WOODLANDS RING SECONDARY SCHOOL

Name : ______________________ Reg No. ________ Class : __________

EXAMINATION	:	END-OF-YEAR EXAMINATION	
LEVEL	:	SECONDARY 3 EXPRESS SECONDARY 3 NORMAL ACADEMIC	DATE: 02 Oct 2018
SUBJECT	:	MATHEMATICS O-LEVEL (4048/1)	PAPER: 1
DURATION	:	2 hours	MAX MARKS: 80
SETTER(S)	:	Mr ONG CHEE LIM	Parent's/Guardian's Signature:

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
If working is needed for any question, it must be shown with the answer.
Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.
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 or 3.142, unless the question requires the answer in terms of π.

For Examiner's Use
/80

This paper consists of **18** printed pages including the cover page.

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Answer **all** the questions.

1 Given that $\frac{1}{343} = 7^p$, find p.

Answer $p =$ .... [1]

---

2 Represent $-2.5 < x \le 5$ on the number line below.

[1]

---

3 Simplify $18x - 3(2x - 5)^2$.

Answer .... [2]

---

4 Show that, for all positive integer k, $3^k + 3^{k+1}$ is a multiple of 4.

Answer ....

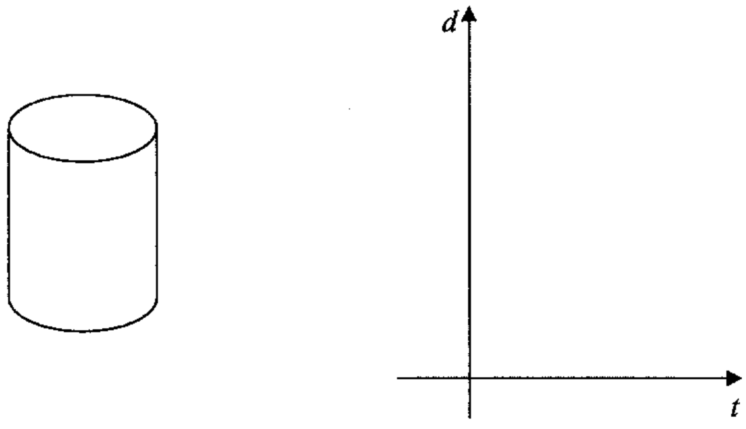
....

.... [2]

---

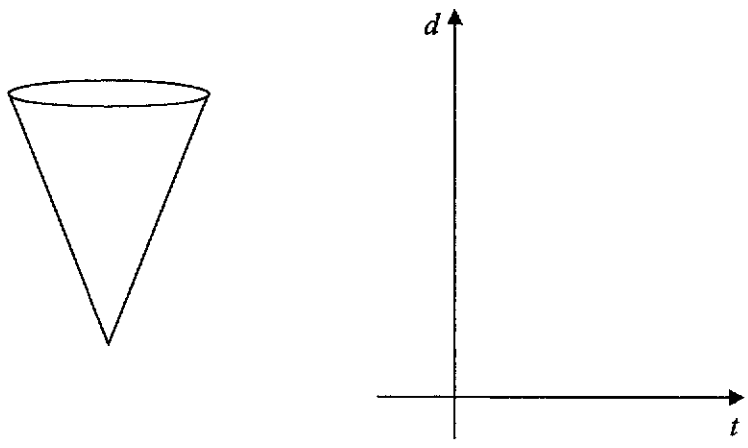
5 Water is poured into each empty container at a constant rate. After t seconds, the depth of water in the container is d cm. sketch the graph of d against t.

(a)



[1]

(b)



[1]

6 The stem-and-leaf diagram shows the height, in centimetres, of some students.

14	7 9
15	1 4 8
16	0 1 3 5 7 7 7 8 9 9
17	0 2 4 5 7 8 9
18	0 2

Key: 14 | 7 represents 147 cm

For these students, find

(a) the modal height,

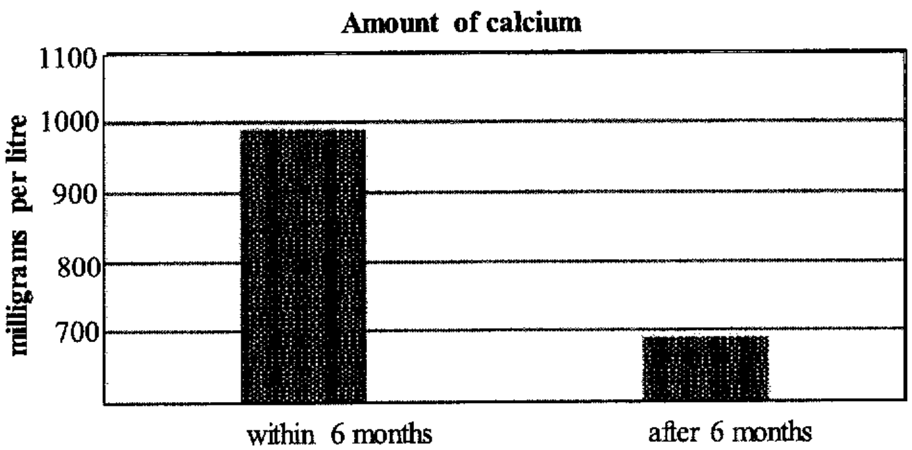
Answer .... cm [1]

(b) the median height.

Answer .... cm [1]

---

7 An advertisement for milk powder shows the amount of calcium in the milk produced over a period of time after a cow gives birth.



State one aspect of the graph that may be misleading and explain how this may lead to a misinterpretation of the graph.

Answer ....

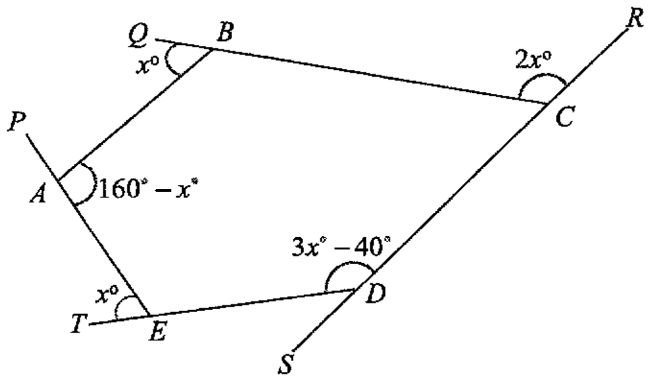
....

.... [2]

---

8 The diagram shows an irregular polygon $ABCDE$ in which $\angle ABQ = x^\circ$, $\angle BCR = 2x^\circ$, $\angle CDE = 3x^\circ - 40^\circ$, $\angle TEA = x^\circ$ and $\angle BAE = 160^\circ - x^\circ$.

Find the value of x.



Answer $x =$ .... [2]

---

9 The gravitational force, F, between two huge objects is inversely proportional to square of the distance between the two objects.

Given that the force is 40 N when the distance is r km, find the gravitational force if the distance is halved.

Answer .... N [2]

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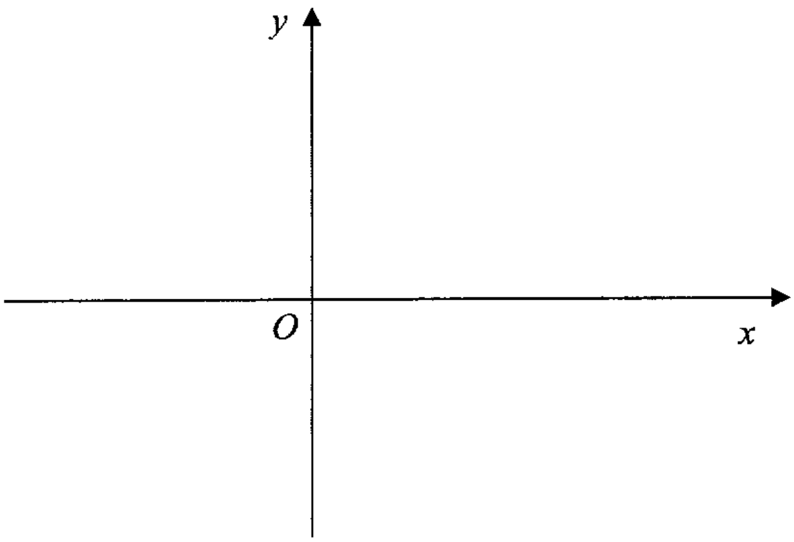
10 **Sketch** the graph of $y=(x+2)(x-4)$ on the axes below.
Indicate clearly the values where the graph crosses the x- and y- axes.



