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BEATTY SECONDARY SCHOOL MID-YEAR EXAMINATION 2014

SUBJECT : Mathematics

LEVEL : Secondary 3 N(A)

PAPER : 4042 / 01

DURATION : 1 hour 30 min

SETTER : Mr Anthony Goh

DATE : 12 May 2014

CLASS :	NAME :	REG NO :
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READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces on the top of this page.

Write in dark blue or black pen.

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.

You are expected to use a scientific calculator to evaluate explicit numerical expressions.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

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

The total number of marks for this paper is 50.

For Examiner's Use

This paper consists of 11 printed pages (including this cover page)

*Mathematical Formulae**Compound Interest*

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

Mensuration

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Answer all questions.

- 1 (a) Evaluate $\frac{578.85 - 412.93}{4.53 \times \sqrt[3]{53.08}}$. Write down all the figures as shown on your calculator.

Answer (a) [1]

- (b) Give your answer correct to 3 significant figures.

Answer (b) [1]

- (c) Write down the difference between the values in (a) and (b).

Answer (c) [1]

- (d) Express the answer in (c) as a percentage of the exact value in (a).

Answer (d) % [1]

- 2 A human heart beats, on average, 70 times per minute.

How many times does the heart beat in one week? Give your answer in standard form.

Answer times in one week [2]

- 3 Simplify the following, giving your answers in positive indices.

(a) $\frac{x^5 y}{xy^2}$

Answer (a) [1]

(b) $(a^2)^{-5}$

Answer (b) [1]

4 (a) Solve the equation $3^x \div 27 = 81$.

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

(b) Given that $2^n = 2\sqrt{8}$, find the value of n .

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

5 Solve $3x(3+x) = 0$.

Answer (a) $x = \dots\dots\dots$ or $\dots\dots\dots$ [2]

Turn over

6 (a) Factorise $4x^2 + 17x - 15$.

Answer (a) [2]

(b) Hence, solve $4x^2 + 17x - 15 = 0$.

Answer (b) $x =$ or [2]

7 Given that $x = -1$ is a solution to the equation $x^2 + ax - 3 = 0$.

Find

(a) the value of a ,

Answer (a) $a =$ [1]

(b) the other solution to the equation $x^2 + ax - 3 = 0$.

Answer (b) $x =$ [2]

8 A triangle has a base of $(4x - 2)$ cm and a height of $(3x - 4)$ cm. It has an area of 35 cm^2 .

(a) Form an equation in x and show that it reduces to $6x^2 - 11x - 31 = 0$.

[2]

(b) Solve the equation $6x^2 - 11x - 31 = 0$.

Answer (b) $x = \dots\dots\dots$ or $\dots\dots\dots$ [2]

(c) Find the height of the triangle.

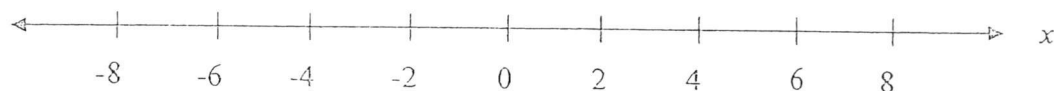
Answer (c) Height = $\dots\dots\dots$ cm [1]

Turn over

- 9 (a) Solve the inequality $-4 < 2x + 4 \leq 16$.

Answer (a) [3]

- (b) Draw the inequality $-3 < x \leq 4$ on the number line below.



[1]

- 10 Given that $2 \leq x \leq 7$ and $-6 \leq y \leq 4$, find

- (a) the largest value of $x - y$,

Answer (a) [1]

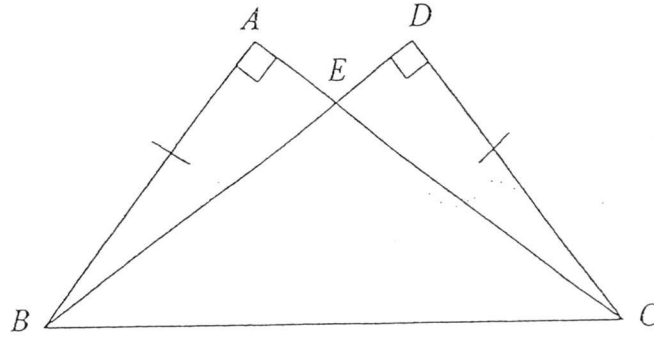
- (b) the smallest value of xy^2 ,

Answer (b) [1]

- (c) the value of y if $y^2 = 25$.

Answer (c) [1]

- 11 In the following figure, $AB = DC$ and $\angle BAE = \angle CDE = 90^\circ$.



- (a) Show that triangles ABE and DCE are congruent.

Answer (a) In triangles ABE and DCE

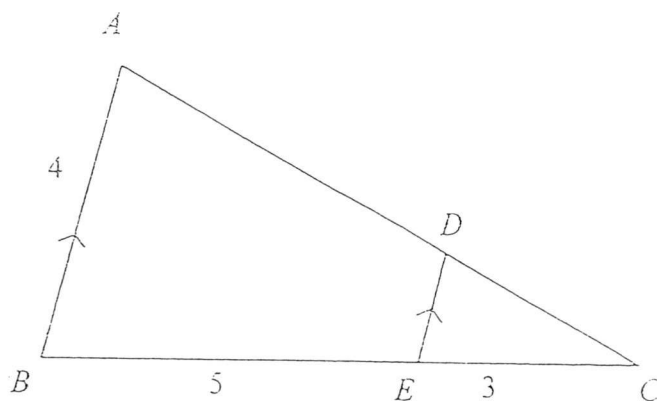
.....

