 = \frac{1}{2} - \frac{1}{3} = \frac{1}{6}$$
$$L_3 = \frac{1}{3} - \frac{1}{4} = \frac{1}{12}$$
$$L_4 = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}$$

    (i) Write down the equation corresponding to line k in terms of k

    (ii) Justify, with appropriate mathematical working, why $\dfrac{1}{340}$ will not appear on the left hand side of the equation in any of the lines

    (iii) Find the sum of the following series without the use of a calculator

$$\frac{1}{2} + \frac{1}{6} + \frac{1}{12} + \frac{1}{20} + \frac{1}{30} + \frac{1}{42} + \frac{1}{56} + \frac{1}{72} + \frac{1}{90}$$
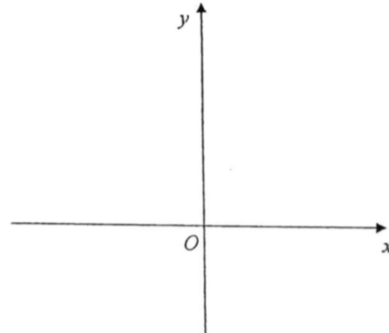
    (iv) Hence, find the sum of the following series

$$1 + \frac{1}{3} + \frac{1}{6} + \frac{1}{10} + \frac{1}{15} + \frac{1}{21} + \frac{1}{28} + \frac{1}{36} + \frac{1}{45}$$

[S4 KSS P2/2016 PRELIM Qn 4]

<u>Topic: Functions & Graphs</u>
(a) Express $14 - 6x^2 + x^2$ in the form $(x - h)^2 + k$
(b) On the axes provided, sketch the graph of $y = 14 - 6x^2 + x^2$
(c) Write down the equation of the line of symmetry of the graph $y = 14 - 6x + x^2$

[S4 NVSS P1/2017 MYE QN 11]

Answer the whole of this question on a sheet of graph paper
The variables x and y are connected by the equation

$$y = \frac{1}{4}x(x^2 - 5)$$

Some of the corresponding values of x and y are given in the table below

x	-3	-2	-1	0	1	2	3	4
y	-3	0.5	1	0	-1	-0.5	3	p

(a) Find the value of p
(b) Using a scale of **2 cm** to represent **1** unit, draw a horizontal x-axis for $-3 \le x \le 4$. Using a scale of **1 cm** to represent **1** unit, draw a vertical y-axis for $-4 \le y \le 12$. On your axes, plot the points given in the table and join them with a smooth curve
(c) The following equation has **3** solutions

$$\frac{1}{4}x(x^2 - 5) + \frac{1}{2} = 0$$

Explain how this can be seen from your graph
(d) By drawing a tangent, find the gradient of the curve at the point $(3, 3)$
(e) (i)   On the same axes, draw the line $y = -x + 8$ for $0 \le x \le 4$
     (ii) Write down the x-coordinate of the point where this line intersects the curve
     (iii) This value of x is a solution of the equation

$$x^3 + Ax^2 - Bx - 32 = 0$$

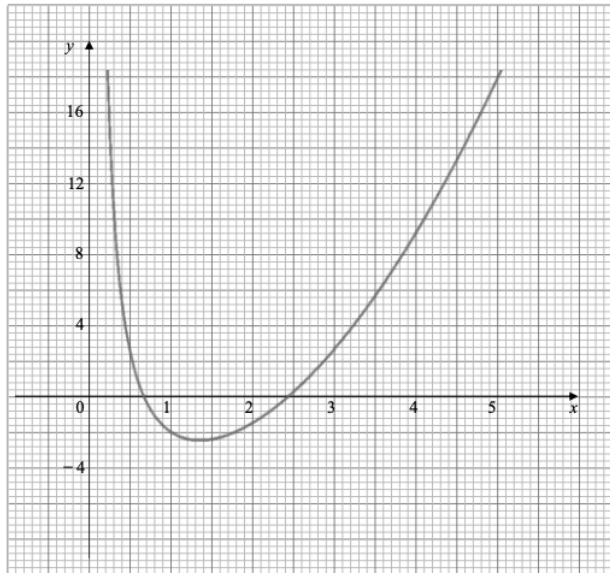Find the value of A and of B

[S4 NBSS P2/2017 PRELIM Qn 8]

Sketch the graph of the following equation on the axes below

$$y = -(x + 3)^2 + 5$$

Indicate clearly the coordinates of the points where the graph crosses the axes and the turning point on the curve

[S4 BPGHS P1/2020 PRELIM Qn 12]

The graph of the following equation, where $x > 0$ is drawn on the grid

$$y = x^2 + \frac{5}{x} - 8$$

(a) Use the graph to find the least value of

$$x^2 + \frac{5}{x} - 8$$

(b) Explain why there is no solution for the following equation, where $x > 0$

$$x^2 + \frac{5}{x} - 4 = 0$$

(c) The point of intersection of the curve and the line $y = 8 - 2x$ give the solutions of an equation
  (i) Find the equation, giving your answer in the following form

$$ax^3 + bx^2 + cx + d = 0$$

  (ii) Use the graph to solve the equation found in part (c)(i)

[S4 CHIJ CHJS P1/2020 PRELIM Qn 24]

Topic: Equations & Inequalities
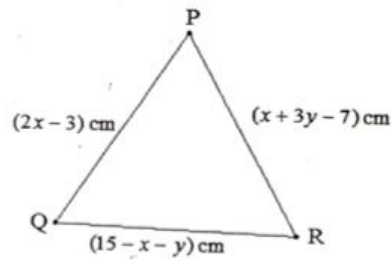
The diagram shows an equilateral triangle PQR with $PQ = (2x - 3)$ cm, $QR = (15 - x - y)$ cm and $PR = (x + 3y - 7)$ cm

(a) Using the information shown in the diagram, write down and simplify two simultaneous equations in x and y

(b) Solve these equations to find the value of x and the value of y

[S4 YISS P1/2017 PRELIM Qn 12]

Jeannie bought some health drink for $\$6400$. She paid $\$x$ for each litre of the drink.