[2]

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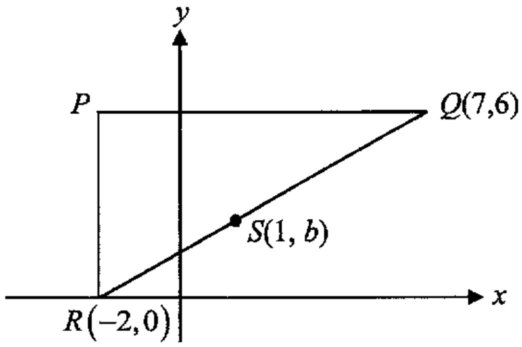
11 A shopkeeper buys 1440 pencils at 25 cents each.
He sells 40 dozens at \$3.60 per dozen and another 30 dozens at \$4.20 per dozen.

Find the price he must sell each of the remaining pencils in order to make a profit of $16\frac{2}{3}$ %.

Answer \$ .... [4]

12



In the diagram above, Q is the point $(7,6)$ and R is the point $(-2,0)$.
PQ is parallel to the x-axis and PR is parallel to the y-axis.

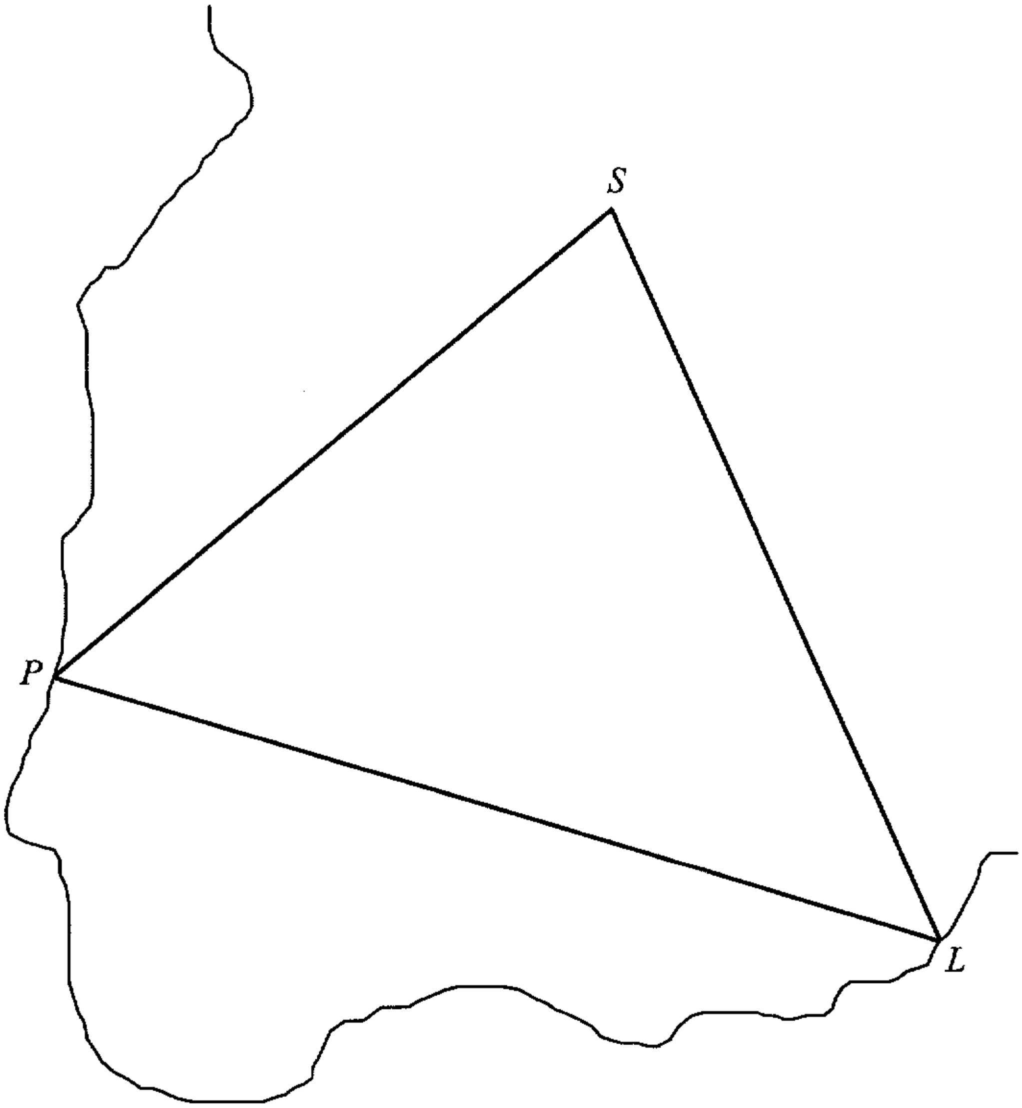
(a) Write down the coordinates of P.

Answer $P =$ (……… , ………) [1]

(b) If $S(1, b)$ is a point on QR, find the value of b.

Answer $b =$ ……………………………. [2]

13 The drawing in the answer space below shows the positions of a port P, a ship S and a lighthouse L.



(a) Construct the perpendicular bisector of SL. [1]

(b) Construct the bisector of angle PSL. [1]

(c) A motorboat has broken down. It is nearer to S than L and nearer to SL than to PS. Shade the region where the motorboat is located. [1]

14 Solve $\frac{a+1}{3}-\frac{a-2}{2}=1$.

Answer $a =$ .... [3]

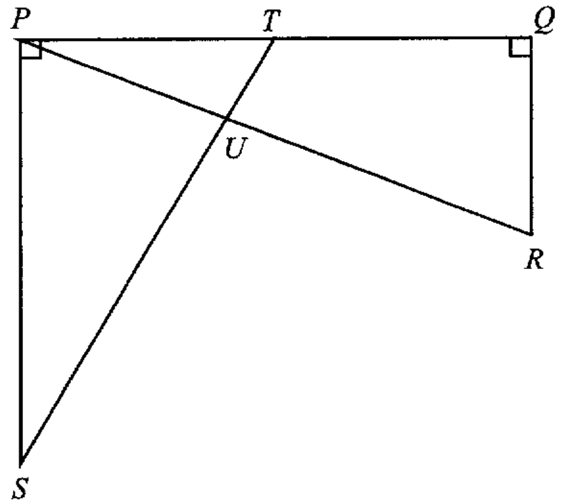
---

15 Adam invested a sum of money in a bank account paying compound interest at 2.5% per year. After 4 years, Adam earned a total interest of $674.79.

Calculate the sum of money Adam invested in the account.

Answer $ .... [3]

16



In the diagram, $\angle PQR = \angle SPT = 90°$.
T is the midpoint of PQ, $PQ = 2\ QR$ and $PQ = PS$.

(a) Show that the triangles PQR and SPT are congruent.

Answer ……….. shown ………… [2]

(b) Name another angle that is equal to $\angle TSP$.

Answer $\angle$ ………………………… [1]

(c) Hence, show that $\angle STP = \angle RPS$.

Answer ……….. shown ………… [1]

17 **(a)** Factorise $2x^2 - 11x - 21$.

