Name | Reg. No | Class

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2EX

MATHEMATICS

Paper 1 [40 marks]

SEMESTER TWO EXAMINATION

October 2017

1 hour

Additional material: NIL

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.
Write your name, register number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **ALL** questions.
Write your answers in the spaces provided on the question paper.
If working is needed for any question, it must be shown with the answer.
Omission of essential working will result in loss of marks.
Write the brand and model of your calculator in the space provided below.

INFORMATION FOR CANDIDATES

You are expected to use a scientific calculator to evaluate explicit numerical expressions.
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.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is **40**.

Brand / Model of Calculator		For Examiner's Use	
		Total	40

This question paper consists of **10** printed pages, including the cover page.

Mathematical Formulae

Compound interest

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

Geometry and Measurement

Curved surface area of a cone $= \pi rl$

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

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

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

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

Arc length $= r\theta$, where θ is in radians

Sector area $= \frac{1}{2}r^2\theta$, where θ 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 Solve $\frac{x}{3} - 1 = 2x$.

Answer $x =$ _____ [1]

---

2 Jen sold her bicycle at \$340 and made a profit of 60%. Find the price at which she bought the bicycle.

Answer \$ _____ [2]

---

3 Kiev randomly tosses an eight-sided die, numbered 1 to 8, five times. The mean of the results is 4.8, median is 4, and the mode is 4. The difference between the smallest and largest result is 7. Find the results of the five tosses.

Answer _____ , _____ , _____ , _____ , _____ [2]

4 The variable q is directly proportional to the square of p. At a certain value of p, $q = 12$. Find the value of q when this value of p is halved.

Answer $q =$ _____ [2]

5 Factorise the following expressions completely.

(a) $5 - 20b^2$

Answer (a) _____ [2]

(b) $2x^2 - 21y + 3xy - 14x$

Answer (b) _____ [2]

6 A box contains 12 red balls and x blue balls.

(a) Given that the probability of choosing a red ball is $\frac{4}{9}$, find the value of x.

Answer *(a)* $x =$ _____ [2]

(b) y green balls are added into the box. State the probability of choosing a green ball in terms of y.

Answer *(b)* _____ [1]

7 **(a)** Written as a product of its prime factorization, $1890 = 2^x \times 3^y \times 5 \times 7$. Find the values of x and y.

(b) Written as a product of its prime factorization, $264 = 2^3 \times 3 \times 11$. Find the smallest positive integer k such that $264k$ is a perfect square.

Answer *(a)* $x =$ _____

$y =$ _____ [2]

(b) $k =$ _____ [1]

8 A lake of 2 km is represented on a map with a length of 10 cm.

(a) Find the scale of the map in the form $1 : n$.

Answer (a) 1 : _____ [1]

(b) Find the length of an expressway on the map that represents an actual distance of 1480 m.

Answer (b) _____ cm [2]

(c) Find the actual area of a park, in m^2, that is represented by 0.35 cm^2 on the map.

Answer (c) _____ m^2 [2]

9 Solve the following pair of simultaneous equations.

$$3x - 5y = 4$$
$$y - 2x = 16$$

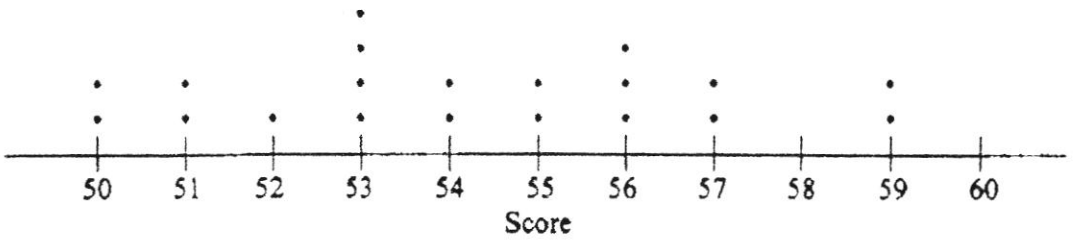
Answer $x =$ _____

$y =$ _____ [3]

