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BEDOK VIEW SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2016

CANDIDATE
NAME

REGISTER
NUMBER

CLASS

MATHEMATICS

Paper 1

4048/01

19 August 2016

2 hours

Candidates answer on the Question Paper.

Secondary 4 Express/4 Normal Academic (Express)

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

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.

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 .

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

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 80.

Total	
-------	--

Setter: Mrs Christina Lee

Parent's / Guardian's Signature:

This document consists of 14 printed pages.

Do not turn over the page until you are told to do so.

*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) Calculate $\frac{10 - \sqrt{36 + 4 \times (-2)}}{3}$.

Write down the first five digits on your calculator display.

Answer (a) [1]

(b) Write your answer to part (a) correct to 3 significant figures.

Answer (b) [1]

2 The first four terms in a particular sequence are 6, 3, -2 and -9.

(a) Write down the next two terms in the sequence.

Answer (a) [1]

(b) Write down an expression, in terms of n , for the n th term in the sequence.

Answer (b) [1]

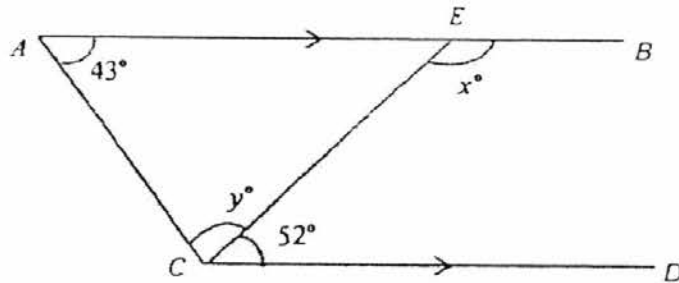
3 (a) Given that $4^n + 2^{-1} = 128$, find the value of n .

Answer (a) $n =$ [2]

(b) The distance from Earth to the Moon is 384 400 km while the distance from Earth to Uranus is 2.72395×10^{12} m. How many times further is Earth from Uranus compared to Earth from the Moon? Leave your answer in standard form.

Answer (b) [2]

4



In the diagram above, AEB is a straight line and AB is parallel to CD .

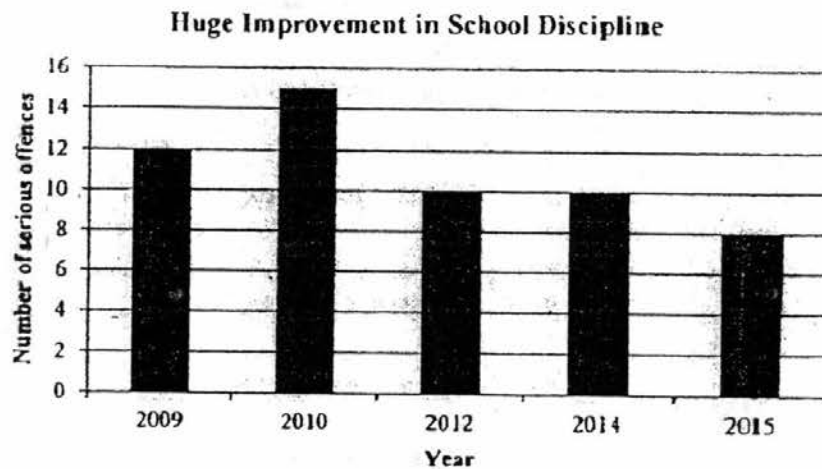
(a) Find x .

Answer (a) $x = \dots\dots\dots$ [1]

(b) Find y .

Answer (b) $y = \dots\dots\dots$ [1]

- 5 The graph below shows the number of serious offences recorded by School A over a number of years.



Explain one way in which the graph is misleading.

Answer

.....

..... [2]

6 Simplify

(a) $(3a+1)^2 - (a+1)^2$

Answer (a) [2]

(b) $\frac{1}{7-x} + \frac{3x}{(x-7)^2}$

Answer (b) [2]

-
- 7 (a) Given that y is directly proportional to the square of x , find the percentage change in y when x increases by 200%.

Answer (a) [3]

- (b) 12 workers can build a house in 25 days. Assuming that all the workers work at the same rate, how many more workers are needed to build 3 of such houses in 30 days?

Answer (b) workers [3]

8 $E = \{x : x \text{ is an integer and } 1 \leq x \leq 11\}$

$A = \{x : x \text{ is divisible by } 5\}$

$B = \{x : x \text{ is a prime number}\}$

- (a) Represent this information in a clearly labelled Venn Diagram.

Answer (a)

[2]

- (b) Write down $n(A \cup B)$.

Answer (b) [1]

- 9 The angles, in degrees, of a pentagon $ABCDE$ are represented by the following expressions:

Angle $A = 80 - x$

Angle $B = 70 + x$

Angle $C = 5x - 50$

Angle $D = 4x$

Angle $E = 80 + 3x$

Calculate the value of x .

Answer $x =$ [3]

- 10 Jason wants to buy 1.2 litres of a particular type of soft drink. He has two possible sizes of that soft drink to buy. Size 1 is a 600 ml bottle at \$1.60 while for Size 2, the capacity is 200 ml at \$0.55. Show and explain clearly which size he should buy and why.

Answer

He should buy Size because

[3]

- 11 (a) Factorise completely $8ab + 4ac - 2b^2 - bc$.

Answer (a) [2]

- (b) Factorise completely $2x^5 + 4x^4 - 6x^3$.

Answer (b) [2]

- 12 An area of 125 m^2 is represented by 5 cm^2 on a map.

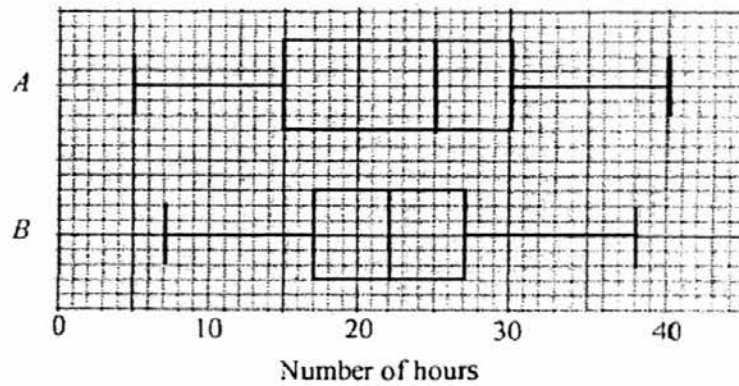
- (a) Calculate, in m^2 , the actual area of a field which is represented by an area of 16 cm^2 on the map.