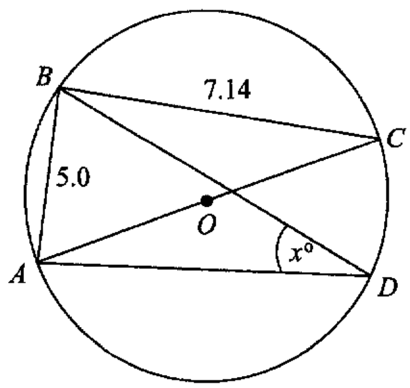
Answer .... [1]

(b) Hence factorise completely $2(2y+1)^2 - 11(2y+1) - 21$.

Answer .... [2]

18 Points A, B, C and D lie on a circle with centre O.
$AB = 5.0$ cm, $BC = 7.14$ cm and angle $BDA = x°$

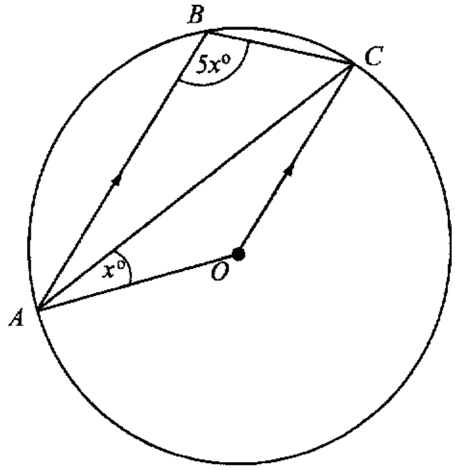
Find the value of x.
Show your working and state all properties clearly.



Answer $x =$ .... [4]

19 In the diagram, A, B, and C are points on a circle, centre O.
OC is parallel to AB.
Angle $OAC = x°$ and angle $OCB = 5x°$.

Find the value of x.
Show your working and state all properties clearly.



Answer $x =$ .... [4]

---

20 **(a)** Use prime factorisation to explain why 15×135 is a perfect square.

Answer ....

.... [3]

(b) a and b are both prime numbers.

Find the values of a and b such that $2025 \times \frac{a}{b}$ is a perfect cube.

Answer $a =$ .... [1]

$b =$ .... [1]

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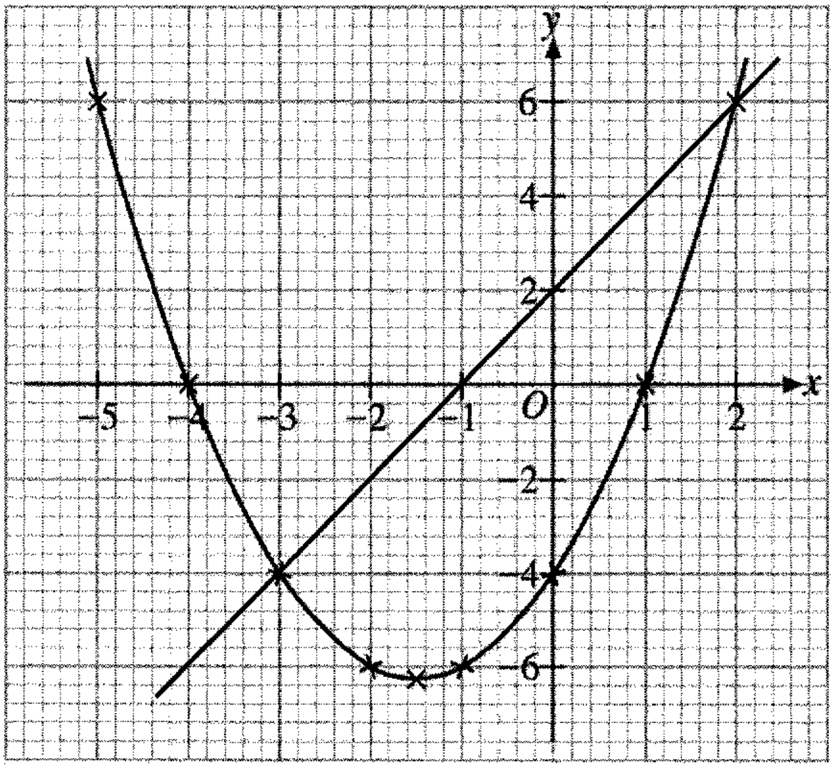
21 The graphs of $y = x^2 + 3x - 4$ and $y = 2x + 2$ are drawn on the grid.



(a) Explain why the equation $x^2 + 3x - 4 = k$ does not have any solution for some values of k.

Answer ....

.... [1]

(b) The points of intersection of the curve and the straight line give the solutions of a quadratic equation.

Find the quadratic equation, giving your answer in the form $ax^2 + bx + c = 0$.

Answer .... [1]

(c) The equation $x^2 + 4x - 2 = 0$ can be solved by drawing a suitable straight line on the grid.

(i) Find the equation of the straight line.

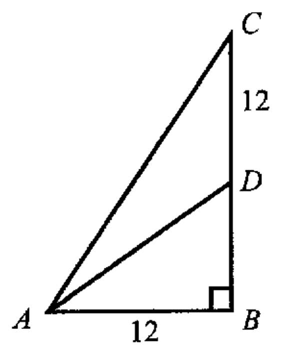
Answer .... [1]

(ii) By drawing this straight line, solve the equation $x^2 + 4x - 2 = 0$.

Answer $x =$ .... or $x =$ .... [3]

---

22 Triangle ABC is a right-angled triangle and D is a point on BC.
It is given that $AB = CD = 12$ cm and $\tan \angle ACB = \frac{4}{7}$.
Find



(a) the area of triangle ABC,

Answer .... cm^2 [2]

(b) the exact value of $\cos \angle ADC$.

Answer .... [2]

23 China's high speed train can travel at an average speed of 300 km/h.

The distance between Beijing and Shanghai is 1318 km.

The distance between Beijing and Guangzhou is approximately 2300 km.

(a) Change 300 km/h into m/s.

Answer .... m/s [1]

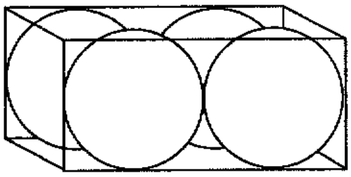
(b) Calculate the time taken for the train to travel from Beijing to Shanghai, leaving your answers in hours, minutes and seconds.

Answer ...... h .... min .... s [2]

(c) Mr Tan took the train from Beijing to Guangzhou. He left Beijing at 7.15 am. What time did he arrive at Guangzhou?

Answer .... [2]

24 Baseballs and other spherical objects are often packed in boxes that are cuboids.
The diagram shows 4 identical baseballs packed tightly inside a cubical box.
The radius of each baseball is 4 cm.



Find

(a) the volume of a baseball, leaving your answer in terms of π,

Answer .... cm^3 [2]

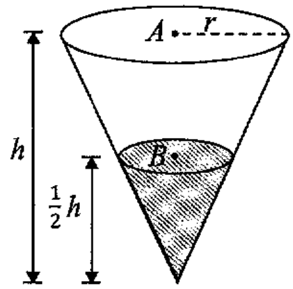
(b) the volume of the box,

Answer .... cm^3 [2]

(c) the percentage of the volume of the box that is not occupied by the baseball, correcting your answer to 1 decimal place.

Answer .... % [2]

25 The diagram shows an inverted cone of height h and radius r. It contains water to a depth of $\frac{1}{2}h$.



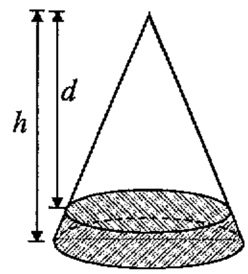
(a) Find ratio of area of surface B : area of surface A.

Answer .... : .... [1]

(b) Find the volume of water if the cone can hold 480 cm^3 of water when full.

Answer .... cm^3 [2]

(c) The cone is now inverted again such that the liquid rests on the flat circular surface of the cone as shown below. Find, in terms of h, an expression for d, the distance of the liquid surface from the top of the cone.