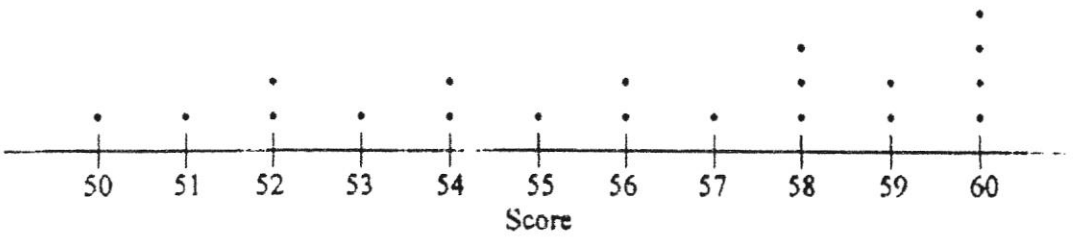
[Turn over]

10 The dot diagram below shows the scores of the junior and senior rugby teams for a particular season. Each team played a total of 20 games.

Dot diagram for junior team



Dot diagram for senior team



(a) State the modal score of the junior team.

(b) Find the median score of the senior team.

(c) Which team had performed better in this season? Justify your answer.

Answer *(a)* _____ [1]

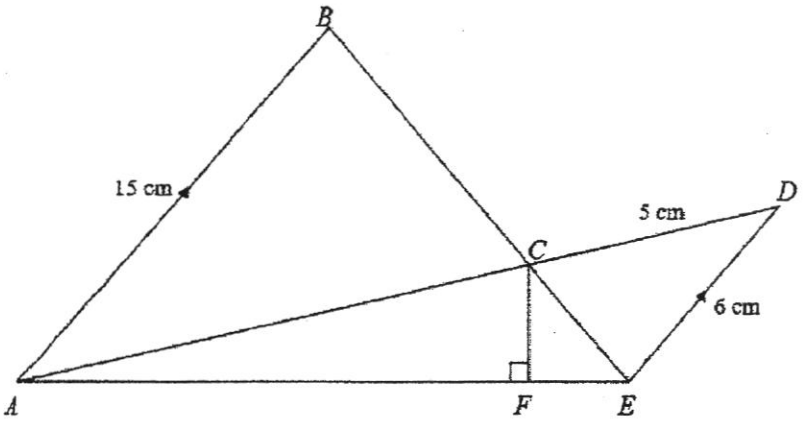
(b) _____ [1]

(c) _____ team performed better because _____

_____

_____ [2]

11 In the diagram below, AB is parallel ED and ΔABC is similar to ΔDEC.
The line CF is perpendicular to the straight line AFE.



(a) Find the length of AD.

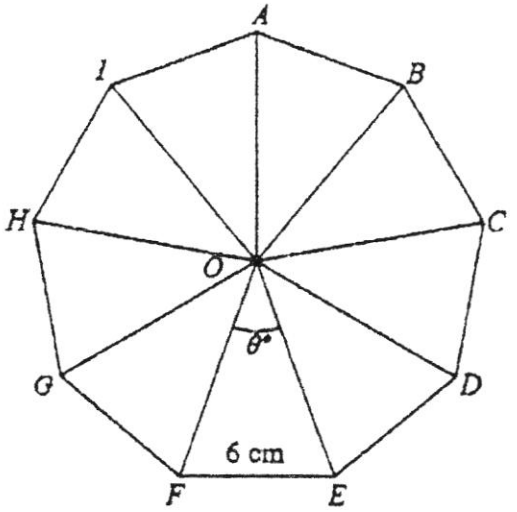
Answer *(a)* _____ cm [2]

(b) Given that the ratio of the length of $AF : CF = 12 : 5$, calculate the length of CF.

Answer *(b)* _____ cm [3]

[Turn over]

12 The diagram below shows the top view of an ornament. A regular nonagon *ABCDEFGHI* forms the base of the pyramid and *O* is the center of the nonagon.



(a) Write down the value of θ.

(b) **(i)** The length of *FE* is 6 cm. Find the perpendicular length from *O* to *FE*.

(ii) Hence calculate the area of the nonagon base.