Answer (a) m^2 [1]

- (b) Find the scale of the map in the form 1 : n .

Answer (b) 1 : [2]

- 13 The box plots below show the distribution of the number of hours worked in a week by 20 employees in each of two branches, *A* and *B*, of a certain restaurant.



- (a) Find the interquartile range for Branch *B*.

Answer (a) hours [1]

- (b) Below are two statements related to the box plots above.

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, the workers in Branch *A* worked more hours in a week than those in Branch *B*.

Answer (i) because [1]

- (ii) The workers in Branch *A* worked more consistent hours of work in a week compared to those in Branch *B*.

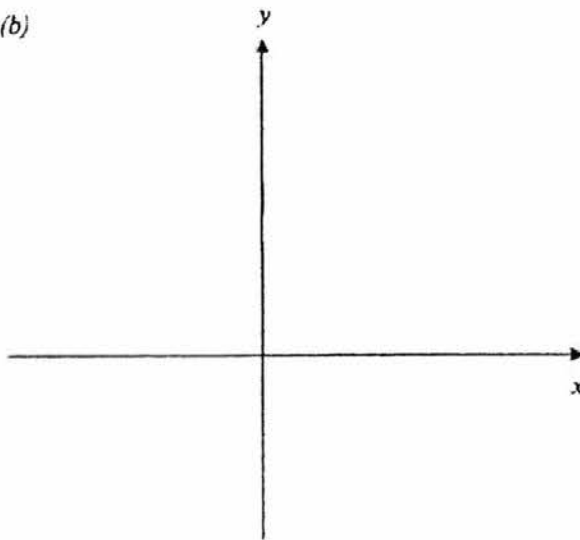
Answer (ii) because [1]

- 14 (a) Express $x^2 - 8x + 15$ in the form $(x - a)^2 + b$.

Answer (a) [2]

- (b) Hence sketch the graph of $y = x^2 - 8x + 15$.

Answer (b)



[2]

- (c) Write down the equation of the line of symmetry of the graph $y = x^2 - 8x + 15$.

Answer (c) [1]

- 15 The buses on three different routes, A , B and C , leave a bus interchange at intervals of 8 mins, 5 mins and 12 mins respectively. Given that the buses first leave the interchange at 8.20 am, at what time will the buses on these three routes next leave the interchange at the same time?

Answer [3]

- 16 Given that a regular polygon has an interior angle of 135° , find the number of sides of this polygon.

Answer sides [2]

- 17 Let $\mathbf{a} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$, $\mathbf{b} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}$ and $\mathbf{c} = \begin{pmatrix} 10 \\ 3 \end{pmatrix}$. If $\mathbf{c} = m\mathbf{a} + n\mathbf{b}$ where m and n are scalars, find the values of m and n .

Answer $m = \dots\dots\dots$, $n = \dots\dots\dots$ [3]

- 18 Tommy is playing a game in which he has to pick 2 balls, one from each of two bags. Bag *A* contains five balls numbered from 1 to 5 while Bag *B* contains three balls numbered 2, 4 and 5.

(a) Complete the table below to show all the possible outcomes.

		Bag <i>A</i>				
		1	2	3	4	5
Bag <i>B</i>	2	(1, 2)	(2, 2)			
	4		(2, 4)	(3, 4)	(4, 4)	(5, 4)
	5		(2, 5)			

[1]

(b) Giving your answer as a fraction in its simplest form, find the probability that Tommy picks

(i) two balls with a prime number,

Answer (i) [1]

(ii) at least one ball with an even number.

Answer (ii) [1]

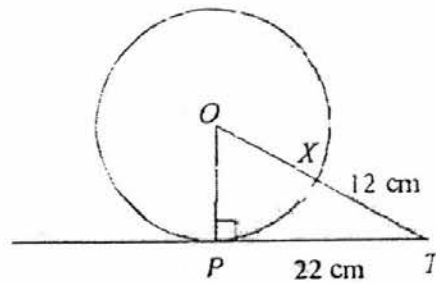
- 19 (a) Solve the inequalities $\frac{x}{2} + 1 \leq 4x + 5 < 3(x + 1) + 4$.

Answer (a) [2]

(b) Write down all the integers that satisfy $\frac{x}{2} + 1 \leq 4x + 5 < 3(x + 1) + 4$.

Answer (b) [1]

20



In the diagram above, O is the centre of the circle, OXT is a straight line, $TX = 12$ cm, $PT = 22$ cm and $\angle OPT = 90^\circ$. Calculate the radius of the circle, giving your answer correct to 1 decimal place.

Answer cm [3]

21 (a) Solve the equation $\frac{4}{x} - 3 = \frac{5}{2x+3}$.

Answer (a) $x = \dots\dots\dots$ [3]

(b) If $x = 2$ is a solution to the equation $2x^2 + mx - 6 = 0$, find

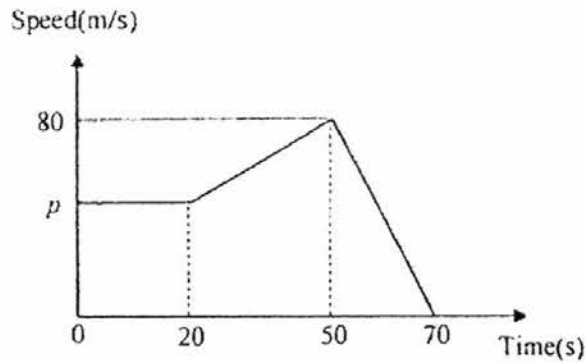
(i) the value of m ,

Answer (b)(i) $m = \dots\dots\dots$ [1]

(ii) the other solution of the equation.

Answer (b)(ii) $x = \dots\dots\dots$ [1]

- 22 The diagram below shows the speed-time graph of a car which travels at a constant speed of p m/s for 20 seconds and then accelerates uniformly for 30 seconds.



- (a) Calculate the value of p , given that the distance travelled in the first 50 seconds is 3 300 m.