Answer .... [2]

[END OF PAPER]

WOODLANDS RING SECONDARY SCHOOL

Name : ____________________ Reg No. _______ Class : __________

EXAMINATION	:	END-OF-YEAR EXAMINATION	
LEVEL	:	SECONDARY 3 EXPRESS	DATE: 03 Oct 2018
		SECONDARY 3 NORMAL ACADEMIC	
SUBJECT	:	MATHEMATICS O-LEVEL (4048/2)	PAPER: 2
DURATION	:	2 hours	MAX MARKS: 80
SETTER(S)	:	Mr Soh Kian Hong	Parent's/Guardian's Signature:

INSTRUCTIONS TO CANDIDATES

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At the end of the examination, fasten all your work securely together.

This paper consists of **9** printed pages including the cover page.

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

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

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

Answer **all** the questions.

1 **(a)** Solve the inequality $\frac{x+9}{3} \geq \frac{5-x}{7}$. [2]

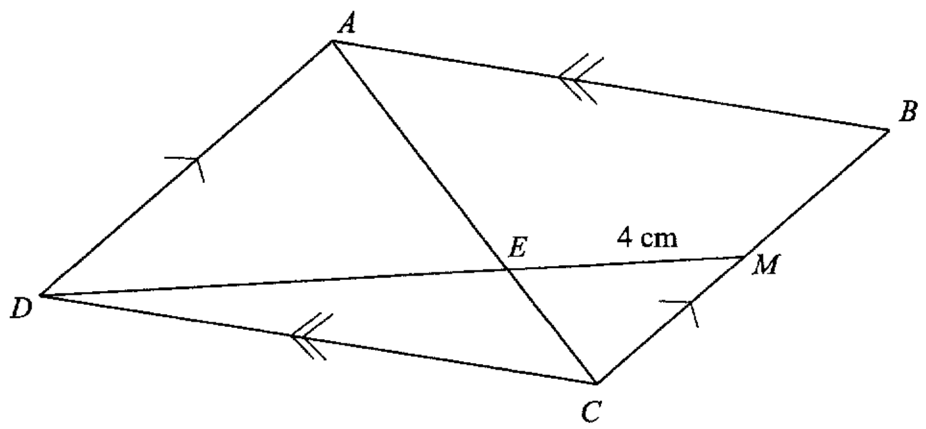
(b) Simplify $\frac{15a^2}{c^2} \div \frac{6a}{14bc^3}$. [2]

(c) It is given that $s = ut + \frac{1}{2}at^2$.

(i) Find s when $u = 1.5$, $a = 2$ and $t = 4$. [1]

(ii) Express a in terms of s, u and t. [2]

2



In the diagram, $ABCD$ is parallelogram. M is the mid-point of BC and AEC and DEM are straight lines. $EM = 4$ cm.

(a) Show that triangle ADE is similar to triangle CME.
Give a reason for each statement you make. [2]

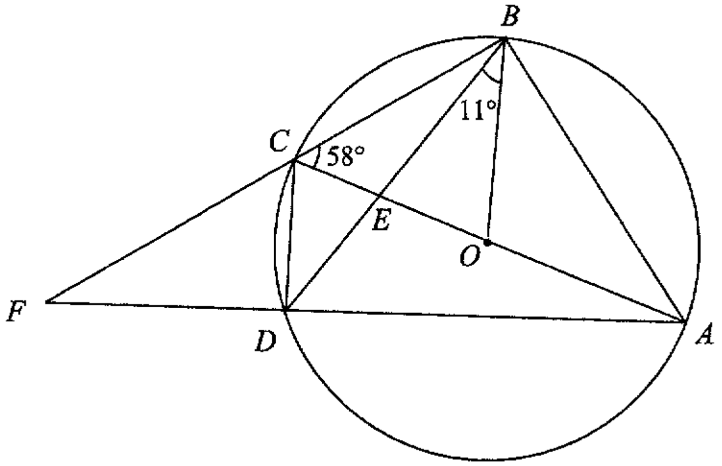
(b) Find the length of DE. [2]

(c) Calculate, as a fraction, the numerical value of the ratio

(i) $\frac{\text{area of triangle } CME}{\text{area of triangle } ADE}$, [1]

(ii) $\frac{\text{area of triangle } ADE}{\text{area of triangle } ADC}$. [1]

3



The diagram shows a circle $ABCD$, centre O.
BC produced and AD produced meet at point F.
BED is a straight line. Angle $OBE = 11°$ and angle $BCE = 58°$.

Find, giving reasons for each answer,

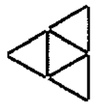
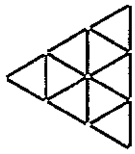
(a) angle ABC, [1]

(b) angle BAC, [1]

(c) angle BAD, [2]

(d) angle ACD. [2]

4 The table shows a sequence of figures formed by drawing lines

			
	Figure 1	Figure 2	Figure 3
Number of non-vertical lines	2	6	12

(a) Find the number of non-vertical lines in figure 4 and figure 5. [2]

(b) Find an expression, in terms of n, in the form $an^2 + bn$ for the number of non-vertical lines found in figure n. [1]

(c) Find the number of non-vertical lines in figure 56. [1]

(d) Hadi claims that one of the figures has 243 non-vertical lines.
Is he correct? Explain your answer. [3]

5 **(a)** Frank is a salesman who is paid 1.5% commission on his sales.
His sales in January was \$26 000.

(i) Find his commission in January. [1]

(ii) His sales increase by 12% from January to February and decrease by 25% from February to March.

Find his sales in the month of March. [2]

(b) The exchange rate between United States dollars (US\$) and Singapore dollars(S\$) was US\$1.00 = S\$1.37.
Paul bought a shirt from an online shop for US\$23.99.

Find the amount of money he paid in Singapore dollars. [2]

---

6 x kg of aluminium metal costs \$25.
An alloy, which is 1 kg lighter, also costs \$25.

(a) Write down an expression, in terms of x, for the cost of 1 kg of aluminium. [1]

(b) Write down an expression, in terms of x, for the cost of 1 kg of alloy. [1]

(c) For an art sculpture, Nurul paid \$55 for 10 kg of aluminium and 5 kg of alloy.
Write down an equation to represent this information and show that it simplifies to

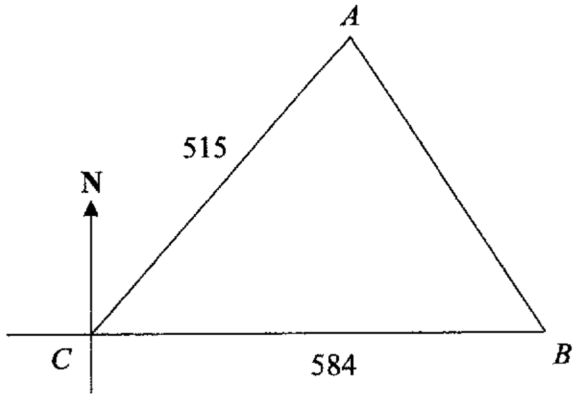
$$11x^2 - 86x + 50 = 0.$$ [3]

(d) Solve the equation $11x^2 - 86x + 50 = 0$. [3]

(e) Explain why one of the solutions in **part (d)** must be rejected as the mass of the aluminium. [1]

(f) Calculate the cost of 1 kg of aluminium. [1]

7



Points A, B and C are on level ground.
B is due east of C.
A is 515 m from C on a bearing of $055°$.
B is 584 m from C.

(a) Calculate AB. [3]

(b) Calculate the bearing of A from B. [3]

(c) Calculate the shortest distance from A to BC. [2]

(d) AT is a vertical tower at A.
The angle of elevation of the top of the tower from C is $25°$.
Calculate the height of the tower, AT. [2]

---

8 A is the point (5, 11) and B is the point (−4, −2) respectively.

(a) Find the length of the line AB. [2]

(b) Find the equation of the line AB. [2]

(c) The equation of line p is $9y = 13x + 9$.