 [2]

- (b) Name two other triangles that are congruent.

Answer (b) Triangles and [1]

- 12 In the diagram, ABC and DEC are triangles. AB is parallel to DE . $AB = 4$ cm, $BE = 5$ cm and $EC = 3$ cm.



- (a) Show that triangles ABC and DEC are similar.

Answer (a) In triangles ABC and DEC

.....

.....

.....

.....

[2]

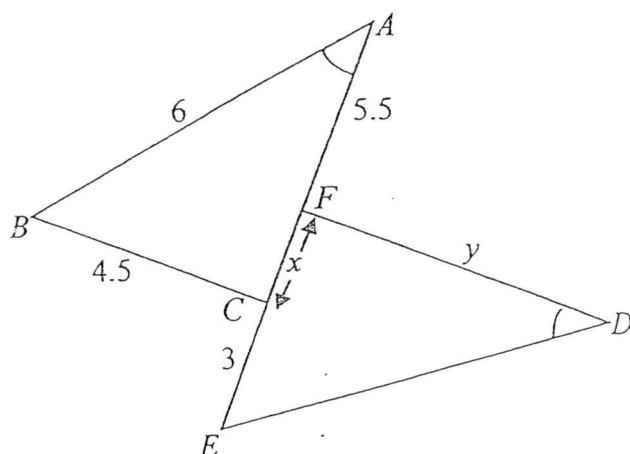
- (b) Calculate the length of DE .

Answer (b) $DE =$ cm [2]

- (c) Given that the area of triangle $DEC = 18 \text{ cm}^2$, find the area of triangle ABC .

Answer (c) Area of $\triangle ABC =$ cm^2 [2]

- 13 In the following figure, the triangles ABC and DEF are congruent.



Given that $AB = 6$ cm, $BC = 4.5$ cm, $AF = 5.5$ cm, $CE = 3$ cm, $CF = x$ cm and $DF = y$ cm.

Find the value of

- (a) x ,
(b) y .

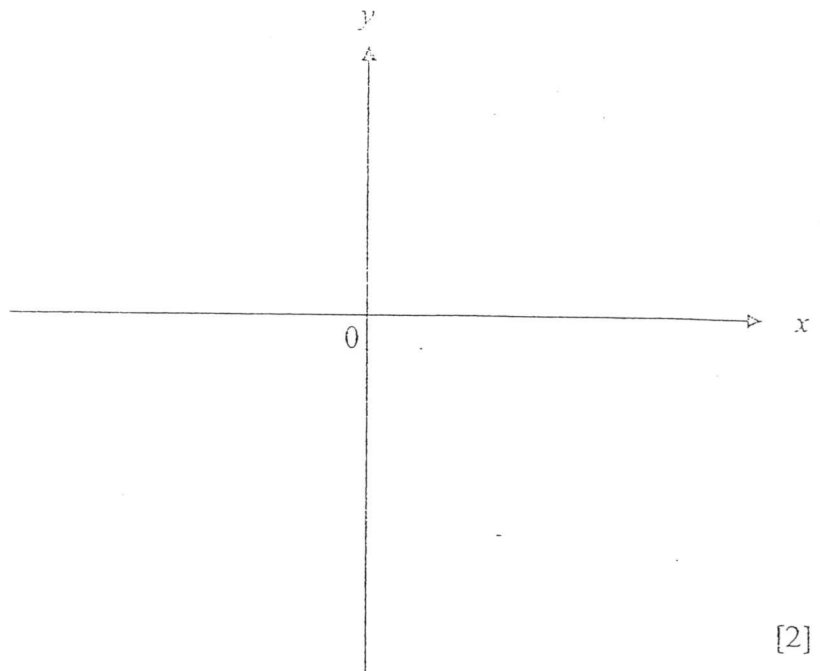
Answer (a) $x = \dots\dots\dots$ cm [2]

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

[Turn over

14 (a) (i) Sketch the graph of $y = x(4 - x)$, labelling all the axes intercepts.

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

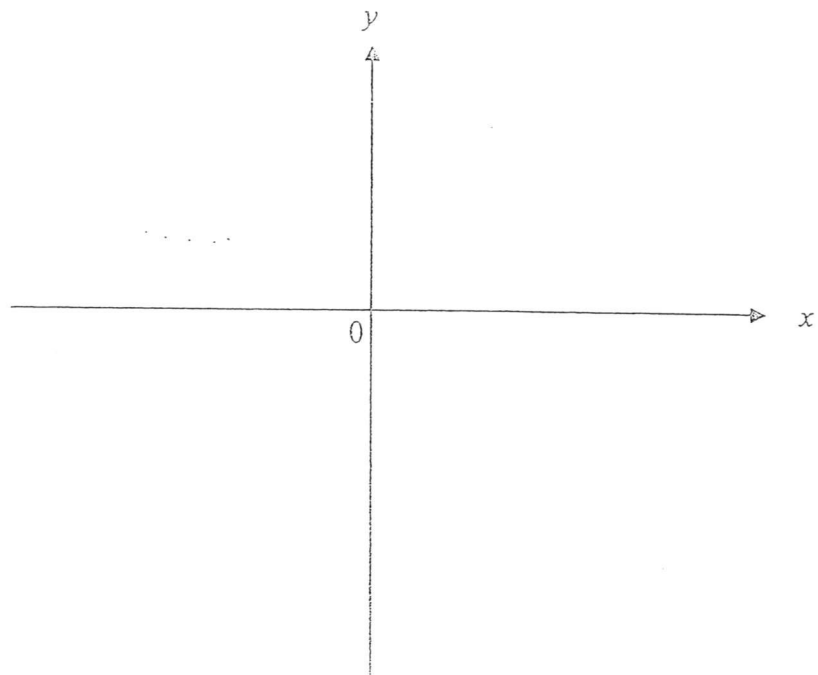


[2]

Answer (a)(ii) [1]

(b) (i) Sketch the graph of $y = (x + 3)^2 - 4$, labelling all the axes intercepts.