(a) Find, in terms of x, an expression for the number of litres she bought.

(b) She gave away **8** litres of the drink to her friends. She sold the remainder of the drink for $\$50$ per litre more than she paid for it. Write down an expression, in terms of x, for the sum of money she received

(c) She made a profit of $\$2960$

    (i) Write down an equation in x to represent this information, and show that it reduces to

$$x^2 + 420x - 40\,000 = 0$$

    (ii) Solve the equation $x^2 + 420x - 40\,000 = 0$

(d) Find the number of litres of drink Jeannie sold

[S4 CHIJSNGS P2/2016 MYE Qn 5]

(a) Factorise completely

    (i)
$$16r^2 - 4s^2$$

    (ii)
$$4x^2y^2 + 14xyz - 8z^2$$

(b) Express the following as a single fraction in its simplest form

$$\frac{3y}{5(x - 1)} + \frac{y}{(x - 1)^2}$$

(c) Solve the inequality

$$\frac{x - 9}{2} \leq \frac{x - 1}{3} < \frac{2x - 5}{4}$$

(d) Make d the subject of the formula

$$S = \frac{n}{2}[2a + (n-1)d]$$

[S4 SJI P2/2016 MYE Qn 1]

Express the following as a single fraction in its simplest form

$$\frac{3}{2-3x} - \frac{24x}{9x^2 - 4} + \frac{4}{3x+2}$$

[S4 SCGS P1/2018 PRELIM Qn 10]

Solve the pair of simultaneous equations

$$3x + 5y = -9$$
$$2x - 9y + 8 = 39$$

[S4 BHSS P1/2016 PRELIM Qn 17]

In **2014**, Mr Lim paid an average of **$350** for his monthly petrol bill when the price of petrol was $\$x$ per litre. In **2015**, the price of petrol had risen by **25 cents** per litre. By cutting down on usage, Mr Lim still managed to pay an average of **$350** for his petrol bill in **2015**
(a) Write down an expression, in terms of x, for the number of litres of petrol used in **2014**
(b) Write down an expression, in terms of x, for the number of litres of petrol used in **2015**
(c) If the number of litres of petrol used in **2015** is **20** less than that used in **2014**, form an equation in x and show that it reduces to $8x^2 + 2x - 35 = 0$
(d) Solve the equation, giving your answer to **3** decimal places
(e) Use the results found in part (d) to find the number of litres of petrol used by Mr Lim in **2015**, giving your answer correct to the nearest **0.1** litres

[S4 CHS P2/2016 PRELIM Qn 2]

A tank with a capacity of **1000** litres could be filled using two taps A and B. Tap A and Tap B are used at different times to fill up the tank
(a) If Tap A supplies water to the tank at a rate of x litres per minute, write down an expression for the time taken, in minutes, by Tap A alone to fill up the tank completely
(b) Tap B supplies water to the tank at a rate of **20** litres per minute fast than Tap A. Write down an expression for the time taken, in minutes, by Tap B alone to fill up the tank completely
(c) Given that the difference in time taken by Tap A and Tap B to fill the tank when used separately is **1 hour**, form an equation in terms of x and show that it reduces to $3x^2 + 60x - 1000 = 0$
(d) Solve the equation, giving your answers correct to **2** decimal places
(e) If Tap A and Tap B are turned on together to fill the tank when it is empty, find the time taken, correct to the nearest minute, for the tank to be completely filled

[S4 TKSS P2/2016 PRELIM Qn 5]

<u>Topic: Set Language & Notation</u>
Given that

$$\zeta = \{x : x \text{ is an integer}, 1 \le x \le 100\}$$
$$A = \{x : x \text{ is divisible by 11}\}$$
$$B = \{x : x \text{ is divisible by 22}\}$$
$$C = \{x : x \text{ is divisible by 33}\}$$

(a) List the elements of $A \cap (B \cup C)'$
(b) Draw a clearly labelled Venn diagram to illustrate the 3 sets, A, B and C

[S4 CHIJSNGS P1/2016 PRELIM Qn 15]

(a) It is given that

$$\xi = \{x : x \text{ is an integer between 0 and 9 inclusive}\}$$
$$A \subset \xi \text{ and } B \subset \xi$$
$$\{0, 2\} \subset (A' \cap B)$$
$$7 \in A \cap B$$
$$\{1, \quad 4, \quad 5, \quad 8\} \subset ((A \cup B) \cap B')$$
$$3, 6, 9 \notin (A \cup B)$$

   Draw a Venn diagram to represent the information given.

(b) List down all the proper subsets of the set $\{a, b, c\}$

[S4 AHS P1/2018 PRELIM Qn 7]

Topic: Matrices

A tour agency records the weekly average number of tour packages to Japan and Korea sold in the months of May and June in **2016**.

In May **2016**, **25** Japan tour packages and **32** Korea tour packages were sold weekly. In June **2016**, **30** Japan tour packages and **40** Korea tour packages were sold weekly. This information can be represented by the matrix

$$L = \begin{pmatrix} \overset{\text{Japan}}{25} & \overset{\text{Korea}}{32} \\ 30 & 40 \end{pmatrix} \begin{matrix} \text{May} \\ \text{June} \end{matrix}$$

It is assumed that there are **4** weeks in each month.

(a) The prices of the Japan and Korea tour packages in **2016** were $690 and $900 respectively. Represent the prices of the tour packages by a 2×1 column matrix N.

(b) Evaluate the matrix $R = 4LN$

(c) State what the elements of R represent

(d) The tour agency decides to offer a discount on the tour packages bought in May and June **2017**. The agency estimated a **30**% increase and **60**% increase in the sales of the Japan tour packages and Korea tour packages respectively compared to **2016**. By using matrix multiplication involving L, calculate the total estimated number of Japan and Korea tour packages sold weekly in May **2017** and June **2017** respectively.

