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**BEATTY SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2014**

SUBJECT : Mathematics

LEVEL : Secondary 3 Express

PAPER : 4016 / 01

DURATION : 1 hour 15 minutes

SETTER : Chai Yoke Leng

DATE : 7 October 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
50

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

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

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

1 The bacteria population in Culture A is 3 560 000 000.

(a) Express 3 560 000 000 in standard form.

Answer (a) [1]

(b) The bacteria population in Culture B is 16.89 billion

Find the difference in population of these two cultures. Give your answer in standard form.

Answer (b) [2]

2 Simplify $\sqrt{\frac{p^2}{4q^4}} \div 16p^{-1}$, giving your answer in positive indices.

Answer [2]

- 3 (a) Given that $a^m = 3$ and $a^n = 5$, find the value of

(i) a^{2m}

Answer (a)(i) [1]

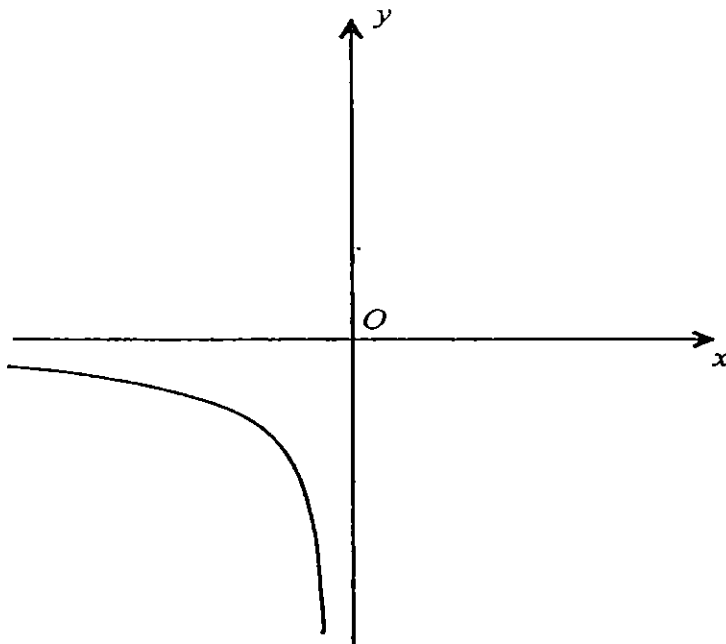
(ii) a^{m-n}

Answer (a)(ii) [1]

- (b) Solve the equation $16^{2-x} = 8$

Answer (b) [2]

- 4 The diagram shows the sketch for the graph of $y = \frac{a}{x^2}$ for $x < 0$.



- (a) Complete the sketch. [1]
 (b) Write down a possible value of a .

Answer (b)..... [1]

5 Solve the following equations.

(a) $2(x+1)^2 = 3(x+1)$

Answer (a) [2]