(ii) Write down the coordinates of the turning point of the curve.

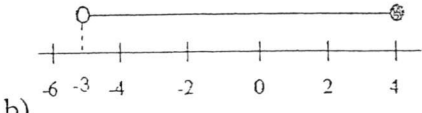
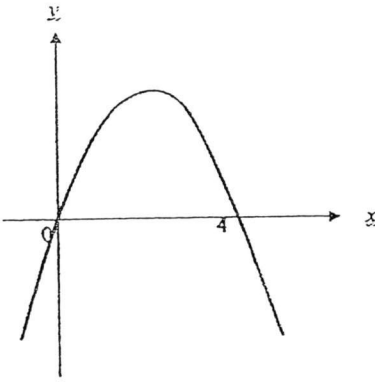
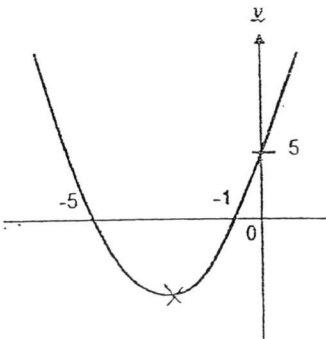


[2]

Answer (b)(ii) [1]

End of Paper

ANSWER KEY

1) a) 9.745936236 or 9.745936237 b) 9.75 c) 0.00406 or 0.004063763 or 0.004063764 or 0.004063387 d) 0.0417%	2) 7.06×10^5	3) a) $\frac{x^4}{y}$ b) $\frac{1}{a^{10}}$
4) a) 7 b) $2\frac{1}{2}$	5) 0 or -3	6) $(x+5)(4x-3)$
7) -0.5 or $\frac{3}{4}$	8) b) 3.37 or -1.53 c) 6.10 cm	9) a) $-4 < x \leq 6$ b) 
10) a) 13 b) 0 c) -5	11) a) $\triangle ABE \equiv \triangle DCE$ (AAS) b) $\triangle ABC$ and $\triangle DCB$	12) a) $\triangle ABC$ is similar to $\triangle DEC$ (AA) b) 1.5 cm c) 128 cm^2
13) a) 1.5 cm b) 7 cm	14 a) i)  ii) $x = 2$	14 b) i)  ii) $(-3, -4)$



Teacher's
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SUBJECT : Mathematics

LEVEL : Secondary 3 N(A)

PAPER : 4042 / 01

DURATION : 1 hour 30 min

SETTER : Mr Anthony Goh

DATE : 12 May 2014

CLASS :	NAME :	REG NO :
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For Examiner's Use
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[Turn over

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[Turn over

Answer all questions.

- 1 (a) Evaluate $\frac{578.85 - 412.93}{4.53 \times \sqrt[3]{53.08}}$. Write down all the figures as shown on your calculator.

Answer (a) 9.745936236 [B1] [1]

- (b) Give your answer correct to 3 significant figures.

Answer (b) 9.75 [B1] [1]

- (c) Write down the difference between the values in (a) and (b).

Answer (c) 0.00406 [B1] [1]

- (d) Express the answer in (c) as a percentage of the exact value in (a).

$$\frac{0.00406}{9.745936236} = 0.00041697 = 0.0417\% \quad [\text{B1}]$$

Answer (d) % [1]

- 2 A human heart beats, on average, 70 times per minute.

How many times does the heart beat in one week? Give your answer in standard form.

$$70 \times 60 \times 24 \times 7 \quad [\text{M1}]$$

$$= 7.056 \times 10^5 \quad [\text{A1}]$$

Answer times in one week [2]

- 3 Simplify the following, giving your answers in positive indices.

(a) $\frac{x^3y}{xy^2}$

$$\frac{x^3y}{xy^2} = \frac{x^2}{y} \quad [\text{B1}]$$

Answer (a) [1]

(b) $(a^2)^{-5}$

$$(a^2)^{-5} = a^{-10} = \frac{1}{a^{10}} \quad [\text{B1}]$$

Answer (b) [1]

- 4 (a) Solve the equation $3^x + 27 = 81$.

$$3^x + 27 = 81$$

$$3^x + 3^3 = 3^4$$

$$3^{x-3} = 3^1 \quad [\text{M1}]$$

$$x - 3 = 1$$

$$x = 4 \quad [\text{A1}]$$

Answer (a) $x =$ [2]

- (b) Given that $2^n = 2\sqrt{8}$, find the value of n .

$$2^n = 2\sqrt{8}$$

$$= 2(2^3)^{\frac{1}{2}}$$

$$= 2^{1+\frac{3}{2}}$$

$$= 2^{\frac{5}{2}}$$

$$\therefore n = \frac{5}{2} \quad [\text{B1}]$$

Answer (b) $n =$ [1]

- 5 Solve $3x(3+x) = 0$.

$$3x(3+x) = 0$$

$$3x = 0 \quad \text{or} \quad 3+x = 0 \quad [\text{M1}]$$

$$x = 0 \quad \text{or} \quad x = -3 \quad [\text{A1}]$$

Answer (a) $x =$ or [2]

- 6 (a) Factorise $4x^2 + 17x - 15$.

$$\begin{array}{r|l} 4x & -3 \\ x & 5 \\ \hline 4x^2 & -15 \\ & 17x \end{array}$$

[B1]

$$4x^2 + 17x - 15 = (x+5)(4x-3)$$

[B1]

Answer (a) [2]

- (b) Hence, solve $4x^2 + 17x - 15 = 0$.

$$4x^2 + 17x - 15 = 0$$

$$(x+5)(4x-3) = 0$$

$$x+5 = 0$$

or

$$4x-3 = 0$$

$$x = -5$$

[B1]

or

$$x = \frac{3}{4}$$

or 0.75

[B1]

Answer (b) $x =$ or [2]

- 7 Given that $x = -1$ is a solution to the equation $x^2 + ax - 3 = 0$.