[S4 XMSS P2/2017 PRELIM Qn 9(b)]

A fitness centres offers daily Zumba classes for morning and afternoon classes. On every weekday morning, 15 males and 10 females will attend the Zumba class, while 20 males and 15 females attend the afternoon Zumba class. This information may be represented by the matrix D below. On each weekend, 30 males and 20 females will attend the morning class, while 25 males and 25 females will attend the afternoon class

$$D = \begin{pmatrix} \overset{\text{males}}{15} & \overset{\text{females}}{10} \\ 20 & 15 \end{pmatrix} \begin{matrix} \text{morning} \\ \text{afternoon} \end{matrix}$$

(a) Express the number of people attending the fitness class on each weekend by a 2×2 matrix E
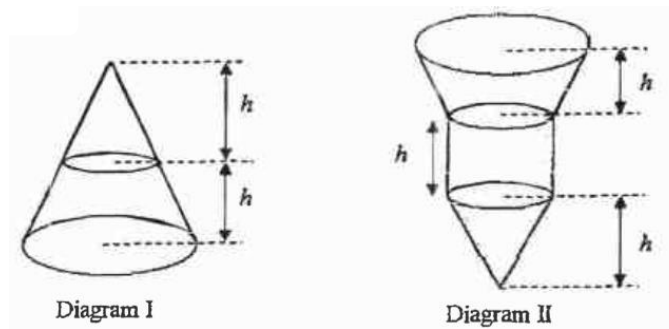
(b) Evaluate the matrix

$$S = 5D + 2E$$

(c) The fitness centre charges each person $10 for a morning session and $15 for an afternoon session. Represent the charges by a row matrix P

(d) Evaluate the matrix T where

$$T = PS$$

(e) State what the elements of T represent

[S4 HYSS P2/2020 PRELIM Qn 3]

Topic: Problems in Real-World Context

Diagram I   Diagram II

A frustum and a cone were obtained by slicing a conical container, height $2h$, as shown in Diagram **I** at the midway of the height. These figures were then attached to a cylinder, height h, to form a new container as shown in Diagram **II**. Water was poured into the empty container in Diagram **II** at a constant rate from the top and it took **33** seconds to fill to the brim. Given that it took p seconds for the water to reach the container to a height of h and q seconds to reach the height $2h$

(a) Find the value of p and q

(b) On the grid in the answer space, sketch the graph of the depth of water (d) against the time
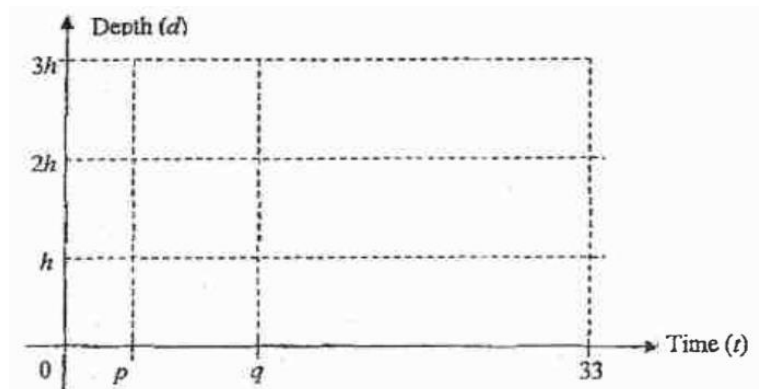
[S4 MJSS P1/2017 PRELIM Qn 23]
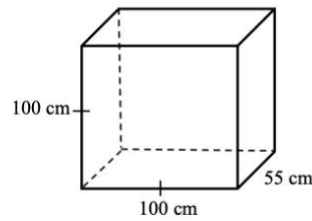
Figure *A*   Figure *B*

The interior of a chest freezer as shown in Figure *A* can be modelled as a cuboid with length and height of **100 cm** and a width **55 cm** as shown in Figure *B*. Cool air must be circulated inside the freezer at any time. When cool air meets the warm and humid air that is outside of the freezer, frost is formed at the point of contact. To allow the freezer to work efficiently, defrosting is required when the layer exceeds 1 cm

(a) Due to the opening and closing of the freezer door, frost of x cm is formed uniformly on the four vertical walls of the freezer. The area of the horizontal base of the freezer not covered by the frost is

$$105(50 - x) \text{ cm}^2$$

Explain if defrosting is required and show your calculations clearly

(b) Kara wants to design a box that can contain the freezer for shipping. There must be free space between the freezer and the box to allow for ease of removal and addition of protective materials to prevent scratches. It is recommended to have a minimum distance of 2 cm of free space around the sides and a minimum distance of 3 cm of free space at the top. The thickness of the freezer wall and door of the freezer is 3.5 cm. Find the smallest dimensions of the box required. State one assumption made in your calculation

[S4 ANDSS P2/2020 PRELIM Qn 11]

(a) The tuition fee of a 4-year undergraduate course is \$152 800. Alan applies for a government tuition grant that pays 75% of the tuition fee. Calculate the amount of tuition fee payable by Alan

(b) Alan decides to take up a study loan to pay off the remaining tuition fee. There are 2 packages available, both commencing after course completion

Package I: Compound Interest of 4% per annum, repayment period of 5 years
Package II: Simple Interest of 4.2% per annum, repayment period of 6 years

   (i)   Calculate the total maount of interest incurred for each package
   (ii) Alan plans to repay a maximum of \$700 per month after graduation. Determine, with clear workings, which package he should choose

(c) Alan decides to apply for a 2-month Global Internship Programme in Japan. The exchange rate between Singapore Dollars (\$) and Japanese Yen (¥) is \$1 = ¥76.50. The estimated expenditure is ¥154 000 per month. Calculate the minimum amount of Singapore dollars. Alan has to save for the trip. Give your answer correct to the nearest dollar

[S4 NGHS P2/2020 PRELIM Qn 3]
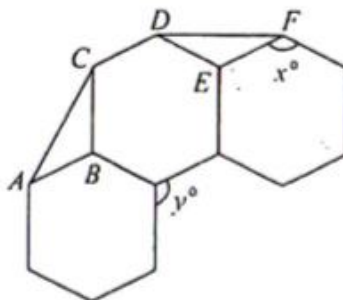
Topic: Angles, Triangles & Polygons
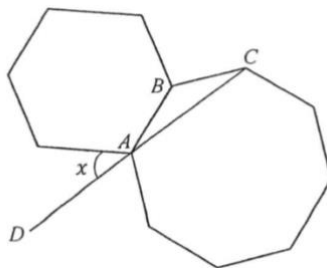
A regular hexagon and regular octagon share a side **AB** as shown in the diagram above. **DAC** is a straight line. Calculate the size of angle x

