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南 华 中 学

NAN HUA HIGH SCHOOL

FIRST PRELIMINARY EXAMINATION 2016

Subject : Mathematics
Paper : 4048/02
Level : Secondary Four Express
Date : 29 June 2016
Duration : 2 hours 30 minutes

READ THESE INSTRUCTIONS FIRST

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The total number of marks for this paper is 100.

This paper consists of 11 printed pages.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

For
Examiner's
Use

Answer **all** the questions.

For
Examiner's
Use

- 1 Evaluate $\frac{\sqrt{\pi^3 + (-1.5)^2} - 5.65}{2^{\frac{5}{2}}}$, leaving your answer correct to 3 significant figures.

Answer

[1]

- 2 (a) Express 8250 as a product of its prime factors.

- (b) Hence, find the smallest positive integer k such that $\sqrt{\frac{8250}{2k}}$ is an integer.

Answer (a)

[1]

(b) $k = \dots\dots\dots$

[1]

For
Examiner's
Use

For
Examiner's
Use

- 3 (a) 265×10^{-5} g can be expressed as k mg. Find the value of k .
(b) The average weight of a grain of sand is 265×10^{-5} g. Find the number of grains of sand in a 1 kg bag of sand, leaving your answer in standard form.

Answer (a) $k =$ [1]

(b) [2]

- 4 Given that $\frac{b^2 - 4}{a} = a - 4$, express a in terms of b .

Answer [3]

For
Examiner's
Use

For
Examiner's
Use

5 Singapore Changi airport occupies an area of 13 km^2 . It is represented on a map with a scale of 1 : 50 000.

- (a) Calculate the area on the map which represents the airport, giving your answer in cm^2 .
- (b) A man walks from Terminal 1 to Terminal 2. The distance between the terminals is 2.25 cm on the map. Given that his average walking speed is 3 km/h, calculate the time taken, in minutes, for him to walk from Terminal 1 to Terminal 2.

Answer (a) cm^2 [2]

(b) min [2]

6 Television Channels *A*, *B* and *C* play a commercial once every 10 minutes, 12 minutes and 20 minutes respectively. If they played a commercial together at 10 00, at what time will they next play a commercial together again?

Answer _____ [2]

For
Examiner's
Use

- 7 It is given that m is inversely proportional to t^3 . Find the percentage change in m when t is increased by 200%.

For
Examiner's
Use

Answer

[3]

- 8 Solve $3^{2x+3} - 3^{2+2x} = 54$.

Answer

$x =$ _____ [3]

For
Examiner's
Use

For
Examiner's
Use

9 (a) Factorise $x^2 + 3x - y^2 + 3y$ completely.

(b) Solve $\frac{5}{6-x-2x^2} + \frac{4}{2x-3} = 1$.

Answer (a)

[2]

(b)

[4]

For
Examiner's
Use

For
Examiner's
Use

- 10 The sum of interior angles of a polygon is 1440° . Two of its interior angles are 130° and 150° while the remaining interior angles are x° each. Find the value of x .

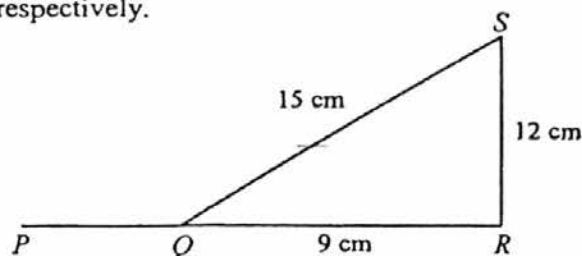
Answer $x =$ [2]

- 11 Arthur takes 2 days to build 1 cupboard while Billy takes 4 days to build 3 cupboards. Together they are completing an order of 13 cupboards. After 5 days, Arthur injures his arm. If Billy continues building the cupboards himself, how many more days does he need to complete the order?

Answer days [3]

For
Examiner's
Use

- 12 In the diagram below, PQR is a straight line. The lengths of QR , RS and QS are 9 cm, 12 cm and 15 cm respectively.



- (a) Prove that $\triangle QRS$ is a right angled triangle.
(b) Hence, without using a calculator, find $\tan \angle PQS$.

For
Examiner's
Use

Answer (a)

[1]

(b)

[2]

- 13 Betty designed the following question in a survey to ascertain the effectiveness of a slimming centre.

How much weight have you lost? Circle one answer.

1–2 kg 3–5 kg 6–10 kg >10 kg

List **two** things wrong with this question.

Answer 1)

2)

[2]

For
Examiner's
Use

For
Examiner's
Use

14 (a) Express $-x^2 + 6x - 5$ in the form $a(x - b)^2 + c$ where a , b and c are constants to be determined.

(b) Hence,

(i) state the maximum value of $-x^2 + 6x - 5$,

(ii) sketch the graph of $y = -x^2 + 6x - 5$, indicating the coordinates of the turning point and axes intercepts clearly.

