Candidate's Name	Class	Register Number

PRELIMINARY EXAMINATION 2013
SECONDARY 4 EXPRESS / 5 NORMAL ACADEMIC

MATHEMATICS
Paper 2 4016/02

2 hours 30 minutes

Additional Materials: Writing paper (4 sheets)
Graph paper (1 sheet)

READ THESE INSTRUCTIONS FIRST

Write your answers and working on the separate writing paper provided.

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, 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.
Calculators should be used 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 100.

For Examiner's use:
/100

This paper consists of 12 printed pages (including this cover page).

[Turn over

Mathematical Formulae

Compound interest

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

Mensuration

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

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

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

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

Answer **ALL** the questions.

1 In November 2009, Adrian changed S$1,000 into US$ when the exchange rate was S$ x = US$1.

(a) Write down an expression, in terms of x, for the amount of US$ he received. [1]

(b) In March 2010, Adrian again changed S$1,000 into US$ when the exchange rate was S$ $(x-0.04)$ = US$1. Write down an expression, in terms of x, for the amount of US$ he received this time. [1]

(c) Given that he received US$21 more in March 2010 than in November 2009, form an equation in x and show that it reduces to $525x^2-21x-1000=0$. [3]

(d) Solve the equation $525x^2-21x-1000=0$, giving your answers correct to 2 decimal places. [2]

(e) Hence, state the exchange rate between the Singapore Dollar and the US Dollar in March 2010. [1]

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2 The sales price of a new car is $80,000. Joseph wants to borrow the full amount and pay for the loan by yearly instalments over 3 years, starting from Jan 2011.

(a) Bank A offers to lend him an annual reducing balance loan at a rate of 3%, where interest is charged on the outstanding loan amount at the start of the year, as shown in the table below.

Year	Loan amount at start of year	Interest charged p.a.	Equal Instalment payable p.a.	Loan amount at end of year
1	80,000.00	2,400.00	28,282.43	54,117.57
2	54,117.57	***a***	28,282.43	***b***
3	***b***	***c***	28,282.43	0.00

(i) Based on the calculations for the repayment scheme of Bank A in the table above, calculate the interest ***c*** charged for Year 3. [3]

(ii) Calculate the total interest payable to Bank A for the loan. [1]

(b) Bank B offers to lend him a loan at a flat rate of 2.5% per annum (p.a.) on the loan amount. Calculate the total amount payable to Bank B for the loan. [2]

(c) Explain (with reasons) which bank Joseph should take the loan from. [2]

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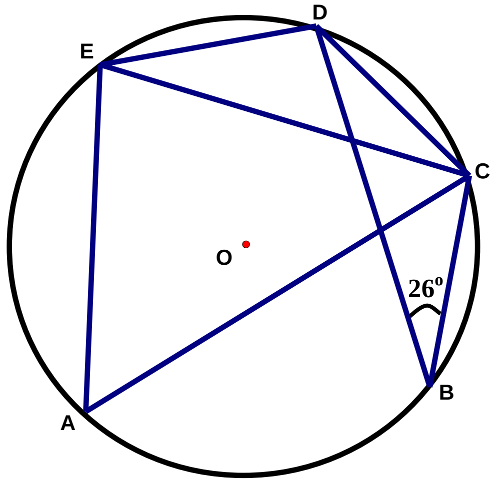
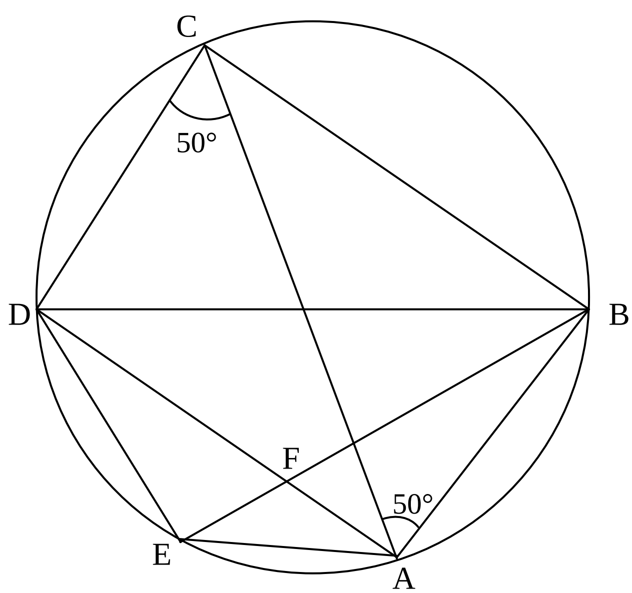
3 **(a)** The figure below shows the points A, B, C, D and E on the circle with centre O, such that $BC = CD = DE$ and $\angle CBD = 26°$.



(i) Show that ΔBCD and ΔCDE are congruent. [3]

(ii) Find the value of obtuse $\angle COE$. [2]

(b) The points A, B, C, D and E lie on the circle below. AC is the diameter of the circle, $\angle ACD = 50°$ and $\angle CAB = 50°$.



(i) Show that DB intersects diameter AC at the centre of the circle. [2]

(ii) Find the value of $\angle ADB$. [1]

(iii) If DB is parallel to EA, show that ΔAEF is similar to ΔDBF. [2]

4 The cost of making a toy car, consisting of material cost, salaries of workers and overheads, can be expressed in the ratio in its simplest form as $a : b : c$, where a, b and c are integers. To make 50 toy cars, the material cost, salaries of workers and overheads are \$246, \$123 and \$615 respectively.