(c) Given that the height of the pyramid is 15 cm, find the volume of the pyramid, leaving your answer to the nearest cm^3.

Answer (a) θ = _____ ° [1]

(b) (i) _____ cm [2]

(ii) _____ cm^2 [2]

(c) _____ cm^3 [1]

-End of Paper-

Name | Reg. No | Class

2EX

MATHEMATICS

PAPER 2 [60 marks]

SEMESTER TWO EXAMINATION

4 October 2017

1 hour 30 minutes

Additional material: Graph paper
Writing Paper

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Mathematical Formulae

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

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

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

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Answer **all** the questions.

1 **(a)** Expand and simplify $2(1-x)+(3x-1)^2$. [2]

(b) Solve $\frac{4}{3}x+4=\frac{2-x}{3}$. [2]

(c) Express $\frac{4}{2x-3}-\frac{1}{x+2}$ as a single fraction in simplest form. [2]

---

2 It is given that $x = \frac{1}{3}\sqrt{p-5m}$.

(a) Express m in terms of x and p. [3]

(b) Explain why x is not a real number when $p = 4$ and $m = 10$. [1]

(c) Under what condition will x be a real number? [1]

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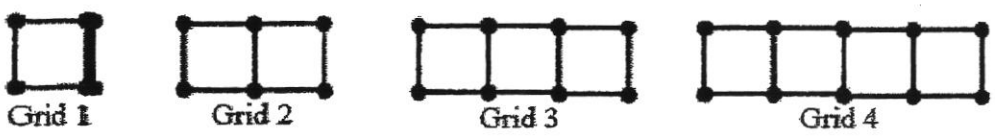
3 The grids in this sequence are made with matchsticks of equal length.



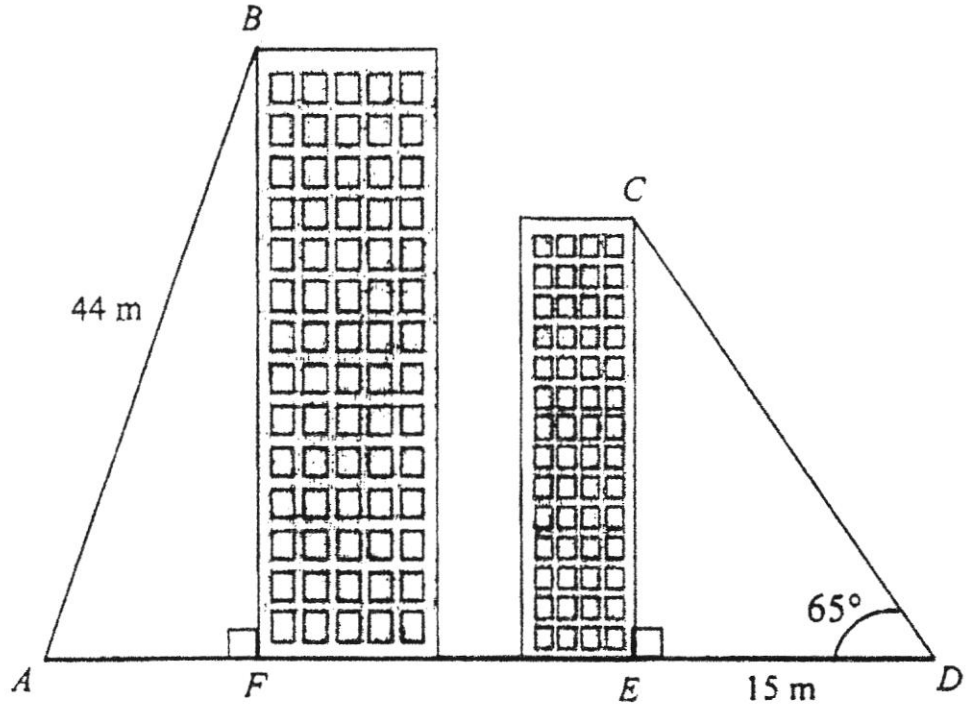
Grid number	1	2	3	4	...	n
Number of matchsticks	4	7	10	13	...	p

(a) State the number of matchsticks for grid number 6. [1]

(b) Write down, an expression in terms of n, for the value of p. [1]

(c) Adam claims that he can form a grid with 302 matchsticks. Is his claim true? Explain your answer. [2]

4



The diagram shows two vertical buildings. B and C are the top of the taller and shorter building respectively. F and E are the foot of the taller and shorter building respectively. Dylan stands 15 m away from E.