Answer (bii)

[3]

Answer (a)

[2]

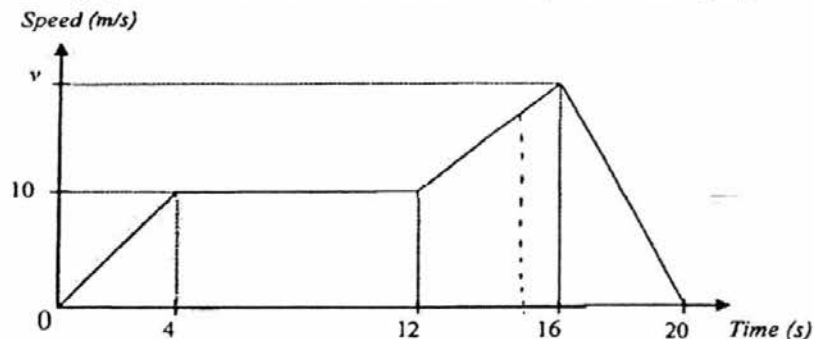
(bi)

[1]

For
Examiner's
Use

For
Examiner's
Use

- 15 The speed-time graph below illustrates the motion of a particle during a period of 20 seconds.



- (a) Given that the distance travelled in the first 12 seconds of motion is the same as the distance travelled in the last 8 seconds of motion find

(i) the maximum speed v ,

Answer

[2]

(ii) the acceleration of the particle between 12 and 16 seconds,

Answer

[1]

(iii) the speed of the particle at 15 seconds.

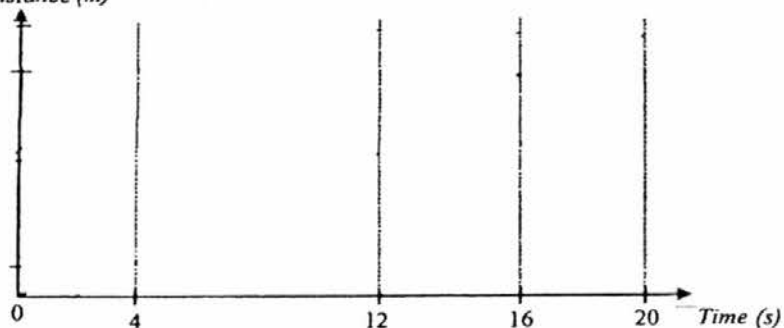
Answer

[1]

- (b) On the axes given, sketch the corresponding distance-time graph for the particle.

Answer (b) Distance (m)

[3]



For
Examiner's
Use

For
Examiner's
Use

16 Given that

$$\mathcal{E} = \{x : x \text{ is an integer, } 2 < x \leq 16\},$$

$$A = \{x : x \text{ is a composite number}\},$$

$$B = \{x : x \text{ is a factor of } 30\},$$

$$C = \{x : x \text{ is a multiple of } 2\},$$

- (a) find $n(A')$,
- (b) list the elements in $A \cap B$,
- (c) draw a Venn diagram to illustrate the relationship between the 3 sets, and hence, shade $(A' \cup C) \cap B$.

Answer (c)

[2]

Answer (a)

[1]

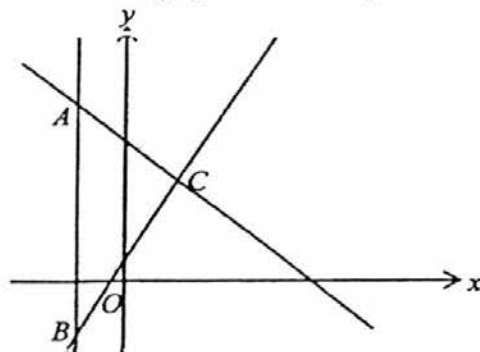
(b)

[1]

For
Examiner's
Use

- 17 The diagram below consists of the graphs of $x = -1$, $y = 3x + 1$ and $x + y = 4$.