[S4 TSS P1/2017 MYE Qn 6]
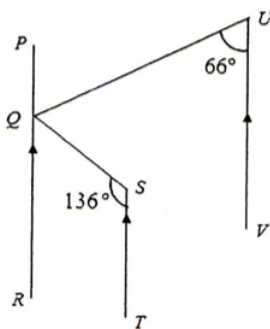
In the diagram, **PQR** is a straight line. **PR**, **ST** and **UV** are parallel to one another. $\angle QST = 136°$ and $\angle QUV = 66°$. Find the value of $\angle UQS$

**[S4 BSS P1/2017 PRELIM Qn 3]**

The diagram shows three regular hexagons
(a) Find the value of x and y
(b) Find $\angle ACD$
(c) Explain why $\triangle ABC$ and $\triangle DEF$ are congruent
(d) Additional hexagons are added to the three hexagons to form a closed ring, which will then form a regular polygon. Calculate the additional number of hexagons required to form the ring

[S4 SGSS P2/2017 PRELIM Qn 2]

In the diagram below, A, B and C are squares. Find the sum of the angles a, b, c, d, e, f and g
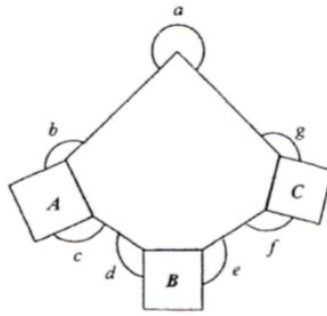
[S4 AMKSS P1/2016 MYE Qn 17(b)]
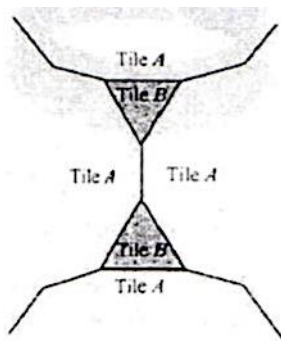
The diagram shows part of a pattern made from tiles. The pattern is made from type A tiles and type B tiles, both of which are regular polygons. Find the number of sides that tile A has
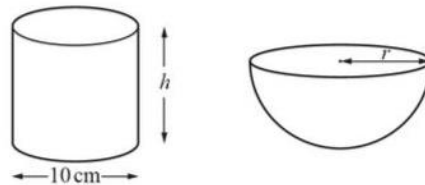
Topic: Congruency and Similarity
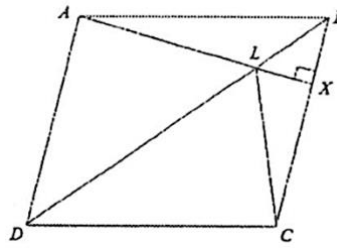
In the diagram, $ABCD$ is a rhombus. AX is perpendicular to BC and intersects BD at L. Prove that $\triangle ALD$ is congruent to $\triangle CLD$

[S4 DSS P1/2017 MYE Qn 17(b)]

(a) Make b the subject of the formula given that the surface area of a solid is given by

$$A = \pi a(a + 2b)$$

(b) The diagram shows a cylinder and a hemisphere. The cylinder has a diameter **10 cm** and height h **cm** and hemisphere has radius r. The volumes of the cylinder and hemisphere are equal. Find r in terms of h
(c) Find the smallest positive integer value of h such that r is a perfect cube

[S4 TKSS P1/2018 PRELIM Qn 23]
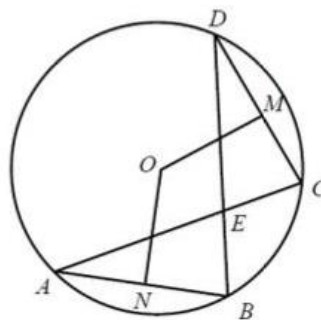
The points A, B, C, D lie on a circle, centre O. N and M are midpoints of AB and CD respectively. It is given that $ON = OM$

(a) Show that the triangles ABE and DCE are congruent.
(b) It is given that $AB = 6$ **cm** and $ON = (r - 1)$ **cm**, where r is the radius of the circle. Find the value of r

[S4 CGS P2/2018 PRELIM Qn 3]

Figure 1   Figure 2
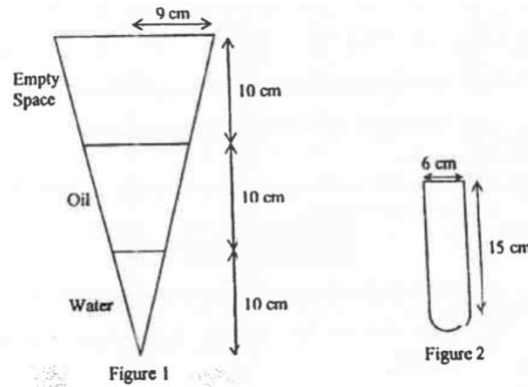
A funnel is in the form of an inverted right circular cone. Figure **I** shows a vertical cross-section of the funnel. It contains oil and water (which do not mix). The depths of water and oil are all **10 cm**, with water at the bottom. It is given that the height of the funnel is **30 cm** and the base radius is **9 cm**

(a) Find the volume of the funnel in terms of x

(b) Find the fraction of

(i)

$$\frac{\textbf{Volume of oil}}{\textbf{Volume of water}}$$

(ii)

$$\frac{\textbf{Surface area of the funnel in contact with water}}{\textbf{Total surface area of the interior of the funnel}}$$