Find

- (a) the value of a ,

$$(-1)^2 + a(-1) - 3 = 0$$

$$a = -2$$

[B1]

Answer (a) $a =$ [1]

- (b) the other solution to the equation $x^2 + ax - 3 = 0$.

$$x^2 - 2x - 3 = 0$$

$$(x+1)(x-3) = 0$$

[M1]

$$x = -1 \text{ or } 3$$

$\therefore$ the other solution is 3

[A1]

Answer (b) $x =$ [2]

- 8 A triangle has a base of $(4x-2)$ cm and a height of $(3x-4)$ cm. It has an area of 35 cm^2 .

- (a) Form an equation in x and show that it reduces to $6x^2 - 11x - 31 = 0$.

$$\frac{1}{2}(4x-2)(3x-4) = 35 \quad [\text{M1}]$$

$$12x^2 - 22x + 8 = 70$$

$$12x^2 - 22x - 62 = 0$$

$$6x^2 - 11x - 31 = 0$$

[A1]

[2]

- (b) Solve the equation $6x^2 - 11x - 31 = 0$.

$$x = \frac{-(-11) \pm \sqrt{(-11)^2 - 4(6)(-31)}}{2 \times 6} \quad [\text{M1}]$$

$$= \frac{11 \pm \sqrt{121 + 744}}{12}$$

$$= 3.3675 \text{ or } -1.5342$$

$$= 3.37 \text{ or } -1.53$$

[A1]

Answer (b) $x =$ [2]

- (c) Find the height of the triangle.

As x is positive, $x = 3.3675$

Height of triangle $= 3x - 4$

$$= (3 \times 3.3675) - 4$$

$$= 6.1025$$

$$= 6.10 \text{ cm (3 s.f.)}$$

[B1]

Answer (c) Height $=$ cm [1]

[Turn over

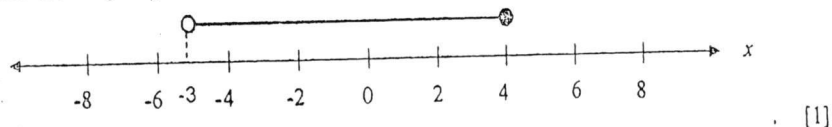
[Turn over

- 9 (a) Solve the inequality $-4 < 2x + 4 \leq 16$.

$$\begin{array}{lll} -4 < 2x + 4 & 2x + 4 \leq 16 & \\ -8 < 2x & 2x \leq 12 & \\ -4 < x & x \leq 6 & \text{[M1]} \\ \therefore -4 < x \leq 6 & & \text{[A1]} \end{array}$$

Answer (a) [3]

- (b) Draw the inequality $-3 < x \leq 4$ on the number line below.



- 10 Given that $2 \leq x \leq 7$ and $-6 \leq y \leq 4$, find

- (a) the largest value of $x - y$,

$$7 - (-6) = 7 + 6 = 13$$

Answer (a) 13 [B1] [1]

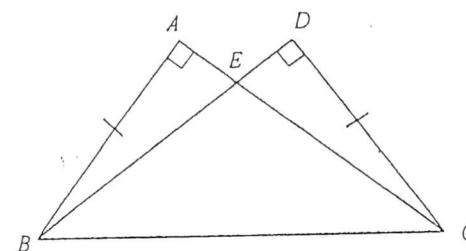
- (b) the smallest value of xy^2 ,

Answer (b) 0 [B1] [1]

- (c) the value of y if $y^2 = 25$.

Answer (c) -5 [B1] [1]

- 11 In the following figure, $AB = DC = 90^\circ$ and $\angle BAE = \angle CDE = 90^\circ$.



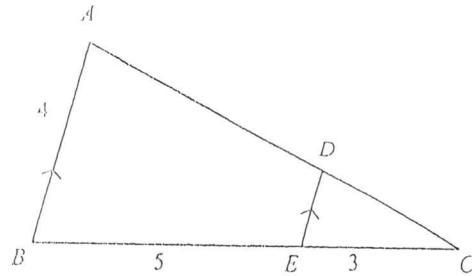
- (a) Show that triangles ABE and DCE are congruent.

$$\begin{array}{lll} \angle BAE = \angle CDE & \text{(given, A)} &) \\ \angle AEB = \angle DEC & \text{(vert opp } \angle\text{s, A)} &) \text{ [B1]} \\ AB = DC & \text{(given, S)} &) \\ \therefore \triangle ABE \equiv \triangle DCE & \text{(AAS)} & \text{[B1]} \end{array}$$

- (b) Name another pair of congruent triangles.

Answer (b) Triangles $\triangle ABC$ and $\triangle DCB$ [B1] [1]

- 12 In the diagram, ABC and DEC are triangles. AB is parallel to DE , $AB = 4$ cm, $BE = 5$ cm and $EC = 3$ cm.