For
Examiner's
Use



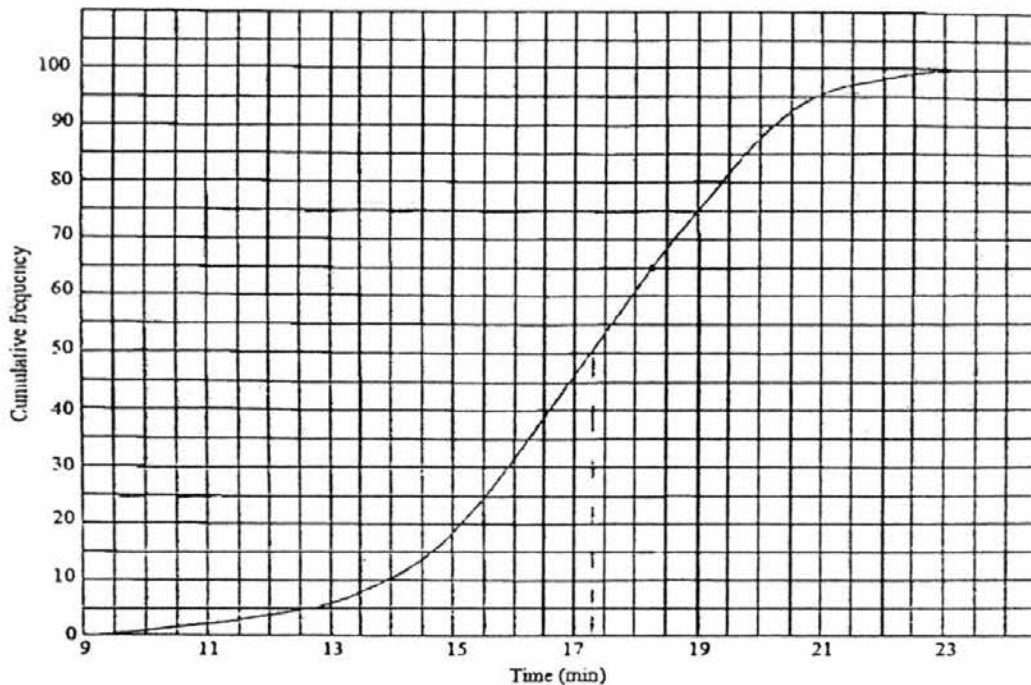
- Find the coordinates of points A , B and C .
- Calculate the length of AC .
- Find the area of $\triangle ABC$.

Answer (a) $A =$ (..... , ...)
 $B =$ (..... , ...)
 $C =$ (..... , ...) [3]
 (b) units [1]
 (c) units^2 [1]

For
Examiner's
Use

- 18 The cumulative frequency curve below shows the time taken (in minutes) for 100 Secondary 2 girls to complete a 2.4 km run.

For
Examiner's
Use

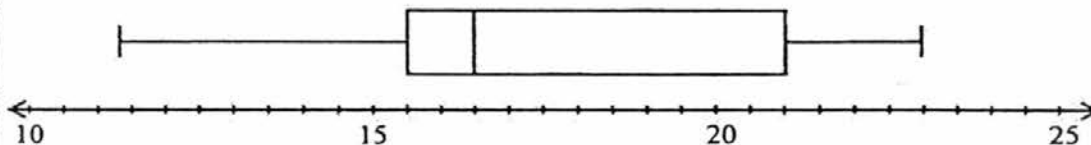


- (a) Use the graph to find,
 (i) the median time taken
 (ii) the interquartile range of the time taken.
 (b) Given that 35% of the girls ran slower than Amy, use the graph to find Amy's time taken.

Answer (ai) — min [1]
 (aii) min [1]
 (b) min [1]

For
Examiner's
Use

The box-and-whisker plot below represents the time taken (in minutes) for 100 Secondary 3 girls to complete a 2.4 km run.



For
Examiner's
Use

- (c) Use the box-and-whisker plot to find,
- the median time taken for the Secondary 3 girls,
 - the interquartile range of the time taken for the Secondary 3 girls.
- (d) Mr Chai claims that, on average, the Secondary 2 girls ran ^{more slowly} faster than the Secondary 3 girls. Do you agree with him? Justify your answer.

Answer (ci)

min [1]

(cii)

min [1]

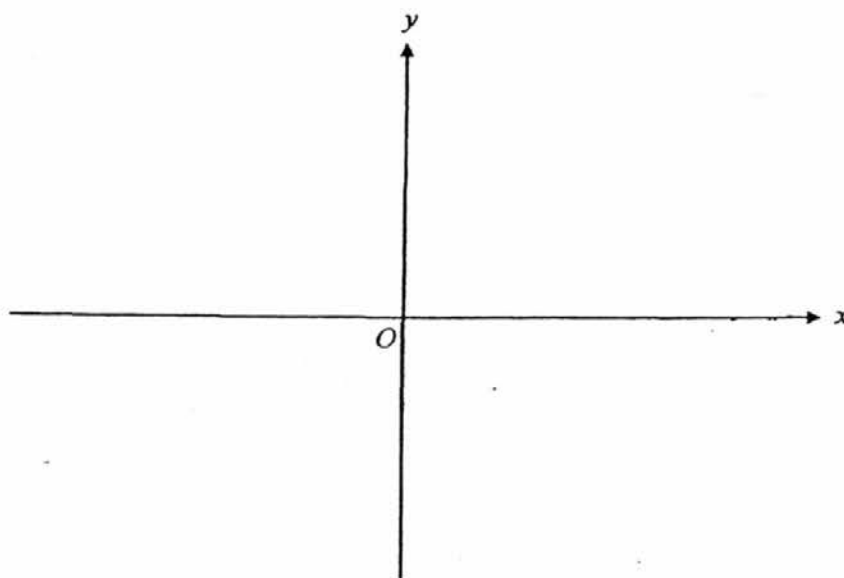
(d)

For
Examiner's
Use

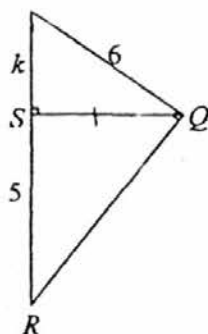
- 19 On the axes provided, sketch the graph of $y = -2x^{-1}$.