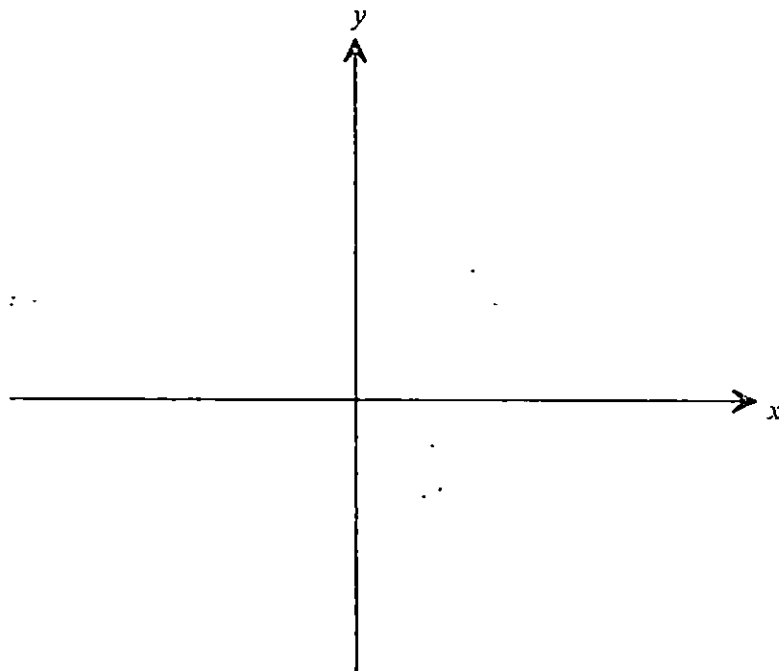
(b) $3x^2 = 5x + 1$

Answer (b) [2]

- 6 (a) Express $x^2 + 4x - 1$ in the form $(x + p)^2 + q$.

Answer (a) [2]

- (b) Sketch the graph of $y = -(x - 2)^2 + 3$, indicating clearly the y - intercept and the coordinates of the turning point. [2]



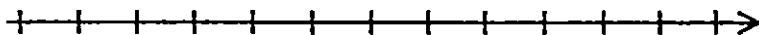
- 7 (a) Find the largest integer value of x for which $\frac{x}{3} - \frac{1}{4} \leq \frac{x+11}{12}$.

Answer (a) [2]

- (b) (i) Solve the inequality $3x - 1 < 5x + 3 \leq 2x + 15$.

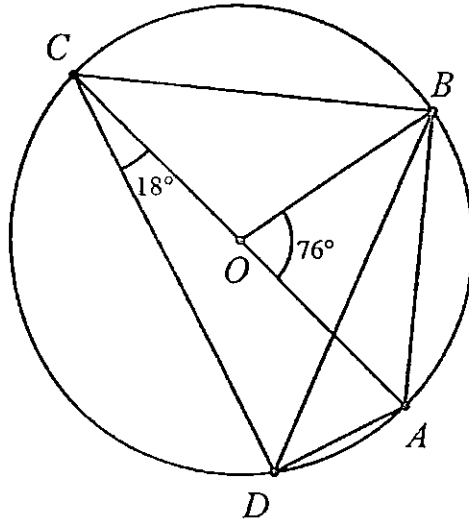
Answer (b)(i) [2]

- (ii) Illustrate the solution to (b)(i) on a number line. [1]



- 8 In the diagram, AC is the diameter of the circle centre O . $\angle BOA = 76^\circ$ and $\angle ACD = 18^\circ$.

Find, stating reasons



- (a) $\angle ABD$,

Answer (a) [1]

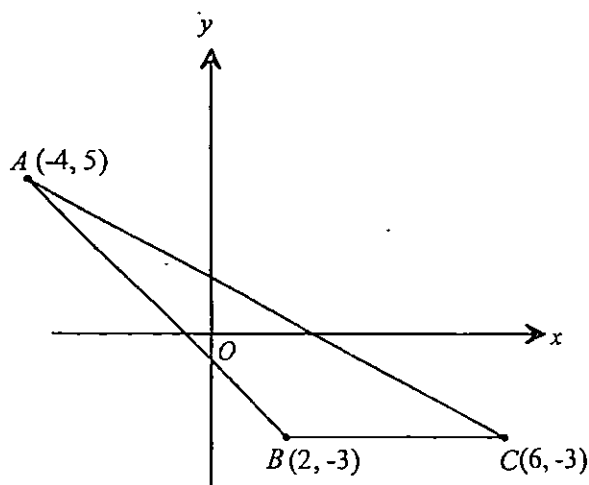
- (b) $\angle DBC$,

Answer (b) [1]

- (c) $\angle BAD$.

Answer (c) [2]

- 9 The diagram shows three points $A(-4, 5)$, $B(2, -3)$ and $C(6, -3)$.



- (a) Find the equation of AC .