(a) Find the values of a, b and c. [1]

(b) Each toy car is sold at a profit of 125%. Find the sales price of a toy car. [2]

(c) Six months later, the material cost and the salaries of workers are increased by 20% and 10% respectively, while overheads is reduced by 20%. Calculate the new cost price of each toy car. [2]

(d) With this new cost price of the toy car, a 25% discount is given on the original sales price. Find the new profit % on the sales of each toy car. [3]

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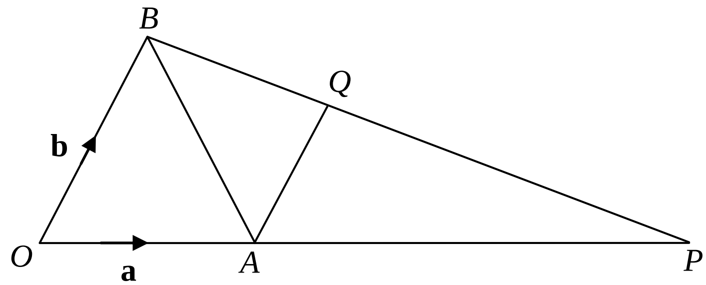
5 In ΔOAB, $\overrightarrow{OA}$ = a and $\overrightarrow{OB} = \mathbf{b}$. P is the point on OA produced such that $OP = 3OA$ and Q is the point on BP such that $PQ = 2QB$.



(a) Express in terms of **a** and/or **b**,

(i) $\overrightarrow{BP}$ [1]

(ii) $\overrightarrow{QB}$ [1]

(iii) $\overrightarrow{AQ}$ [1]

(b) State, with reasons, the special name given to the quadrilateral $OAQB$. [1]

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

(i) $\dfrac{Area\ of\ \Delta OAB}{Area\ of\ \Delta PAB}$ [1]

(ii) $\dfrac{Area\ of\ \Delta OAB}{Area\ of\ \Delta BAQ}$ [2]

(iii) $\dfrac{Area\ of\ \Delta PAQ}{Area\ of\ quad\ OAQB}$ [2]

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6 **(a)** **(i)** Write down the first 4 terms of a sequence whose *n*th term is given by $5n^2 - 3$. [2]

(ii) The first 4 terms of a second sequence are -3, 12, 37, 72, … By comparing the second sequence with the first sequence in **(a)(i)** above, write down the *n*th term of the second sequence. [2]

(b) Jonathan arranged squares in a pattern as shown below, and he counted the terms N_1 to N_4, where N_m represents the number of squares in Figure *m*.

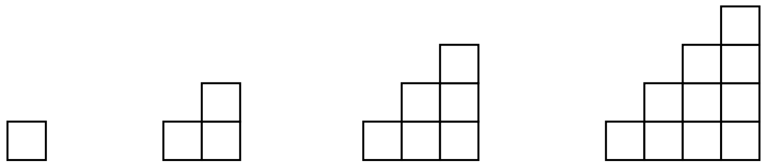


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Figure	No. of columns	Term	No. of squares
1	1	N_1	1
2	2	N_2	3
3	3	N_3	6
4	4	N_4	10
5	5	N_5	***a***
6	6	N_6	***b***
m	*m*	N_m	***c***

(i) State the values of ***a*** and ***b***. [2]

While playing Tetris, Jonathan realised that a set of Figure 4 squares can be rotated and added onto the original Figure 4, as shown in Figure 4a below. He found that N_4 can also be calculated by considering Figure 4a.

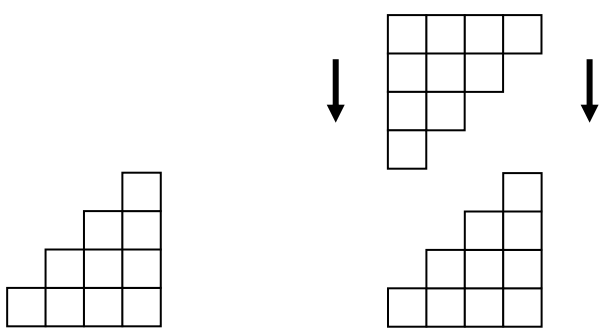


Fig. 4 Fig. 4a

(ii) By considering Figure 4a or otherwise, express ***c*** in terms of ***m***. [3]

7 The variables x and y are connected by the equation $y = \frac{18}{x^2} + 3x$. Some corresponding values of x and y, correct to 1 decimal place, are given in the following table.

x	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
y	21.0	12.5	10.5	10.4	11.0	12.0	13.1	14.4

(a) Using a scale of 4 cm to 1 unit, draw a horizontal x-axis for $0 \le x \le 5$. [3]
Using a scale of 1 cm to 1 unit, draw a vertical y-axis for $0 \le y \le 22$.
On your axes, plot the points given in the table and join them with a smooth curve.