- a) Show that triangles ABC and DEC are similar.

$$\begin{aligned} \angle ABC &= \angle DEC & (\text{corr } \angle, AB \parallel DE, A) &) \\ \angle BAC &= \angle EDC & (\text{corr } \angle, AB \parallel DE, A) &) \text{ Any 2 of the 3 [B1]} \\ \angle ACB &= \angle DCE & (\text{common angle, A}) &) \\ \therefore \triangle ABC &\text{ is similar to } \triangle DEC & (\text{AA}) & \end{aligned}$$

[B1]

[2]

- (b) Calculate the length of DE .

$$\begin{aligned} \frac{DE}{AB} &= \frac{EC}{BC} \\ \frac{DE}{4} &= \frac{3}{8} & [\text{M1}] \\ DE &= \frac{3}{8} \times 4 = 1.5 \text{ cm} & [\text{A1}] \end{aligned}$$

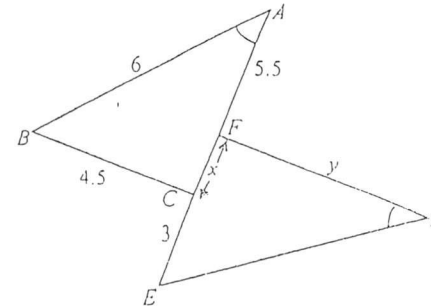
Answer (b) $CB = \dots\dots\dots$ cm [2]

- (c) Given that the area of triangle $DEC = 18 \text{ cm}^2$, find the area of triangle ABC .

$$\begin{aligned} \frac{\text{Area of } \triangle ABC}{\text{Area of } \triangle DEC} &= \left(\frac{BC}{EC} \right)^2 \\ \frac{\text{Area of } \triangle ABC}{18} &= \left(\frac{8}{3} \right)^2 & [\text{M1}] \\ \text{Area of } \triangle ABC &= 18 \times \frac{64}{9} \\ &= 128 \text{ cm}^2 & [\text{A1}] \end{aligned}$$

Answer (b) Area of $\triangle ABC = \dots\dots\dots$ cm² [2]

- 13 In the following figure, the triangles ABC and DEF are congruent.



Given that $AB = 6$ cm, $BC = 4.5$ cm, $AF = 5.5$ cm, $CE = 3$ cm, $CF = x$ cm and $DF = y$ cm.

Find the value of

(a) x ,

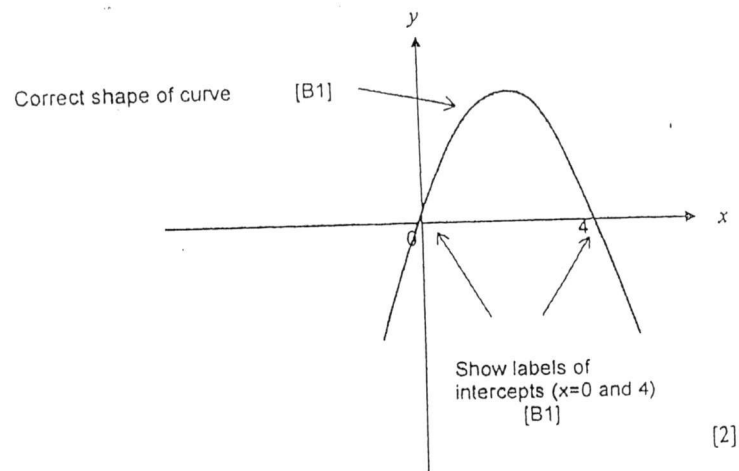
(b) y .

$$\begin{aligned} BC &= EF \\ 4.5 &= 3 + x & [\text{M1}] \\ x &= 4.5 - 3 \\ &= 1.5 \text{ cm} & [\text{A1}] \end{aligned}$$

$$\begin{aligned} FD &= AC \\ y &= 5.5 + 1.5 \\ &= 7 \text{ cm} & [\text{B1}] \end{aligned}$$

Answer $x = \dots\dots\dots$ cm, $y = \dots\dots\dots$ cm [3]

- 14 (a) (i) Sketch the graph of $y = x(4 - x)$, labelling all the axes intercepts.
 (ii) Write down the equation of the line of symmetry.

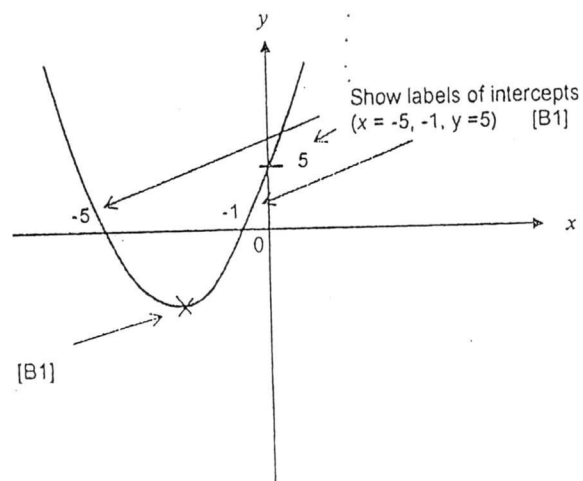


Answer (a)(ii) $x = 2$ [B1] [1]

- (b) (i) Sketch the graph of $y = (x + 3)^2 - 4$, labelling all the axes intercepts.
 (ii) Write down the coordinates of the turning point of the curve.

$$\begin{aligned}(x+3)^2 - 4 &= 0 \\(x+3)^2 &= 4 \\x+3 &= \pm 2 \\x &= -3+2 \text{ or } -3-2 \\&= -1 \text{ or } -5\end{aligned}$$

Correct shape of curve



Note: Must have brackets and comma

Answer (b)(ii) $(-3, -4)$ [B1] [1]

End of Paper



BEATTY SECONDARY SCHOOL
MID YEAR EXAMINATION 2014

SUBJECT : Mathematics

LEVEL : Sec 3 Normal Academic

PAPER : 4042 /02

DURATION : 1 hour 30 minutes

SETTER : Mr. Cheong Boon Wee

DATE : 19 May 2014

CLASS :	NAME :	REG NO :
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For π , use either your calculator value or 3.142.