Answer (a) $p = \dots\dots\dots$ [2]

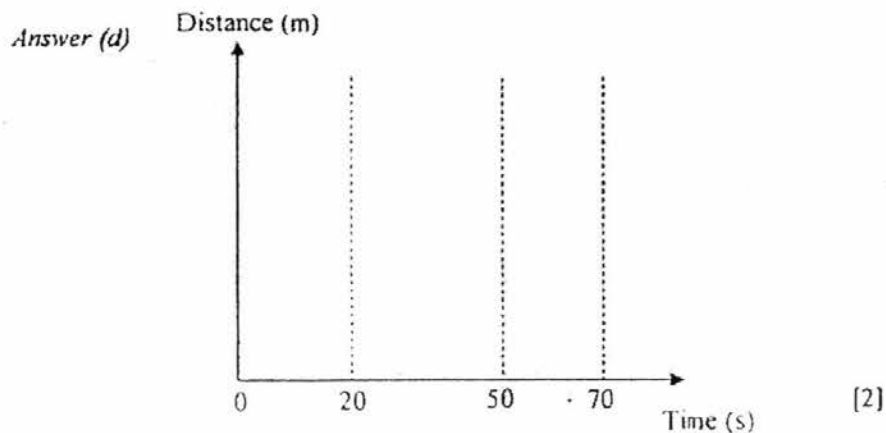
- (b) Calculate the speed of the car, in m/s, when $t = 25$ s.

Answer (b) $\dots\dots\dots$ m/s [2]

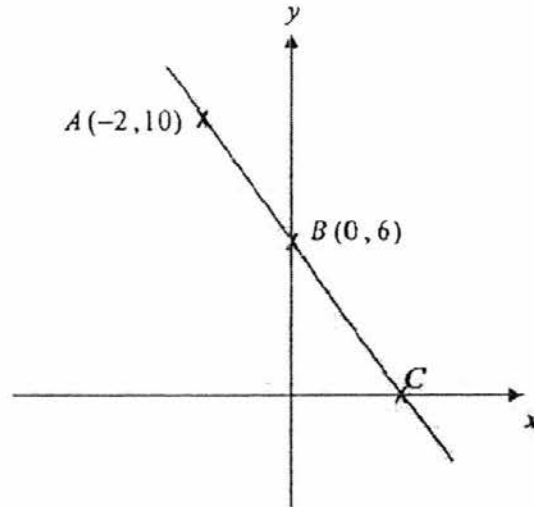
- (c) Calculate the retardation of the car in the last 20 seconds.

Answer (c) $\dots\dots\dots$ m/s² [1]

- (d) On the axes in the answer space below, sketch the distance-time graph of the car for the 70 seconds.



- 23 The diagram below shows a sketch of a straight line passing through $A(-2, 10)$, $B(0, 6)$ and C .



- (a) Calculate the length of the line joining A to B .

Answer (a) [2]

- (b) Find the equation of the line AB .

Answer (b) [2]

- (c) Find the coordinates of point C .

Answer (c) C (.....,) [1]

END OF PAPER

No.	Working		Remarks
1	(a)	1.5694 [B1]	
	(b)	1.57 (3 s.f.) [B1]	

[Total : 2m]

2	(a)	-18, -29 [B1]	For both answers
	(b)	n th term = $7 - n^2$ [B1]	

[Total : 2m]

3	(a)	$4^n \div 2^{-3} = 128$ $2^{2n-(-3)} = 2^7$ [M1] $2n + 3 = 7$ $2n = 4$ $n = 2$ [A1]	
	(b)	Number of times Earth is further from Uranus compared to the Moon $= \frac{2.72395 \times 10^{12}}{384\,400 \times 1000}$ [M1] $= 7.09 \times 10^3$ (3 s.f.) [A1]	

[Total : 4m]

4	(a)	$x = 128$ (int. $\angle$ s) [B1]	If reason is not stated, deduct 'P' from each part
	(b)	$y = 128 - 43 = 85$ (ext. $\angle$ of Δ) [B1]	

[Total : 2m]

No.	Working	Remarks
5	(a) Not all the years are shown. (b) For 2011 and 2013 that are missing, there could have been a large increase in the number of offences. or (a) Vertical axis should be percentage of offences. (b) The school population varies from year to year. or (a) The title of the graph is biased. (b) It does not let the reader interpret the information on their own. [B1, B1]	(a) B1 for the misleading feature (b) B1 for effect of the feature on the graph Accept other reasonable explanations.

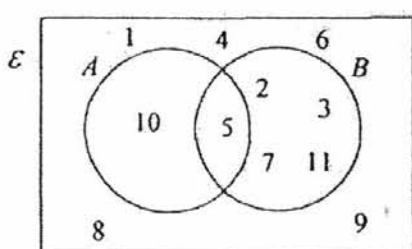
[Total : 2m]

6	(a)	$(3a+1)^2 - (a+1)^2$ $= 9a^2 + 6a + 1 - (a^2 + 2a + 1) \quad \text{[M1]}$ $= 8a^2 + 4a$ $= 4a(2a+1) \quad \text{[A1]}$	Accept difference of two squares method Accept $8a^2 + 4a$
	(b)	$\frac{1}{7-x} + \frac{3x}{(x-7)^2}$ $= \frac{3x}{(x-7)^2} + \frac{1}{7-x}$ $= \frac{3x}{(x-7)^2} - \frac{1}{x-7} \quad \text{[M1]}$ $= \frac{3x - 1(x-7)}{(x-7)^2}$ $= \frac{2x+7}{(x-7)^2} \quad \text{[A1]}$	

[Total : 4m]

No.	Working	Remarks
7	(a) $y = kx^2 \Rightarrow k = \frac{y}{x^2}$ } [M1] new $x = 3x$ new $y = k(3x)^2 = \frac{y}{x^2}(9x^2) = 9y$ [M1] % change in $y = \frac{9y - y}{y} \times 100\% = 800\%$ [A1]	
	(b) no. of workers needed for 3 houses to be completed in 30 days $= \frac{12 \times 25 \times 3}{30}$ } [M2] $= 30$ no. of additional workers required $= 30 - 12 = 18$ workers [A1]	

[Total : 6m]