Answer (a) [2]

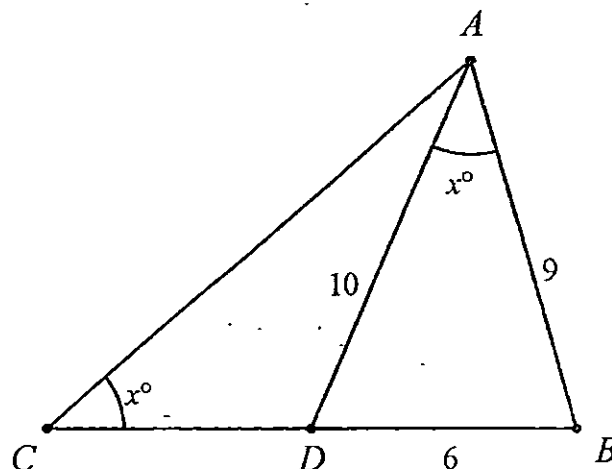
- (b) Find the length of AB .

Answer (b) [1]

- (c) Write down the exact value of $\cos \angle ABC$.

Answer (c) [1]

- 10 In the diagram, $AB = 9$ cm, $AD = 10$ cm, $DB = 6$ cm and $\angle ACB = \angle BAD = x^\circ$.



- (a) Prove that $\triangle ABC$ and $\triangle DBA$ are similar.

Answer (a)

.....

 [2]

- (b) Find the length of AC .

Answer (b) [2]

- 11 Two similar containers have base areas of 36 cm^2 and 100 cm^2 .

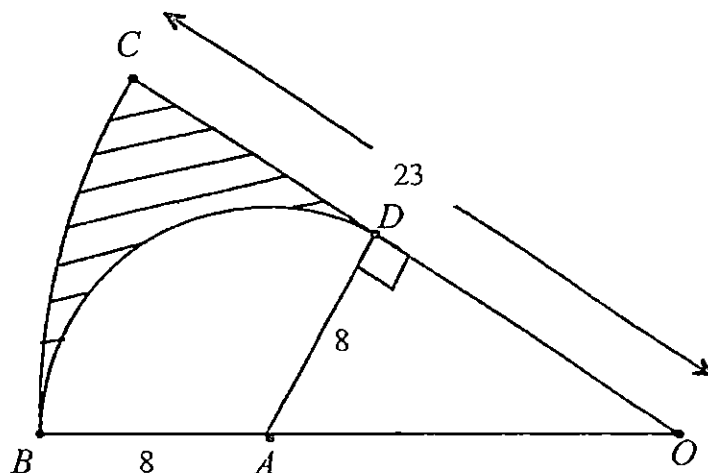
- (a) Given that the height of the larger container is 50 cm, find the height of the smaller container.

Answer (a) cm [2]

- (b) If the volume of the smaller container is 640 cm^3 , find the volume of the larger container.

Answer (b) cm^3 [2]

- 12 The diagram shows a sector OBC of a circle centre O and radius 23 cm. BAD is a sector of the circle centre A and radius 8 cm and $\angle ADO = 90^\circ$. Calculate



- (a) $\angle AOD$,

Answer (a) [2]