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

This paper consists of 6 printed pages (including this cover page)

1 Solve the inequality $\frac{3x}{2} - \frac{13x}{9} < 5 - \frac{x}{3}$. [2]

2 (a) Express $x^2 + 12x - 17$ in the form of $(x - h)^2 + k$. [2]

(b) Hence solve the equation $x^2 + 12x - 17 = 0$, giving your answers correct to two decimal place. [3]

3 Solve the following equations.

(a) $\frac{x}{25} = \frac{256}{x}$ [2]

(b) $\frac{12}{x+2} - \frac{3}{x} = 1$ [3]

4 (a) Solve $\frac{1}{625} = 5^{(6-3x)}$. [2]

(b) Given that $a^{1m} = 216$, find the value of $5a^n$. [2]

5 It is estimated that the average diameter of one haze particle is 2.48 micrometres.

(a) Express this diameter in metres.
Give your answer in standard form. [1]

(b) If 6.12×10^9 haze particles are arranged side by side, find the total length of the string of haze particles, in kilometres. [2]

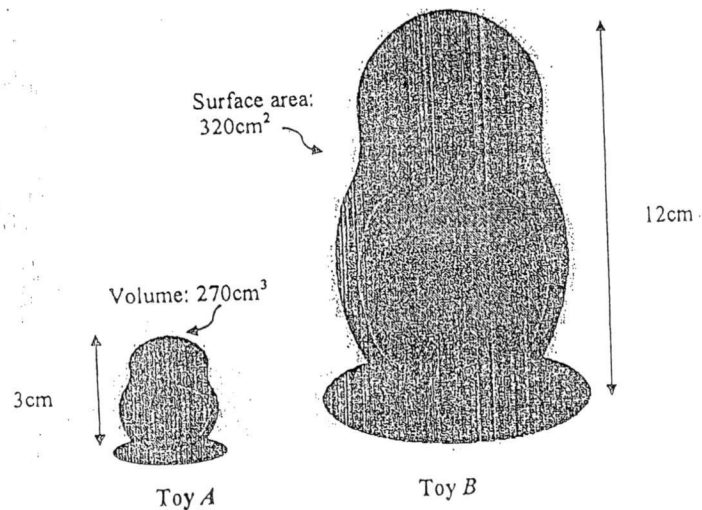
6 Simplify the following, expressing your answer in positive index notation.

(a) $\left(\sqrt[4]{\sqrt[3]{b^5}}\right)^{-1}$ [2]

(b) $\frac{(-3m^3n^5)^3}{(2m^2n^4)^4} + \frac{(m^{-4})^2}{(m^3n)^2}$ [3]

[Turn Over]

- 7 The diagram below shows two similar toys with circular bases. The height of Toy A is 3 cm, while the height of Toy B is 12 cm. The volume of Toy A is 270 cm^3 , while the surface area of Toy B is 320 cm^2 .



- (a) Find
- the ratio of the diameters of the bases of both toys,
 - the surface area of Toy A,
 - the volume of the Toy B.
- (b) Two Toy Bs were melted to make Toy A. How many Toy As can be produced?

[1]

[2]

[2]

[2]

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

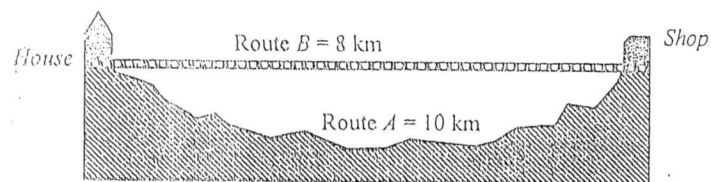
The table shows some values for the graph of $y = -x^2 + 3x + 2$.

x	-0.5	0.5	1	2	2.5	3	4
y	0.25	3.25	4	a	3.25	2	-2

- (a) Calculate the value of a . [1]
- (b) Using a scale of 2cm to 1 unit, draw a horizontal x -axis for $-1 \leq x \leq 4$.
Using a scale of 2cm to 1 unit, draw a vertical y -axis for $-2 \leq y \leq 5$.
Plot the points, from the table of values above, on the axes. Join the points with a smooth curve. [3]
- (c) Use your graph to find
- the value of y when $x = 1.5$, [1]
 - the coordinates of the turning point of the curve, [1]
 - the coordinates where the curve cuts the y -axis, [1]
 - the solutions to the equation $-x^2 + 3x + 2 = 0$. [2]

[Turn Over]

- 9 A shop can be reached via Route A or Route B from Elton's house.
Route A is 10 km and Route B is 8 km.



- (a) On a particular day, Elton cycled to the shop on Route A, at an average speed of m km/h.
Find an expression in terms of m , for the time taken, in hours, to reach the shop.

[1]

- (b) He returned home on Route B at an average speed that was 2 km/h faster than his speed on Route A.
Find an expression in terms of m , for the time taken, in hours, to reach his home.

[1]

- (c) Elton took 15 minutes longer on Route A to the shop than to cycle on Route B.
Write down an equation to represent this information and show that it simplifies to

$$m^2 - 6m - 80 = 0.$$

[3]

- (d) Solve the equation $m^2 - 6m - 80 = 0$, giving your solutions correct to 2 decimal places.

