# SINGAPORE CHINESE GIRLS' SCHOOL
# PRELIMINARY EXAMINATION 2018
# SECONDARY FOUR
# O-LEVEL PROGRAMME

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | |
| CLASS | 4 | | | REGISTER NUMBER | | | |
| CENTRE NUMBER | | | | | INDEX NUMBER | | | |

**MATHEMATICS** **4048/01**

**Paper 1**

**Friday** **20 July 2018** **2 hours**

Candidates answer on the Question Paper.

**READ THESE INSTRUCTIONS FIRST**

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Write your class, 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 $\pi$, use either your calculator value or 3.142, unless the question requires the answer in terms of $\pi$.

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.

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## *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*

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

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



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**1** **(a)** Factorise $6f^2 - 11f + 3$.

*Answer* ……..…..…… [1]

**(b)** Hence solve $6f^2 + 3 = 11f$.

*Answer* $f$ = ……..……...……..……. [1]

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**2** $10 000 was invested in an account which pays $r$ % per annum compound interest.
At the end of 3 years, the interest earned was $1910.16.
Find the value of $r$.

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*Answer* $r$ = ……..…… [2]

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**3** Adam has written down seven numbers.
The mean of these numbers is 8, the median is 7 and the mode is 11.
The smallest number is an even prime number and the largest number is eight times the smallest number.
The second and third numbers are consecutive numbers.

Find the seven numbers.

*Answer* ……. , …….. , …….. , ……. , ……. , …….. , ……. [2]

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**4** China has an estimated land area of $9.39\times10^{6}$ square kilometres. In 2017, the country had an estimated population of 1.4 billion. Find, giving your answer to a reasonable degree of accuracy, the average number of people per square kilometre of the country in 2017.

*Answer* ……..…….…… [2]

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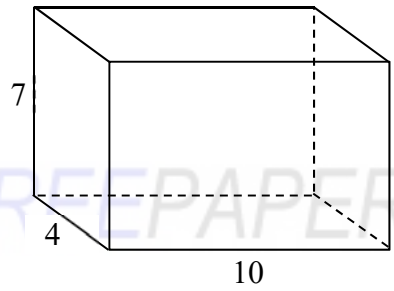
**5** The area of a triangle $XYZ$ is 166 cm$^2$. $XY$ = 20.7 cm and $YZ$ = 40.5 cm.

Find the two possible sizes of angle $XYZ$.

*Answer* ……..…… or …….. [2]

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**6** A solid cuboid has a length of 10 centimetres and a width of 4 centimetres.
Its height, when correct to the nearest centimetre, is 7 centimetres.




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**(a)** Given that 1 cubic centimetre of the material used to make the cuboid has a mass of 0.65 grams, find the maximum possible mass of the cuboid.

*Answer* ……..…… grams [1]

**(b)** Cubes of side 3 centimetres are to be cut from the cuboid. Find the largest possible number of cubes which can be obtained.

*Answer* ……..…..…… [1]

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**7** **(a)** Simplify $a(5b-a)-(b-a)^2$.

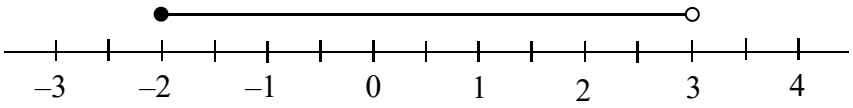
*Answer* ……[1]

**(b)** Factorise $6d^2+30de-10e-2d$ completely.

*Answer* ……[2]

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**8** The solution of the inequality $-6\frac{1}{4} < \frac{x-4}{4} - 2x \leq c$, where $c$ is a constant, is represented on the number line below.




Find $c$.

*Answer* $c$ = ……[2]

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**9** On a particular day, the exchange rate between Singapore dollar ($) and Japanese yen (¥) was $100 = ¥8187. Anna bought a watch for ¥55 499 and sold it to her friend for $700. Express Anna's profit as a percentage of the price she paid for the watch.

*Answer* ……..……..…… % [2]

---

**10** Express $\frac{3}{2-3x} - \frac{24x}{9x^2-4} + \frac{4}{3x+2}$ as a single fraction in its simplest form.

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*Answer* ……..……..…… [3]

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**11** Expressed as the products of their prime factors,

$$196 = 2^2 \times 7^2,$$
$$252 = 2^2 \times 3^2 \times 7.$$

**(a)** Write down the highest common factor of 196 and 252.

*Answer* ……..…… [1]

**(b)** The lowest common multiple of 252 and an even number is 756.

**(i)** Express 756 as the product of its prime factors.

*Answer* 756 = ……..…… [1]

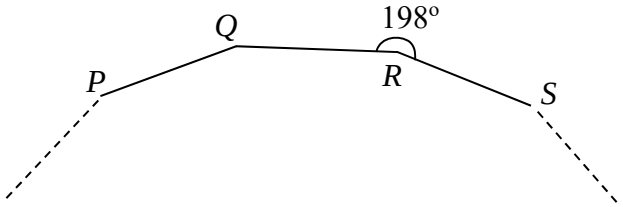
**(ii)** Find the smallest possible value of the even number.

*Answer* ……..…… [1]



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**12** The diagram shows part of a regular polygon *PQRS* … .
Reflex angle *QRS* = 198°.




**(a)** Find angle *QPS*.

*Answer* ……..…..…… ° [1]

**(b)** Find the sum of interior angles of the polygon.

*Answer* ……..…..…… ° [2]

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**13** The map of a national park is drawn to a scale of 1 : *n*. A lake, which has an actual area of 7.5 km$^2$, is represented by an area of 4.8 cm$^2$ on the map.

**(a)** Find the value of *n*.

*Answer* $n$ = ….…….…… [2]

**(b)** Calculate the actual perimeter of the lake, in km, if its perimeter on the map is 9 cm.

*Answer* ……..…….…… km [1]

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**14** **(a)** Simplify $\frac{a^7 b}{2} \times \left(a^3 b\right)^{-2}$.

*Answer* …… [1]

**(b)** Solve $\frac{2 \times 3^x}{\sqrt{3}} = 162$.

*Answer* $x$ = …… [2]

---

**15** **(a)** 12 men can complete a project in 27 days. Assuming that all the men work at the same rate, find the additional number of men needed to complete the project in 6 days.

*Answer* …… [1]

**(b)** $P$ is proportional to the square root of $Q$. Find the percentage increase in $P$ if $Q$ is increased by 300%.

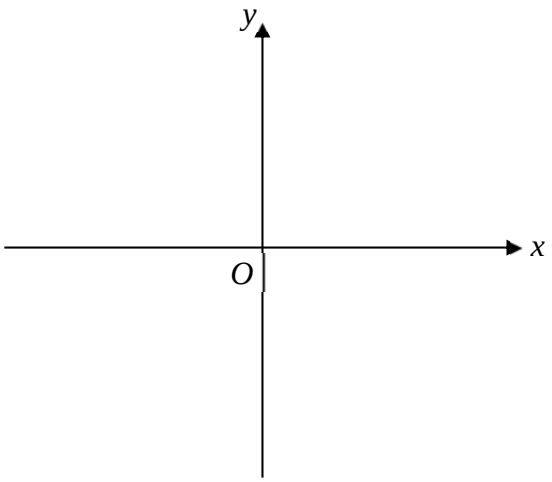
*Answer* …… % [2]

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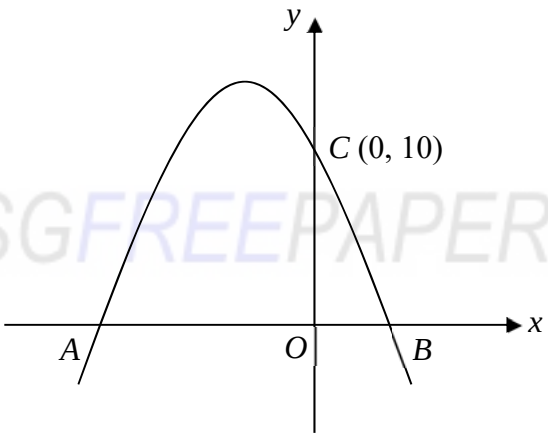
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**16** **(a)** Sketch the graph of $y = 3^x$ in the space below.