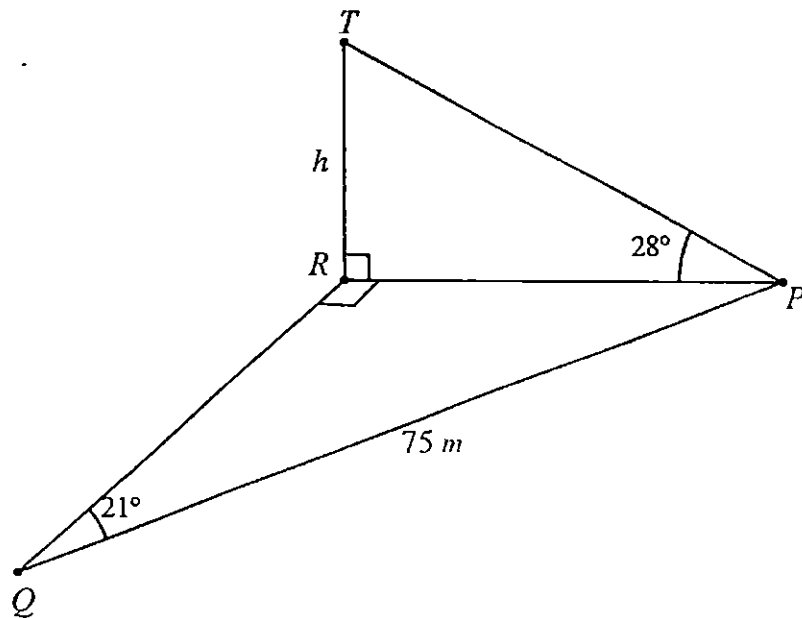
- (b) length of the arc BC ,

Answer (b) cm [2]

- (c) area of the shaded region BCD .

Answer (c) cm^2 [2]

13



In the diagram, P , Q and R are on level ground.

Alan is working out the height, h metres, of a building RT . He measures the angle TPR as 28° .

He was not able to measure the distance PR and so he walks 75 m from P to Q , where $\angle PQR = 21^\circ$ and $\angle PRQ = 90^\circ$. Calculate

(a) the distance PR ,

Answer (a) m [2]

(b) the height of the building, RT .

Answer (b) m [2]

End of Paper

Answer Key:

- 1 (a) 3.56×10^9 (b) 1.333×10^{10}
- 2 $\frac{p^2}{32q^2}$
- 3 (a) (i) 9 (ii) $\frac{3}{5}$ (b) $1\frac{1}{4}$
- 4 (a) sketch (b) any negative real number
- 5 (a) $-1, \frac{1}{2}$ (b) $1.85, -0.180$
- 6 (a) $(x+2)^2 - 5$ (b) sketch
- 7 (a) 4 (b) (i) $-2 < x \leq 4$ (ii) number line
- 8 (a) 18° (b) 72° (c) 124°
- 9 (a) $y = -\frac{4}{5}x + 1\frac{4}{5}$ (b) 10 units (c) $-\frac{3}{5}$
- 10 (a) $\angle ABC = \angle DBA$ (common angle). $\angle ACB = \angle DAB = x^\circ$ (given), hence $\triangle ABC$ is similar to $\triangle DBA$ (AA)
 (b) 15 cm
- 11 (a) 30 cm (b) $2962\frac{26}{27} \text{ cm}^3$
- 12 (a) 32.2° (b) 12.9 cm (c) 29.8 cm^2
- 13 (a) 26.9 m (b) 14.3 m



**BEATTY SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2014**

SUBJECT : Mathematics

LEVEL : Sec 3 Express

PAPER : 2

DURATION : 1 hour 30 minutes

SETTER : Mr Bernard Lee

DATE : 8 Oct 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.

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Omission of essential working will result in loss of marks.

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three significant figures. Give answers in degrees to one decimal place.

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

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

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

The total number of marks for this paper is 50.

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

Mathematical Formulae

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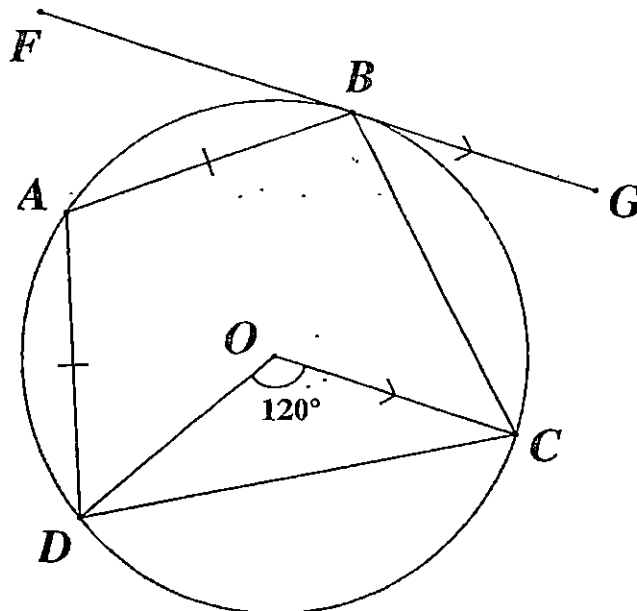
Answer all the questions.