[3]

- (e) Calculate the total time Elton spent cycling on Route A and Route B.
Give your answers in hours and minutes.

[2]

~~~ End of Paper ~~~

## Answer Key

1.  $x < 12\frac{6}{7}$  or 12.9 (3sf)    2(a)  $(x+6)^2 - 53$     2(b)  $x = 1.28$  (2d.p) or  $-13.28$  (2d.p)

3(a)  $x = \pm 80$     3(b)  $x = 6$  or  $x = 1$     4(a)  $x = 6\frac{2}{3}$  or 6.67 (3sf)    4(b)  $5a'' = 30$

5(a)  $2.48 \times 10^{-6}$  metres    5(b) 15.2 km    6(a)  $\frac{1}{b^{12}}$     6(b)  $\frac{-27m^{13}n}{16}$

7(ai)  $\frac{\text{Diameter of Toy B}}{\text{Diameter of Toy A}} = \frac{4}{1}$  or  $\frac{\text{Diameter of Toy A}}{\text{Diameter of Toy B}} = \frac{1}{4}$

7(a(ii))  $20 \text{ cm}^2$     7(a(iii))  $17280 \text{ cm}^3$

7(b) 128

8(a)  $a=4$

8(c)

(i)  $x = 4.25$

(ii) (1.5, 4.25)

(iii) (0, 2)

(iv)  $x = -0.5, 3.5$  ( $\pm 0.1$ )

9(a)  $\frac{10}{m}$  hours    9(b)  $\frac{8}{m+2}$  hours    9(d)  $m = 12.43$  or  $m = -6.43$

9(e) 1.358 hours = 1 hour 22 minutes



BEATTY SECONDARY SCHOOL  
MID YEAR EXAMINATION 2014  
ANSWER KEY

SUBJECT : Mathematics

LEVEL : Sec 3 Normal Academic

PAPER : 4042 /02

DURATION : 1 hour 30 minutes

SETTER : Mr Cheong Boon Wee

DATE : 19 May 2014

$$1 \quad \frac{3x}{2} - \frac{13x}{9} < 5 - \frac{x}{3}$$

$$\frac{27x - 26x}{18} < \frac{15 - x}{3} \quad (M1)$$

$$3x < 18(15 - x)$$

$$3x < 270 - 18x$$

$$21x < 270$$

$$x < \frac{270}{21}$$

$$x < 12\frac{6}{7} \text{ or } 12.9 \text{ (3sf)} \quad (A1)$$

$$2(a) \quad x^2 + 12x - 17 = \left(x + \frac{12}{2}\right)^2 - \left(\frac{12}{2}\right)^2 - 17 \quad (M1)$$

$$= (x + 6)^2 - 36 - 17$$

$$= (x + 6)^2 - 53 \quad (A1)$$

$$2(b) \quad x^2 + 12x - 17 = 0$$

$$(x + 6)^2 - 53 = 0$$

$$(x + 6)^2 = 53$$

$$(x + 6) = \pm\sqrt{53} \quad (M1)$$

$$x = -6 \pm \sqrt{53}$$

$$x = 1.28 \text{ (2d.p.) or } -13.28 \text{ (2d.p.)} \quad (A2)$$

$$3(a) \quad \frac{x}{25} = \frac{256}{x}$$

$$x^2 = 6400 \quad (M1)$$

$$x = \pm\sqrt{6400}$$

$$x = \pm 80 \quad (A1)$$

$$3(b) \quad \frac{12}{x+2} - \frac{3}{x} = 1$$

$$\frac{12x - 3(x+2)}{x(x+2)} = 1 \quad (M1)$$

$$12x - 3(x+2) = x(x+2)$$

$$12x - 3x - 6 = x^2 + 2x$$

$$x^2 - 7x + 6 = 0$$

$$(x-6)(x-1) = 0 \quad (M1)$$

$$x = 6 \text{ or } x = 1 \quad (A1)$$

$$4(a) \quad \frac{1}{625} = 5^{16-3x}$$

$$\frac{1}{5^4} = 5^{16-3x} \quad (M1)$$

$$5^{-4} = 5^{16-3x}$$

$$-4 = 16 - 3x$$

$$3x = 20$$

$$x = 6\frac{2}{3} \text{ or } 6.67 \text{ (3sf)} \quad (A1)$$

$$4(b) \quad a^{3n} = 216$$

$$a^{3n} = 6^3 \quad (M1)$$

$$(a^n)^3 = 6^3$$

$$a^n = 6$$

$$5a^n = 30 \quad (A1)$$

$$5(a) \quad \text{Diameter of haze particle} = 2.48 \times 10^{-6} \text{ metres} \quad (B1)$$

$$5(b) \quad \text{Total length} = (6.12 \times 10^9) \times (2.48 \times 10^{-6}) \quad (M1)$$

$$= 15177.6 \text{ m}$$

$$= 15.1776 \text{ km} = 15.2 \text{ km} \text{ (3sf)} \quad (A1)$$

$$\begin{aligned}
 6(a) \quad (\sqrt[3]{\sqrt{b^5}})^{-1} &= (\sqrt[3]{b^{\frac{5}{2}}})^{-1} \\
 &= \left( (b^{\frac{5}{2}})^{\frac{1}{3}} \right)^{-1} \quad (M1) \\
 &= b^{-\frac{5}{12}} \\
 &= \frac{1}{b^{\frac{5}{12}}} \quad (A1)
 \end{aligned}$$

$$\begin{aligned}
 6(b) \quad \frac{(-3m^3n^5)^3}{(2m^2n^4)^4} + \frac{(m^{-4})^2}{(m^3n)^2} &= \frac{(-3)^3 m^9 n^{15}}{2^4 m^8 n^{16}} + \frac{m^{-8}}{m^6 n^2} \quad (M1) \\
 &= \frac{(-3)^3 m^9 n^{15}}{2^4 m^8 n^{16}} \times \frac{m^6 n^2}{m^8} \quad (M1) \\
 &= \frac{-27 m^{9+6} n^{15+2}}{16 m^{8+(-8)} n^{16}} \\
 &= \frac{-27 m^{15} n^{17}}{16 n^{16}} \\
 &= \frac{-27 m^{15} n}{16} \quad (A1)
 \end{aligned}$$