(a) Given that $\angle CDE = 65°$, calculate the height of the shorter building. [2]

(b) The height of the taller building is 30 % more than that of the shorter building. Given that the distance between Alex and B is 44 m, find $\angle BAF$. [3]

---

5 The membership fee for a fitness club is \$80 and the club has 100 members. The manager proposes to reduce the membership fee by \$$x$ when the number of members reaches $100 + 4x$.

(a) Write down an expression, in terms of x, for the total amount of membership money collected under the new proposal. [1]

(b) The total amount of money collected under the new proposal is \$10 800. Write down an equation to represent this information, and show that it simplifies to $x^2 - 55x + 700 = 0$. [3]

(c) Solve the equation $x^2 - 55x + 700 = 0$. [2]

(d) Find the possible new membership fees. [1]

---

6 The table below shows the weekly wages, $\$x$, of 100 private hire car drivers.

Weekly wages ($\$x$)	$0 \le x < 200$	$200 \le x < 300$	$300 \le x < 400$	$400 \le x \le 500$
Number of drivers	20	30	p	14

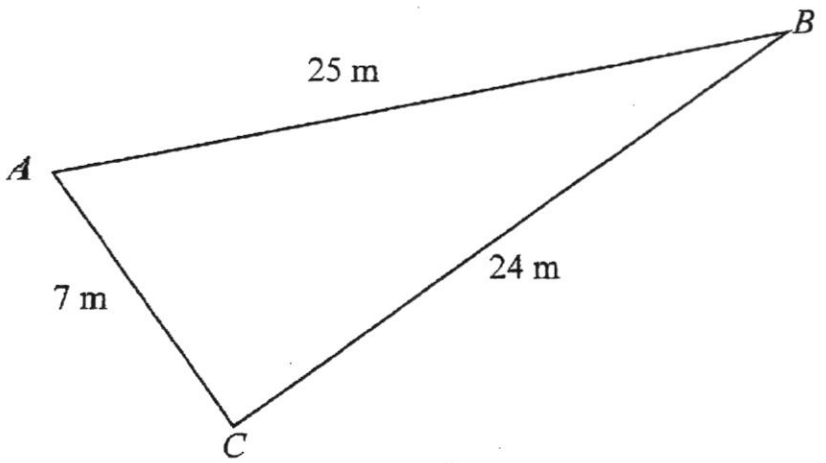
(a) Find the value of p. [1]

(b) **(i)** Calculate an estimate of the mean wages of the private hire car drivers. [2]

(ii) Explain why the mean in **(b)(i)** is an estimate. [1]

(c) A private car driver is selected at random. Find the probability that the driver earns a weekly wage of at least \$200. [1]

7



The diagram shows a triangular playground ABC.

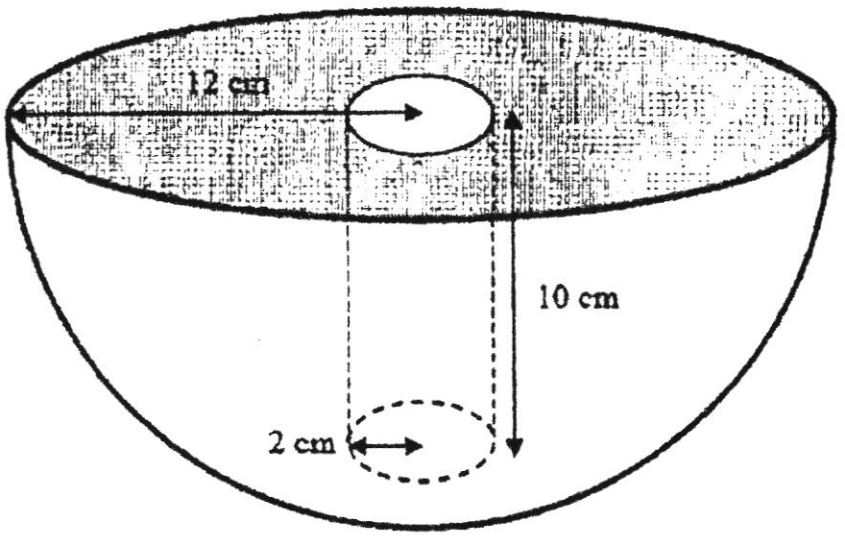
$AB = 25$ m, $BC = 24$ m and $AC = 7$ m.