(i) Show how you can tell that the line p does not intersect the line AB. [2]

(ii) Another line q is $3y - 5x = 6$.
Find the coordinates of the point of intersection of the line p and the line q. [3]

---

9 Answer the whole of this question on a single sheet of graph paper.

The variables x and y are connected by the equation

$$y = \frac{x^3}{30} + \frac{20}{x} - 10.$$

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

x	1	2	3	4	5	6	7
y	p	0.27	−2.43	−2.87	−1.83	0.53	4.29

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $0 \le x \le 7$.
Using a scale of 1 cm to represent 1 unit, draw a vertical y-axis for $-3 \le y \le 11$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

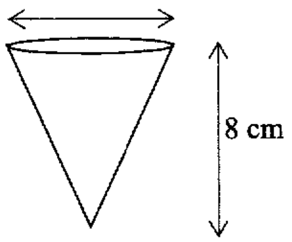
(c) By drawing a line, use your graph to find the solution to the equation
$\frac{x^3}{30} + \frac{20}{x} = 15$. [2]

(d) By drawing a tangent, find the gradient of the curve at $x = 2$. [2]

(e) **(i)** On the same axes, draw the line $y + 2x = 10$. [1]

(ii) Write down the x-coordinates of the points where the line intersects the curve. [2]

10 The figure below shows a conical paper cup used by a company water dispenser. The cup has diameter of 6 cm and a height of 8 cm.



(a) Calculate the full volume of water each cup can hold. Leave your answer to the nearest whole number. [2]

(b) The water dispenser tank is cylindrical with diameter 50 cm and height 60 cm.

(i) Find the volume of water in a full dispenser tank. Leave your answer in 2 significant figures. [2]

(ii) Teresa, the company manager, wishes to purchase cups and water dispenser tanks for her company.

Information that Teresa needs is found below.

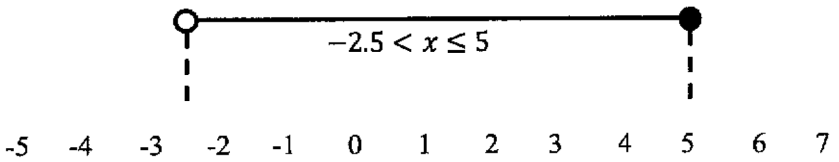
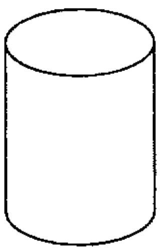
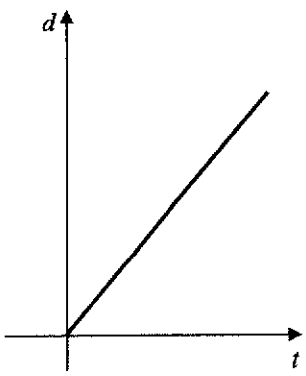
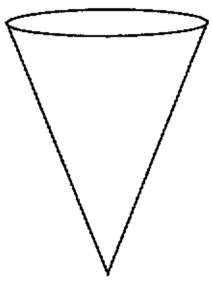
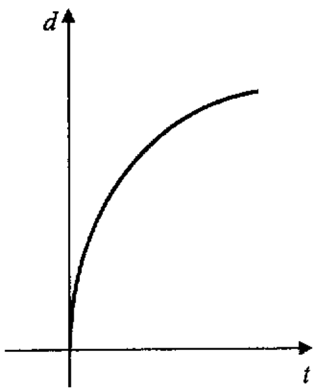
Item	*Description*	*Unit Cost*
Conical cups	1 pack of 50	\$2.50
	1 pack of 250	\$10.00
Cylindrical water tanks	1 drum (≤ 50 drums)	\$20.00
	Bulk price (> 50 drums)	\$15.00

She estimates that 10 000 litres of water is consumed per year.

Using your answers in **(a)** and **(bi),** work out a suitable amount of money Teresa needs to budget for her company's water dispenser per year.

Justify the decision you make and show your calculations clearly. [5]

-- **END OF PAPER** --

1	$\frac{1}{343} = \frac{1}{7^3} = 7^{-3} = 7^p$, By comparing indices, p= -3	B1
2		B1
3	$18x - 3(2x-5)^2 = 18x - 3(4x^2 - 20x + 25)$ $= 18x - 12x^2 + 60x - 75$ $= -12x^2 + 78x - 75$ o.e.	M1 A1
4	$3^k + 3^{k+1} = 3^k + 3^k.3$ $= 3^k(1+3)$ $= 3^k(4)$ Since k is a positive integer, 3^k is also a positive integer So $3^k + 3^{k+1}$ is a multiple of 4.	M1 A1
5(a)	 	B1
(b)	 	B1

<table>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td>6(a)</td><td colspan="2">Mode = 1167 cm</td><td>A1</td></tr>
<tr><td>(b)</td><td colspan="2">Median = $\frac{167+168}{2} = 167.5$ cm</td><td>B1</td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td>7</td><td colspan="2">Vertical axis <u>does not start from zero</u>

Hence this makes change <u>seems like 25% of original,</u>
when the change is actually 60% of original.</td><td>B1

B1</td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td>8</td><td colspan="2"><u>Method 1 (using exterior angles)</u>

$x + 2x + [180 - (3x - 40)] + x + [180 - (160 - x)] = 360$
$240 + 2x = 360$
$x = 60$

<u>Method 2 (using interior angles)</u>
$(180 - x) + (180 - 2x) + (3x - 40) + (180 - x) + (160 - x) = 180(5 - 2)$
$660 - 2x = 540$
$x = 60$</td><td>M1

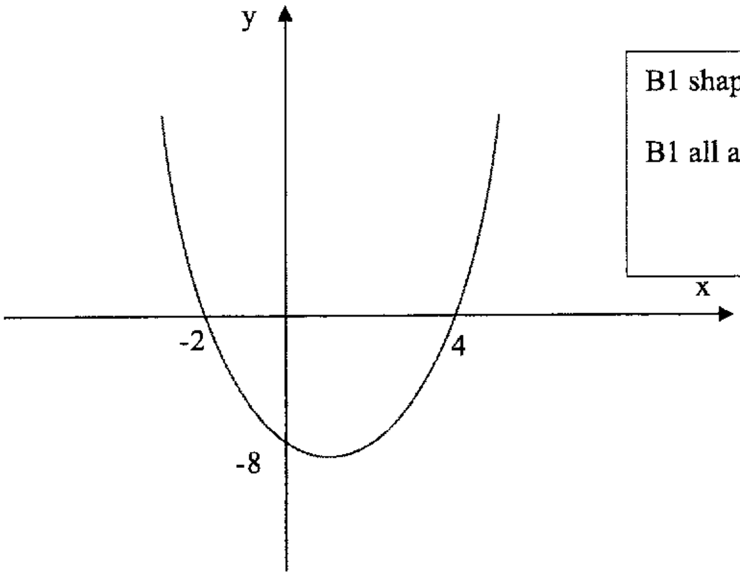
A1</td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td>9</td><td>$F = \frac{k}{d^2}$

New $F = \frac{k}{\left(\frac{d}{2}\right)^2}$
$= \frac{4k}{d^2}$
$= 4(40)$
$= 160\text{N}$</td><td>$F = \frac{k}{d^2}$
Sub $F = 40$, $d = r$
$40 = \frac{k}{r^2}$

$k = 40r^2$
$\therefore F = \frac{40r^2}{d^2}$
Sub $d = \frac{1}{2}r$
$F = \frac{40r^2}{(\frac{1}{2}r)^2}$
$F = \frac{40r^2}{\frac{1}{4}r^2}$
$\therefore F = 160\text{N}$</td><td>M1