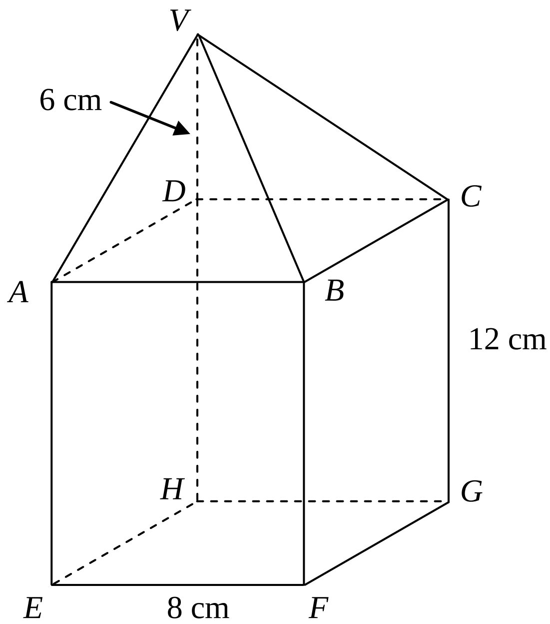
(b) By drawing a tangent, find the gradient of the curve at $(2, 10.5)$. [2]

(c) Use your graph to estimate, for $0 \le x \le 5$, the least value of $\frac{18}{x^2} + 3x$. [1]

(d) By drawing a suitable graph, estimate, for $0 \le x \le 5$, the solutions of $3x^3 - 14x^2 + 18 = 0$. [3]

(e) On the same axes, draw the graph of $y = 18 - 2x$. Hence estimate, for $0 \le x \le 5$, the range of values of x for which $5x^3 - 18x^2 + 18 \le 0$. [3]

8 The diagram below shows a solid which is composed of a pyramid *VABCD* and a cuboid *ABCDEFGH* . Vertex *V* is vertically above point *D* and the height *VD* of the pyramid, is 6 cm. *EFGH* is a square of side 8 cm. The height *CG* of the cuboid is 12 cm.

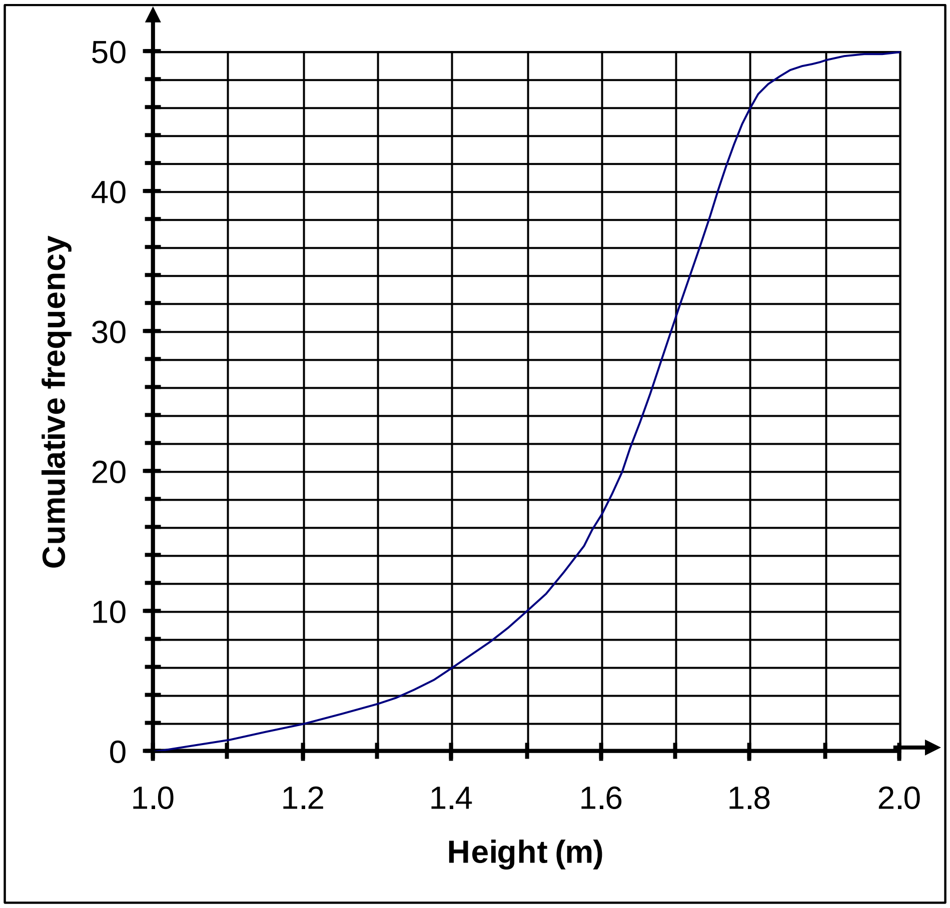


(a) Find the volume of the whole solid. [3]

(b) Find the total surface area of the whole solid. [5]

(c) Find the smallest angle of elevation of vertex *V* from any point on *ABCD* [3]

9 **(a)** The heights of 50 students were measured and recorded. The cumulative frequency curve below shows the distribution of their height.



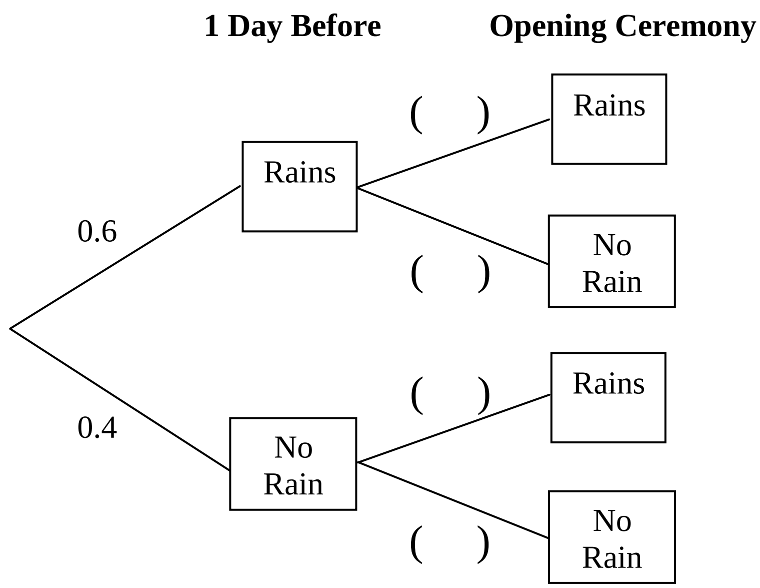
(i) Copy and complete the grouped frequency table of the height of the students below. [2]