1 (a) Simplify $\frac{x^2 + 3x - 4}{4x - 4}$. [2]

(b) Find the largest prime number x which satisfies the inequality $-\frac{1}{4}x > -5$ [2]

(c) Simplify $\left(\frac{5}{2x^2}\right)^{-3} \div 5x$. [2]

2



A, B, C and D lie on a circle, centre O . FBG is tangent to the circle at B , and is parallel to OC . $AB = AD$ and $\widehat{COD} = 120^\circ$.

(a) Show clearly that $\widehat{BCO} = 45^\circ$. [2]

(b) Stating your reasons clearly, find

(i) $\widehat{OCD}$, [1]

(ii) $\widehat{DAB}$, [1]

(iii) $\widehat{DBC}$, [1]

(iv) $\widehat{ABC}$. [2]

[Turn over

3 The cost of a \$500 birthday present is to be shared equally by x people.

(a) Write down the amount of money that each person has to pay in terms of x . [1]

4 more people decide to share the cost of the present as well.

(b) Write down the new amount of money that each person has to pay in terms of x . [1]

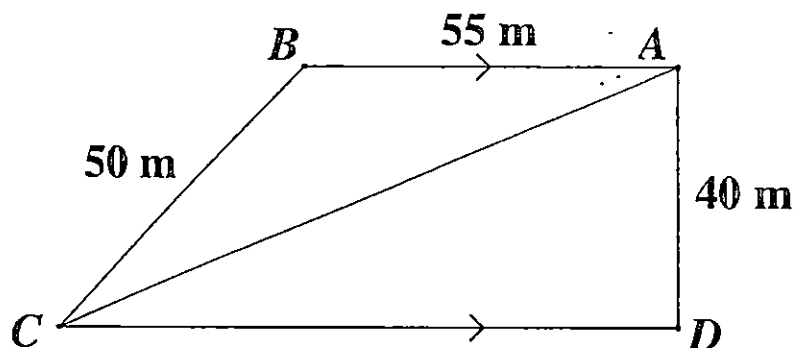
After the addition of 4 people, each person pays \$6.25 less.

(c) Form an equation in x and shows that it reduces to $x^2 + 4x - 320 = 0$. [3]

(d) Solve the equation $x^2 + 4x - 320 = 0$. [3]

(e) Hence, find the new amount of money that each person has to pay. [1]

4 Points A , B , C and D are on level ground, where $AB = 55$ m, $BC = 50$ m and $AD = 40$ m.
 B is due west of A and D is due south of A . BA is parallel to CD .



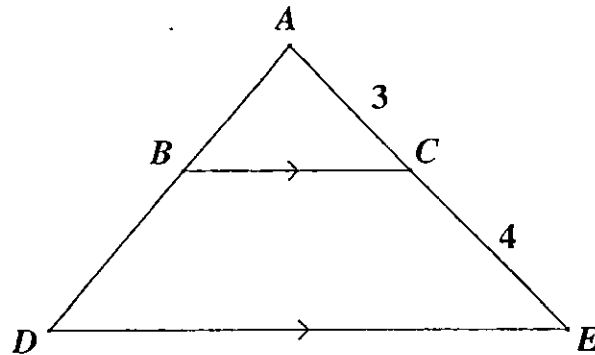
(a) Calculate the bearing of D from B . [2]

(b) Show that $CD = 85$ metres. [1]

(c) Calculate $\hat{ABC}$. [3]

(d) Calculate the area of the trapezium $ABCD$. [2]

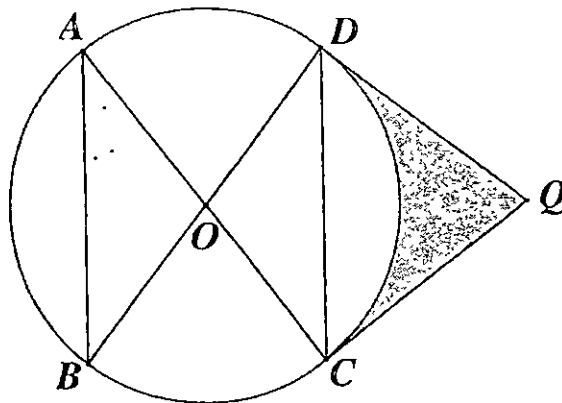
- 5(a) In the diagram below, B and C are points on AD and AE such that BC is parallel to DE . $AC = 3$ cm and $CE = 4$ cm.