8	(a)  [B2] All numbers put in the correct places or [B1] 8 to 10 numbers put in the correct places	Universal set & two intersecting circles, A and B, must be drawn and labelled, otherwise deduct 'P' If less than 8 numbers are put in the correct places, no B mark
	(b) $n(A \cup B) = 7$	

[Total : 3m]

No.	Working	Remarks
9	Sum of angles in a pentagon = $(5-2)180 = 540^\circ$ [M1] $(80-x) + (70+x) + (5x-50) + 4x + (80+3x) = 540$ [M1] $12x + 180 = 540$ $12x = 360$ $x = 30$ [A1]	

[Total : 3m]

10	He should buy Size 1 [A1] because 2 containers of 600 ml (from Size 1) = 1200 ml $\Rightarrow$ amount = $2 \times 1.60 = \\$3.20$ 6 containers of 200 ml (from Size 2) = 1200 ml $\Rightarrow$ amount = $6 \times 0.55 = \\$3.30$ $\therefore$ it will be \$0.10 cheaper to buy Size 1.	Accept alternative explanations [M2]
----	---	--

[Total : 3m]

11	(a)	$8ab + 4ac - 2b^2 - bc = 4a(2b+c) - b(2b+c)$ [M1] $= (4a-b)(2b+c)$ [A1]	
	(b)	$2x^5 + 4x^4 - 6x^3 = 2x^3(x^2 + 2x - 3)$ [M1] $= 2x^3(x+3)(x-1)$ [A1]	

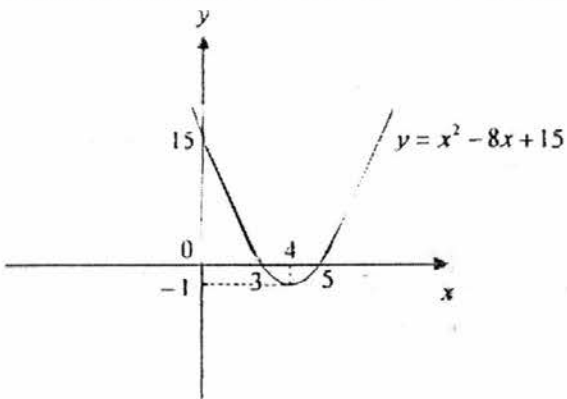
[Total : 4m]

12	(a)	Actual area = $\frac{16}{5} \times 125 = 400\text{m}^2$ [B1]	
	(b)	$125\text{m}^2 = 125 \times 100^2 = 1250000\text{cm}^2$ $5\text{cm}^2 : 1250000\text{cm}^2$ [M1] $1\text{cm}^2 : 250000\text{cm}^2$ $1\text{cm} : 500\text{cm}$ $\therefore$ scale is 1 : 500 [A1]	

[Total : 3m]

No.	Working		Remarks
13	(a)	interquartile range for Branch B = $27 - 17 = 10$ hours [B1]	
	(b)	(i) I agree because the <u>median</u> of 25 hours in Branch A is <u>higher than the median</u> of 22 hours in Branch B [B1].	Accept alternative explanations as long as median is used as evidence
		(ii) I disagree because the <u>interquartile range</u> of 15 hours in Branch A is <u>higher than the interquartile range</u> of 10 hours in Branch B [B1].	Accept alternative explanations as long as interquartile range is used as evidence

[Total : 3m]

14	(a)	$x^2 - 8x + 15 = (x^2 - 8x + \left(\frac{-8}{2}\right)^2) + 15 - \left(\frac{-8}{2}\right)^2$ $= (x - 4)^2 - 1$ [M1] [A1]	Accept method by comparing coeff.
	(b)	 [B1] Shape of graph, turning point [B1] x & y-intercepts	
	(c)	$x = 4$ [B1]	

[Total : 5m]

No.	Working	Remarks
15	$\text{LCM of } 8, 5 \text{ \& } 12 = 2^3 \times 3 \times 5 \text{ [M1]}$ $= 120$ Time bus will next leave at the same time $= 8.20 + 120 \text{ mins [M1]}$ $= 10.20 \text{ am [A1]}$	Accept 1020

[Total : 3m]

16	$\frac{(n-2)180}{n} = 135 \text{ [M1]}$ $180n - 360 = 135n$ $45n = 360$ $n = 8 \text{ sides [A1]}$	Accept exterior angle method
----	--	------------------------------

[Total : 2m]

17	$\begin{pmatrix} 10 \\ 3 \end{pmatrix} = m \begin{pmatrix} 2 \\ 3 \end{pmatrix} + n \begin{pmatrix} -2 \\ 1 \end{pmatrix}$ $\begin{pmatrix} 10 \\ 3 \end{pmatrix} = \begin{pmatrix} 2m - 2n \\ 3m + n \end{pmatrix}$ $\left. \begin{array}{l} 2m - 2n = 10 \text{ --- (1)} \\ 3m + n = 3 \text{ --- (2)} \end{array} \right\} \text{ [M1]}$ $(2) \times 2; 6m + 2n = 6 \text{ --- (3)}$ $(3) + (1); (6m + 2n) + (2m - 2n) = 6 + 10$ $8m = 16$ $m = 2 \text{ [A1]}$ Sub $m = 2$ into (1); $2(2) - 2n = 10$ $2n = -6$ $n = -3 \text{ [A1]}$	Accept substitution method
----	--	----------------------------

[Total : 3m]

No.	Working						Remarks																																
18	(a)	<table><tr><td colspan="2" rowspan="2"></td><th colspan="5">Bag A</th></tr><tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><td rowspan="3">Bag B</td><td>2</td><td>(1, 2)</td><td>(2, 2)</td><td>(3, 2)</td><td>(4, 2)</td><td>(5, 2)</td></tr><tr><td>4</td><td>(1, 4)</td><td>(2, 4)</td><td>(3, 4)</td><td>(4, 4)</td><td>(5, 4)</td></tr><tr><td>5</td><td>(1, 5)</td><td>(2, 5)</td><td>(3, 5)</td><td>(4, 5)</td><td>(5, 5)</td></tr></table> [B1] All blanks are correct								Bag A					1	2	3	4	5	Bag B	2	(1, 2)	(2, 2)	(3, 2)	(4, 2)	(5, 2)	4	(1, 4)	(2, 4)	(3, 4)	(4, 4)	(5, 4)	5	(1, 5)	(2, 5)	(3, 5)	(4, 5)	(5, 5)	
		Bag A																																					
		1	2	3	4	5																																	
Bag B	2	(1, 2)	(2, 2)	(3, 2)	(4, 2)	(5, 2)																																	
	4	(1, 4)	(2, 4)	(3, 4)	(4, 4)	(5, 4)																																	
	5	(1, 5)	(2, 5)	(3, 5)	(4, 5)	(5, 5)																																	
	(b)	(i)	P(two balls with a prime number) $= \frac{6}{15}$ $= \frac{2}{5}$ [B1]																																				
		(ii)	P(at least one ball with an even number) $= \frac{12}{15}$ $= \frac{4}{5}$ [B1]																																				