[1]

**(b)** The diagram shows the graph of $y = (x + p)(2 - x)$, where $p$ is a constant. The graph cuts the $x$-axis at $A$ and $B$ and the $y$-axis at $C(0, 10)$.




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**(i)** Write down the value of $p$.

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

**(ii)** Write down the equation of the line of symmetry of the graph.

*Answer* ..... [1]

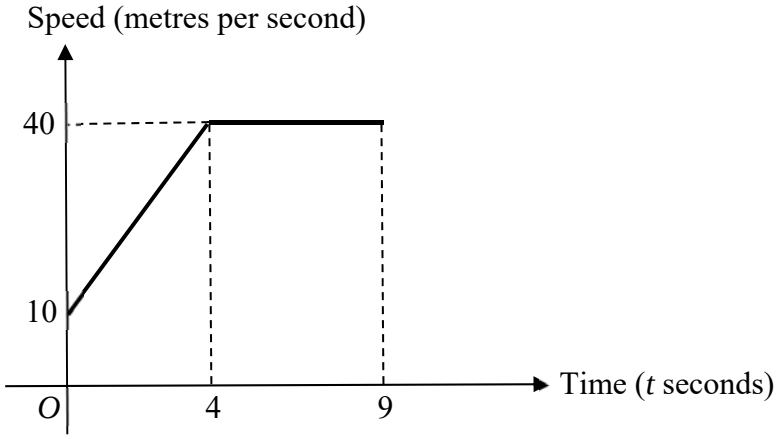
**(iii)** Find the maximum value of $y = (x + p)(2 - x)$.

*Answer* ..... [1]



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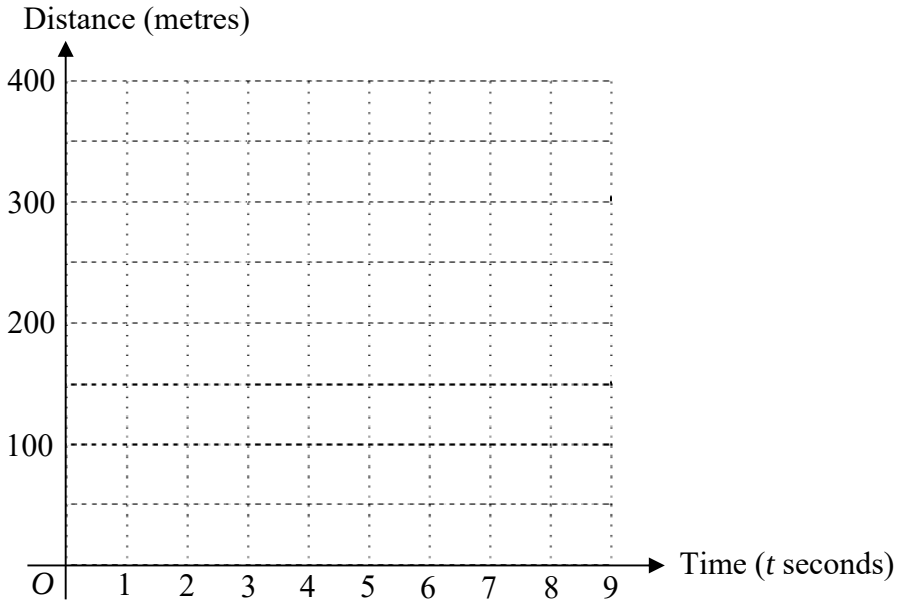
**17** The diagram shows the speed-time graph for the first 9 seconds of an object's journey.




**(a)** Find the speed when $t = 2.5$.

*Answer* …… m/s [1]

**(b)** Sketch the distance-time graph for the first 9 seconds of the object's journey in the space below.




[2]

After the first 9 seconds, the object decelerated uniformly until it came to rest at $t = 17$.

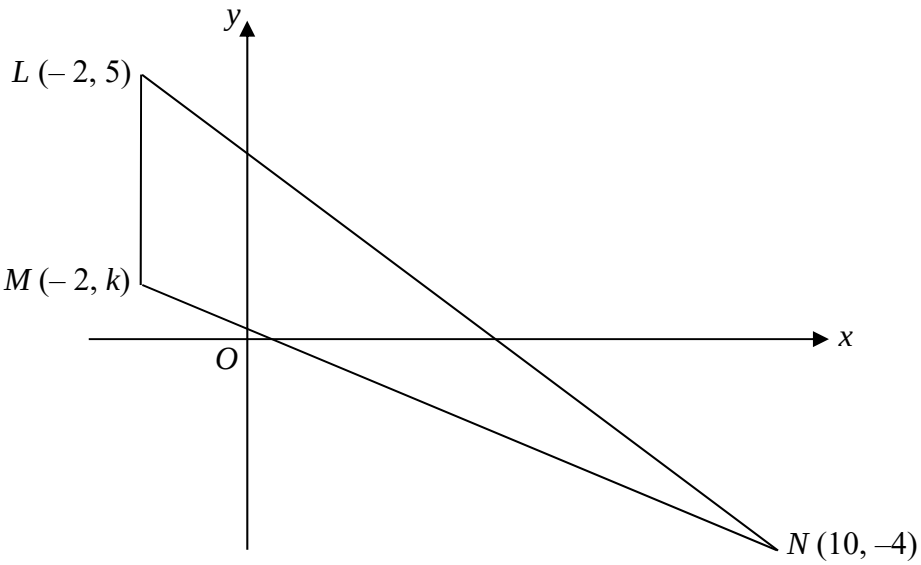
**(c)** Calculate the deceleration.

*Answer* …… m/s$^2$ [1]



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**18** $L$, $M$ and $N$ are the points $(-2, 5)$, $(-2, k)$ and $(10, -4)$ respectively.




The area of triangle $LMN$ is 24 square units.

**(a)** Show that $k = 1$.

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[1]

**(b)** Find, in its simplest form, the value of $\cos L\hat{M}N$.

*Answer* …… [1]

**(c)** Find the equation of the line passing through $M$ and parallel to $LN$.

*Answer* …… [2]

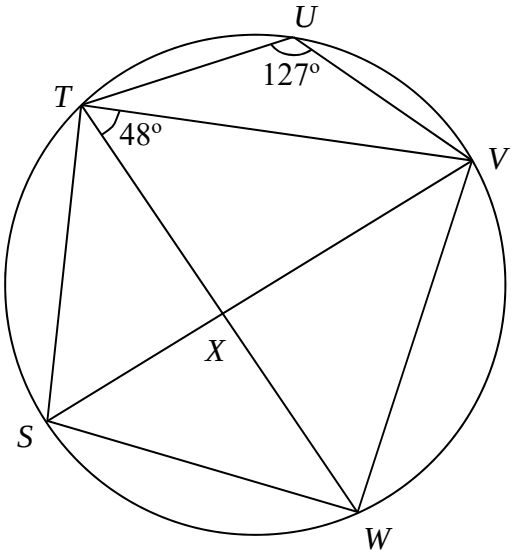
**(d)** Write down the $x$-coordinate of the point $P$ such that $LPMN$ is a parallelogram.

*Answer* $x$ = …… [1]



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**19** $S$, $T$, $U$, $V$ and $W$ are points on a circle. $SV$ is the diameter and it intersects $TW$ at $X$. Angle $VTW = 48^o$ and angle $TUV = 127^o$.