(c) All the water in the funnel is then drained through the tap at the vertex of the funnel, into another container formed by a cylinder of diameter **6 cm** and surmounted by a hemisphere at the lower part of the cylinder, as shown in Figure **2**. The height of the cylindrical part of the container is **15 cm**. Find the depth of the water in this container
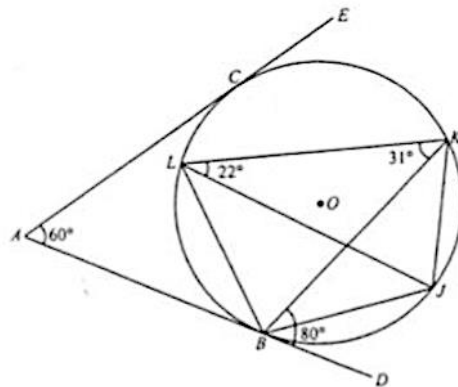
[S4 GMS(S) P2/2017 PRELIM Qn 8]

<u>Topic: Properties of Circle</u>

A circular trampoline similar to the figure shown below is set up for the event at the play area
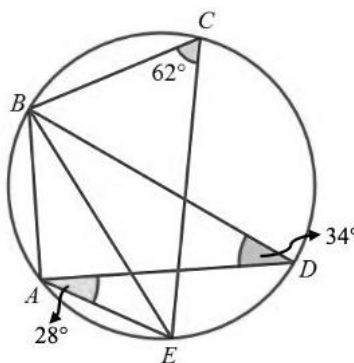

The diagram below shows the top view of the trampoline as a circle **BLCKJ** with centre **O**. **AE** and **AD** are safety barriers which are tangents to the circle. $\angle JLB = \angle JBD$. $\angle BAC = 60°$, $\angle JLK = 22°$, $\angle KBD = 80°$ and $\angle BKL = 31°$

(a) Find, giving reasons for each answer,
   (i) $\angle JBK$
   (ii) $\angle KBL$
   (iii) $\angle KOL$
   (iv) $\angle COB$

(b) Given that $AO = 14$ **m**, calculate the area of sector **BOCKJ**, leaving your answer in terms of π.

[S4 WGSS P2/2017 PRELIM Qn 6]

A circle passes through **A**, **B**, **C**, **D** and **E**. It is given that $\angle ADB = 34°$, $\angle DAE = 28°$ and $\angle BCE = 62°$. By stating the reasons clearly,
(a) show that **BD** is a diameter of the circle
(b) show that **BE** bisects $\angle ABD$

[S4 ZHSS P1/2018 PRELIM Qn 21]

<u>Topic: Pythagoras' Theorem & Trigonometry</u>

Given that $0° < \theta < 180°$

$$\cos\theta = -\frac{21}{29}$$

Find, without using a calculator, the value of

(a) $\sin\theta$

(b) $\tan\theta$

(c) $\cos(\theta - 90°)$

[S4 PRSS P1/2017 PRELIM Qn 12]

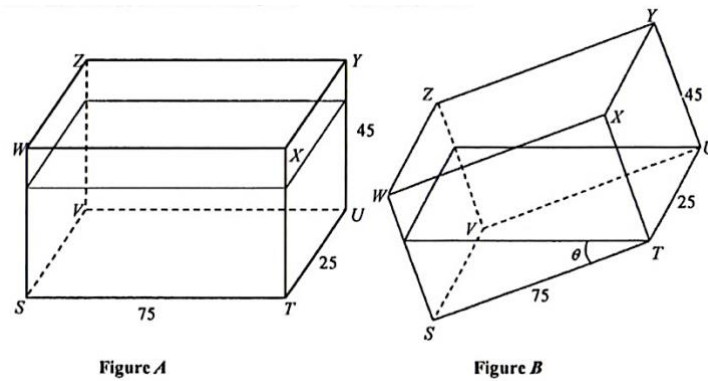
Figure A   Figure B

Figure A shows an open rectangular container $STUVWXYZ$ which is $\frac{4}{5}$ filled with water. The internal dimensions of the container are **75 cm** long, **25 cm** wide and **45 cm** high. The base, $STUV$, of the container is resting on a flat surface. Figure B shows the remaining amount of water left after **40%** of the amount of water has been poured out. The container has been tilted when SV is resting on the flat surface. Calculate the angle θ

[S4 EVSS P1/2017 PRELIM Qn 17]
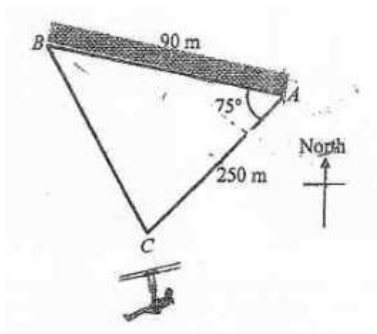
Point A and B are points at the bottom of a cliff **50 metres** tall. Point C on a flat ground is **250 metres** away from A with AB making an angle of **75°** with the line AC. The bearing of C from A is **217°** and A and B are **90 metres** apart. Calculate the

(a) bearing of B from A

(b) area of the land formed by the points A, B and C

(c) shortest distance from C to the bottom of the cliff

An outdoor adventure company wants to build a flying fox using a metal cable with the starting point X on the cliff and the landing point at C

(d) Find the distance away from B vertically below X such that the slope is the greatest
(e) Find the angle that the metal cable makes with the ground at point C

[S4 SGSS P2/2017 PRELIM Qn 9]
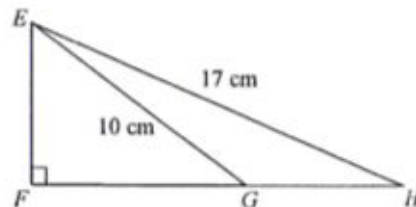
(a) The figure shows triangle EFH where $EH = 17$ cm and $\angle EFH = 90°$. G is a point on FH such that $EG = 10$ cm. Given that $\sin \angle EGH = \dfrac{3}{5}$, find
   (i) EF
   (ii) $\tan \angle EGH$
(b) Find the shortest distance from F to EH
(c) A circle C_1 is drawn passing through E, F and G. A second circle C_2 is drawn passing through E, F and H. Find the ratio of the circumference of C_1 to circumference of C_2