(a) Prove that ABC is a right-angled triangle. [2]

(b) Find the area of triangle ABC. [1]

(c) Edwin stands at C and walks towards AB. Find the shortest possible distance Edwin can take. [2]

8



The diagram shows a candle holder that can be modelled by removing a cylinder of radius 2 cm and height 10 cm from a solid hemisphere of radius 12 cm.

(a) A candle is placed into the hollow cylinder. Calculate the total surface area of the candle holder in contact with the candle. [2]

(b) Calculate the total surface area of the candle holder. [2]

(c) Calculate the volume of the candle holder. [3]

(d) Candle holders are packed into a rectangular box of length 60 cm, width 48 cm and height 40 cm. If m number of candle holders are packed into the box, find the largest value of m. [1]

(e) Using the value of m in (d), calculate the volume of empty space in the rectangular box. [2]

9 The stem and leaf diagram below shows the number of story books read by children in two kindergartens in a particular year.

Jas Playhouse				Learning Space				
	9	7	7	0	5	8		
				1	2	2	7	
8	5	3	1	2	1	6	6	8
	6	6	3	3	0	8	9	9

Key: 1 | 0 means 10 books

(a) State the median for

(i) Jas Playhouse, and [1]

(ii) Learning Space. [1]

(b) Mrs Ong claims that the children in Jas Playhouse read more story books. Do you agree with her? Justify with a reason. [1]

(c) A new child joined Jas Playhouse. The new mean number of story books read by the children in Jas Playhouse becomes 23. Find the number of story books read by the new child. [2]

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

A company is launching a new product. The total profit, $\$y$ million, when the price of each product is $\$x$, is given by $y = 40x - 4x^2$.

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

x	0	2	4	5	6	10	12
y	0	64	96	100	p	0	- 96

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

(b) Using a scale of 1 cm to represent 1 unit, draw a horizontal x-axis for $0 \leq x \leq 12$.

Using a scale of 1 cm to represent 10 units, draw a vertical y-axis for $-100 \leq y \leq 100$.

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

(c) Use your graph to estimate

(i) the price of each product in order to maximise total profit, [1]

(ii) the total profit when the price of each product is \$2.50. [1]

(d) The company targets to earn a profit of at least \$80 million. Write down the price range of each product. [1]

(e) Is it advisable to price the product at \$11 each? Justify your answer. [1]

End of Paper

Qn No.	Solutions		Marks
1.	$\frac{x}{3} - 1 = 2x$ $x - 3 = 6x$ $5x = -3$ $x = -\frac{3}{5}$		B1
2.	160% of cost price	= \$340	
	Cost price	= \$340 ÷ 160 × 100	M1
		= \$ 212.50	A1
3.	Sum of results	= 5 × 4.8 =24	M1
	Results	1, 4, 4, 7, 8	A1
	If only correct answer		[B2]
4.		$q = kp^2$	
	When $q = 12$,	$12 = kp^2$	
		$k = \frac{12}{p^2}$	M1
	When p is halved,	$q = k(\frac{p}{2})^2$	
		$q = \frac{12}{p^2}(\frac{p^2}{4})$	
		$q = 3$	A1
	OR		
		$q = kp^2$	
	When p is halved,	$q = k(\frac{p}{2})^2$	
		$q = 0.25\ kp^2$	[M1]
		$q = 0.25\ (12)$	
		$q = 3$	[A1]
5.	(a) $5 - 20b^2$	$= 5(1 - 4b^2)$	M1
		$= 5(1 - 2b)(1 + 2b)$	A1