Height (h m)	No. of students
$1.0 < h \leq 1.2$	2
$1.2 < h \leq 1.4$	
$1.4 < h \leq 1.6$	
$1.6 < h \leq 1.8$	
$1.8 < h \leq 2.0$	

(ii) Using your grouped frequency table, calculate the mean and standard deviation of the distribution. [2]

(b) The Singapore Youth Olympic Games (YOG) Organising Committee looked at the probability table of rain on the Opening Ceremony. The probability that it rains the day before the Opening Ceremony is 0.6. If it rains the day before, then the probability that it rains on the day of the Opening Ceremony is 0.3. However, if it does not rain the day before, then the probability that it rains on the day of the Opening Ceremony is 0.6.

(i) Based on the information given above, copy and complete the tree diagram below. [1]

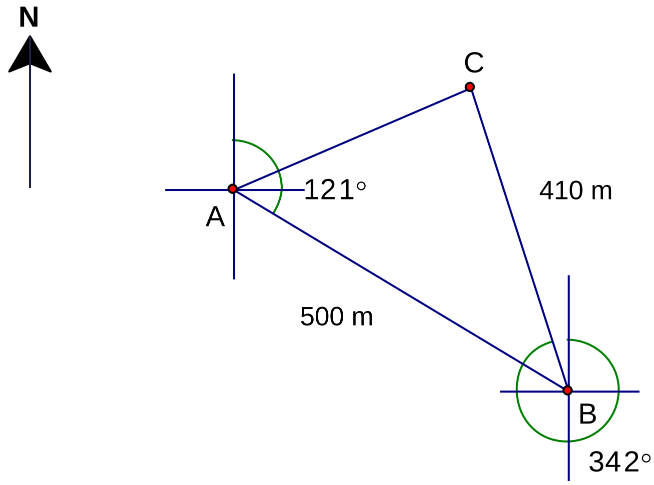


The Committee was further told that the probability that it rains the day before the Closing Ceremony is 0.8. If it rains the day before, then the probability that it rains on the day of the Closing Ceremony is 0.1. However, if it does not rain the day before, then the probability that it rains on the day of the Closing Ceremony is 0.80.

(ii) Draw a second tree diagram for the Closing Ceremony. [1]

(iii) Given that the probability of rain on the days of the Opening and Closing Ceremony are independent events, by drawing a third tree diagram or otherwise, calculate the probability that it does not rain on both the Opening and Closing Ceremony. [3]

10 Jenna walked from her house at Novena Lodge, point *A*, to Square 2, point *B*, which is 500 m away on a bearing of $121°$. After buying some bubble tea, she walked to Singapore Secondary School, point *C*, on a bearing of $342°$, which is 410 m from B.



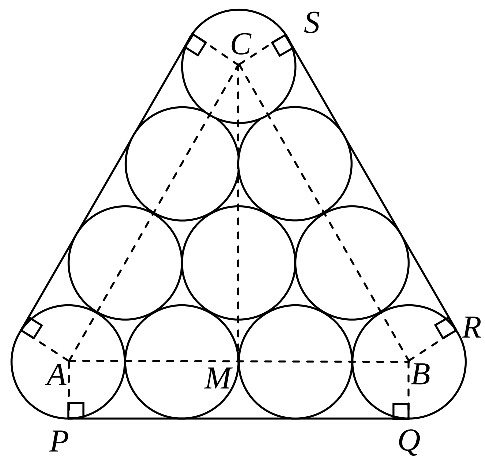
(a) Show that $\angle ABC$ is $41°$. [2]

(b) Find the distance *AC*. [2]

(c) Calculate the bearing of *A* from *C*. [2]

(d) Find the shortest distance from *A* to *BC*. [2]

11 The figure below shows the top view of 10 balls held in place by a holder of negligible thickness. Each spherical ball has a radius of 2 cm. The three sides of the holder are tangents to the balls. The balls touch one another and three balls fit neatly at the corners of the holder. The points *A*, *B*, and *C* are centres of the balls. The midpoint of *AB* is *M*. Both *PQ* and *RS* are tangents to the ball with centre *B* at *Q* and *R* respectively.