[S4 TKSS P1/2017 PRELIM Qn 17]
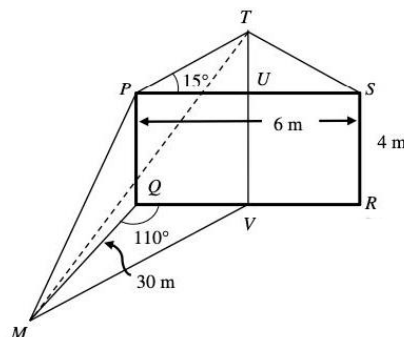
The diagram shows the front view of the N.R.G greenhouse which is vertical to the ground. PT and ST make up the roof which makes angles of $15°$ with the horizontal. Given that $SR = 4$ m, $QR = 6$ m and M is a point due south of Q on the ground such that $MQ = 30$ m and $\angle MQR = 110°$. U and V are the midpoints of PS and QR respectively
(a) Find
   (i) the distance between T and V
   (ii) the angle of elevation of T from M
   (iii) the bearing of V from M
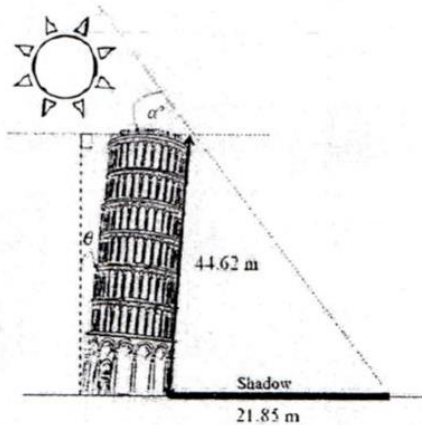**(b)** A student walks from M to V. Find the distance that he has to walk to that he is closest to Q

[S4 AHS P2/2016 PRELIM Qn 7]
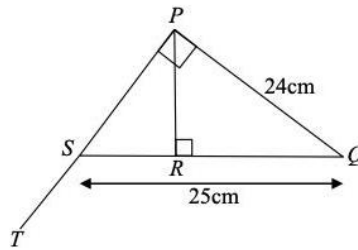
In the diagram, $\angle QPS = \angle QRP = 90°$, $PQ = 24 \text{ cm}$, $QS = 25 \text{ cm}$, PST and QRS are straight lines. Calculate
(a) PS
(b) PR
(c) $\cos \angle QST$

[S4 MSHS P1/2016 PRELIM Qn 20]

The Leaning Tower of Pisa in Italy was constructed since 1173 and was only completed 1372. The tower began to lean after the construction had progressed to the second floor in 1178. This is due to the weak foundation of the ground that caused the design of the tower to be flawed from the beginning. The leaning angle is defined as θ as the top of the building is parallel to the ground. The diagram shows the tower in 1319. There was **7** storeys built and the height of the shorter side of the tower is **44.62 m**, as shown. Given that the shadow of the tower is **21.85 m**, where $\alpha = 68°$, find the leaning angle θ

[S4 NCHS P2/2016 PRELIM Qn 10(b)]

Topic: Mensuration
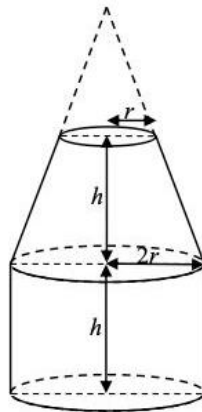
The diagram shows a milk container which is made up of a frustum and a cylinder. The height, h **cm**, of the cylinder is the same as the height of the frustum. The radius of the cylinder base is twice the radius of the top circular surface of the frustum, r **cm**. Given that the curved surface areas of the frustum and cylinder are equal, find an expression for h, in terms of r
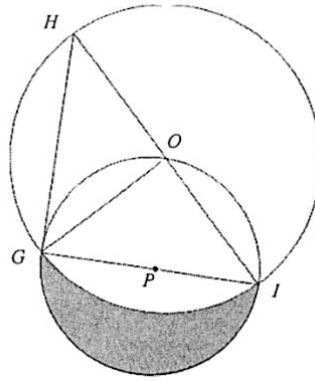
[S4 NCHS P2/2018 PRELIM Qn 10]
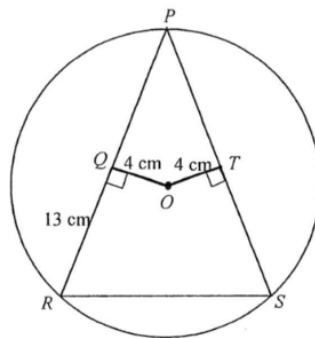
In the figure, O is the centre of the circle, $OQ = OT = 4$ **cm** and $QR = 13$ **cm**. P, S and R are points on the circle
(a) State the length of PS
**(b)** Find the length of the shortest cord

[S4 CCHS(Y) P1/2017 MYE Qn 13]

The diagram shows two circles C_1 and C_2 with centre O and P respectively. HI and GI are diameters of C_1 and C_2 respectively

(a) Show that ΔHGI and ΔGOI are similar. Give a reason for each statement you make

(b) Given that $HI = 10$ **cm** and $GI = 5\sqrt{2}$ **cm**. Find the ratio of the area of ΔHGI to ΔGOI

(c) Find the shaded area

**[S4 FSS P2/2017 MYE Qn 6]**
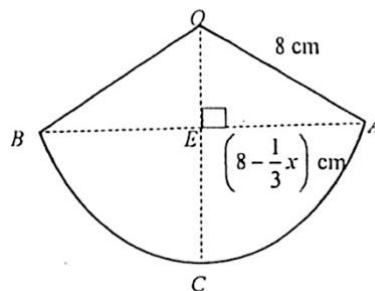
OAB is a sector of a circle, with centre O and radius **8 cm**. OC cuts AB at E. It is given that

$$AE = \left(8 - \frac{1}{3}x\right) \text{ cm}, \qquad \angle OEA = 90°$$

(a) Given that $EC = x$ **cm**, express OE in terms of x

(b) Hence, by making use of your answer in (a), write an equation in terms of x and show that it reduces to $5x^2 - 96x + 288 = 0$