Find the ratio $\frac{\text{Area of } \triangle ABC}{\text{Area of quadrilateral } BCED}$.

[2]

(b)



AOC and BOD are diameters of a circle with O as the centre. DQ and CQ are tangents to the circle.

- (i) Show that $\triangle ABO \cong \triangle DCO$. [3]
- (ii) It is given that $\angle DOC = 1.92$ radians and the radius of the circle is 8 cm.
 - (a) Show that the area of quadrilateral $DOCQ$ is 91.4 cm^2 . [2]
 - (b) Calculate the shaded area. [2]

6 Answer the whole of this question on the graph paper provided.

The variables t and v are connected by the equation $v = \frac{800}{t^2} + 32 - \frac{320}{t}$. Some corresponding values of t and v are given in the table below.

t	2.5	3	4	5	10	15	20	25	30
v	32	p	2	0	8	14.2	18	20.5	22.2

- (a) Calculate the value of p . [1]
- (b) Using a scale of 2 cm to represent 5 units on each axis, draw a horizontal t -axis for $2.5 \leq t \leq 40$ and a vertical v -axis for $0 \leq v \leq 25$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]
- (c) Write down the coordinates of the turning point of the curve. [1]
- (d) By drawing a tangent, find the gradient of the curve at the point (20, 18). [2]
- (e) On the same axes, draw the graph of $v = 32 - t$ for $0 \leq t \leq 40$. [2]
- (f) (i) Write down the t -coordinates of the points where the two graphs intersect. [1]
- (ii) These values of t are solutions to the equation $t^3 + At^2 + Bt + C = 0$.
Find the values of A , of B and of C . [1]

~~~ **End of Paper** ~~~

| Qn        | Answer                |  | Qn       | Answer                                      |
|-----------|-----------------------|--|----------|---------------------------------------------|
| 1(a)      | $\frac{x+4}{4}$       |  | 4(a)     | $126.0^\circ$                               |
| 1(b)      | 19                    |  | 4(b)     | <i>Show</i>                                 |
| 1(c)      | $\frac{8x^5}{625}$    |  | 4(c)     | $126.9^\circ$                               |
|           |                       |  | 4(d)     | $2800 \text{ m}^3$                          |
| 2(a)      | <i>Show</i>           |  |          |                                             |
| 2(b)(i)   | $30^\circ$            |  | 5(a)     | $\frac{9}{40}$                              |
| 2(b)(ii)  | $105^\circ$           |  | 5(b)(i)  | <i>Proof</i>                                |
| 2(b)(iii) | $60^\circ$            |  | 5(b)(ii) | $29.96 \text{ cm}^2$ or $30.0 \text{ cm}^2$ |
| 2(b)(iv)  | $37.5^\circ$          |  |          |                                             |
|           |                       |  | 6(a)     | 14.2                                        |
| 3(a)      | $\frac{500}{x}$       |  | 6(b)     | <i>Graph</i>                                |
| 3(b)      | $\frac{500}{x+4}$     |  | 6(c)     | (5, 0)                                      |
| 3(c)      | <i>Show</i>           |  | 6(d)     | $0.6 \pm 0.1$                               |
| 3(d)      | $x = -20$ or $x = 16$ |  | 6(e)     | <i>Graph</i>                                |
| 3(e)      | \$25                  |  | 6(f)(i)  | $t = 2.5$ and $16.5 (\pm 0.5)$              |
|           |                       |  | 6(f)(ii) | $A = 0, B = -320, C = 800$                  |

### 3E EOY 2014 P2 Soln

| Qn        | Solution                                                                                      | Marks |
|-----------|-----------------------------------------------------------------------------------------------|-------|
| 1(a)      | $\frac{x^2 + 3x - 4}{4x - 4}$                                                                 |       |
|           | $= \frac{(x-1)(x+4)}{4(x-1)}$                                                                 | M1    |
|           | $= \frac{(x+4)}{4}$                                                                           | A1    |
| 1(b)      | $-\frac{1}{4}x > -5$                                                                          |       |
|           | $x < 20$                                                                                      | M1    |
|           | Largest prime number $x = 19$                                                                 | A1    |
| 1(c)      | $\left(\frac{5}{2x^2}\right)^{-3} \div 5x$                                                    |       |
|           | $= \frac{8x^6}{125} \div 5x$                                                                  | M1    |
|           | $= \frac{8x^5}{625}$                                                                          | A1    |