(b) $2x^2 - 14x - 21y + 3xy$ $= 2x(x-7) + 3y(x-7)$ M1
$= (2x + 3y)(x - 7)$ A1

6. (a) $P(\text{red}) = \frac{4}{9}$

$\frac{4}{9} = \frac{12}{12+x}$

$48 + 4x = 108$

$x = 15$

Or using unitary method,

4 units = 12 M1
5 units = 15

A1

(b) $\frac{y}{y+27}$ B1

Wrong answer if student answer in terms of x

7. (a) $1890 = 2 \times 3^3 \times 5 \times 7$ M1

Hence, $x = 1$ and $y = 3$ A1
(no marks if only x or y correct)

(b) $k = 2 \times 3 \times 11$
$k = 66$ B1
(no marks if k is left in prime factors)

8. (a)

10 cm : 2 km
1 cm : 0.2 km
1 : 20 000 B1

(b) Actual length $= 1.480$ km

1.48 km $= 10 \times \frac{1.48}{2}$ M1
$= 7.4$ cm A1

(b) If 0.35 cm^2,

100 cm^2 $= 4$ km^2

0.35 cm^2 $= 4 \times \frac{0.35}{100}$ M1
$= 0.014$ km^2
$= 14\,000$ m^2 A1

9. $3x - 5y = 4$ (1)
$y - 2x = 16$ (2)
$y = 16 + 2x$ (3)

Sub (3) into (1)

$3x - 5(16 + 2x) = 4$ M1
$3x - 80 - 10x = 4$
$-7x = 84$
$x = -12$ A1
$y = -8$ A1

10. (a) Modal score = 53 B1

(b) Median score = 0.5 (56 +57)
= 56.5 B1

(c) Senior team performed better as the median score, 56.5, is higher than that of the junior team which is 54. B1 B1
(B 1 for stating senior team because median is higher,
B1 for stating median of junior team 54)

Students may justify the senior team did better using mean.
Mean (senior) = 56.1 and Mean (junior) = 54.2 [B2]

11. (a) $\frac{AB}{DE} = \frac{AC}{DC}$

$\frac{15}{6} = \frac{AC}{5}$

$AC = \frac{15}{6} \times 5$ M1

$AC = 12.5$ cm
$AD = 12.5 + 5$
$AD = 17.5$ cm A1

b. Let the length of CF be $5x$, then the length of AF is $12x$.

By Pythagoras theorem,
$AC^2 = AF^2 + CF^2$

$12.5^2 = (12x)^2 + (5x)^2$ M1 (allow e.c.f.)

$12.5^2 = 169x^2$

$x = \frac{12.5}{13}$ M1 (allow e.c.f)

$CF = 5(\frac{12.5}{13})$

$CF = 4.80769$
$CF = 4.81$ cm (3 s.f) A1

12. (a) $\theta = 40°$ (sum of $\angle$ at a point = 360°) B1

(b) $\angle OFE = \frac{180 - 40}{2}$ (angles of isos triangle)

(i) $\angle OFE = 70°$

$\tan 70° = \frac{h}{3}$

$h = 3 \tan 70°$ M1

$= 8.242432$

$= 8.24$ cm (3 s.f.) A1

(ii) Area of 1 triangle $= \frac{1}{2}(6)(3 \tan 70°)$ M1

Area of nonagon $= 9\ (9 \tan 70°)$

$= 222.54567$

$= 223\ cm^3$ (3 s.f) A1

OR

bi. $0.5\theta = 20°$

$\tan 20° = \frac{3}{h}$

$h = \frac{3}{\tan 20°}$ [M1]

$h = 8.24$ cm (3 s.f) [A1]

(ii) Area of 1 triangle $= \frac{1}{2}(6)(\frac{3}{\tan 20°})$ [M1]

Area of nonagon $= 9\ (\frac{9}{\tan 20°})$

$= 222.54567$

$= 223\ cm^3$ (3 s.f) [A1]

c. Vol of pyramid $= \frac{1}{3} \times 222.54567 \times 15$

$= 1112.72835\ cm^3$

$= 1113\ cm^3$ B1

(nearest cm^3)