[Total : 3m]

19	(a)	$\frac{x}{2} + 1 \leq 4x + 5 \quad , \quad 4x + 5 < 3(x + 1) + 4$ $4x + 5 \geq \frac{1}{2}x + 1 \quad 4x + 5 < 3x + 3 + 4$ $3\frac{1}{2}x \geq -4 \quad x < 2$ $x \geq -1\frac{1}{7}$ $\therefore -1\frac{1}{7} \leq x < 2$				[B2]
	(b)	-1, 0 and 1 [B1]				

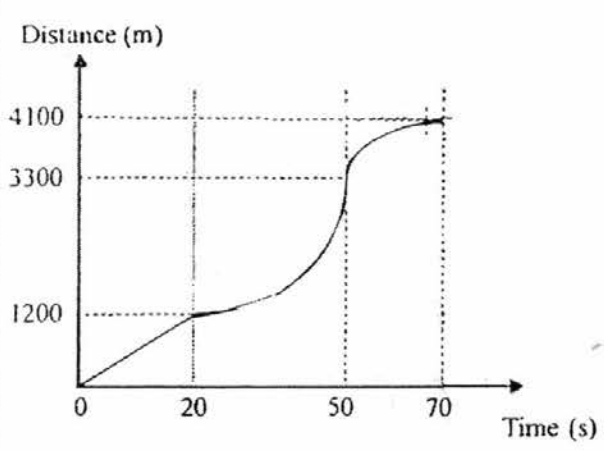
[Total : 3m]

No.	Working	Remarks
20	Let the radius of the circle be x cm. $OP^2 + PT^2 = OT^2$ $x^2 + 22^2 = (x + 12)^2 \quad [\text{M1}]$ $x^2 + 484 = x^2 + 24x + 144 \quad [\text{M1}]$ $24x = 340$ $x = 14.16$ $x = 14.2 \text{ (1 d.p.)}$ $\therefore \text{radius} = 14.2 \text{ cm} \quad [\text{A1}]$	

[Total : 3m]

21	(a)	$\frac{4}{x} - 3 = \frac{5}{2x+3}$ $\frac{4-3x}{x} = \frac{5}{2x+3} \quad \left. \vphantom{\frac{4-3x}{x} = \frac{5}{2x+3}} \right\} [\text{M1}]$ $(2x+3)(4-3x) = 5x$ $x^2 + x - 2 = 0$ $(x+2)(x-1) = 0 \quad [\text{M1}]$ $\therefore x = -2 \text{ or } x = 1 \quad [\text{A1}]$	
	(b) (i)	Sub $x = 2$; $2(2)^2 + m(2) - 6 = 0$ $8 + 2m - 6 = 0$ $2m = -2$ $m = -1 \quad [\text{B1}]$	
	(ii)	$2x^2 - x - 6 = 0$ $(2x+3)(x-2) = 0$ $x = -1\frac{1}{2} \text{ or } x = 2$ The other solution is $x = -1\frac{1}{2}$. $[\text{B1}]$	

[Total : 5m]

No.	Working	Remarks
22	(a) $20p + \frac{1}{2}(p+80)30 = 3300$ [M1] $20p + 15(p+80) = 3300$ $20p + 15p + 1200 = 3300$ $35p = 2100$ $p = 60$ [A1]	
	(b) acc. at that time $= \frac{20}{30} = \frac{2}{3} \text{ m/s}^2$ [M1] speed when $t = 25 \text{ s}$ is $60 + 5(\frac{2}{3}) = 63\frac{1}{3} \text{ m/s}$ [A1]	Accept 63.3 m/s
	(c) retardation of the car in the last 20 seconds $= \frac{80}{20}$ $= 4 \text{ m/s}^2$ [B1]	
	(d)  [B1] Respective times with their corresponding distance [B1] Shape at the 3 time segments of the graph	

[Total : 7m]

No.	Working	Remarks
23	(a) Length of $AB = \sqrt{(-2-0)^2 + (10-6)^2}$ [M1] $= \sqrt{20}$ units [A1]	Accept 4.47 units (3 s.f.)
	(b) grad. of line $AB = \frac{10-6}{-2-0} = -2$ [M1] $\therefore$ equation of line AB is $y = -2x + 6$ [A1]	
	(c) Sub $y = 0$; $0 = -2x + 6$ $2x = 6$ $x = 3$ $\therefore C(3, 0)$ [B1]	

[Total : 5m]



BEDOK VIEW SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2016

CANDIDATE
NAME

REGISTER
NUMBER

CLASS

MATHEMATICS

Paper 2

4048/02

22 August 2016

2 hours 30 minutes

Additional Materials: Writing Paper
Graph paper (1 sheet)

Secondary 4 Express / 4 Normal Academic (Express Syllabus)

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

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.

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 .

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

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 100.

Setter: Mrs Alice Pang

Parent's / Guardian's Signature:

This document consists of 11 printed pages.

Do not turn over the page until you are told to do so.