| 2(a)      | $\angle GBO = 90^\circ$ (tan $\perp$ rad)                                                     |       |
|           | $\angle BOC = 180^\circ - 90^\circ = 90^\circ$ (int $\angle$ s)                               | M1    |
|           | $\angle BCO = \frac{180^\circ - 90^\circ}{2} = 45^\circ$ (isos $\Delta$ ) (shown)             | A1    |
|           | <i>*Note that question says to show CLEARLY</i>                                               |       |
| 2(b)(i)   | $\angle OCD = \frac{180^\circ - 120^\circ}{2} = 30^\circ$ (isos $\Delta$ )                    | B1    |
| 2(b)(ii)  | $\angle DAB = 180^\circ - (30^\circ + 45^\circ) = 105^\circ$ ( $\angle$ s in opp segments)    | B1    |
| 2(b)(iii) | $\angle DBC = \frac{120^\circ}{2} = 60^\circ$ ( $\angle$ at ctr = $2\angle$ at circumference) | B1    |
| 2(b)(iv)  | $\angle ABD = \frac{180^\circ - 105^\circ}{2} = 37.5^\circ$ (isos $\Delta$ )                  | M1    |
|           | $\angle ABC = 37.5^\circ + 60^\circ = 97.5^\circ$                                             | A1    |
| 3(a)      | $\frac{500}{x}$                                                                               | B1    |
| 3(b)      | $\frac{500}{x+4}$                                                                             | B1    |

|      |                                                                                                                   |         |
|------|-------------------------------------------------------------------------------------------------------------------|---------|
| 3(c) | $\frac{500}{x} - \frac{500}{x+4} = 6.25$                                                                          | M1 o.e. |
|      | $500(x+4) - 500x = 6.25x(x+4)$                                                                                    | M1      |
|      | $6.25x^2 + 25x - 2000 = 0$                                                                                        |         |
|      | $x^2 + 4x - 320 = 0$ (shown)                                                                                      | A1      |
| 3(d) | $x^2 + 4x - 320 = 0$                                                                                              |         |
|      | $(x+20)(x-16) = 0$                                                                                                | M1      |
|      | $x = -20$ or $x = 16$                                                                                             | A1 + A1 |
| 3(e) | $\frac{500}{16+4} = \$25$                                                                                         | B1      |
|      |                                                                                                                   |         |
|      |                                                                                                                   |         |
| 4(a) | $\tan \angle ABD = \frac{40}{55}$                                                                                 |         |
|      | $\angle ABD = \tan^{-1} \frac{40}{55} = 36.027^\circ$                                                             | M1      |
|      | Bearing of $D$ from $B = 90^\circ + 36.027^\circ = 126.0^\circ$ (to 1dp)                                          | A1      |
| 4(b) | Let $E$ be the foot of the perpendicular of $B$ on $CD$ .                                                         |         |
|      | $BE = 40$ m                                                                                                       |         |
|      | $CE = \sqrt{50^2 - 40^2} = 30$ m                                                                                  |         |
|      | $CD = 30 + 55 = 85$ m (shown)                                                                                     | B1      |
| 4(c) | $AC = \sqrt{40^2 + 85^2} = \sqrt{8825}$                                                                           | M1      |
|      | $\cos \angle ABC = \frac{50^2 + 55^2 - 8825}{2(50)(55)} = -0.6$                                                   | M1      |
|      | $\angle ABC = \cos^{-1}(-0.6)$                                                                                    |         |
|      | $= 126.870^\circ$                                                                                                 |         |
|      | $= 126.9^\circ$ (to 1dp)                                                                                          | A1      |
| 4(d) | Area of $ABCD = \frac{1}{2}(50)(55)\sin 126.87^\circ + \frac{1}{2}(40)(85)$                                       | M1      |