(a) Show that $\angle QBR$ is $120°$. [1]

(b) Calculate the area of minor sector *QBR*. [1]

(c) Calculate the length of *CM*. [1]

(d) The cross sectional area of the holder consists of 3 minor sectors similar to *QBR*, triangle *ABC* and 3 rectangles similar to *ABQP*. Hence calculate the cross sectional area of the holder. [3]

(e) If the holder is covered with lids of negligible thickness on the top and bottom, calculate the volume of the free space not occupied by the balls. [2]

End of Paper

Answer Key

1 (a) US$ $\frac{1000}{x}$ [B1]

(b) US$ $\frac{1000}{x-0.04}$ [B1]

(c) $\frac{1000}{x-0.04}-\frac{1000}{x}=21$ [M1]

$\Rightarrow \frac{1000x-1000(x-0.04)}{x(x-0.04)}=21$ [M1]

$\Rightarrow 40=21x(x-0.04)$

$\Rightarrow 21x^2-0.84x-40=0$

$\Rightarrow 525x^2-21x-1000=0$ (shown) [A1]

(d) $x=\frac{-(-21)\pm\sqrt{(-21)^2-4(525)(-1000)}}{2(525)}$ [M1]

= 1.400 or -1.360

$\Rightarrow$ x = 1.40 or -1.36 (correct to 2 decimal places) [A1]

(e) The exchange rate between the Singapore Dollar and the US Dollar in March 2010 is S\$$(x-0.04)$ = S\$1.36 = US\$1.
[B1]

2 (a) (i) Interest charged for Year 2 = \$54,117.57 x 3% = \$1,623.53 [M1]
Loan amount at the end of Year 2 = \$(54,117.57 + 1,623.53 - 28,282.43)
= \$27,458.67 [M1]
Interest charged for Year 3 = \$27,458.67 x 3% = \$823.76 [A1]

(ii) Total amount repayable = \$28,282.43 x 3 = \$84,847.29
Total Interest = \$84,847.29 – \$80,000 = \$4,847.29 [B1]

(b) Interest to Bank B= PRT = \$80,000 x 2.5% x 3 = \$6,000 [M1]
Total amount repayable = \$80,000 + \$6,000 = \$86,000 [A1]

(c) Since Bank A charges less interest (\$4,847.29) than Bank B (\$6,000), [M1]
Joseph should take the loan from Bank A. [A1]

3 (a) (i) $\angle BDC = \angle CBD = 26^o$ (base $\angle$, isos. Δ)

$\Rightarrow \angle BCD = 180^o - 26^o - 26^o = 128^o$ ($\angle$ sum of Δ) [M1]

$\angle CED = \angle CBD = 26^o$ ($\angle$s in the same seg)

$\angle ECD = \angle CED = 26^o$ (base $\angle$, isos Δ)

$\Rightarrow \angle CDE = 180^o - 26^o - 26^o = 128^o = \Delta BCD$ [M1]

Since, BC = CD, $\angle BCD = \angle CDE$ and CD = DE, [M1]

$\Rightarrow \Delta BCD$ and ΔCDE are congruent (SAS).

(ii) $\angle CAE = 180^o - 128^o = 52^o$ ($\angle$s in opp. segments) [M1]
$\angle COE = 52^o \times 2 = 104^o$ ($\angle$ at centre = twice $\angle$ at circumference) [A1]

(b) (i) $\angle ADC = 90^\circ$ ($\angle$s in semicircle)
$\angle CAD = 180^\circ - 90^\circ - 50^\circ = 40^\circ$ (sum of $\angle$s in Δ) [M1]
$\angle DAB = 40^\circ + 50^\circ = 90^\circ$
$\Rightarrow DB$ is also a diameter ($\angle$s in semicircle)
hence it intersects AC at the centre of the circle. [A1]

(ii) $\angle ACB = 90^\circ - 50^\circ = 40^\circ$ ($\angle$s in semicircle)
$\angle ADB = \angle ACB = 40^\circ$ ($\angle$s in the same seg) [B1]

(iii) Since DB is parallel to EA,
$\angle AEF = \angle DBF$ (*alt.* $\angle s$) …(1)
$\angle FAE = \angle FDB$ (*alt.* $\angle s$) …(2)
$\angle EFA = \angle BFD$ (*vert.opp.* $\angle s$) …(3) any 2 [B2]
$\Rightarrow \Delta AEF$ is similar to ΔDBF.

4 (a) 246 : 123 : 615 = 2 : 1 : 5
$\Rightarrow$ a = 2, b = 1 and c = 5 [B1]

(b) $(246+123+615) = $984. Each car costs $984/50 = $19.68 [M1]
Profit = 125% x $19.68 = $24.60 $\Rightarrow$ S.P. = $(24.60 + 19.68)
= $44.28 [A1]

(c) New cost price of each toy car = $[(1.2x246) + (1.1x123) + (0.8x615)]/50 [M1]
= $922.50/50 = $18.45 [A1]

(d) New Sales Price = $44.28x0.75 = $33.21 [M1]
Profit = [$(33.21 – 18.45)/$18.45] x 100% [M1]
= 14.76/18.45 x 100% = 80% [A1]

5 (a) (i) $\overrightarrow{BP} = \overrightarrow{BO} + \overrightarrow{OP} = -\mathbf{b} + 3\mathbf{a} = 3\mathbf{a} - \mathbf{b}$ [B1]

(ii) $PQ = 2QB \Rightarrow \overrightarrow{QB} = -\frac{1}{3}\overrightarrow{BP} = -\frac{1}{3}(3\mathbf{a} - \mathbf{b}) = \frac{b}{3} - \mathbf{a}$ [B1]

(iii) $\overrightarrow{AQ} = \overrightarrow{AB} + \overrightarrow{BQ} = (-\mathbf{a} + \mathbf{b}) + \frac{1}{3}(3\mathbf{a} - \mathbf{b}) = \frac{2}{3}\mathbf{b}$ [B1]

(b) Since $\overrightarrow{AQ} = \frac{2}{3}\mathbf{b} = \frac{2}{3}\overrightarrow{OB} \Rightarrow AQ \,//\, OB \Rightarrow$ quad. $OAQB$ is a trapezium. [B1]

(c) (i) $\frac{Area\ of\ \Delta OAB}{Area\ of\ \Delta PAB} = \frac{0.5 \times OA \times h}{0.5 \times PA \times h} = \frac{0.5\ x\ AP}{AP} = \frac{1}{2}$ [B1]

(ii) $\frac{Area\ of\ \Delta OAB}{Area\ of\ \Delta BAQ} = \frac{Area\ of\ \Delta OAB}{Area\ of\ 1/3\Delta PAB}$ [M1]

$= \frac{3}{2}$ [A1]

(iii) $AQ \,//\, OB \Rightarrow \Delta PAQ$ and ΔPOB are similar.