*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) Factorise $32m^2 - 18n^2$ completely. [2]
- (b) Find the values of the variables in the equation $a - 2 - 5ab + 10b = 0$. [3]
- (c) A hollow spherical ball with outer radius R cm is made of plastic of thickness t cm. The volume V cm³ of the plastic needed to make the ball can be calculated by using the formula $V = \frac{4}{3}\pi[R^3 - (R - t)^3]$.
- (i) Show how the formula in (c) is derived. [1]
- (ii) Find the volume of plastic needed to make a spherical ball for which $R = 4$ cm and $t = 0.3$ cm. [2]

- 2 (a) During a period of 75 days, a fire brigade attended to the incidents as follows:

Number of incidents in one day	Frequency
0	10
1	21
2	15
3	13
4	8
5	5
6	2
7	0
8	1

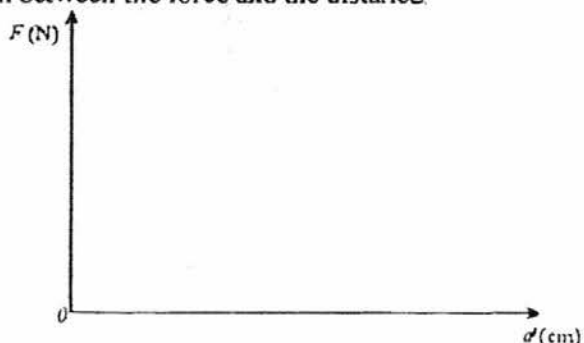
- (i) Find
- (a) the mode of the distribution, [1]
- (b) the mean number of incidents attended per day, [1]
- (c) the standard deviation of the number of incidents during the period. [2]
- (ii) If the sample shown in the table above is assumed to be typical of the whole year, estimate to the nearest whole number, the number of days in the year when the brigade has no calls. (Take 1 year = 365 days.) [2]
- (b) A box contains 5 pears, 3 apples and 2 bananas. Two fruits are taken out at random, without replacement.
- (i) Construct a probability tree diagram to show all the possible outcomes of taking out two fruits from the box. [3]
- (ii) Find, as a fraction in its simplest form, the probability that
- (a) no apple is taken, [1]
- (b) the first fruit taken is a banana. [1]

- 3 (a) The available balance, $\$Y$, of a pre-paid Railway Pass changes with the distance travelled in d kilometres.
The initial value of the card is $\$80$.
After a total of 175 km has been travelled, the balance in the Railway Pass was $\$24$.

- (i) Sketch the graph of Y against d . [2]
(ii) Calculate the gradient of the graph and explain its significance. [2]

- (b) The force, F Newtons, between two particles is inversely proportional to the square of the distance, d centimetres, between them.

- (i) Copy the axes shown below and use it to sketch the graph that represents the relation between the force and the distance.



[1]

- (ii) Given that $F = 5$ Newtons when $d = 4$ cm, find the equation connecting F and d . [2]
(iii) The force is 8 Newtons when the particles are at a certain distance apart. Find the force when this distance is doubled. [2]
-

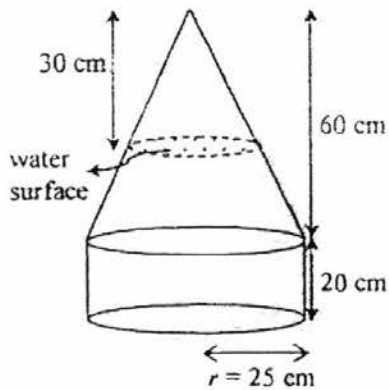


Figure 1

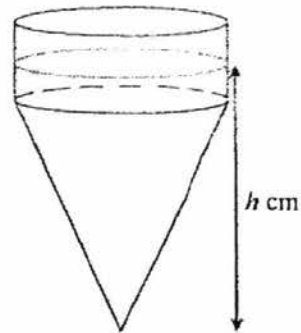


Figure 2

Figure 1 above shows a closed vessel consisting of two parts. The bottom part is a cylinder with a base radius of 25 cm and a height of 20 cm. The top part is made up of a cone with a base radius of 25 cm and a height of 60 cm. The vessel contains water such that the water surface is 30 cm from the vertex of the cone.

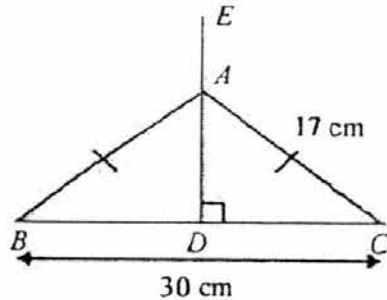
(a) From Figure 1, calculate

- (i) the radius of the water surface, [2]
- (ii) the volume of the space above the water in cm^3 , giving your answer correct to 1 decimal place, [2]
- (iii) the volume of the water in the container, giving your answer correct to the nearest cm^3 . [3]

(b) The vessel is then turned over as shown in Figure 2.

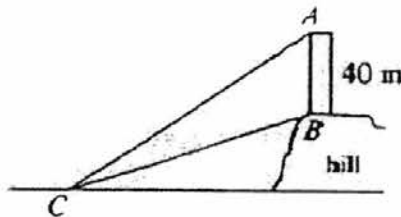
- (i) Calculate the height h cm of the surface of the water from the vertex of the cone. [3]
- (ii) The water leaks out from a small hole at the vertex at a constant rate. Sketch a possible graph of the height h cm of the water surface from the vertex against the time taken, in minutes, for the vessel to be empty. [2]

- 5 (a) In the diagram below, ABC is an isosceles triangle where $AB = AC = 17$ cm and $BC = 30$ cm. D is the midpoint of BC and DAE is a straight line.



Find

- (i) the length of AD , [2]
 - (ii) $\angle BAC$, [2]
 - (iii) the exact value of $\cos \angle EAC$. [1]
- (b) The diagram below shows a vertical building AB of height 40 m built on top of a hill. From a point C on the ground, the angles of elevation of the top A and the base B of the building are 36° and 24° respectively.



- (i) Find the distance AC . [3]
 - (ii) Find the height of the hill. [3]
-

- 6 (a) A computer shop offers discounts to customers who pay \$30 to become a member.

Item	Members' discount
Laptop computer	20%
Tablet	15%
Power bank	10%

Candy wants to buy a laptop computer which costs \$2500. The salesgirl suggests that she joins as a member.

- (i) How much lesser does Candy pay in total if she joins as a member and buys the laptop computer?

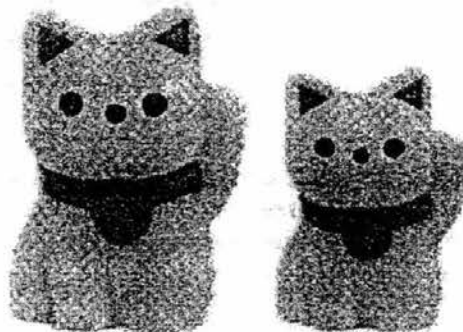
[2]

After Candy has joined as a member and bought the laptop computer, the salesgirl offers Candy a further 5% discount on the members' price for a tablet and a power bank.