**(a)** Find, stating your reasons clearly,

**(i)** angle $VSW$,

*Answer* …… $^o$ [1]

**(ii)** angle $TVS$,

*Answer* …… $^o$ [2]

**(iii)** angle $WXV$.

*Answer* …… $^o$ [1]

**(b)** Is $X$ the centre of the circle? Explain your answer, stating your reasons clearly.

*Answer*

……

……

……

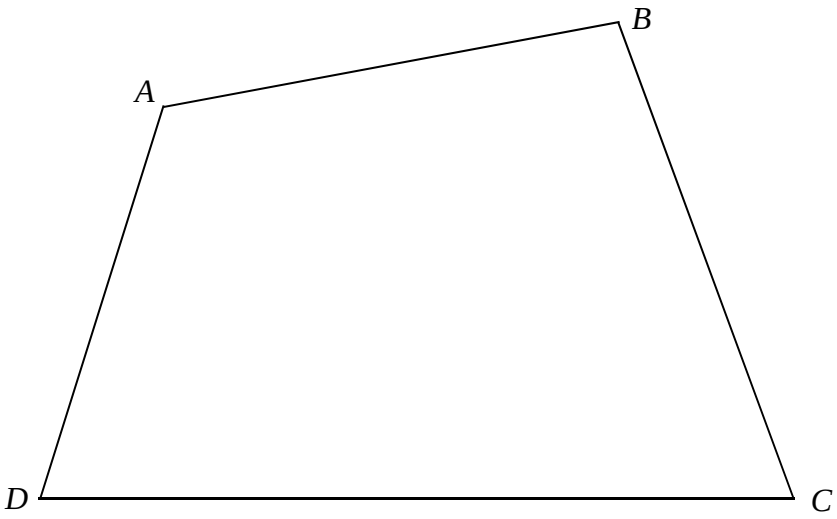
…… [1]



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**20** The diagram shows a scale drawing of a park *ABCD*.
*D* is due West of *C*.

**Scale: 1 cm to 10 m**




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**(a)** Write down the bearing of *B* from *C*.

*Answer* …… ° [1]

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

**(c)** Two benches are to be placed in the park such that they are equidistant from *AB* and *AD* and 50 metres from the point *D*. Write down the actual distance between the two benches.

*Answer* …… m [1]

**(d)** Construct the perpendicular bisector of *CD*. [1]

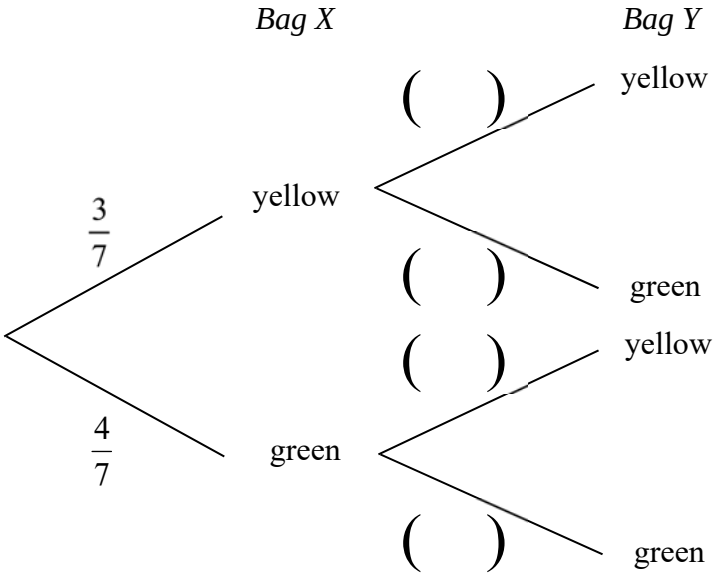
**(e)** A lamp post, *P*, is to be erected in the park, nearer to *C* than to *D* and nearer to *AD* than to *AB*. Mark and label a possible position of *P*. [1]



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**21** Two bags contain coloured marbles.
Bag *X* contains 3 yellow marbles and 4 green marbles.
Bag *Y* contains 5 yellow marbles and 6 green marbles.
A marble is drawn at random from Bag *X* and put into Bag *Y*.
A marble is then drawn at random from Bag *Y*.

**(a)** Complete the tree diagram to show this information.




[2]

**(b)** Find, in its simplest form, the probability that the two marbles drawn are of different colours.

*Answer* …… [2]

If the marble drawn from Bag *Y* has the same colour as the marble drawn from Bag *X*, it is set aside and another marble is drawn at random from Bag *Y*.

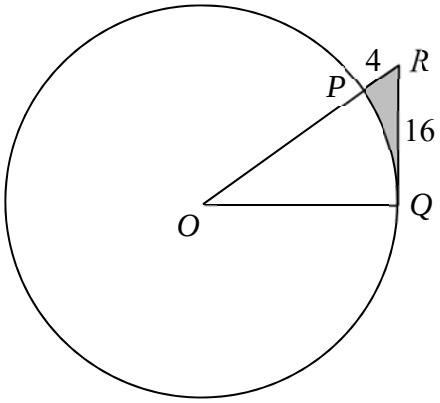
**(c)** Find, in its simplest form, the probability that all the three marbles drawn have the same colour.

*Answer* …… [2]



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**22** $P$ and $Q$ are points on a circle, centre $O$. $RQ$ is a tangent to the circle at $Q$.
$PR = 4$ cm and $RQ = 16$ cm.




**(a)** Show that the radius of the circle is 30 cm.

*Answer*

[2]

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**(b)** Find angle $ROQ$ in radians.

*Answer* ……..…… radians [2]

**(c)** Find the perimeter of the shaded region.

*Answer* ……..…… cm [2]

**(d)** Calculate the area of the shaded region.

*Answer* ……..…… $cm^2$ [2]



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**23** A unit fraction is a fraction with 1 as its numerator.

**(a)** The first four terms of a sequence of unit fractions are

$$\frac{1}{37}\ ,\ \frac{1}{31}\ ,\ \frac{1}{25}\ ,\ \frac{1}{19}\ ,\ \ldots\ .$$

**(i)** Write down the first negative term in the sequence.

*Answer* ..... [1]

**(ii)** Find the $n$th term of the sequence.

*Answer* ..... [1]

**(b)** A unit fraction can be expressed as the sum of two or more unit fractions.

For example, $\frac{1}{24} = \frac{1}{88} + \frac{1}{33}$.

The following method is used to find the two unit fractions that add up to $\frac{1}{24}$ .

$$\begin{aligned}\frac{1}{24} &= \frac{1}{3\times 8}\\ &= \frac{11}{3\times 8\times 11}\\ &= \frac{3+8}{3\times 8\times 11}\\ &= \frac{3}{3\times 8\times 11} + \frac{8}{3\times 8\times 11}\\ &= \frac{1}{88} + \frac{1}{33}\end{aligned}$$



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**(i)** In a similar manner, showing each step clearly, express $\frac{1}{24}$ as a sum of two **other** unit fractions.

*Answer*

[2]

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**(ii)** Using a similar method, express $\frac{1}{24}$ as a sum of **three** different unit fractions.

*Answer*

[2]



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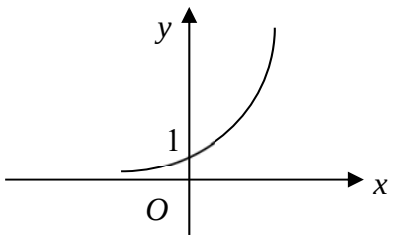
**Marking Scheme**

| Qn | Solution |
|---|---|
| 1(a) | $(2f-3)(3f-1)$ |
| (b) | $f = 1\frac{1}{2}$ or $\frac{1}{3}$ |
| 2 | $10000 + 1910.16 = 10000\left(1+\frac{r}{100}\right)^3$<br>$r = 6$ |
| 3 | 2, 4, 5, 7, 11, 11, 16 |
| 4 | Average number per km$^2$ $= \frac{1.4\times10^9}{9.39\times10^6}$<br>$= 150$ (2sf) |
| 5 | 23.3° or 156.7°<br>Alternatively, 0.407 rad or 2.73 rad |
| 6(a) | Max mass = 195 grams |
| (b) | 6 cubes |
| 7(a) | $7ab - 2a^2 - b^2$ |
| (b) | $6d^2 + 30de - 10e - 2d$<br>$= 2[3d(d+5e) - (d+5e)]$<br>$= 2(3d-1)(d+5e)$ |
| 8 | $\frac{x-4}{4} - 2x \le c$<br>$x \ge \frac{-4c-4}{7}$<br>$\frac{-4c-4}{7} = -2$<br>$c = 2\frac{1}{2}$ |
| 9 | Selling price in \$ $= \frac{55499}{8187}\times100$<br>$= 677.89$<br>Percentage $= \frac{700-677.89}{677.89}\times100$<br>$= 3.26\%$<br>Or,<br>Cost price in ¥ $= 7\times8187$<br>$= 57309$<br>Percentage $= \frac{57309-55499}{55499}\times100$<br>$= 3.26\%$ |