Answer

[1]



- 20 In the diagram below, $\angle PQR = \angle PSQ = 90^\circ$. $PQ = 6$ cm, $PS = k$ cm, $SR = 5$ cm. Given that PSR is a straight line, find the value of k .



Answer $k =$

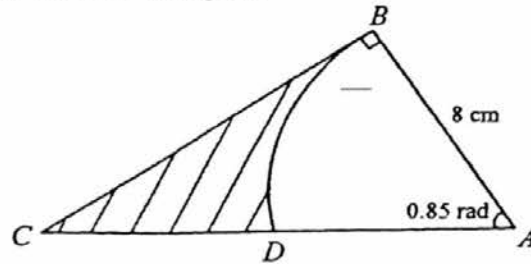
[5]

For
Examiner's
Use

For
Examiner's
Use

- 21 In the diagram, ABD is a sector of a circle, centre A , of radius 8 cm and $\angle BAD = 0.85$ radians. Given that ADC is a straight line and $\angle ABC = \frac{\pi}{2}$ radians, find

- (a) the perimeter of the shaded region,
(b) the area of the shaded region.



(a) cm [3]

(b) cm² [2]

For
Examiner's
Use

For
Examiner's
Use

22 A line AB , 8 cm long, is shown below.

(a) Construct

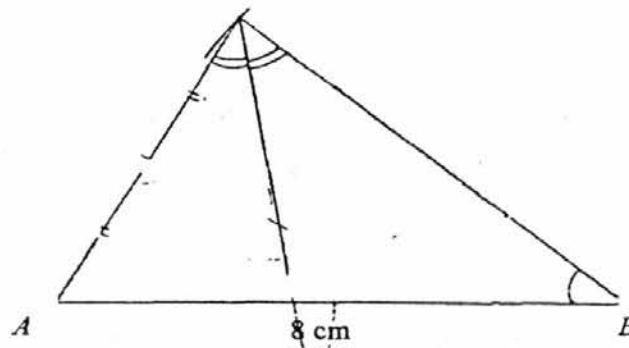
(i) a triangle ABC , using line AB , where $\angle ABC = 40^\circ$ and $BC = 7.1 \text{ cm}$, [1]
extend compass to 7.1 cm and mark an arc.

(ii) the perpendicular bisector of AC , [1]

(iii) the angle bisector of $\angle BCA$. [1]

(b) Mark and label a possible point X inside the triangle which is equidistant from C and A but nearer to side AC than BC . [1]

Answer



End of Paper

Answer Key:

1 0.0207

2a $8250 = 2 \times 3 \times 5^3 \times 11$

2b $k = 33$

3a $k = 2.65$

3b 3.77×10^5

4 $a = 2 \pm b$

5a 52 cm^2

5b 22.5 min

6 11 00

7 -96.3%

8 $x = \frac{1}{2}$

9a $(x+y)(3+x-y)$

9b $x = -1\frac{1}{2}$ or 3

10 $x = 145^\circ$

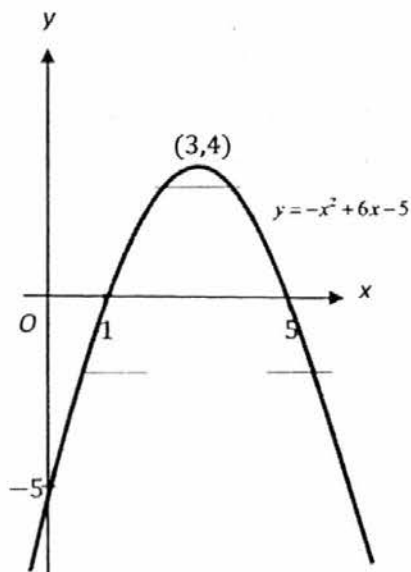
11 9

12b $\tan \angle PQS = -\frac{4}{3}$

14a $-(x-3)^2 + 4$

14bi 4

14bii



15ai $v = 20$

15aii $a = 2.5 \text{ m/s}^2$

15b Refer to the back

16a $n(A') = 5$

16b $A \cap B = \{6, 10, 15\}$

16c Refer to the back

17a $A(-1, 5)$

$B(-1, -2)$

$C\left(\frac{3}{4}, 3\frac{1}{4}\right)$

17b 2.47 units

17c $6\frac{1}{8} \text{ units}^2$

18ai Median = 17.25 min

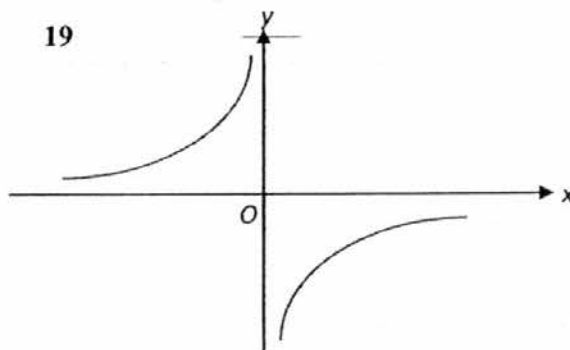
18aii Interquartile range = 3.5 min

18b Amy's time taken = 18.25 min

18ci Median = 16.5 min

18cii Interquartile range = 5.5 min

19

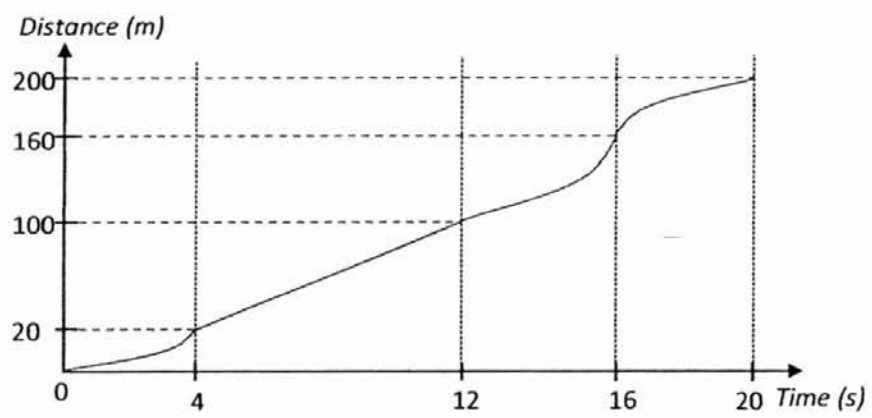


20 $k = 4$

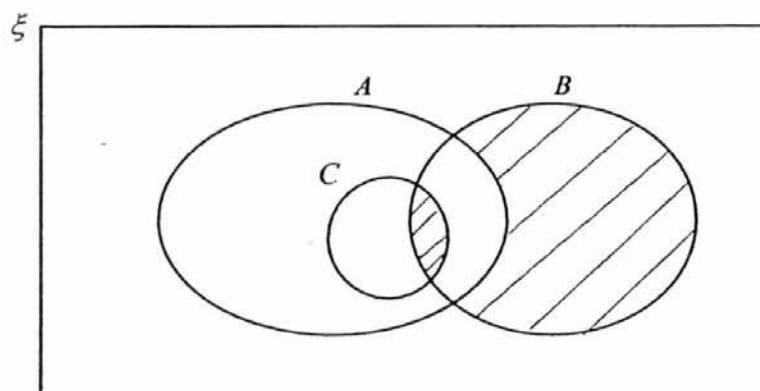
21a 20.0 cm

21b 9.23 cm^2

15b



16c





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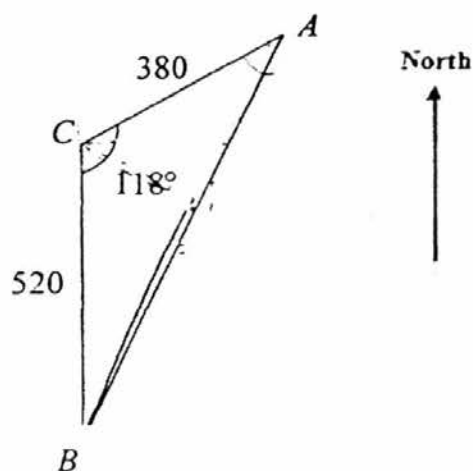
Answer all the questions

1 (a) Solve the inequality $\frac{2x+2}{3} < \frac{3x-2}{2} < \frac{2x+13}{5}$ [2]

(b) Evaluate $\frac{\sqrt{9^{2p-4}} \times 3^{3-p}}{(27)^{\frac{1}{3}p}}$. [3]

(c) Solve the equation $4 - 5x - 3x^2 = 0$, giving your answers to 3 decimal places. [2]

2



The diagram shows a field ABC on horizontal ground. C is due north of B ,
 $AC = 380$ m, $BC = 520$ m and angle $ACB = 118^\circ$.

Find

- (a) the area of the field, [2]
(b) the length of AB , [2]

A 45m transmission tower stands at C . A cyclist cycles from A towards B .

Find

- (c) the largest angle of elevation of the top of the tower from the path AB . [3]
(d) the distance between the cyclist and his destination when he is due east of the tower. [2]

- 3 A company runs 2 restaurants. The French Table and Pizza Fresca.

[Note: Lighting consumption = Power Consumption of Light $\times$ Number of hours of operation, units in Watt-hour]

Table 1 shows that the type and number of lights used in the restaurants

Restaurant	LED Lights	Fluorescent Lights	Incandescent Lights
The French Table	20	24	68
Pizza Fresca	57	12	10

Table 2 shows the operating hours of the restaurants in a week

Restaurant	Mondays to Fridays	Saturdays and Sundays
The French Table	45	20
Pizza Fresca	55	22

The power consumption for LED lights is 15 Watts, for Fluorescent is 30Watts and for Incandescent Light is 60 Watts.