No marks awarded if students use 223 as base area, resulting in volume = 1115 cm^3

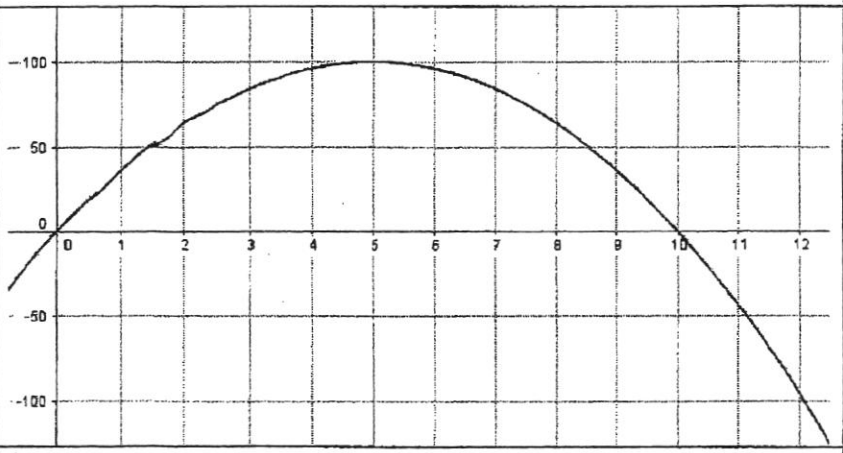
2 Express Math SA2 2017 Paper 2 Marking Scheme

1a	$2(1-x)+(3x-1)^2$ $=2-2x+9x^2-6x+1$ $=9x^2-8x+3$	M1 for $9x^2-6x+1$ A1
b	$\frac{4}{3}x+4=\frac{2-x}{3}$ $4=\frac{2-x}{3}-\frac{4x}{3}$ $4=\frac{2-x-4x}{3}$ $12=2-5x$ $5x=-10$ $x=-2$ OR $\frac{4}{3}x+4=\frac{2-x}{3}$ $4x+12=2-x$ $5x=-10$ $x=-2$	M1 for combining to single fraction A1 M1 for multiplying 3 to every term A1
c	$\frac{4}{2x-3}-\frac{1}{x+2}$ $=\frac{4(x+2)-(2x-3)}{(2x-3)(x+2)}$ $=\frac{4x+8-2x+3}{(2x-3)(x+2)}$ $=\frac{2x+11}{(2x-3)(x+2)}$	M1 for combining to common denominator A1 accept $\frac{2x+11}{2x^2+x-6}$

2a	$x = \frac{1}{3}\sqrt{p-5m}$ $3x = \sqrt{p-5m}$ $9x^2 = p-5m$ $5m = p-9x^2$ $m = \frac{p-9x^2}{5}$ OR $x = \frac{1}{3}\sqrt{p-5m}$ $x^2 = \frac{1}{9}(p-5m)$ $9x^2 = p-5m$ $5m = p-9x^2$ $m = \frac{p-9x^2}{5}$	 M1 for multiplying 3 M1 for square both sides A1 M1 for square both sides M1 for multiplying 9 A1
b	When $p = 4$ and $m = 10$, $x = \frac{1}{3}\sqrt{4-5(10)}$ $x = \frac{1}{3}\sqrt{-46}$ Since $\sqrt{-46}$ is undefined, x is not a real number when $p = 4$ and $m = 10$.	 B1 Accept if students write $p - 5m$ is negative AND $\sqrt{p - 5m}$ is undefined.
c	$p-5m \geq 0$ OR $p \geq 5m$	B1
3a	19	B1
b	$p = 3n + 1$	B1
c	$3n + 1 = 302$ $3n = 301$ $n = \frac{301}{3}$ Since the value of n for 302 matchsticks is not an integer, Adam's claim is not true.	 M1 for value of n (ecf) A1