A1</td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
</table>

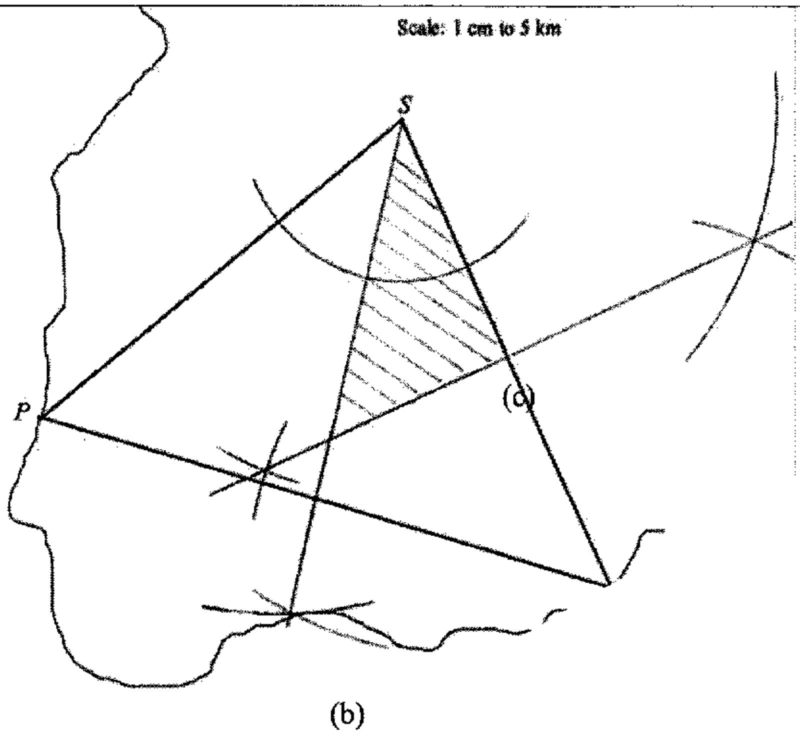
10



B1 shape

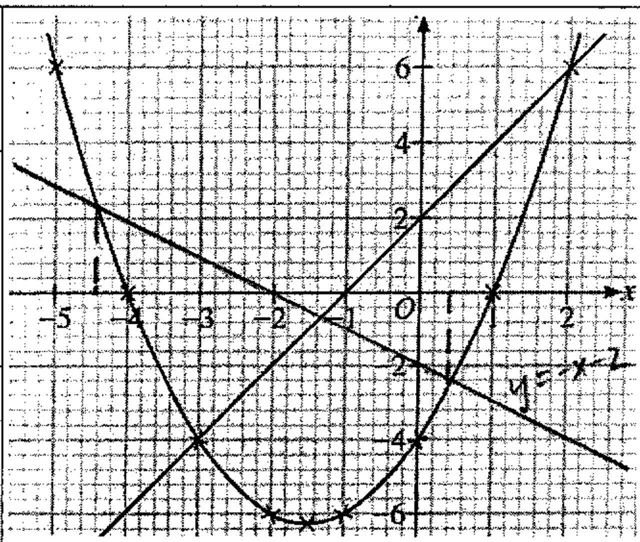
B1 all axis values shown

11	No. of remaining pencils $= 1440 - (30+40)(12)$ $= 600$	M1
	Amount to be made from sale of remaining pencils $= \frac{116\frac{2}{3}}{100} \times 1440 \times 0.25 - (40 \times 3.6) - (30 \times 4.2)$ $= \$\ 150$	M1
	Selling price per pencil $= 150 \div 600$ $= \$0.25$	M1 A1
12(a)	P = (-2, 6)	B1
(b)	Using similar triangle or $\frac{6-b}{6} = \frac{6}{9}$ $6 - b = \frac{36}{9} = 4$ $b = 2$ Gradient RQ $= \frac{6-0}{7-(-2)} = \frac{2}{3}$ Gradient RS $= \frac{b-0}{1-(-2)} = \frac{b}{3}$ $\frac{b}{3} = \frac{2}{3}$ $b = 2$	M1 A1

13	 (a) Construct the perpendicular bisector of SL (b) Construct the bisector of angle PSL (c) As above	B1 B1 B1
14	$\frac{a+1}{3}-\frac{a-2}{2}=1$ $\frac{2(a+1)-3(a-2)}{6}=1$ $2a+2-3a+6=6$ $-a=-2$ $a=2$	 M1 M1 A1
15	A = P + 674.79 $A=P(1+\frac{2.5}{100})^4$ P + 674.79 = $P(1+\frac{2.5}{100})^4$ $P[(1+\frac{2.5}{100})^4]=674.79$ P = 6499.67	 M1 M1 A1

16(a)	T is the midpoint of PQ >> thus PT = TQ $PQ = 2\ QR$ >> thus QR = PT = TQ PQ = SP (given) $\angle PQR = \angle SPT = 90°$ QR = PT (given) *Thus* triangle PQR and triangle SPT are congruent (SAS)	M1 A1
(b)	$\angle RPQ$	B1
(c)	$\angle STP = 180 - \angle TPS - \angle TSP$ (angle sum of triangle) $= 180 - 90 - \angle TSP$ $= 90 - \angle RPQ$ $= \angle RPS$	B1
17(a)	$2x^2 - 11x - 21 = (2x+3)(x-7)$	B1
(b)	Let $x = 2y + 1$ $2(2y+1)^2 - 11(2y+1) - 21 = 2x^2 - 11x - 21$ $= (2x+3)(x-7)$ *Sub* $x = 2y + 1$ *into* $(2x+3)(x-7)$ $(2x+3)(x-7) = (2[2y+1]+3)([2y+1]-7)$ $= (4y+5)(2y-6)$ $= 2(4y+5)(y-3)$	M1 A1
18	$\angle ABC = 90^o$ ($\angle$ in a semi-circle) $tan\angle ACB = \frac{5}{7.14}$ $\angle ACB = 35.0^o$ $\angle x = \angle ACB = 35.0^o$ (angles in same segment)	M1 M1 M1 A1

19	$\angle OCA = x$ (base $\angle$ of isos triangle)	
	obtuse $\angle AOC = 180 - 2x$ (angle sum of triangle)	M1
	reflex $\angle AOC = 2(5x) = 10x$ ($\angle$ at centre $= 2\angle$ at circumference)	M1
	$180 - 2x + 10x = 360$ (angles at a point)	M1
	$x = 22.5$	A1
20(a)	$15 \times 135 = (3 \times 5) \times (3^3 \times 5)$	M1
	$= (3^2 \times 5)^2 = 45^2$	M1
	45^2 is a perfect square or the powers are even / powers are multiples of 2	A1
(b)	a = 5, b = 3	B2
21(a)	When k is less than minimum point of the graph, there is not intersection of the graph of $y = x^2 + 3x - 4$ with graph of y = k, and thus no solution of the equation $x^2 + 3x - 4 = k$. Note: accept (k < -6 or k< -7).	A1
(b)	$x^2 + 3x - 4 = 2x + 2$ Shift all terms to LHS, $x^2 + x - 6 = 0$	B1
(c)	$x^2 + 4x - 2 = 0$ $x^2 + 3x - 4 = -x - 2$ suitable straight line : $y = -x - 2$	B1
(d)	Draw line of $y = -x - 2$ (e.c.f. for a straight line drawn) x = 0.4 or -4.4	M1 A2