- (i) Given $A = \begin{bmatrix} 20 & 24 & 68 \\ 57 & 12 & 10 \end{bmatrix}$ and $P = \begin{bmatrix} 15 \\ 30 \\ 60 \end{bmatrix}$, evaluate the matrix AP . [1]
- (ii) Explain what your answer to (i) represents. [1]
- (iii) By multiplying 2 matrices only, find the operating hours of each restaurant for a week. [1]
- (iv) Express the operating hours by a matrix H such that HAP gives total lighting consumption of each restaurant for a week. [1]
- (v) Evaluate the matrix HAP . [1]

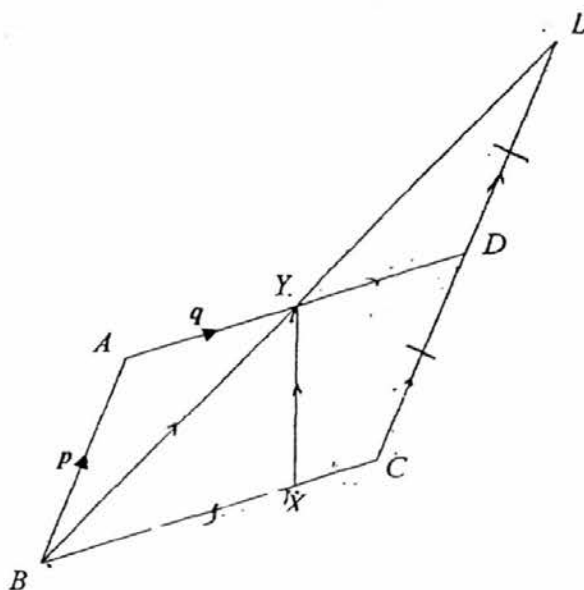
- 4 (a) M is the point $(-5, 2)$. N is the point $(3, 8)$.

(i) Write down the column vector $\overrightarrow{MN}$. [1]

(ii) Find $|\overrightarrow{MN}|$. [1]

(iii) P is a point such that $\overrightarrow{MP} = 5\overrightarrow{MN}$. Find the coordinates of P . [2]

(b)



$ABCD$ is a parallelogram and L lies on $\overline{CD}$ produced such that $CD = DL$.

$\overrightarrow{BA} = \mathbf{p}$ and $\overrightarrow{AY} = \mathbf{q}$.

Y is the midpoint of AD , and X is a point on BC such that $BX : XC = 3 : 1$.

- (i) Express each of the following, as simply as possible, in terms of $\mathbf{p}$ and/or $\mathbf{q}$.

(a) $\overrightarrow{BY}$, [1]

(b) $\overrightarrow{XY}$, [1]

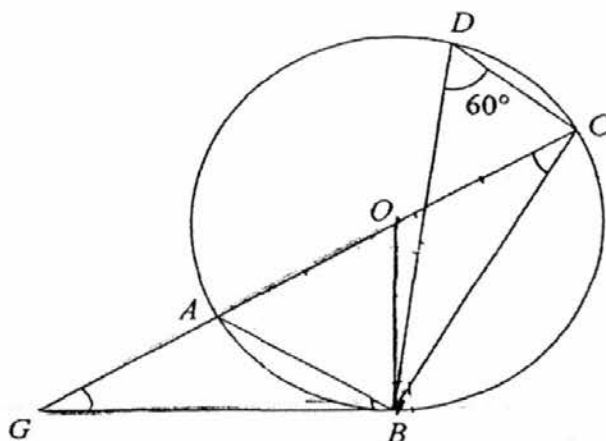
(c) $\overrightarrow{BL}$. [1]

- (ii) What can you deduce about B , Y and L ? [2]

(iii) Find $\frac{\text{Area of triangle } ABY}{\text{Area of quadrilateral } XYDC}$ [2]

- 5 (i) The cash price of a laptop is \$2 680. If a customer chooses to pay by hire purchase, a \$200 down payment has to be made followed by monthly instalments of \$80 for 36 months. Calculate the interest rate charged per annum. [3]
- (ii) A customer can also choose to pay for the laptop by taking a loan for 1 year at an interest of 2% p.a. compounded monthly. Calculate the total amount of interest paid. [2]
- (iii) The same laptop is sold online for USD 1779 with free delivery. Given that the exchange rate between Singapore dollar (SGD) and US dollar (USD) is SGD1 = USD 0.7342, and a 7% Goods and Services Tax will be levied for the purchase, find the cost of purchasing the laptop online. [2]

6 (a)



The diagram shows a circle $ABCD$, with centre O .

$COAG$ is a straight line.