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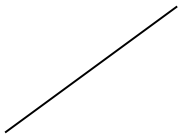


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| | |
|---|---|
| 10 | $\frac{3}{2-3x}-\frac{24x}{9x^2-4}+\frac{4}{3x+2}$<br>$=\frac{-3(3x+2)-24x+4(3x-2)}{(3x+2)(3x-2)}$<br>$=\frac{-21x-14}{(3x+2)(3x-2)}$<br>$=\frac{7}{2-3x}$ or $-\frac{7}{3x-2}$ |
| 11(a) | 28 |
| (b)(i) | $2^2\times3^3\times7$ |
| (ii) | 54 |
| 12(a) | $18^o$ |
| (b) | No. of sides = 20<br>Sum of interior angles = $3240^o$ |
| 13(a) | 1 cm ----- $\sqrt{\frac{25}{16}}$ km<br>$n$ = 125 000 |
| (b) | 11.25 km |
| 14(a) | $\frac{a}{2b}$ |
| (b) | $\frac{2\times3^x}{\sqrt{3}}=162$<br>$3^{x-\frac{1}{2}}=3^4$<br>$x-\frac{1}{2}=4$<br>$x=4\frac{1}{2}$ |
| 15(a) | 42 men |
| (b) | $P_{new}=\frac{P}{\sqrt{Q}}\left(\sqrt{4Q}\right)$<br>Percentage increase = 100% |
| 16(a) |  |
| (b)(i) | $p$ = 5 |
| (ii) | $x$ = –1.5 |



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| | |
|---|---|
| (iii) | Maximum value = 12.25 |
| 17(a) | 28.75 m/s |
| (b) |  , 100<br> , 300 |
| (c) | 5 m/s$^2$ |
| 18(a) | $\frac{1}{2}(5-k)(12)=24$<br>$k=1$ |
| (b) | cos $\angle LMN = -\frac{5}{13}$ |
| (c) | Gradient = $-\frac{3}{4}$<br>At $M(-2, 1)$, $1=-\frac{3}{4}(-2)+c$<br>$y=-\frac{3}{4}x-\frac{1}{2}$ |
| (d) | $x=-14$ |
| 19(a)(i) | Angle $VSW$ = 48° (angles in same segment) |
| (ii) | Angle $STV$ = 90° (right angle in semicircle)<br>Angle $TSV$ = 53° (angles in opposite segments)<br>Angle $TVS$ = 37° |
| (iii) | Angle $WXV$ = 85° (vertically opposite angles) |
| (b) | Since angle $VXW \neq$ twice of angle $VTW$, $X$ is not the centre (*angle at centre = 2 angle at circumference*)<br>Or,<br>Angle $TSW$ = 53° + 48° ≠ 90°<br>$TW$ is not the diameter (*right angle in semicircle*)<br>Therefore, $X$ is not the centre. |
| 20(a) | 340° |
| (b) | Bisector of angle $DAB$ |
| (c) | 38 m |
| (d) | Perpendicular bisector of $CD$ |
| (e) | Correct possible position of $P$ |

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| | |
|---|---|
| 21(a) | $\frac{1}{2}$ and $\frac{1}{2}$<br>$\frac{5}{12}$ and $\frac{7}{12}$ |
| (b) | P(different) = $\frac{3}{7}\left(\frac{1}{2}\right)+\frac{4}{7}\left(\frac{5}{12}\right)$<br>= $\frac{19}{42}$ |
| (c) | P(same) = $\frac{3}{7}\left(\frac{1}{2}\right)\left(\frac{5}{11}\right)+\frac{4}{7}\left(\frac{7}{12}\right)\left(\frac{6}{11}\right)$<br>= $\frac{43}{154}$ |
| 22(a) | Let $r$ cm be the radius.<br>$(r+4)^2 = r^2+16^2$<br>$r^2+8r+16 = r^2+256$<br>$r = 30$ |
| (b) | $\tan\angle ROQ = \frac{16}{30}$<br>$\angle ROQ = 0.48995$<br>= 0.490 rad (3sf) |
| (c) | Arc length $PQ = 30(0.48995)$<br>Perimeter = $30(0.48995)+16+4$<br>= 34.7 cm (3sf) |
| (d) | Area of sector $OPQ = \frac{1}{2}(30^2)(0.48995)$<br>Shaded area = $\frac{1}{2}(30)(16)-\frac{1}{2}(30^2)(0.48995)$<br>= 19.5 cm$^2$ (3sf) |
| 23(a)(i) | $-\frac{1}{5}$ |
| (ii) | $\frac{1}{43-6n}$ |
| (b)(i) | $\frac{1}{24} = \frac{1}{2\times12}$<br>$= \frac{14}{2\times12\times14}$<br>$= \frac{2+12}{2\times12\times14}$<br>$= \frac{2}{2\times12\times14}+\frac{12}{2\times12\times14}$<br>$= \frac{1}{168}+\frac{1}{28}$<br>Or, |



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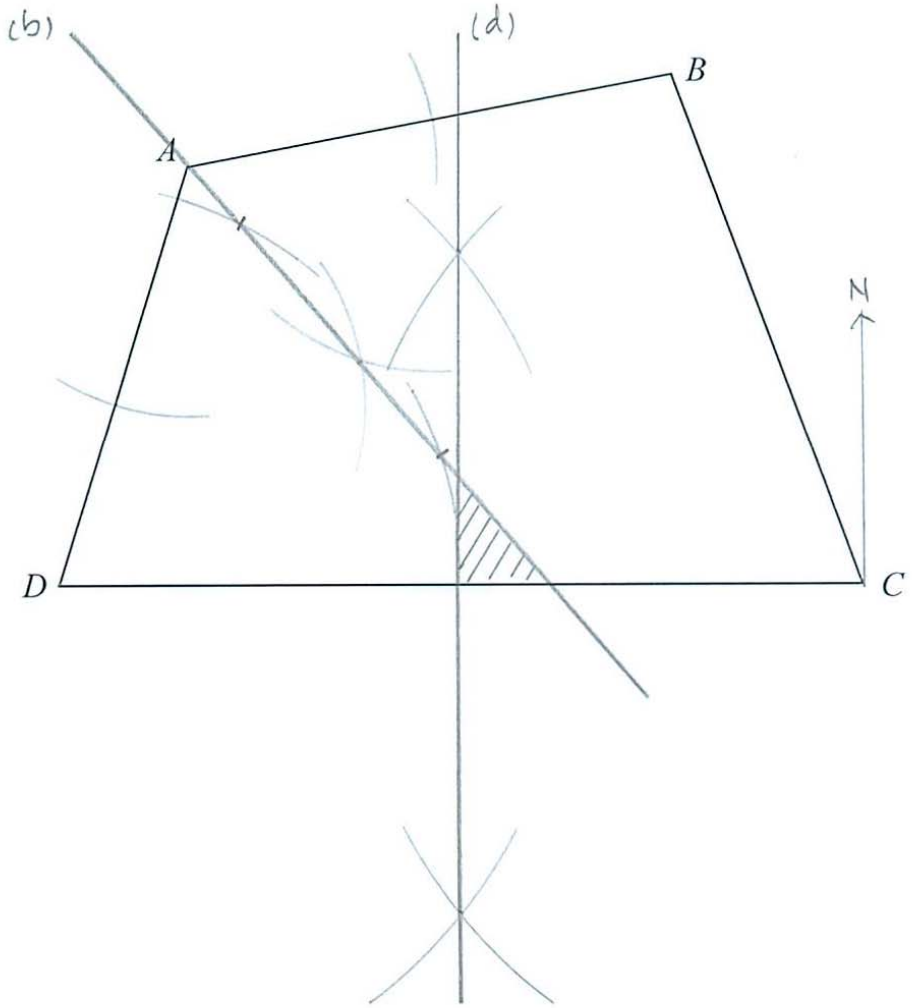
| | |
|---|---|
| | $\frac{1}{24} = \frac{1}{4\times 6}$<br>$= \frac{10}{4\times 6\times 10}$<br>$= \frac{4+6}{4\times 6\times 10}$<br>$= \frac{4}{4\times 6\times 10} + \frac{6}{4\times 6\times 10}$<br>$= \frac{1}{60} + \frac{1}{40}$<br>Or,<br>$\frac{1}{24} = \frac{1}{1\times 24}$<br>$= \frac{25}{1\times 24\times 25}$<br>$= \frac{1+24}{1\times 24\times 25}$<br>$= \frac{1}{1\times 24\times 25} + \frac{24}{1\times 24\times 25}$<br>$= \frac{1}{600} + \frac{1}{40}$ |
| (ii) | $\frac{1}{24} = \frac{1}{2\times 3\times 4}$<br>$= \frac{2+3+4}{2\times 3\times 4\times 9}$<br>$= \frac{2}{2\times 3\times 4\times 9} + \frac{3}{2\times 3\times 4\times 9} + \frac{4}{2\times 3\times 4\times 9}$<br>$= \frac{1}{108} + \frac{1}{72} + \frac{1}{54}$ |