- (ii) Write down a formula for the total amount, T , that she needs to pay for a tablet and a power bank. Use b and p to represent the original price of a tablet and a power bank respectively.

[1]

- (b) A souvenir shop sells lucky cat figurines. The diagram below shows two similar solid ones made of clay. The smaller one is of height 8 cm and mass 240 g.



- (i) If the bigger cat is 25% taller than the smaller one, find the mass of the bigger one.
- (ii) The cost, \$ C , of each cat figurine of height, H cm, is given by the function $C = aH + bH^2$, where a and b are constants. The costs for an 8 cm and a 12 cm figurine are \$8 and \$24, respectively. Find the cost for the figurine that is 25% taller than the smaller one.

[3]

[4]

- 7 (a) Amy walks on a treadmill every morning and evening.
 In the morning she walks for 10 minutes at a slow speed and 15 minutes at a fast speed.
 In the evening she walks for 5 minutes at a slow speed and 20 minutes at a fast speed.

This information can be represented by the matrix $K = \begin{matrix} & \begin{matrix} \text{Slow} & \text{Fast} \end{matrix} \\ \begin{matrix} \text{Morning} \\ \text{Evening} \end{matrix} & \begin{pmatrix} 10 & 15 \\ 5 & 20 \end{pmatrix} \end{matrix}$

- (i) Evaluate the matrix $L = 60K$. [1]
- (ii) Amy's slow speed is 1.2 m/s and her fast speed is 1.6 m/s.
 Represent her walking speeds in a 2×1 column matrix M . [1]
- (iii) Evaluate the matrix $N = LM$. [1]
- (iv) State what the elements of N represent. [1]
- (b) One weekend, Amy goes for a walk in a nature reserve.
- (i) The length of her route on a map is 17.5 cm.
 The scale of the map is 1 : 50 000.
 Work out the number of kilometres Amy walks. [1]
- (ii) The walk takes Amy 2 hours and 20 minutes.
 Calculate Amy's average speed in kilometres per hour. [2]
- (c) How does Amy's speed in the nature reserve compare with her speed on the treadmill? Justify your answer with figures. [2]
-

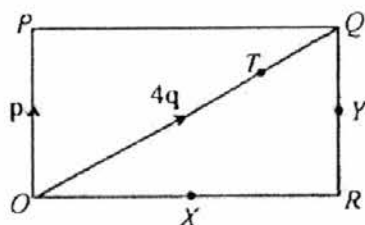
- 8 (a) A is the point $(-1, 4)$. B is the point $(3, 1)$.

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

(ii) Find $|\overrightarrow{AB}|$. [2]

(iii) C is the point such that $\overrightarrow{AC} = 3\overrightarrow{AB}$.
Find the coordinates of C . [2]

(b)



$OPQR$ is a rectangle.

$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = 4\mathbf{q}$.

X is the mid-point of OR and Y is the mid-point of QR .

T is the point on OQ such that $OT : TQ = 3 : 1$.

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

(a) $\overrightarrow{PQ}$. [1]

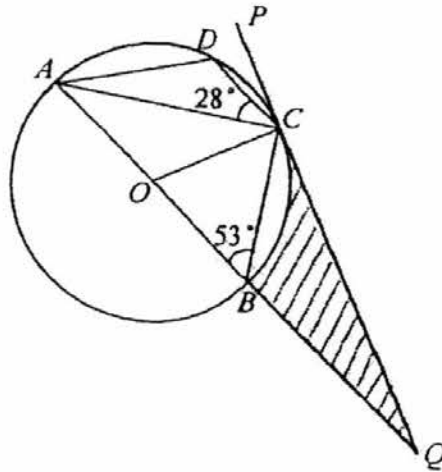
(b) $\overrightarrow{XY}$. [1]

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

(d) $\overrightarrow{XT}$. [1]

- (ii) What type of quadrilateral is $XYQT$? Justify your answer using vectors. [2]

- 9 In the diagram below, O is the centre of the circle $ABCD$.
 PQ is the tangent to the circle at C .
 $AOBQ$ is a straight line, $\angle ACD = 28^\circ$ and $\angle OBC = 53^\circ$.



- (a) Find
- | | | |
|-------|----------------|-----|
| (i) | $\angle BOC$, | [1] |
| (ii) | $\angle OAC$, | [1] |
| (iii) | $\angle DAC$, | [2] |
| (iv) | $\angle DCP$. | [1] |
- (b) If the radius of the circle is 10 cm, find the area of the shaded region BQC . [5]
-

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

The variables x and y are connected by the equation

$$y = \frac{x^2}{5} + \frac{9}{x} - 4.$$

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

x	0.5	1	2	3	4	5	6
y	14.05	5.2	p	0.8	1.45	2.8	4.7

- (a) Calculate the value of p . [1]
- (b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x -axis for $0 < x \leq 6$.
Using a scale of 1 cm to represent 1 unit, draw a vertical y -axis for $0 < y \leq 15$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]
- (c) Use your graph to find the two solutions of $\frac{x^2}{5} + \frac{9}{x} = 8$ in the range $0 < x \leq 6$. [3]
- (d) By drawing a tangent, find the gradient of the curve at (1, 5.2). [2]
-

END OF PAPER

No.		Remarks
1	(a) $32m^2 - 18n^2 = 2(16m^2 - 9n^2)$ [M1] $= 2(4m - 3n)(4m + 3n)$ [A1]	
	(b) $a - 2 - 5ab + 10b = 0$ $(a - 2) - 5b(a - 2) = 0$ $(a - 2)(1 - 5b) = 0$ [M1] $a = 2, \quad b = \frac{1}{5} \text{ or } 0.2$ [A1, A1]	
	(c) (i) Vol of plastic = Vol of large sphere - Vol of small sphere $= \frac{4}{3}\pi R^3 - \frac{4}{3}\pi(R - t)^3$ $= \frac{4}{3}\pi(R^3 - (R - t)^3)$ } [B1]	
	(ii) Sub $R = 4$ and $t = 0.3$, $V = \frac{4}{3}\pi(4^3 - (4 - 0.3)^3)$ [M1] $= 55.90778...$ $= 55.9 \text{ cm}^3 \text{ (3 s.f.)}$ [A1]	