$\Rightarrow \frac{Area\ of\ \Delta PAQ}{Area\ of\ \Delta POB} = \left(\frac{AQ}{OB}\right)^2 = \left(\frac{2}{3}\right)^2 = \frac{4}{9}$ [M1]

$\Rightarrow \frac{Area\ of\ \Delta PAQ}{Area\ of\ quad\ OAQB} = \frac{4}{5}$ [A1]

6 (a) (i) 2, 17, 42, 77, [B2]

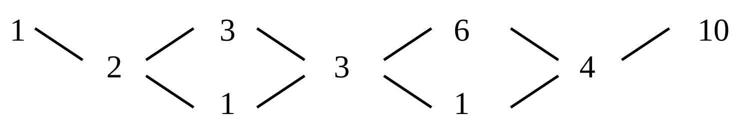
(ii) Since this sequence differs from the previous sequence by 5, [M1]
the nth term is $5n^2 - 3 - 5 = 5n^2 - 8$. [A1]

(b) (i) a =15, b = 21 [B2]

(ii) 2 c = m [columns] x (m + 1) [rows] [M1]
= (m)(m +1) [M1]

$\Rightarrow c = \frac{m(m+1)}{2}$ [A1]

<u>Alternative Solution:</u>

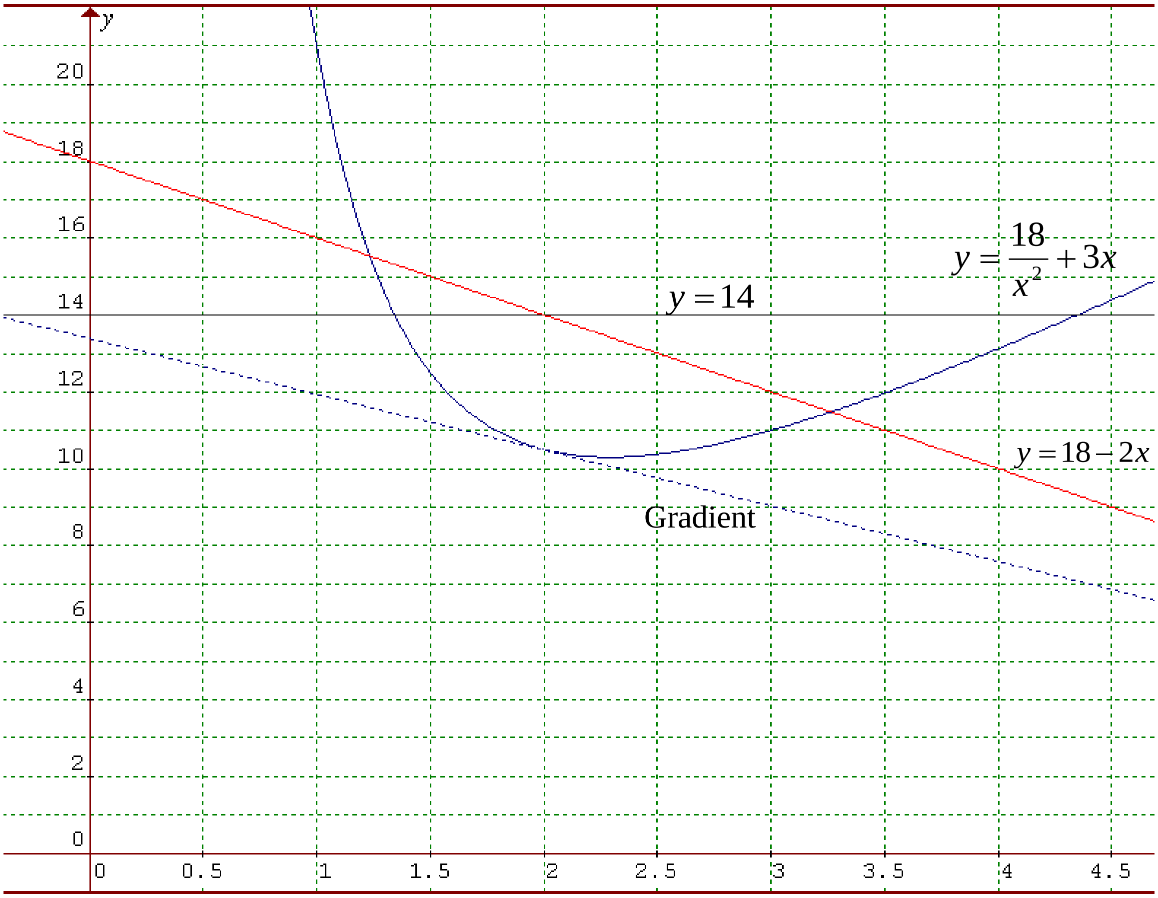


Let $c = am^2 + bm + c$ [M1]

$\Rightarrow a = \frac{1}{2},\ b = \frac{1}{2}\ \&\ c = 0$ [M1]