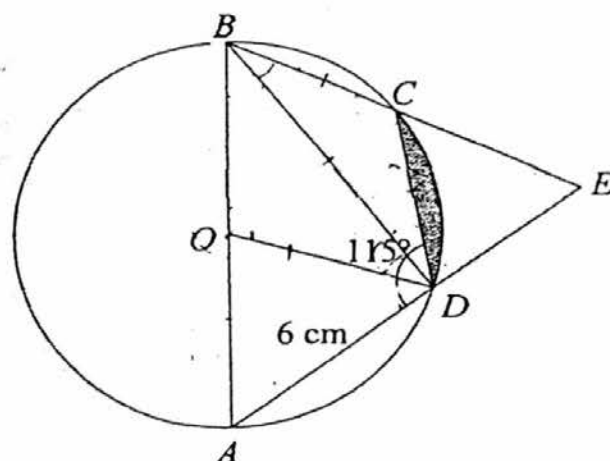
GB is a tangent to the circle.

Angle $BDC = 60^\circ$.

Stating your reasons clearly,

- (i) find angle OGB , [3]
- (ii) show that triangle OGB is congruent to triangle ACB . [3]

(b)

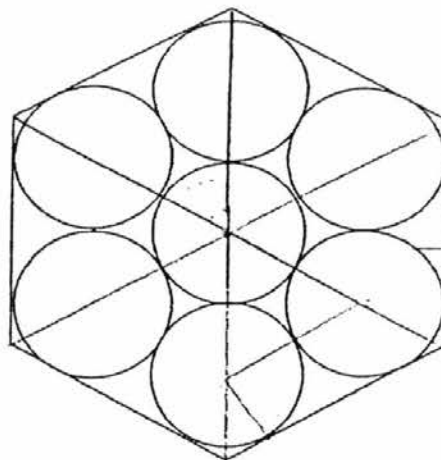


The diagram shows a circle $ABCD$, with centre O .
 AD and BC produced meet at E .
 $CD = CB$, $AD = 6$ cm and angle $ADC = 115^\circ$.

Stating your reasons clearly,

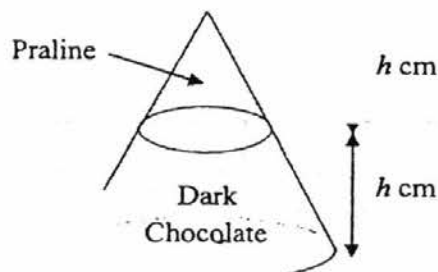
- (i) find reflex angle BOD , [2]
- (ii) find the radius of the circle $ABCD$, [3]
- (iii) find the area of the shaded region. [3]
- (iv) explain why B , D and E lie on the circumference of another circle. [1]

7



7 spherical dark chocolates of the same size are packed into a box in the shape of a regular hexagonal prism. The cross section of the box is shown in the diagram. The box is designed such that all the chocolates touch one another and the sides of the box as shown. The chocolates also touch the top and bottom of the box. Given that the radius of each chocolate is 1.5 cm, find

- (a) the volume of the chocolate box, [2]
(b) the total volume of the 7 spherical dark chocolates. [1]



A limited edition of the chocolate is created. Shaped in a right circular cone, it has dark chocolate for the base, topped with praline as shown in the diagram. Both layers of chocolate are of equal height, h cm. The amount of chocolate used for making the 7 spherical dark chocolates can be used to produce the base of 10 limited edition pieces. 98.9601w
dark chocolate

- (c) Find the volume of praline chocolate needed for each piece of the limited edition chocolate. [2]

- 8 The variables x and y are connected by the equation $y = \frac{x^3}{30} + \frac{8}{x} - 3$.

Some corresponding values of x and y , correct to 2 decimal places, are given in the table below.

x	1	1.5	2	2.5	3	3.5	4	5	6
y	5.03	2.46	1.27	p	0.57	0.71	1.13	2.77	5.53

- (a) Calculate the value of p . [1]
- (b) Using a scale of 2 cm to represent 1 unit on each axis, draw the graph of $y = \frac{x^3}{30} + \frac{8}{x} - 3$ for $1 \leq x \leq 6$. [3]
- (c) By drawing a tangent, find the gradient of the curve at (4, 1.13). [2]
- (d) By drawing a suitable straight line on the same axes, find the solutions of the equation $\frac{x^3}{30} + \frac{8}{x} = 6$. [2]
- (e) (i) On the same axes, draw the line $y = -\frac{3}{4}x + 5$ for $1 \leq x \leq 6$. [1]
- (ii) Write down the x -coordinates of the points where this line intersects the curve. [1]
- (iii) Find the equation, in the form $Ax^4 + Bx^2 + Cx + 32 = 0$, which is satisfied by the values of x found in part (e)(ii). [2]

- 9 The first four terms in a sequence of numbers are $\frac{1}{2}, \frac{5}{4}, \frac{9}{8}, \frac{13}{16}$.

- (i) Write down the fifth term of the sequence. [1]
- (ii) Find an expression, in terms of n , for the n th term, T_n , of the sequence. [1]
- (iii) Show that the sum of any 2 consecutive terms is always greater than the term after them. [3]

- 10 There are 28 candidates waiting to be interviewed in two rooms. There are 17 candidates in room *A* and 11 candidates in room *B*. The stem-and-leaf diagrams below show the age distributions of the candidates in the rooms.