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**SINGAPORE CHINESE GIRLS' SCHOOL**
**PRELIMINARY EXAMINATION 2018**
**SECONDARY FOUR**
**O-LEVEL PROGRAMME**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | |
| CLASS | 4 | | | REGISTER NUMBER | | | | |
| CENTRE NUMBER | | | | | INDEX NUMBER | | | | |

**MATHEMATICS** **4048/02**
**PAPER 2**

**Monday** **30 July 2018** **2 hours 30 minutes**

Additional Materials: Writing Paper
Graph Paper

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## READ THESE INSTRUCTIONS FIRST

Write your name, class and index number 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/tape.

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 $\pi$, use either your calculator value or 3.142, unless the question requires the answer in terms of $\pi$.

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.

This question paper consists of **12** printed pages.

[Turn over

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## *Mathematical Formulae*

*Compound Interest*

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

*Mensuration*

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 $\theta$ is in radians

Sector area = $\frac{1}{2}r^2\theta$, where $\theta$ 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*

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

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

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**1** **(a)** Given that $\sqrt{\frac{r}{7+q^2}} - p = r$,

**(i)** evaluate $p$ when $q = -3$ and $r = 36$, [1]

**(ii)** express $q$ in terms of $p$ and $r$. [3]

**(b)** Mr Ang makes $x$ bowls and $y$ jugs.

**(i)** He has 22.9 kilograms of clay.
He uses 300 grams of clay for a bowl and 800 grams of clay for a jug.
Write down an equation in terms of $x$ and $y$, and show that it simplifies to $3x + 8y = 229$. [1]

**(ii)** He has $6\frac{3}{5}$ hours to make the bowls and the jugs.
It takes him 8 minutes to make a bowl and 12 minutes to make a jug.
Write down an equation in terms of $x$ and $y$, to represent this information. [1]

**(iii)** Solve these two equations to find the value of $x$ and the value of $y$. [3]

---

**2** Mr Lee went on a journey of 190 km.
For the first 100 km, he drove at an average speed of $v$ km/h.
For the remaining journey, he drove at an average speed which was 25 km/h slower than the speed for the first 100 km.

**(a)** Write down an expression, in terms of $v$, for the time taken in hours for the first 100 km. [1]

**(b)** Given that the journey took a total of 2 hours 45 minutes, form an equation in $v$ and show that it simplifies to $11v^2 - 1035v + 10000 = 0$. [4]

**(c)** Solve the equation $11v^2 - 1035v + 10000 = 0$, giving each answer correct to two decimal places. [3]

**(d)** Which solution in **part (c)** represents the speed for the first 100 km of Mr Lee's journey?
Give a reason for rejecting the other solution. [1]

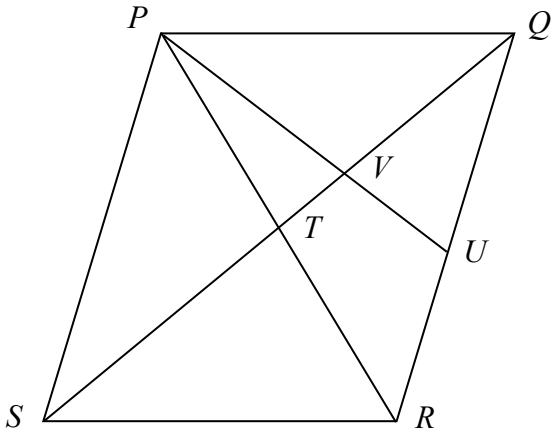
**(e)** Find the difference between the times taken for the first and second parts of the journey.
Give your answer correct to the nearest minute. [2]

---



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**3**




The diagram shows a parallelogram $PQRS$ with diagonals $PR$ and $QS$ intersecting at $T$. The point $U$ is the mid-point of $QR$ and the line $PU$ cuts $QS$ at $V$.

**(a)** Name a triangle that is congruent to triangle $PTQ$. [1]

**(b)** Prove that

**(i)** triangles $PVS$ and $UVQ$ are similar, [2]

**(ii)** $QV = 2VT$. [2]

**(c)** Find the ratio of the area of triangle $QVU$ to the area of trapezium $PURS$. [2]

---

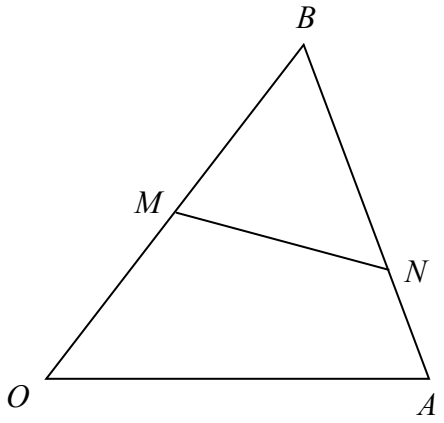
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**4** **(a)** The point $P$ is $(5, -8)$ and the point $Q$ is $(-4, 7)$.

The point $L$ is such that $\overrightarrow{QP} = \frac{1}{2}\overrightarrow{PL}$ and $O$ is the origin.

Find $\left|\overrightarrow{OL}\right|$. [3]

**(b)** In the diagram, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
$M$ is a point on $OB$ where $OB = 2MB$ and the point $N$ lies on $AB$ such that $3BN = 2BA$.




**(i)** Express in terms of **a** and **b**, simplifying your answers where possible,

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

**(b)** $\overrightarrow{MN}$. [2]

The point $P$ lies on $OA$ produced such that $OA : OP = 1 : 2$.

**(ii)** Determine whether the points $M$, $N$ and $P$ are collinear.
Justify your answer. [2]

The point $Q$ is such that $k\overrightarrow{BQ} = \mathbf{a}$ and $ONQ$ is a straight line.

**(iii)** Write down the value of $k$. [1]

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**5**

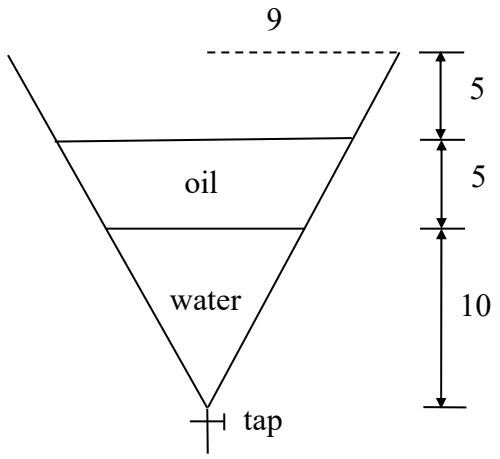



**Diagram 1**

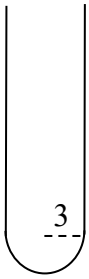



**Diagram 2**

**Diagram 1** shows the vertical cross-section of a separating funnel with a small tap at its vertex.
The funnel is in the shape of an inverted right circular cone of base radius 9 cm and height 20 cm.
It contains water and oil, which do not mix, of depths 10 cm and 5 cm respectively, with the water at the bottom.