4a	$\tan 65° = \frac{CE}{15}$ $CE = 15\tan 65$ $= 32.167$ $= 32.2\text{m (3sf)}$	M1 (soi) A1
b	$BF = 1.3 \times 32.167$ $= 41.817$ $\sin \angle BAF = \frac{41.817}{44}$ $\angle BAF = \sin^{-1}\frac{41.817}{44}$ $= 71.876$ $= 71.9° \text{ (1dp)}$	M1 for BF (deduct 1 mark from whole paper if student uses 32.2 m in working) (ecf) M1 (soi) (ecf) A1
5a	$(80 - x)(100 + 4x)$	B1 (ignore subsequent working)
b	$(80 - x)(100 + 4x) = 10800$ $8000 + 320x - 100x - 4x^2 = 10800$ $-4x^2 + 220x - 2800 = 0$ $x^2 - 55x + 700 = 0$	M1 (ecf) M1 for expansion of LHS (ecf) M1 for simplifying equation
c	$x^2 - 55x + 700 = 0$ $(x - 20)(x - 35) = 0$ $x = 20, \quad x = 35$	M1 for factorisation A1 SC1 if students just give final answers
d	New membership fees = \$60 or \$45	B1
6a	$p = 100 - 20 - 30 - 14 = 36$	B1
bi	Mean $= [20(100) + 30(250) + 36(350) + 14(450)] \div 100$ $= \$284$	M1 (ecf) A1
bii	We do not know the exact weekly wages earned by the 100 private hire car drivers. OR We estimated that 20 earned \$100, 30 earned \$250, 36 earned \$350 and 14 earned \$450.	B1
c	P(driver earns at least \$200) $= \frac{80}{100} = \frac{4}{5}$	B1

7a	$AB^2 = 25^2$ $= 625$ $AC^2 + BC^2 = 7^2 + 24^2$ $= 625$ Since $AB^2 = AC^2 + BC^2$, by the converse of Pythagoras' Theorem, ABC is a right-angled triangle.	M1 A1 for conclusion
b	Area of $\Delta ABC = \frac{1}{2} \times 24 \times 7 = 84\ m^2$	B1
c	Let x be the shortest distance. $84 = \frac{1}{2} \times 25 \times x$ $x = 6.72$ m	M1 A1
8a	Surface area in contact $= 2\pi(2)(10) + \pi(2^2)$ $= 138.23$ $= 138\ cm^2$ (3sf)	M1 A1
b	Total surface area of candle holder $= 2\pi(12)^2 + 2\pi(2)(10) + \pi(12^2)$ $= 1482.83$ $= 1480\ cm^2$ (3sf) OR Total surface area of candle holder $= 138.23 + \pi(12^2) - \pi(2^2) + 2\pi(12^2)$ $= 1482.83$ $= 1480 cm^2$ (3sf)	M1 for $2\pi(12)^2 + \pi(12^2)$ A1 M1 for $\pi(12^2) - \pi(2^2) + 2\pi(12^2)$ A1
c	Volume of candle holder $= \frac{2}{3}\pi(12^3) - \pi(2^2)(10)$ $= 3493.45$ $= 3490\ cm^3$ (3sf)	M1 for $\frac{2}{3}\pi(12^3)$ M1 for $\pi(2^2)(10)$ A1
d	Largest value of $m = 2 \times 2 \times 3 = 12$	B1
e	Volume of empty space $= 60 \times 48 \times 40 - 12 \times 3493.45$ $= 73278.6$ $= 73300\ cm^3$ (3sf)	M1 (deduct 1 mark from whole paper if student uses 3490 in working) (ecf) A1

9ai	$\text{Median} = \frac{23+25}{2} = 24$	B1
aii	Median = 26	B1
b	I disgaree, because Jas Playhouse has a lower median. OR I disagree, because Jas Playhouse has a lower mean.	B1
c	Total number of books = 23 x 11 = 253 Number of story books $= 253 - 7 - 7 - 9 - 21 - 23 - 25 - 28 - 33 - 36 - 36$ $= 28$	 M1 A1
10a	$p = 96$	B1
b		S1 for scale P1 for plotting all points C1 for smooth curve
ci	\$5	B1
cii	\$76 million (±2 million)	B1
d	\$2.80 ≤ x ≤ \$7.20 (± \$0.10 for each value)	B1
e	No, because the company will make a loss.	B1