Room A

1	8	9						
2	2	4	<i>x</i>	8	8	8	9	9
3	0	0	0	2				
4	0	2	3					

Room B

1	8				
2	4	8	8	9	9
3	1	3	4	6	
4	0		1		

Key 1 | 8 means 18 years old

It is given that the interquartile ranges of the age distributions of the candidates in room *A* and room *B* are equal.

- (a) Find the value of *x*. [3]
- (b) Calculate the mean and standard deviation for Room *B*. [3]
- (c) (i) Two candidates are selected at random from Room *A*. Find the probability that at least one of them is more than 30 years old. [2]
- (ii) If one of the candidates in Room *B* left before the interview, find the probability that the mean age of the remaining 10 candidates is 30.2. [2]
- (d) As room *A* is too crowded, one candidate is chosen at random from room *A* to move to room *B*. A candidate is then randomly selected from room *B* as the first interviewee.

By drawing a tree diagram, calculate the probability that the first interviewee chosen is of age 40 or above. [4]

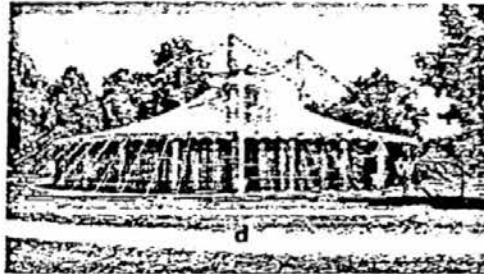
- 11 Here is some information of a circus tent.

Dimension of Circus Tent

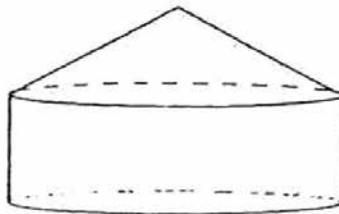
Maximum height (h): 1080 cm

Height of wall (w): 610cm

Diameter of floor (d): 5660cm



In this question, the circus tent can be modelled as a cylinder with a cone on top



- (a) Work out the volume, in cubic metres, of the circus tent. [3]
- (b) Air-conditioning units are to be installed to cool down the tent.

Useful Information

- Temperature Range: 28°C to 33°C
- Density of air: 1.16 kg/m^3
- Amount of heat to be extracted from the environment to achieve a 1 degree drop in temperature: 1000J/kg of air
- Cooling capacity of air-conditioning unit: 289kJ/min

In order to cool down the tent to a temperature of 26°C within 10 minutes, how many air conditioning units need to be installed?

Justify your answer with calculations. [6]

End of Paper

Answer Key for Prelim 1 E Math P2

1a. $2 < x < 3\frac{3}{11}$ b. $-\frac{1}{3}$ c. -2.257 or 0.591

2a. 87200 m^2 b. 775 m c. 11.3°

2d. 577 m

3i. $\begin{bmatrix} 5100 \\ 1815 \end{bmatrix}$

ii. Matrix represents the **power consumption** of the **lighting** used in **each** restaurant

iii. $\begin{bmatrix} 65 \\ 77 \end{bmatrix}$ or $\begin{bmatrix} 65 & 77 \end{bmatrix}$ iv. $\begin{bmatrix} 65 & 0 \\ 0 & 77 \end{bmatrix}$ v. $\begin{bmatrix} 331500 \\ 139755 \end{bmatrix}$

4ai $\begin{pmatrix} 8 \\ 6 \end{pmatrix}$ aii 10 units aiii $P(35, 32)$

4bi(a) $p + q$ 4bi(b) $p - \frac{1}{2}q$ 4bi(c) $2p + 2q$

4b(ii) $\overline{BL} = 2\overline{BY}$

BL and BY are parallel and since B is a common point. B, L and Y are collinear. BL is twice the length of BY

4b(iii) $\frac{2}{3}$

5i $5.38\% p.a.$ 5ii $\$54.09$ 5iii $\text{SGD}2\ 592.66$

6ai 30° 6bi 260° 6bii 4.67 cm

6biii $1.16\dot{\text{cm}}^2$

$$\begin{aligned} \angle BDE &= 180^\circ - 90^\circ \\ &= 90^\circ \end{aligned}$$

6biv $\angle BDE$ is an angle in a semi-circle.

Therefore B, D and E lie on the circumference of a circle

7a. 175 cm^3 b. 99.0 cm^3 c. 1.41 cm^3

8a. 0.72 c. 1 d. 1.35 or 5.15

8e(ii). $x = 1.15$ or $x = 4.45$ 8e(iii) $\frac{2}{15}x^4 + 3x^2 - 32x + 32 = 0$

9i. $\frac{17}{32}$ 9ii. $T_n = \frac{4n-3}{2^n}$

10a. 6 b. $30 \text{ years old}, 5.66 \text{ years old}$ ci. $\frac{29}{68}$

10cii. $\frac{2}{11}$ d $\frac{5}{51}$ 11a. 19300 m^3 b. 55