$$7(a) \quad (i) \quad \frac{\text{Diameter of Toy A}}{\text{Diameter of Toy B}} = \frac{3}{12} = \frac{1}{4} \quad (B1) \quad \text{or} \quad \frac{\text{Diameter of Toy B}}{\text{Diameter of Toy A}} = \frac{12}{3} = \frac{4}{1} \quad (B1)$$

$$7(a) \quad (ii) \quad \frac{\text{Surface area of Toy A}}{\text{Surface area of Toy B}} = \left( \frac{1}{4} \right)^2 \quad (M1)$$

$$\begin{aligned}
 \frac{\text{Surface area of Toy A}}{320} &= \frac{1}{16} \\
 \text{Surface area of Toy A} &= 20 \text{ cm}^2 \quad (A1)
 \end{aligned}$$

$$\begin{aligned}
 7(a) \quad (iii) \quad \frac{\text{Volume of Toy A}}{\text{Volume of Toy B}} &= \left( \frac{1}{4} \right)^3 \quad (M1) \\
 \frac{270}{\text{Volume of Toy B}} &= \frac{1}{64}
 \end{aligned}$$

$$\text{Volume of Toy B} = 17280 \text{ cm}^3 \quad (A1)$$

$$\begin{aligned}
 7(b) \quad \text{Number of Toy A that can be produced} \\
 &= \frac{17280 \times 2}{270} \quad (M1) \\
 &= 128 \quad (A1)
 \end{aligned}$$

$$8(a) \quad a = 4 \quad (B1)$$

8(b) Refer to the graph attached  
 Correct points plotted (G1)  
 Correct axis with labellings (G1)  
 Smooth curve plotted (G1)

$$\begin{aligned}
 8(c) \quad (i) \quad x &= 4.25 \quad (\pm 0.1) \quad (B1) \\
 (ii) \quad (1.5, 4.25) & \quad (B1) \\
 (iii) \quad (0, 2) & \quad (B1) \\
 (iv) \quad x &= -0.5, 3.5 \quad (\pm 0.1) \quad (B2)
 \end{aligned}$$

$$9(a) \quad \text{Time taken to reach the shop} = \frac{\text{Distance}}{\text{Time}} = \frac{10}{m} \text{ hours} \quad (B1)$$

$$9(b) \quad \text{Time taken to reach home} = \frac{8}{m+2} \text{ hours} \quad (B1)$$

$$9(c) \quad \frac{8}{m+2} + \frac{15}{60} = \frac{10}{m} \quad (M1)$$

$$\frac{8}{m+2} + \frac{1}{4} = \frac{10}{m}$$

$$\frac{32 + (m+2)}{4(m+2)} = \frac{10}{m}$$

$$\frac{34 + m}{4(m+2)} = \frac{10}{m}$$

$$m(34 + m) = 40(m+2) \quad (M1)$$

$$m^2 + 34m = 40m + 80$$

$$m^2 - 6m - 80 = 0 \quad (\text{Shown}) \quad (A1)$$

$$9(d) \quad m^2 - 6m - 80 = 0$$

$$(m-3)^2 - 3^2 - 80 = 0 \quad (M1)$$

$$(m-3)^2 = 89$$

$$m-3 = \pm\sqrt{89} \quad (M1)$$

$$m = 12.43 \text{ or } m = -6.43 \quad (A1)$$

$$(2dp) \quad (2dp)$$

$$m^2 - 6m - 80 = 0$$

$$m = \frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(-80)}}{2} \quad (M1)$$

$$m = \frac{6 \pm \sqrt{356}}{2} \quad (M1)$$

$$m = 12.43 \text{ or } m = -6.43 \quad (A1)$$

$$(2dp) \quad (2dp)$$

$$9(e) \quad \text{Since } m = 12.43,$$

$$\text{Total time taken for whole journey} = \frac{10}{m} + \frac{8}{m+2}$$

$$= \frac{10}{12.43} + \frac{8}{12.43+2} \quad (M1)$$

$$= 1.358 \text{ hours}$$

$$= 1 \text{ hour } 22 \text{ minutes} \quad (A1)$$

| Question    |      | Marks Allocated |
|-------------|------|-----------------|
| 1           |      | 2               |
| 2           | a    | 2               |
|             | b    | 3               |
| 3           | a    | 2               |
|             | b    | 3               |
| 4           | a    | 2               |
|             | b    | 2               |
| 5           | a    | 1               |
|             | b    | 2               |
| 6           | a    | 2               |
|             | b    | 3               |
| 7           | a    | 1               |
|             | b    | 2               |
|             | c    | 2               |
|             | d    | 2               |
| 8           | a    | 1               |
|             | b    | 3               |
|             | ci   | 2               |
|             | cii  | 1               |
|             | ciii | 1               |
| 9           | a    | 1               |
|             | b    | 2               |
|             | c    | 3               |
|             | d    | 3               |
|             | e    | 2               |
| Total Marks |      | 50              |