[Total : 8m]

2	(a)	(i) (a) Mode = 1 incident a day [A1]																																			
		(b) Mean = $\frac{167}{75}$ 13 = 2.2266... = 2.23 incidents a day (3 sf) [A1]																																			
		(c) Standard deviation = 1.6937... = 1.69 incidents (3 s.f) [A2]																																			
		(ii) Out of 75 days, there were 10 days when there were no calls (i.e. no incidents) No. of days in a year when there are no calls = $\frac{10}{75} \times 365$ [M1] = 48.666... = 49 days (to nearest whole no.) [A1]																																			
(b)	(i)	<table border="1"> <thead> <tr> <th>1st Fruit</th> <th>2nd Fruit</th> <th>Outcomes</th> <th>Probability</th> </tr> </thead> <tbody> <tr> <td rowspan="3">$\left(\frac{5}{10}\right)$ pear</td> <td>$\left(\frac{4}{9}\right)$ pear</td> <td>pp</td> <td>$\frac{20}{90}$</td> </tr> <tr> <td>$\left(\frac{3}{9}\right)$ apple</td> <td>pa</td> <td>$\frac{15}{90}$</td> </tr> <tr> <td>$\left(\frac{2}{9}\right)$ banana</td> <td>pb</td> <td>$\frac{10}{90}$</td> </tr> <tr> <td rowspan="3">$\left(\frac{3}{10}\right)$ apple</td> <td>$\left(\frac{5}{9}\right)$ pear</td> <td>ap</td> <td>$\frac{15}{90}$</td> </tr> <tr> <td>$\left(\frac{2}{9}\right)$ apple</td> <td>aa</td> <td>$\frac{6}{90}$</td> </tr> <tr> <td>$\left(\frac{2}{9}\right)$ banana</td> <td>ab</td> <td>$\frac{6}{90}$</td> </tr> <tr> <td rowspan="3">$\left(\frac{2}{10}\right)$ banana</td> <td>$\left(\frac{5}{9}\right)$ pear</td> <td>bp</td> <td>$\frac{10}{90}$</td> </tr> <tr> <td>$\left(\frac{3}{9}\right)$ apple</td> <td>ba</td> <td>$\frac{6}{90}$</td> </tr> <tr> <td>$\left(\frac{1}{9}\right)$ banana</td> <td>bb</td> <td>$\frac{2}{90}$</td> </tr> </tbody> </table> [A3] Deduct 1m for any fraction that is not correctly shown. Deduct a P mark for any missing heading / incorrect outcome. No need to show the Probability column.	1 st Fruit	2 nd Fruit	Outcomes	Probability	$\left(\frac{5}{10}\right)$ pear	$\left(\frac{4}{9}\right)$ pear	pp	$\frac{20}{90}$	$\left(\frac{3}{9}\right)$ apple	pa	$\frac{15}{90}$	$\left(\frac{2}{9}\right)$ banana	pb	$\frac{10}{90}$	$\left(\frac{3}{10}\right)$ apple	$\left(\frac{5}{9}\right)$ pear	ap	$\frac{15}{90}$	$\left(\frac{2}{9}\right)$ apple	aa	$\frac{6}{90}$	$\left(\frac{2}{9}\right)$ banana	ab	$\frac{6}{90}$	$\left(\frac{2}{10}\right)$ banana	$\left(\frac{5}{9}\right)$ pear	bp	$\frac{10}{90}$	$\left(\frac{3}{9}\right)$ apple	ba	$\frac{6}{90}$	$\left(\frac{1}{9}\right)$ banana	bb	$\frac{2}{90}$	
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		(ii) (a) $P(\text{no apples taken}) = \frac{20}{90} + \frac{10}{90} + \frac{10}{90} + \frac{2}{90} = \frac{7}{15}$ [B1]																																			
		(b) $P(\text{1st fruit is a banana}) = \frac{10}{90} + \frac{6}{90} + \frac{2}{90} = \frac{1}{5}$ [B1]																																			

[Total : 11m]

3	(a)	(i)	[A2]	Award 1 mark for correct shape of graph. Award 1 mark for labelling of axes and values.
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		Sub into (1), $a = 1 - 8\left(\frac{1}{4}\right)$ $a = -1$ 14 [M1] $\therefore C = -H + \frac{1}{4}H^2$ Sub $H = 10$, $C = -10 + \frac{1}{4}(10)^2$ $= 15$ Cost of taller cat = \$15 [A1]	
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[Total : 10m]

7	(a)	(i)	$L = 60 \begin{pmatrix} 10 & 15 \\ 5 & 20 \end{pmatrix}$ $= \begin{pmatrix} 600 & 900 \\ 300 & 1200 \end{pmatrix}$	[B1]	
		(ii)	$M = \begin{pmatrix} 1.2 \\ 1.6 \end{pmatrix}$	[B1]	
		(iii)	$N = LM = \begin{pmatrix} 600 & 900 \\ 300 & 1200 \end{pmatrix} \begin{pmatrix} 1.2 \\ 1.6 \end{pmatrix}$ $= \begin{pmatrix} 2160 \\ 2280 \end{pmatrix}$	[B1]	
		(iv)	N represents the <u>distances that she walked</u> each day in the <u>morning and in the evening</u> respectively.		[B1]
	(b)	(i)	1 : 50 000 17.5 cm : 875 000 cm Distance Amy walks = 8.75 km	[B1]	
		(ii)	Average speed = $8.75 \div 2 \frac{20}{60}$ [M1] $= 3.75 \text{ km/h}$ [A1]		
	(c)		$3.75 \text{ km/h} = \frac{3.75 \times 1000 \text{ m}}{1 \times 60 \times 60 \text{ s}}$ $= 1.04 \text{ m/s}$ [M1] <u>1.04 m/s is slower than her slow speed of 1.2 m/s on the treadmill</u>, so her speed in the nature reserve is <u>slower</u> than her speeds on the treadmill.	[A1]	Allow for conversion of treadmill speed to km/h.