(c) Solve the equation, giving your answers correct to two decimal places

(d) Calculate the length of AB

(e) Calculate $\angle AOB$ in terms of radians

(f) A cone is made from using the sector by joining OA to OB. Calculate the radius of the circular base of this cone

[S4 MGS P2/2017 MYE Qn 9]
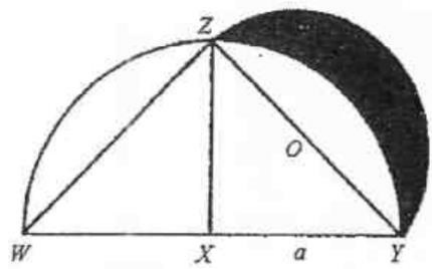
WY is the diameter of a semi-circle with centre X and radius a cm. Z is on the circumference and $\angle ZXY$ is a right angle. A smaller semicircle, centred at O, is drawn with ZY as diameter. Find the area of the shaded region, in terms of a, in its simplest form
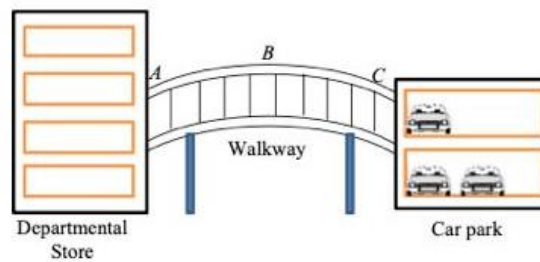
[S4 JYSS P1/2017 PRELIM Qn 19]
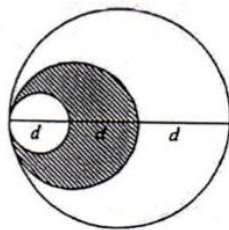

The diagram shows three circles with diameters d cm, $2d$ cm and $3d$ cm respectively. Find, in terms of π and d, the difference in area between the unshaded region and the shaded region

[S4 CCHS(M) P1/2016 PRELIM Qn 19]

The figure shows a pedestrian walkway joining a multi-storey car park and a Departmental Store

To estimate its length the walkway is modelled by the arc ABC as shown in the figure below, where A is the entrance to the department store and C is the exit to the car park. The arc ABC is part of a sector with centre O.
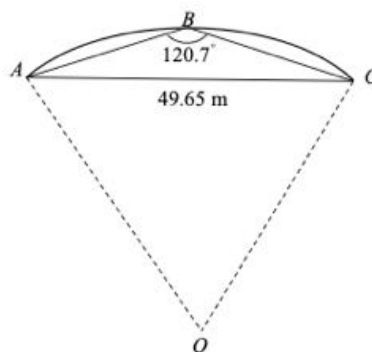
Given $AC = 49.65$ m and $\angle ABC = 120.7°$,

(a) Show that $AO = 29$ m

(b) Show that the length of arc ABC is 60 m

(c) As a safety measure, John is required to conduct an emergency evacuation drill. He planned to conduct the drill on a Thursday and record the time taken by visitors to evacuate the walkway. The table below shows the average walking speed of visitors along the walkway to the Departmental Store at various timings in a day

Time	Average walking speed in km/h	
	Weekends	Weekdays
11 00	4.5	5.0
14 00	3.5	4.5
17 00	3.5	3.5

At 12 noon, John will make an announcement for everyone to evacuate the department store via exit A. John predicts each visitor will be able to evacuate the walkway from A to C in less than a minute

  (i)   With clear mathematical working, determine whether John's prediction is accurate
  (ii) State **1** assumption you made in the calculation
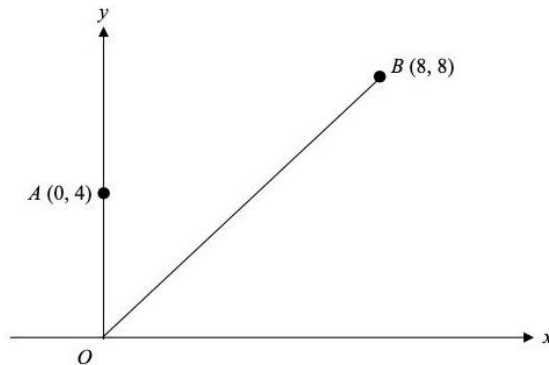
[S4 CSS P2/2018 PRELIM Qn 11]

Topic: Coordinate Geometry

The equation of a straight line PQ is

$$\frac{x}{3} - \frac{y}{4} = 1$$

(a) Find the gradient of the line PQ

(b) Find the equation of the line AB, parallel to PQ, which passes through the point $\left(\frac{3}{2}, \frac{1}{2}\right)$

(c) Find the coordinates of the point M on the line PQ such that it is equidistant from the x-axis and the y-axis
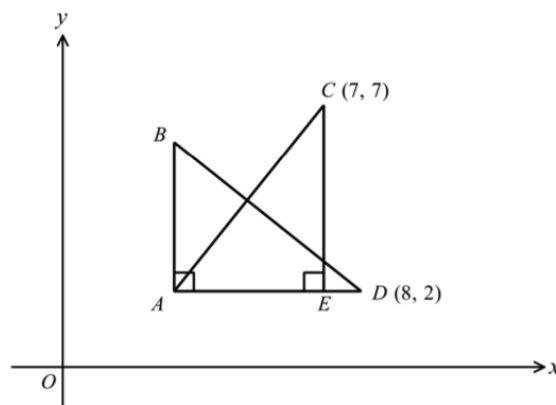
[S4 MSHS P1/2017 PRELIM Qn 15]

A is the point $(0, 4)$ and B is the point $(8, 8)$

(a) Find the equation of the line AB

(b) Given that $ABCO$ is a kite and AC is a diagonal of the kite, find the coordinates of point C

(c) Find the area of kite $ABCO$

**[S4 YTSS P1/2018 PRELIM Qn 17]**

The diagram shows two congruent right-angled triangles ACE and BDA. The sides AB and CE are vertical. The sides AB and CE are vertical. The side AD is horizontal and point E lies on it. Point C has coordinates $(7, 7)$ and D has coordinates $(8, 2)$. Find the equation of line AC

[S4 NHHS P1/2020 PRELIM Qn 11]

Topic: Vectors in 2 Dimensions

<p style="text-align:center">**CLT topic removed from 2021 'O' Levels**</p>

Topic: Data Analysis & Handling
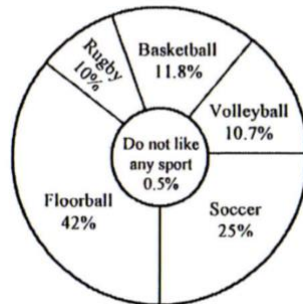
Winston draws the pie chart to represent the favourite sports of his classmates for his Mathematics project. Explain one way in which the pie chart is misleading and suggest one way to improve it

[S4 BMSS P1/2017 PRELIM Qn 8]

The table shows the scores of 10 students in a Mathematics test.