$\Rightarrow c = \frac{1}{2}m^2 + \frac{1}{2}m + 0 = \frac{m(m+1)}{2}$ [A1]

7 (a) Correct scale used for x-axis and y-axis (labelled), [B1]
Points plotted correctly, [B1]
Graph drawn smoothly (labelled). [B1]



(b) The tangent of the curve at $(2, 10.5)$ cuts the points $(0, 13.5)$ and $(3, 9)$, [M1]

$\Rightarrow$ gradient = $\frac{9-13.5}{3-0}$ = -1.5 ± 0.2 (i.e. between -1.7 and -1.3) [A1]

(c) When $x = 2.3$, the least value of y = 10.3 ± 0.1 (i.e. b/w 10.2 & 10.4) [B1]

(d) $3x^3 - 14x^2 + 18 = 0 \Rightarrow 3x - 14 + \frac{18}{x^2} = 0 \Rightarrow \frac{18}{x^2} + 3x = 14$ [M1]

Correct graph of $y = 14$ drawn. [M1]

At the intersection of the 2 graphs, x = 1.35 ± 0.05, x = 4.35 ± 0.05 [A1]

(e) Correct graph of $y = 18 - 2x$ drawn. [B1]

At the intersection of the graphs $y = \frac{18}{x^2} + 3x$ and $y = 18 - 2x$,

$\frac{18}{x^2} + 3x = 18 - 2x \Rightarrow \frac{18}{x^2} + 5x - 18 = 0 \Rightarrow 18 + 5x^3 - 18x^2 = 0$

$\Rightarrow 5x^3 - 18x^2 + 18 = 0$ at x = 1.25 ± 0.05 or x = 3.25 ± 0.05 [M1]

For $5x^3 - 18x^2 + 18 \le 0$, $\frac{18}{x^2} + 3x \le 18 - 2x \Rightarrow 1.2 \sim 1.3 \le x \le 3.2 \sim 3.3$ [B1]

8 (a) Volume of cuboid = $8 \times 8 \times 12 = 768 \text{ cm}^3$ [M1]

Volume of pyramid = $\frac{1}{3}(8 \times 8) \times 6 = 128 \text{ cm}^3$ [M1]

Volume of the whole solid = (768 + 128) = 896 cm^3 [A1]

(b) S.A. of vertical sides & base of cuboid = $(4 \times 8 \times 12) + (8 \times 8) = 448 \text{ cm}^2$ [M1]

Length $VA = \sqrt{6^2 + 8^2} = 10$ cm [M1]

SA of sides VAB & $VBC = 2 \times \frac{1}{2}(8 \times 10) = 80 \text{ cm}^2$ [M1]

SA of sides VAD & $VDC = 2 \times \frac{1}{2}(8 \times 6) = 48 \text{ cm}^2$ [M1]

Surface area of the whole solid = (448 + 80 + 48) = 576 cm^2 [A1]

(c) The smallest angle of elevation of V is from point B (furthest from D). [M1]

Diagonal $BD = \sqrt{8^2 + 8^2} = 11.31$ cm [M1]

Angle of elevation = $\tan^{-1}(6 \div 11.31) = 27.9°$ (1 dec. pl.) [A1]

9 (a) (i) [B2]

Height (h m)	No. of students
$1.0 < h \le 1.2$	2
$1.2 < h \le 1.4$	4
$1.4 < h \le 1.6$	11
$1.6 < h \le 1.8$	29
$1.8 < h \le 2.0$	4

(ii)

Height (h m)	Mid-value (x)	Frequency (f)	fx	x^2	fx^2
$1.0 < h \le 1.2$	1.1	2	2.2	1.21	2.42
$1.2 < h \le 1.4$	1.3	4	5.2	1.69	6.76
$1.4 < h \le 1.6$	1.5	11	16.5	2.25	24.75
$1.6 < h \le 1.8$	1.7	29	49.3	2.89	83.81
$1.8 < h \le 2.0$	1.9	4	7.6	3.61	14.44
		$\sum f = 50$	$\sum fx = 80.8$		$\sum fx^2 = 132.18$

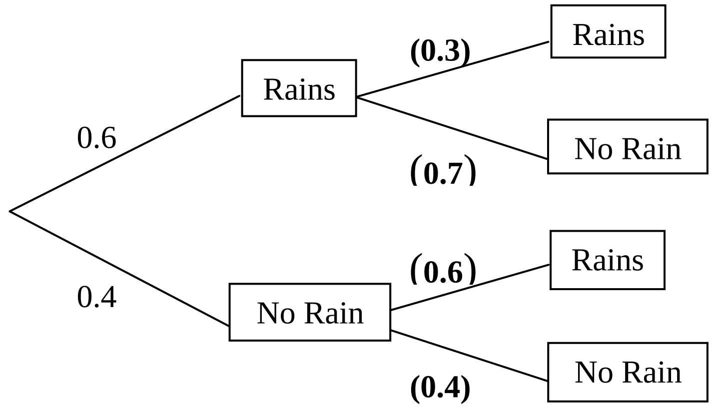
Mean = $\frac{\sum f x}{\sum f} = \frac{80.8}{50} = 1.616$ m [B1]

Standard deviation = $\sqrt{\frac{\sum f x^2}{\sum f} - \left(\frac{\sum f x}{\sum f}\right)^2} = \sqrt{\frac{132.18}{50} - (1.616)^2} = 0.179287478$

= 0.179 m (3 s.f.) [B1]