22(a)	$\tan \angle ACB = \frac{4}{7} = \frac{12}{12+SQ}$ $4(12+SQ) = 12 \times 7$ $48+4SQ = 84$ $SQ = 9$ Area $= \frac{1}{2} \times 12 \times (9+12)$ $= 126 \text{ cm}^2$	$\frac{4}{7} = \frac{12}{BC}$ BC = 21 Area $= \frac{1}{2} \times 12 \times (21)$ $= 126 \text{ cm}^2$	M1 A1
(b)	$AD^2 = 12^2 + 9^2$ (Pythagoras' Theorem) $AD = 15$ cm $\cos PSR = -\cos PSQ = -\frac{9}{15} = -\frac{3}{5}$		M1 A1
23(a)	$83\frac{1}{3}$ m/s (accept 83.3 m/s) , ($\frac{250}{3}$ m/s not accepted)		A1
(b)	Time taken $= \frac{1318}{300}$ $= \frac{659}{150}h$ or 4.39h or $4\frac{59}{150}$ h = 4 h 23 m 36 s		M1 A1
(c)	Time taken= $\frac{2300}{300}$ $= 7\frac{2}{3}$ = 7 h 40 mins Reached at 2.55 pm or 1455h		M1 A1
24(a)	Volume of a sphere $= \frac{4}{3} \times \pi \times 4^3$ $= 85\frac{1}{3}\pi \text{ cm}^3$	accept $85.3\pi \text{ cm}^3$, $\frac{256}{3}\pi \text{ cm}^3$	M1 A1
(b)	Diameter of sphere $= 2 \times 4$ $= 8$ cm Length of box $= 2 \times 8 = 16$ cm | Width of box $= 2 \times 8 = 16$ cm | Height of box = 8 cm		M1

	Volume of box $= 16 \times 16 \times 8$ $= 2048 \text{ cm}^3$	A1
(c)	Volume of 4 spheres $= 4 \times 85\frac{1}{3}\pi$ $= 341\frac{1}{3}\pi \text{ cm}^3$ $or = 1072.33\ cm^3$ Percentage of box not occupied by spheres $= \frac{2048 - 341\frac{1}{3}\pi}{2048} \times 100\%$ $= 47.6\%$ (Correct to 1 decimal place)	M1 A1
25(a)	Let A_A be the area of surface A Let A_B be the area of surface B $\frac{A_B}{A_A} = (\frac{1}{2})^2 = \frac{1}{4}$ 1:4 accept 0.25:1 or $\frac{1}{4}$:1	A1
(b)	Let V_B be the vol of the water V_A be the vol of the cone $\frac{V_B}{V_A} = (\frac{1}{2})^3 = \frac{1}{8}$ $V_B = \frac{480}{8} = 60$	M1 A1
(c)	Let V_C be the vol of the empty cone V_A be the vol of the empty cone $\frac{V_C}{V_A} = \frac{480-60}{480} = \frac{7}{8}$ (ratio of vol of similar solids) Let h_C *be height of the empty cone,* h_A *be height of the empty cone* $\frac{h_C}{h_A} = \sqrt[3]{\frac{7}{8}}$ (ratio of length of similar solids) $h_C = \frac{\sqrt[3]{7}}{2}h$ or $\sqrt[3]{\frac{7}{8}}$ h	 M1 A1

2018 WRSS Sec 3E EOY P2 Solutions

1a	$\frac{x+9}{3} \geq \frac{5-x}{7}$ $7(x+9) \square 3(5-x)$ .... $7x+63 \square 15-3x$ $10x \square -48$ $\boldsymbol{x \geq -4.8 \,/\, -4\frac{4}{5} \,/\, -\frac{24}{5}}$	M1 A1
b	$= \frac{15a^2}{c^2} \times \frac{14bc^3}{6a}$ $= \boldsymbol{35abc}$	M1 A1
ci	$s = ut + \frac{1}{2}at^2$ $= 1.5(4) + 0.5(2)(4)^2 = \mathbf{22}$	B1
1cii	$\frac{1}{2}at^2 = s - ut$ $at^2 = 2(s-ut)$ $a = \frac{2(s-ut)}{t^2} \,/\, \frac{2s-2ut}{t^2} \,/\, -\frac{2(ut-s)}{t^2} \,/\, -\frac{2ut-2s}{t^2} \,/\, \frac{2s}{t^2} - \frac{2u}{t}$	M1 A1

2a	$\angle DAE = \angle MCE$ (alternate $\angle$s, AD // BC), $\angle ADE = \angle CME$ (alternate $\angle$s, AD // BC), $\angle AED = \angle CEM$ (vert. opp. $\angle$s) ...any 1 statement .... By **AA similarity test**, ΔADE is similar to ΔCME. OR ΔADE is similar to ΔCME because **3 pairs of corresponding angles are equal**. Note A1 will not be awarded if **AA similarity test** or **3 pairs of corresponding angles are equal** not stated.	M1 A1
b	Since both Δs are similar, hence the ratios of the corresponding sides are the same. $\frac{DE}{ME} = \frac{AD}{MC}$ $\frac{DE}{4\,cm} = \frac{2}{1}$ (Note: M is the mid-point of BC) $DE = $ **8 cm**	 M1 A1
ci	$\frac{\text{area of triangle } CME}{\text{area of triangle } ADE} = \left(\frac{l_1}{l_2}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$ Note Wrong working: No mark awarded (e.g. assume the side or height of triangles to be of certain length.	B1
2cii	$\frac{\text{area of triangle } ADE}{\text{area of triangle } ADC} = \frac{\frac{1}{2}(Base\ \text{AE})(\text{common ht})}{\frac{1}{2}(Base\ \text{AC})(\text{common ht})} = \frac{2\text{ parts}}{3\text{ parts}} = \frac{2}{3}$ Note Wrong working: No mark awarded (e.g. assume the side or height of triangles to be of certain length.	B1

3a	$\angle ABC = \mathbf{90^\circ}$ ($\angle$s in the semi-circle)	B1
b	$\angle BAC = 180^\circ - 90^\circ - 58^\circ$ (Sum of $\angle$s, Δ) or ($\angle$s sum of Δ) $= \mathbf{32^\circ}$	B1
c	$\angle OAB = \angle OBA = 32^\circ$ (base $\angle$s, isosceles Δ) $\angle CBD = 90^\circ - 11^\circ - 32^\circ = 47^\circ$ Hence, $\angle CAD = 47^\circ$ ($\angle$s in same segment) $\therefore \angle BAD = 32^\circ + 47^\circ = \mathbf{79^\circ}$ <u>Note</u> Missing important working: 1m deducted (in red)	M1 A1
3d	$\angle BCD = 180^\circ - 79^\circ = 101^\circ$ ($\angle$ in opposite segment) Hence, $\angle ACD = 101 - 58 = \mathbf{43^\circ}$ **or** $\angle ADC = 90^\circ$ ($\angle$s in the semi-circle) Hence, $\angle ACD = 180 - 90 - 47 = \mathbf{43^\circ}$ <u>Note</u> Missing important working: 1m deducted (in red)	M1 A1 M1 A1

4na	Figure 4 = 4×5 = **20** Figure 5 = 5×6 = **30** <u>Note</u> Did not write "20" is for Figure 4 or Figure 5: 1m deducted	B1 B1
b	Sequence pattern is: Fig_1 : $1^2 + 1 = 2$ Fig_2 : $2^2 + 2 = 6$ Fig_3 : $3^2 + 3 = 12 \ldots$ Expression for the number of non-vertical lines in Figure n = $\boldsymbol{n^2 + n}$	B1
c	Number of non-vertical lines in figure 56 $= 56^2 + 56$ $= \mathbf{3192}$	B1
4**d**	<u>Method 1</u> According to Hadi's claim, $n^2 + n = 243$ $n^2 + n - 243 = 0$ [redacted] [redacted] Since [redacted], Hadi's claim is wrong as there is no figure with 243 non-vertical lines. Note: One colour one mark. Student can either solve or state to prove that n is not a positive integer. <u>Method 2</u> Number of non-vertical lines $= n^2 + n$ $= n(n+1)$ [redacted] Since [redacted] represents the product of two consecutive integers and it will always result in an [redacted], Hadi's claim is wrong as there is no figure with 243 non-vertical lines as it is an odd integer. Note: One colour one mark. If students only state that number of non-vertical line must be an even integer: Award 1m only <u>Method 3</u> Fig 15 = 240 [redacted].	