|      | $= 2800 \text{ m}^2$ (to 3sf)                                                                                     | A1      |
|      | Alternatively, Area of $ABCD = 0.5(40)(55+85) \dots$ M1                                                           |         |
|      | $= 2800 \text{ m}^2 \dots$ A1                                                                                     |         |
| 5(a) | $\frac{\text{Area of } \triangle ABC}{\text{Area of } \triangle ADE} = \left(\frac{3}{7}\right)^2 = \frac{9}{49}$ | M1      |
|      | $\frac{\text{Area of } \triangle ABC}{\text{Area of quadrilateral } BCED} = \frac{9}{40}$                         | A1      |

|          |                                                                                                        |                                            |
|----------|--------------------------------------------------------------------------------------------------------|--------------------------------------------|
| 5(b)(i)  | $DO = AO$ (radii of circle)*                                                                           | B1                                         |
|          | $CO = BO$ (radii of circle)*                                                                           | B1                                         |
|          | $\angle AOB = \angle DOC$ (vert opp $\angle$ s)                                                        | B1                                         |
|          | $\therefore \triangle ABO \equiv \triangle DCO$ (SAS)                                                  |                                            |
|          | <i>*markers need to take note of the naming of the sides.</i>                                          |                                            |
|          | <i>Students may also use <math>\angle</math>s at same segment. 0 marks for AA proof</i>                |                                            |
| 5(b)(ii) | (a) $\tan\left(\frac{1.92}{2}\right) = \frac{DQ}{8}$                                                   |                                            |
|          | $DQ = 8 \tan 0.96 = 11.425 \text{ cm}$                                                                 | M1                                         |
|          | Area of $DOCQ = 2\left(\frac{1}{2} \times 11.425 \times 8\right) = 91.4 \text{ cm}^2$ (to 3sf) (shown) | A1                                         |
|          | (b) Area of minor sector $DOC = \frac{1}{2} \times 8^2 \times 1.92 = 61.44 \text{ cm}^2$               | M1                                         |
|          | Shaded area $= 91.4 - 61.44 = 29.96 \text{ cm}^2$                                                      | A1                                         |
|          | <i>Accept also <math>30.0 \text{ cm}^2</math> (to 3 sig fig)</i>                                       |                                            |
| 6(a)     | $p = 14.2$ (to 1dp)                                                                                    | B1                                         |
| 6(b)     | Graph                                                                                                  | Curve – G1<br>Points – G1<br>Axes – G1     |
| 6(c)     | (5, 0)                                                                                                 | B1 ✓                                       |
| 6(d)     | Tangent at (20, 18)                                                                                    | B1                                         |
|          | Gradient $= 0.6$ (Accept $\pm 0.1$ )                                                                   | B1                                         |
| 6(e)     | Graph of $v = 32 - t$                                                                                  | G2 – correct start point, correct gradient |
| 6(f)(i)  | $t = 2.5$ and $16.5$ (Accept $\pm 0.5$ )                                                               | B1                                         |
| 6(f)(ii) | $\frac{800}{t^2} + 32 - \frac{320}{t} = 32 - t$                                                        |                                            |
|          | $t^3 - 320t + 800 = 0$                                                                                 |                                            |
|          | $A = 0, B = -320, C = 800$                                                                             | A1                                         |