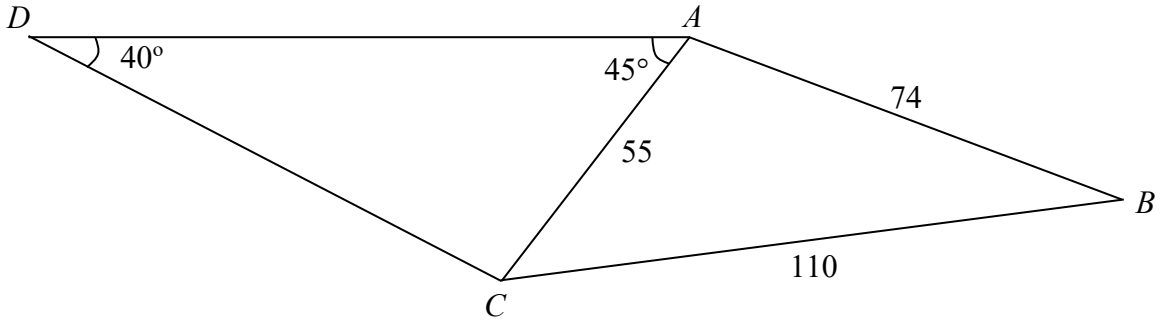
**(a)** Find the ratio of volume of water : volume of oil : capacity of the funnel. [3]

**(b)** All the water in the funnel is drained through the tap into a glass test-tube.
The test-tube consists of a hollow cylindrical upper part of internal radius 3 cm and a hollow hemispherical lower part of the same radius, as shown in **Diagram 2**.
Find the total surface area of the test-tube in contact with the water. [5]

---

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**6** The diagram shows four points $A$, $B$, $C$ and $D$ on a horizontal land where $A$ is due east of $D$.
$AB = 74$ m, $BC = 110$ m and $AC = 55$ m.
Angle $ADC = 40^o$ and angle $CAD = 45^o$.




**(a)** Calculate

**(i)** $AD$, [2]

**(ii)** the area of triangle $ACD$, [2]

**(iii)** angle $BAC$, [3]

**(iv)** the bearing of $A$ from $B$. [2]

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**(b)** A vertical tower stands at $B$.
A man walks along $CA$ produced such that the largest angle of elevation of the top of the vertical tower is $10^o$.
Find the height of the tower. [3]

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**7** **(a)** $\mathscr{E}$ = { students in Class 4B }
$H$ = { students who study History }
$G$ = { students who study Geography }

There are 32 students in Class 4B.
13 students study History, 23 students study Geography and 11 students study both subjects.

**(i)** Draw a Venn diagram to illustrate this information. [1]

**(ii)** Find the total number of students who study only one of these two subjects. [1]

**(b)** $D$ = { students who play the drums }
$P$ = { students who play the piano }

**(i)** Express, in set notation, 'All students who play the drums also play the piano'. [1]

**(ii)** Write the set notation $D \cap P \neq \phi$ in words. [1]

**(c)** A factory supplies boxes of cereals to 3 supermarkets $X$, $Y$ and $Z$.
The number of boxes of cereals supplied per delivery to each supermarket, the sizes and sale prices of the boxes, together with the number of deliveries made to each supermarket over a 4-month period are shown in the table below.

| | | Number of boxes per delivery | | | Number of deliveries over 4 months |
|---|---|---|---|---|---|
| Size of box | | small | medium | large | |
| Supermarket | $X$ | 300 | 350 | 0 | 8 |
| | $Y$ | 250 | 0 | 200 | 11 |
| | $Z$ | 100 | 200 | 150 | 13 |
| Sale price per box | | \$2.50 | \$4.25 | \$7.80 | |

It is given that $\mathbf{A} = \begin{pmatrix} 300 & 350 & 0 \\ 250 & 0 & 200 \\ 100 & 200 & 150 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 8 & 11 & 13 \end{pmatrix}$.

**(i)** Calculate **BA**. [1]

**(ii)** Explain what the elements of **BA** represent. [1]

**(iii)** Given that $\mathbf{C} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$, calculate **AC**. [1]

**(iv)** Describe what is represented by the elements of **AC**. [1]

**(v)** Using matrix multiplication, calculate the total amount of money that will be collected from the sale of all the boxes of cereals to Supermarket $Z$ over 4 months. [2]

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

A particle moves in a straight line so that at time $t$ seconds, its distance $y$ metres from a fixed point, $O$, is given by $y = t + \frac{32}{t+2} - 8$.

The following table gives some corresponding values of $t$ and $y$.

| $t$ (seconds) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $y$ (metres) | 8 | 3.67 | 2 | 1.4 | 1.33 | 1.57 | 2 | 3.2 | 4.67 | $k$ | 8 |

**(a)** Calculate the value of $k$. [1]

**(b)** Using a scale of 1 cm to represent 1 second, draw a horizontal $t$–axis for $0 \le t \le 14$.
Using a scale of 2 cm to represent 1 metre, draw a vertical $y$–axis for $0 \le y \le 8$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

**(c)** Explain the significance of the $y$–intercept. [1]

**(d)** Find the time when the particle is nearest to the fixed point, $O$. [1]

**(e)** Mark and label $P$, the point on your graph when the particle is 4 metres from the fixed point, $O$ and moving away from $O$. [1]

**(f)** Find the length of time for which the particle is less than or equal to 2.5 metres from the fixed point, $O$. [1]

**(g)** By drawing a tangent, find the gradient of the curve at $t = 6$. [2]

**(h)** The equation $t + \frac{32}{t+2} = 13 - \frac{1}{4}t$ can be solved by drawing a straight line on the same axes.

**(i)** Draw this line for $0 \le t \le 14$. [1]

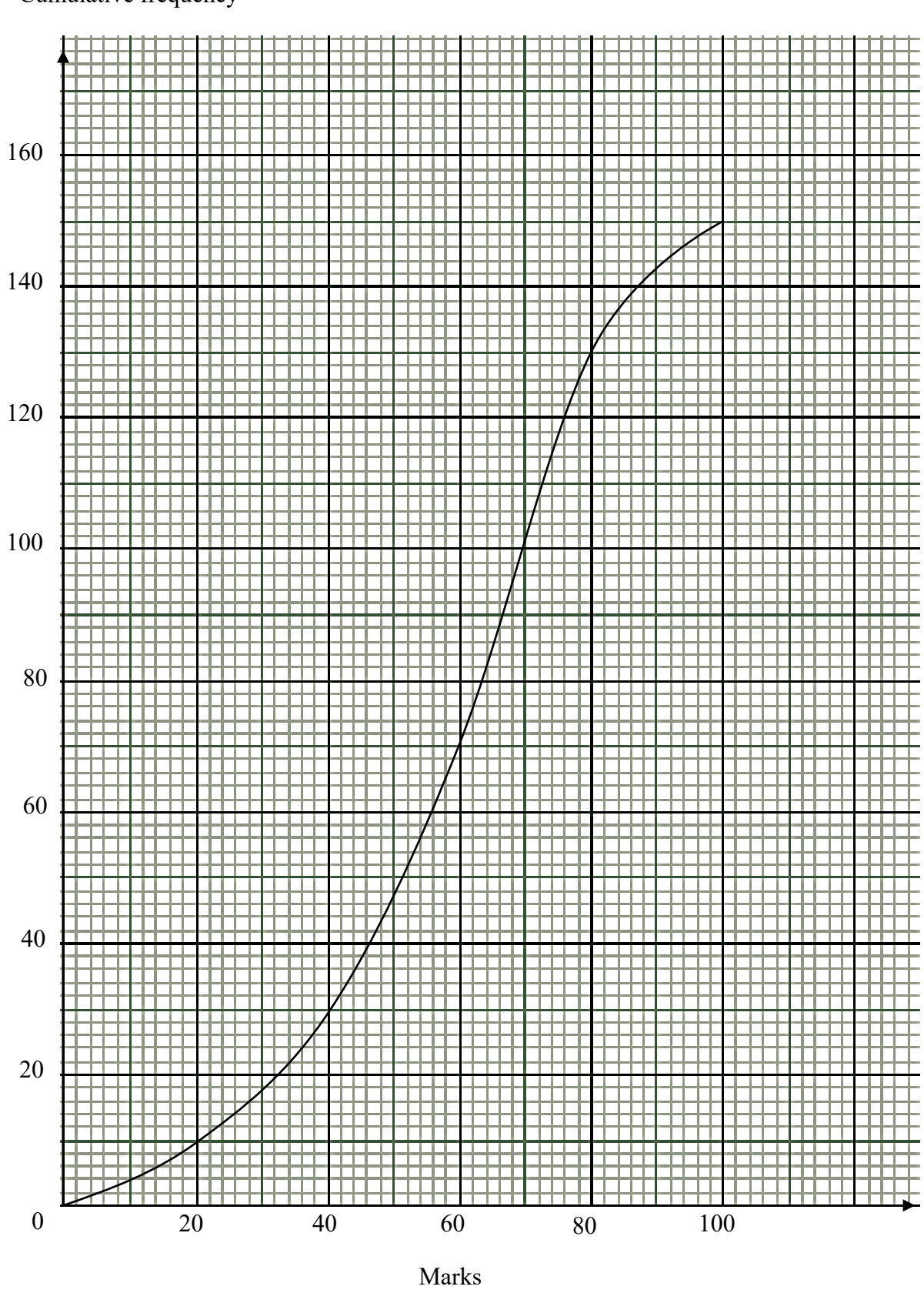
**(ii)** Write down the $t$–coordinates of the points where the line intersects the curve. [2]