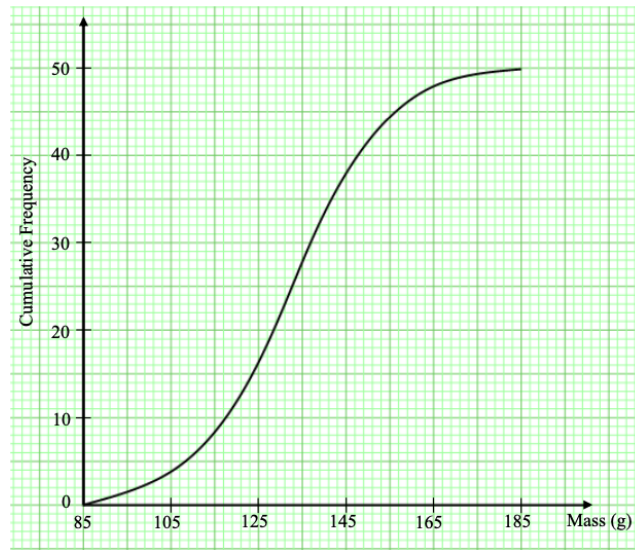| Test score	Frequency
21	2
49	3
55	1
65	1
80	1
95	2

The test scores are also represented in the box-and-whisker plot below.

(a) Find the value of x
**(b)** Calculate the standard deviation of the test scores

[S4 CHIJKC P1/2018 PRELIM Qn 8]

(a) The cumulative frequency curve below shows the distribution of the masses of 50 apples

Mass $(x\text{ g})$	Number of apples
$x < 85$	0
$85 \leq x \leq 105$	4
$105 \leq x \leq 125$	p
$125 \leq x \leq 145$	22
$145 \leq x \leq 165$	q
$165 \leq x \leq 185$	2

    (i) The masses of these apples were tabulated into a grouped frequency table as follows. Find the values of p and of q

   (ii) Using the grouped frequency table, calculate an estimate of
        (a)   the mean mass of the apples
        (b)   the standard deviation

(b) Another set of **50** apples have the same median but a smaller standard deviation. Describe how the cumulative frequency curve will differ from the give curve

[S4 MGS P1/2018 PRELIM Qn 14]
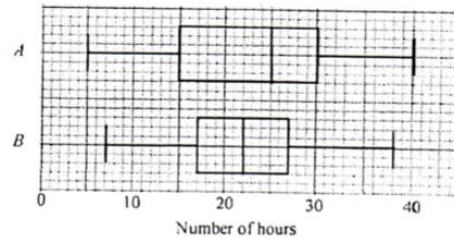
The box plots below show the distribution of the number of hours worked in a week by **20** employees in each of the **2** branches, **A** and **B**, of a certain restaurant
(a) Find the interquartile range of Branch **B**
(b) Below are **2** statements related to the above box plots. For each statement, write down whether you agree or disagree with the statement, explaining clearly what evidence you have used to make your decision
    (i) On average, workers in Branch **A** worked more hours in a week than those in Branch **B**
    (ii) The workers in Branch **A** worked more consistent hours of work in a week compared to those in Branch **B**

[S4 BVSS P1/2016 PRELIM Qn 13]

The number of hours of sleep per night of a group of girls is recorded in the table shown below

Number of hours	4	5	6	7	8	9
Frequency	5	6	7	2	x	6

(a) Given that the median is **6**, find the largest possible value of x
(b) With the value of x found in (i), calculate
    (i) the mean number of hours of sleep
    (ii) the standard deviation
(c) The number of hours of sleep per night of a group of boys is summarised below

Mean	5.75
Standard Deviation	2.31

    Make **2** comparisons between the number of hours of sleep per night by the two groups, using your answer found in (ii)
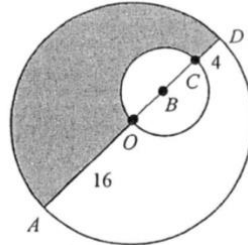
[S4 PLMGS P2/2016 PRELIM Qn 3]

Topic: Probability

Two fair six-sided dice are thrown. Find the probability that
(a) both dice show different numbers
(b) the sum of the two numbers shown is **12**
(c) the sum of the two numbers shown is a prime number

[S4 BDSS P1/2017 PRELIM Qn 12]

(a) In the diagram, the big circle, centre O, has a radius of **16 cm**. The small circle, centre B, has OC as diameter. $AOBCD$ is a straight line with $CD = 4$ **cm**. Find the perimeter of the shaded region, leaving your answer in terms of π

(b) A point is chosen, at random within the big circle. Find the probability that this point is in the shaded region

[S4 JWSS P1/2017 MYE Qn 17]

A bag contains four balls, numbered 2, 3, 6 and 9. Two balls are picked from the bag at random, one after another, without replacement
(a) Draw a possibility diagram to represent the outcomes
(b) Find, in its simplest form, the probability that
  (i)   both balls have numbers less than 6
  (ii) both balls are odd numbers
  (iii) the product of the numbers is more than 10
(c) The two balls are now picked from the bag, one after another, with replacement. Ken claims:

"the probability that the product of the numbers is more than 10 has increased because there are more favourable outcomes"

Do you agree? Justify by showing your calculations

[S4 HIHS P2/2020 PRELIM Qn 1]

End of Paper ☺