5ai	$\frac{1.5\%}{100\%} \times \$26000$, $\therefore$ commission = **\$390**	B1
aii	$100\% = \$26000$ $112\% = \frac{112}{100} \times 26000$ $= \$29120$ (Feb) $100\% = \$29120$ $75\% = \frac{75}{100} \times 29120$ = **\$21 840 (in March)**	 M1 A1
5b	S\$ paid $= \frac{1.37}{1} \times \$23.99$ $= 32.8663 \approx$ **\$32. 87** Note: No d.p: -1m	M1 A1

6a	$\$\left(\frac{25}{x}\right)$ = cost of 1kg of Aluminium	B1
b	$\$\left(\frac{25}{x-1}\right)$	B1
c	$10\left(\frac{25}{x}\right)+5\left(\frac{25}{x-1}\right)=55$ $250(x-1)+125x=55x(x-1)$ $55x^2-430x+250=0$ $11x^2-86x+50=0$ **(Shown)**	M1 M1 A1
d	$a=11, b=-86, c=50$ $x=\frac{-(-86)\pm\sqrt{(-86)^2-4(11)(50)}}{2(11)}$ $x=\frac{86+\sqrt{5196}}{22}$ *or* $\frac{86-\sqrt{5196}}{22}$ $x=7.1856...$ or $x=0.63257...$ $x=\mathbf{7.19}$ or $x=\mathbf{0.633}$ ....(3 sig. figs)............................	M1 A1,A1
6e	$x=\mathbf{0.633}$ is rejected as the term $\left(\frac{25}{x-1}\right)$ needs to be positive (2 conditions). Or , x > 1 for the term $\left(\frac{25}{x-1}\right)$.	B1
6f	Cost of 1 kg of Al = $\left(\frac{25}{7.1856...}\right)=3.4791...\approx$ **\$3.48** (3 sig. figs)	B1

7a	$\angle ACB = 90° - 055° = \mathbf{35°}$ Cosine Rule: $(AB)^2 = 515^2 + 584^2 - 2(515)(584)\cos 35°$ $= 113544.6623\ldots$ $AB = 336.9638\ldots \approx$ **337 m (3 sig. figs)**	B1 M1 A1
b	$\dfrac{\sin\angle ABC}{515} = \dfrac{\sin 35}{336.9638}$:(Sine Rule) $\angle ABC = \sin^{-1}\left(\dfrac{515\times\sin 35}{336.9638}\right) = \sin^{-1}(0.87662\ldots) = 61.2382\ldots \approx 61.2°$ Hence, bearing of A from B = $180° + 90° + 61.2°$ .... $\approx$ **331.2°** (1 dec. place)	M1 M1 A1
c	Let x be the shortest distance from A to AC. $\sin 35 = \dfrac{x}{515}$ or $\dfrac{1}{2}(584)(x) = \dfrac{1}{2}(515)(584)\sin 35$ .... $x = \sin 35° \times 515 = 295.3918\ldots \approx$ **295 m** (3 sig. figs)	 M1 A1
7d	$\tan 25^{\circ} = \dfrac{AT}{515}$ .... $AT = \tan 25° \times 515 = 240.1484\ldots \approx$ **240 m** (3 sig. figs)	M1 A1

8a	Length $AB = \sqrt{(5-(-4))^2 + (11-(-2)^2)}$ $= \sqrt{81+169} = \sqrt{250} = 15.8113\ldots \approx$ **15.8 unit** (3 sig. figs)	M1 A1
b	Gradient $AB = \dfrac{11-(-2)}{5-(-4)} = \dfrac{13}{9}$ or $1\dfrac{4}{9}$ .... Substitute (5, 11) into: $(11) = \left(\dfrac{13}{9}\right)(5) + c \Rightarrow c = \dfrac{34}{9}$ Equation AB is: $y = \dfrac{13}{9}x + \dfrac{34}{9}$ or $\mathbf{9y = 13x + 34}$	M1 A1
8ci	line p: $9y = 13x + 9$ (Given) Hence, $y = \dfrac{13}{9}x + 1$ .... Since line p and line AB shared the same gradient (13/9), both lines are parallel. And parallel lines do not intersect. (all 3 conditions stated) Or substitute line p into line AB, to get an equation of no real solutions, thus no intersection points between the 2 lines.	 M1 A1

8cii	line p: $9y = 13x + 9 \Rightarrow y = \dfrac{13}{9}x + 1$, substitute into line q: $3y - 5x = 6$ $3(\dfrac{13}{9}x + 1) = 5x + 6$ .... $\dfrac{13x - 15x}{3} = 3$ $-2x = 9 \Rightarrow x = -4.5$ or $y = -5.5$ .... Hence, y coordinate $\Rightarrow y = \dfrac{13}{9}(-4.5) + 1 = -5.5$ Coordinate is : $(-4.5, -5.5)$	 M1 A1 A1

9a	$p =$ **10.03** (2 dec. pls) **or 10.0** (3 sig. figs) or $10\frac{1}{30}$	B1
b	Accurately plotted coordinates (at least 3 pairs) ....see graph..................... Correct scales & ranges for x and y axes + label of curve & axes Smoothness of curve	B1 B1 B1
c	$\frac{x^3}{30}+\frac{20}{x}=15$ is the intersection points between the graph, $y=\frac{x^3}{30}+\frac{20}{x}-10$ and $y=5$. Intersection point are: $\mathbf{x = 1.30 \pm 0.2}$	B1:draw $y=5$ B1
d	Draw tangent at (2, 0.27). Suggest a new plotting point of (1.5, 3.4) $\text{Grad.}_T=\frac{0.27-5}{2-1}=-4.73$ **−4.90 ≤ accepted gradient range ≤ −4.30** (Note: calculated gradient = −4.60)	B1 B1
ei	Draw the line $y+2x=10$	B1
9eii	Intersection points are: $\mathbf{x = 1.15 \pm 0.2}$ **and** $\mathbf{x = 5.45 \pm 0.2}$	B1,B1

10a	Vol. of conical cup $= \frac{1}{3}\pi(3)^2(8)$ $= 75.3982 ...$ **≈ 75 cm^3 (nearest whole number)**	M1 A1
bi	Vol. of cylinder tank $= \pi(25)^2(60)$ $= 117809.7245 ...$ $\approx$ **120 000 cm^3 (2 sig. figs)**	M1 A1

Note: 1 m^3 = 100 00 00 cm^3 , 0.00001 m^3 = 1 cm^3 , 1 m*l* = 1 cm^3

bii	**No. of tanks needed** $= 10\,000$ litre × 1000 cm^3 .... $= \frac{10^7}{120000} = 83.333... \approx 84$ tanks	**or** $\frac{10^7}{117809.7245...} = 84.8826...$ (≈ 85 tanks)	Find vol. M1 M1 Find tanks
	No. of cups needed $\frac{10^7}{75} = 133333.333... \approx 133\,334$ cups No. of 250 packs required $= \frac{133334}{250} = 533.336 =$ 533 or 534 packs No. of 50 packs required = 2 packs (if 533 packs)	or $\frac{10^7}{75.3982...} = 132629.1609..$ (≈ 132 630 cups) $\frac{132\,630}{250} = 530.52$ = (531 packs) (3 packs if 530 packs)	M1 Find cups
	Cost of water tanks = \$15 × 84 = \$1260 **Cost of cups** = (\$10 × 533) + (\$2.50 × 2) = \$5335	\$15 × 85 = \$1275 (\$10 ×530) + (\$2.50×3) = \$5307.50	M1
	Total budget = \$1260 + 5335 (84 tanks) = **\$6 595** **or** (for 85 tanks) = **\$6 610** **or** (\$10 × 534 packs) + (\$15 × 85) = **\$66 00**	= \$1260 + 5307.5 = **\$6 567.50** = **or \$6 582.50**	A1

Q9 -Graph

Name (2018) 3E EoY Math P2 Index No.

Subject Q9 (Graph) Class Date

9 a) P = 10.03