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**9** The cumulative frequency graph shows the distribution of marks of 150 students in a Mathematics examination.




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**9** **(a)** Use the graph to estimate

**(i)** the number of students who score more than 36 marks, [1]

**(ii)** the interquartile range. [2]

**(b)** Two students are selected at random.
Find the probability that

**(i)** both students score more than 36 marks, [1]

**(ii)** one student scores at most 64 marks while the other student scores more than 80 marks. [2]

**(c)** **(i)** Copy and complete the grouped frequency table of the marks of the 150 students. [1]

| $x$ (marks) | $0 < x \leq 20$ | $20 < x \leq 40$ | $40 < x \leq 60$ | $60 < x \leq 80$ | $80 < x \leq 100$ |
|---|---|---|---|---|---|
| Number of students | | | | | |

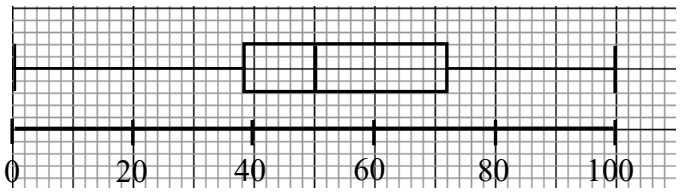
**(ii)** Using your grouped frequency table, calculate an estimate of

**(a)** the mean mark, [1]

**(b)** the standard deviation. [1]

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**(d)** The same group of students took a Science examination.
The box and whisker plot shows the distribution of their marks.




**(i)** Which examination was more difficult? Justify your answer. [1]

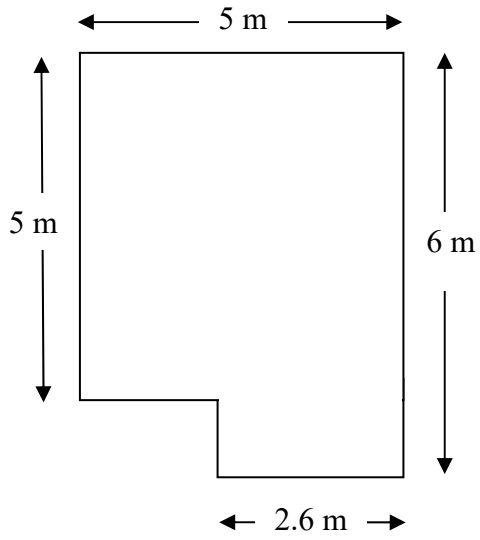
**(ii)** Compare and comment on the consistency of the performances of the students in the two examinations. [1]

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**10** **(a)** Mrs Wong had a budget of $2000 to spend on buying new kitchen flooring.
A sketch of the kitchen floor plan is shown below.
All angles shown in the diagram are right angles.




Mrs Wong planned to use either tiles or single coloured vinyl floor covering to cover the whole of the kitchen floor.

Each square tile measures 20 cm by 20 cm.
A box of 25 floor tiles costs $66.25.
Floor tiles are only sold in complete boxes.

The vinyl floor covering is cut to the required length from a roll.
A roll of vinyl floor covering is 1.8 metres wide and is sold at a price of $118.70 per metre length.
It is sold in lengths measured in a whole number of metres only.

Are both types of flooring materials within Mrs Wong's budget?
Show all your working and give reasons for your answers. [5]

**(b)** Mrs Wong saw an advertisement for a refrigerator and bought it using a payment plan.
The total price of the payment plan is 12% more than the advertised price.
The payments are calculated as shown.

- deposit of one-third of total price
- 8 equal instalments of $92.60 per month
- final payment of $200

Find the advertised price. [3]

**(c)** Mrs Wong also bought a washer which cost $569.24, inclusive of 7% Goods and Services Tax (GST).
Find the amount of GST paid by Mrs Wong. [2]

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**Preliminary Examination 2018**
**Secondary Four O Level Mathematics**
**Paper 2 Solutions**

| | | |
|---|---|---|
| **1** | **(a)(i)** | –34.5 |
| | **(a)(ii)** | $\sqrt{\frac{r}{7+q^2}} - p = r$<br>$\frac{r}{7+q^2} = (r+p)^2$<br>$q^2 = \frac{r}{(r+p)^2} - 7$<br>$q = \pm\sqrt{\frac{r}{(r+p)^2} - 7}$ |
| | **(b)(i)** | $300x + 800y = 22900$ |
| | **(b)(ii)** | $8x + 12y = 396$ or $2x + 3y = 99$ |
| | **(b)(iii)** | substitution or elimination<br>$x = 15$<br>$y = 23$ |
| **2** | **(a)** | $\frac{100}{v}$ |
| | **(b)** | $\frac{100}{v} + \frac{90}{v-25} = \frac{11}{4}$<br>$\frac{100(v-25)+90v}{v(v-25)} = \frac{11}{4}$<br>$760v - 10000 = 11v^2 - 275v$<br>$11v^2 - 1035v + 10000 = 0$ |
| | **(c)** | $\frac{-(-1035) \pm \sqrt{(-1035)^2 - 4(11)(10000)}}{2(11)}$<br>$= 83.16\,(2\text{dp})$ or $10.93\,(2\text{dp})$ |
| | **(d)** | 83.16<br>The other solution is rejected because it will give a negative speed for the second part of the journey. |
| | **(e)** | $\frac{90}{83.1589-25} - \frac{100}{83.1589}$<br>$= 21\,\text{min (nearest min)}$ |