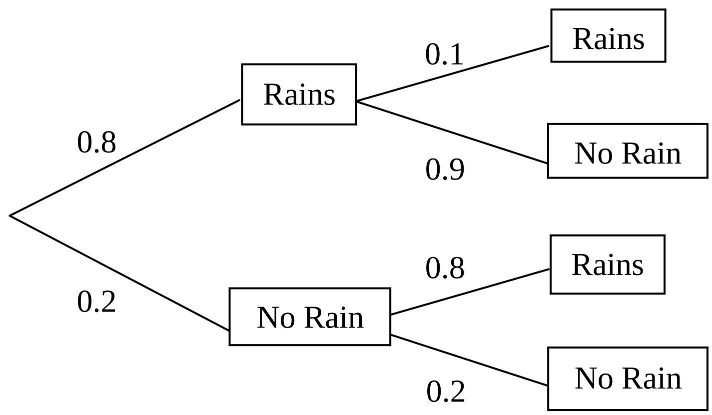
(b) (i) [B1]

1 Day Before **Opening Ceremony**



(ii) [B1]

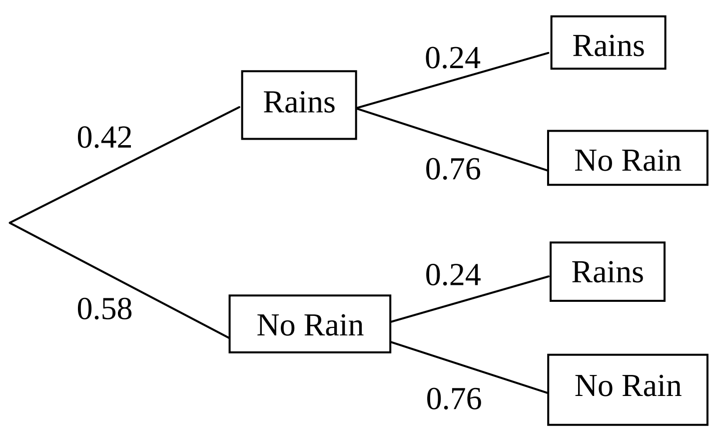
1 Day Before **Closing Ceremony**



(iii) P (Rains on OC) = (0.6 x 0.3) + (0.4 x 0.6) = 0.18 + 0.24 = 0.42
P (No rain on OC) = (0.6 x 0.7) + (0.4 x 0.4) = 0.42 + 0.16 = 0.58 [M1]

P (Rains on CC) = (0.8 x 0.1) + (0.2 x 0.8) = 0.08 + 0.16 = 0.24
P (No rain on CC) = (0.8 x 0.9) + (0.2 x 0.2) = 0.72 + 0.04 = 0.76 [M1]

Opening Ceremony **Closing Ceremony**



P (No Rain on both days) = (0.58 x 0.76) = 0.4408 [A1]

10 (a) $\angle ABN = 180° - 121°$ (int $\angle$s, // lines) = $59°$
$\angle CBN = 360° - 342°$ ($\angle$s at a point) = $18°$ [M1]
$\Rightarrow$ $\angle ABC = 59° - 18° = 41°$ [A1]

(b) $AC^2 = AB^2 + BC^2 - 2(AB)(BC)\cos\angle ABC$
$\Rightarrow$ $AC^2 = 500^2 + 410^2 - 2(500)(410)\cos 41°$ [M1]
$\Rightarrow$ $AC = 329.6$ = 330 m (correct to 3 sig. fig.) [A1]

(c) $\dfrac{\sin\angle ACB}{AB} = \dfrac{\sin\angle ABC}{AC}$
$\Rightarrow$ $\angle ACB = \sin^{-1}\dfrac{500}{329.6}\sin 41° = 84.4°$ [M1]
$\Rightarrow$ The bearing of A from C = $(180° - 18°) + 84.4° = 246.4°$ [A1]

(d) Let the shortest distance from A to BC be the $\perp$ line AD.
$\Rightarrow$ $\sin\angle ABC = \dfrac{AD}{AB}$
$\Rightarrow$ $AD = (AB)\sin\angle ABC = (500)\sin 41°$ [M1]
$\Rightarrow$ $AD = 328.0$ = 328 m (correct to 3 sig. fig.) [A1]

11 (a) $\angle QBR$ = $360° - 90° - 60° - 90°$ = $120°$ (shown) [B1]

(b) Area of minor sector QBR = $\dfrac{120°}{360°} \times 3.142 \times 2^2$ = 4.189 = 4.19 cm^2 (3 s.f.) [B1]

(c) $CM^2 = 12^2 - 6^2 = 108$ $\Rightarrow$ $CM = 10.39$ = 10.4 cm (3 s.f.) [B1]

(d) 3 x Area of minor sector QBR = 3 x 4.189 = 12.567 cm^2 [M1]
Area of ΔABC = $\dfrac{1}{2} \times 12 \times 10.39$ = 62.34 cm^2 [M1]
3 x Area of rectangle $ABQP$ = 3 x 12 x 2 = 72 cm^2 [M1]
$\Rightarrow$ The cross sectional area of the holder = 12.567 + 62.34 + 72
= 146.907 = 147 cm^2 (3 s.f.)

(e) Volume of holder plus lids = 146.907 x 4 = 587.628 cm^3 [M1]
Volume of 10 balls = $10 \times \dfrac{4}{3} \times 3.142 \times 2^3$ = 335.15 cm^3 [M1]
The volume of the free space not occupied by the balls = 587.628 - 335.15
= 252.48 = 252 cm^3(3 s.f.)