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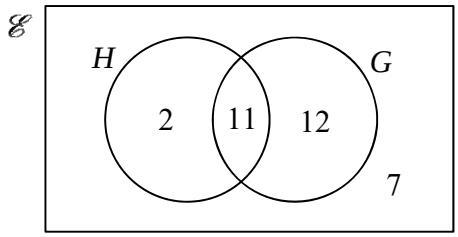
| | | |
|---|---|---|
| **3** | **(a)** | Triangle *RTS* |
| | **(b)(i)** | $P\hat{V}S = U\hat{V}Q$ (vertically opposite angles)<br>$V\hat{P}S = V\hat{U}Q$ (alternate angles, *PS* parallel to *QR*)<br>$V\hat{S}P = V\hat{Q}U$ (alternate angles, *PS* parallel to *QR*)<br>Thus, triangles *PVS* and *UVQ* are similar. |
| | **(b)(ii)** | $\frac{QV}{QS} = \frac{1}{3}$<br>$QS = 2QT$<br>$\frac{QV}{2QT} = \frac{1}{3}$<br>$\frac{QV}{QT} = \frac{2}{3}$<br>Thus, $QV = 2VT$ |
| | **(c)** | $\frac{\text{area of } \Delta QVU}{\text{area of trapezium} PURS}$<br>$= \frac{\text{area of } \Delta QVU}{\text{area of } \Delta QPU} \times \frac{\text{area of } \Delta QPU}{\text{area of trapezium} PURS}$<br>$= \frac{1}{3} \times \frac{3}{9}$<br>$= \frac{1}{9}$<br>Ratio is 1 : 9 |
| **4** | **(a)** | $\overrightarrow{QP} = \frac{1}{2}\overrightarrow{PL}$<br>$2\left(\overrightarrow{OP} - \overrightarrow{OQ}\right) = \overrightarrow{OL} - \overrightarrow{OP}$<br>$\overrightarrow{OL}$<br>$= 2\left[\begin{pmatrix} 5 \\ -8 \end{pmatrix} - \begin{pmatrix} -4 \\ 7 \end{pmatrix}\right] + \begin{pmatrix} 5 \\ -8 \end{pmatrix}$<br>$= \begin{pmatrix} 23 \\ -38 \end{pmatrix}$<br>$\left\lvert\overrightarrow{OL}\right\rvert = \sqrt{23^2 + (-38)^2}$<br>$= 44.4$ units (3sf) |
| | **(b)(i) (a)** | $\frac{2}{3}\mathbf{a} - \frac{2}{3}\mathbf{b}$ |
| | **(b)(i)(b)** | $\frac{1}{2}\mathbf{b} + \frac{2}{3}\mathbf{a} - \frac{2}{3}\mathbf{b}$<br>$= \frac{2}{3}\mathbf{a} - \frac{1}{6}\mathbf{b}$ |

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| **4** | **(b)(ii)** | $\overrightarrow{MP}$<br>$= 2\mathbf{a} - \frac{1}{2}\mathbf{b}$<br>$= 3\left(\frac{2}{3}\mathbf{a} - \frac{1}{6}\mathbf{b}\right)$<br>$= 3\overrightarrow{MN}$<br>Since $\overrightarrow{MP} = 3\overrightarrow{MN}$, points *M*, *N* and *P* are collinear. |
| | **(b)(iii)** | $\frac{1}{2}$ |
| **5** | **(a)** | vol of water : vol of oil : vol of funnel<br>= $10^3$ : $15^3 - 10^3$ : $20^3$<br>= 8 : 19 : 64 |
| | **(b)** | Volume of water<br>$= \frac{8}{64} \times \frac{1}{3}\pi(9^2)20$<br>$= 67.5\pi \text{ cm}^3$<br><br>Vol of water in cyindrical part of test-tube<br>$= 67.5\pi - \frac{2}{3}\pi(3)^3$<br>$= 49.5\pi$<br><br>Height of water in cylindrical part of test-tube<br>$= \frac{49.5\pi}{\pi(3)^2}$<br>$= 5.5$<br><br>Surface area in contact with water<br>$= 2\pi(3)^2 + 2\pi(3)(5.5)$<br>$= 160 \text{ cm}^2$ (3sf) |
| **6** | **(a)(i)** | $\frac{55\sin 95^o}{\sin 40^o}$<br>$= 85.2 \text{ m}$ (3sf) |
| | **(a)(ii)** | $\frac{1}{2} \times 55 \times 85.2392 \times \sin 45^o$<br>$= 1660 \text{ m}^2$ (3sf) |
| | **(a)(iii)** | $\angle BAC = \cos^{-1}\left(\frac{110^2 - 55^2 - 74^2}{-2(55)(74)}\right)$<br>$= 116.2^o$ (1dp) |
| | **(a)(iv)** | $360^o - (116.2403^o - 45^o)$<br>$= 288.8^o$ (1dp) |

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| | | |
|---|---|---|
| **6** | **(b)** | perpendicular distance from $B$ to $AC$ produced<br>$= 74\sin 63.7597^o$<br>$= 66.3741$<br>height of tower<br>$= 66.3741\tan 10^o$<br>$= 11.7$ m (3sf) |
| **7** | **(a)(i)** |  |
| | **(a)(ii)** | 14 students |
| | **(b)(ii)** | $D \subset P$ |
| | **(b)(ii)** | There are some students who play the drums <u>and</u> the piano. |
| | **(c)(i)** | $\begin{pmatrix}6450 & 5400 & 4150\end{pmatrix}$ |
| | **(c)(ii)** | Total number of boxes of cereals of <u>each size</u> delivered to all supermarkets over <u>4 months</u>. |
| | **(c)(iii)** | $\begin{pmatrix}650\\450\\450\end{pmatrix}$ |
| | **(c)(iv)** | Total number of boxes of cereals delivered <u>to each of the supermarkets per delivery</u>. |
| | **(c)(v)** | $13\begin{pmatrix}100 & 200 & 150\end{pmatrix}\begin{pmatrix}2.5\\4.25\\7.8\end{pmatrix}$<br>$= \begin{pmatrix}29510\end{pmatrix}$<br>Total amount is \$29510 |
| **8** | **(a)** | 6.29 |
| | **(b)** | correct plotted points (at least 8 points)<br>smooth curve |
| | **(c)** | Object is <u>8 metres from $O$</u> at <u>$t = 0$</u> |
| | **(d)** | $3.6 \pm 0.1$ and 3.8 seconds |
| **8** | **(e)** | $P$ labelled on graph at $(9.1 \pm 0.1, 4)$ |
| | **(f)** | $5.3 \pm 0.2$ |

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| | | |
|---|---|---|
| | **(g)** | Tangent drawn and calculation of gradient<br>$0.5 \pm 0.05$ |
| | **(h)(i)** | Draw the line $y = 5 - \frac{1}{4}t$ for $0 \le t \le 14$. |
| | **(h)(ii)** | $0.6 \pm 0.1$<br>$7.8 \pm 0.1$ |
| **9** | **(a)(i)** | 126 students |
| | **(a)(ii)** | $73 - 45$<br>$= 28$ marks |
| | **(b)(i)** | $\frac{105}{149}$ |
| | **(b)(ii)** | $\frac{82}{150} \times \frac{20}{149} \times 2$<br>$= \frac{328}{2235}$ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **(c)(i)** | $x$ (marks) | $0 < x \le 20$ | $20 < x \le 40$ | $40 < x \le 60$ | $60 < x \le 80$ | $80 < x \le 100$ |
| | | No of students | 10 | 20 | 40 or 41 | 60 or 59 | 20 |

| | | |
|---|---|---|
| | **(c)(ii)(a)** | 58 marks |
| | **(c)(ii)(b)** | 21.7 marks |
| | **(d)(i)** | Science examination is more difficult as it has a lower median mark. |
| | **(d)(ii)** | The interquartile range for the Science examination is larger. Hence the performance for Science examination is less consistent. |
| **10** | **(a)** | No of boxes of tiles required<br>$= \frac{5 \times 5 + 2.6}{0.2 \times 0.2} \div 25$<br>$= 27.6$<br>$= 28$ (whole number)<br>Total cost<br>$= 28 \times 66.25$<br>$= \$1855$<br><br>Length required |

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| | | |
|---|---|---|
| | | $= \frac{27.6}{1.8}$<br>$= 15.333$<br>$= 16 \text{ (whole number)}$<br><br>Cost of vinyl flooring<br>$= 16 \times 118.7$<br>$= \$1899.20$<br><br>Both types of floorings are within Mrs Wong's budget. |
| | **(b)** | Let advertised price be $A$<br>$\frac{1}{3} \times \frac{112A}{100} + 8 \times 92.6 + 200 = \frac{112A}{100}$<br>$940.8 = \frac{56A}{75}$<br>$A = \$1260$ |
| | **(c)** | $\frac{569.24}{107} \times 7$<br>$= \$37.24$ |

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