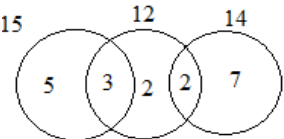

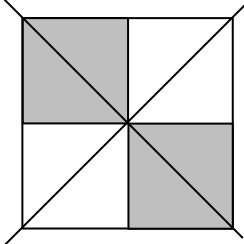


| Question | Working   | Answer | Mark | Notes  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
|----------|---|--------|------|--|----|---|---|---|--|---|---|--|--|---|---|--|---|---|--|--|---|---|--|---|--|--|---|--|--|----|----|----|---|---|--|---|---|---|---|--|
| 1        | <p>Two from<br/><math>12 = 2^2 \times 3</math>(or <math>12 = 4 \times 3</math>), <math>14 = 2 \times 7</math> or<br/><math>15 = 3 \times 5</math><br/><b>or</b></p> <table border="1"><tr><td></td><td>12</td><td>14</td><td>15</td></tr><tr><td>2</td><td>6</td><td>7</td><td></td></tr><tr><td>2</td><td>3</td><td></td><td></td></tr><tr><td>3</td><td>1</td><td></td><td>5</td></tr><tr><td>5</td><td></td><td></td><td>1</td></tr><tr><td>7</td><td></td><td>1</td><td></td></tr></table> <p><b>or</b></p>  |        | 12   | 14   | 15 | 2 | 6 | 7 |  | 2 | 3 |  |  | 3 | 1 |  | 5 | 5 |  |  | 1 | 7 |  | 1 |  |  | 2 | <p>M1 for correct prime factors for 12 and one of 14 or 15. We are accepting <math>12 = 4 \times 3</math> (may be seen on factor tree)<br/><b>or</b> a list of at least <b>5</b> multiples including 420 for 12 and one of 14 or 15<br/><b>or</b><br/>Use of table method for 12 and one of 14 or 15. Do not need all the rows but the final number in the columns should be prime eg</p> <table border="1"><tr><td></td><td>12</td><td>14</td><td>15</td></tr><tr><td>3</td><td>4</td><td></td><td>5</td></tr><tr><td>2</td><td>2</td><td>7</td><td></td></tr></table> <p><b>or</b> Venn diagram for 12 and one of 14 or 15</p>  |  | 12 | 14 | 15 | 3 | 4 |  | 5 | 2 | 2 | 7 |  |
|          | 12  | 14     | 15   |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 2        | 6   | 7      |      |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 2        | 3   |        |      |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 3        | 1   |        | 5    |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 5        |   |        | 1    |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 7        |   | 1      |      |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
|          | 12  | 14     | 15   |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 3        | 4   |        | 5    |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
| 2        | 2   | 7      |      |  |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
|          | <i>Working required</i>   | 420    |      | A1 oe ISW eg $2^2 \times 3 \times 5 \times 7$ or $2 \times 2 \times 3 \times 5 \times 7$ |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |
|          |   |        |      | <i>Total 2 marks</i>   |    |   |   |   |  |   |   |  |  |   |   |  |   |   |  |  |   |   |  |   |  |  |   |  |  |    |    |    |   |   |  |   |   |   |   |  |

| Question      | Working                           | Answer  | Mark | Notes   |
|---------------|-----------------------------------|---|------|---|
| 2             | $\frac{6}{5} \times \frac{7}{12}$ |   | 2    | <p>M1 Correct multiplication of an improper fraction.</p> <p><b>ALT</b> <math>[1 \times] \frac{7}{12} + \frac{1}{5} \times \frac{7}{12}</math></p>  |
|               | Working required                  | $\frac{\cancel{6}^1}{5} \times \frac{7}{\cancel{12}_2} = \frac{7}{10}$<br>or $\frac{1}{5} \times \frac{7}{2} = \frac{7}{10}$<br>or $\frac{42}{60} = \frac{7}{10}$ |      | <p>A1 cao dep on M1 scored and must see one of cancelling fractions prior to multiplication or a correct uncanceled single fraction eg</p> <p><math>\frac{\cancel{6}}{5} \times \frac{7}{\cancel{12}_2} = \frac{7}{10}</math> or <math>\frac{7}{5 \times 2} = \frac{7}{10}</math> <b>for ALT</b> method allow</p> <p><math>\frac{35}{60} + \frac{7}{60} = \frac{7}{10}</math> ISW</p> |
| Total 2 marks |                                   |   |      |   |

| Question |     | Working | Answer | Mark | Notes                |
|----------|-----|---------|--------|------|----------------------|
| 3        | (a) |         | $8x^2$ | 1    | B1 cao Do not ISW    |
|          | (b) |         | $6y^5$ | 1    | B1 cao Do not ISW    |
|          |     |         |        |      | <i>Total 2 marks</i> |

| Question |     | Working | Answer   | Mark | Notes   |
|----------|-----|---------|--|------|---|
| 4        | (a) |         |  | 1    | B1 cao two lines(allow dashed or dotted) joining opposite corners drawn on diagram. No extra incorrect lines must be drawn unless clearly crossed out |
|          | (b) |         | 3  | 1    | B1 cao must be a single number  |
|          |     |         |  |      | <i>Total 2 marks</i>  |

| Question |     | Working | Answer | Mark | Notes                                |
|----------|-----|---------|--------|------|--------------------------------------|
| 5        | (a) |         | 38, 45 | 1    | B1 Ignore extra terms. Accept 45, 38 |
|          | (b) |         | 80     | 1    | B1                                   |
|          |     |         |        |      | <i>Total 2 marks</i>                 |

| Question |  | Working      | Answer                          | Mark | Notes   |
|----------|--|--------------|---------------------------------|------|---|
| 6        |  | $(x-7)(x+2)$ |                                 | 2    | M1 Factorised form must expand to give 2 terms of the quadratic.<br>eg $(x-2)(x+7)=x^2+5x-14$   |
|          |  |              | $(x-7)(x+2)$<br>or $(x+2)(x-7)$ |      | A1 Do not ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining. |
|          |  |              |                                 |      | <i>Total 2 marks</i>  |

| Question |     | Working  | Answer | Mark | Notes   |
|----------|-----|--|--------|------|---|
| 7        | (a) |  | 5      | 1    | B1 cao no other numbers must be given   |
|          | (b) | 2,3,5,5,5,7,8,9,10,11  |        | 2    | M1 place numbers in order (at least 6 with none missing) or sight of $\frac{5+7}{2}$<br>May be seen in part (a) or in question. Allow with signs eg + between |
|          |     | Correct answer scores full marks (unless from obvious incorrect working) | 6      |      | A1 cao  |
|          |     |  |        |      |   |

| Question |  | Working   | Answer | Mark | Notes  |
|----------|--|---|--------|------|--|
| 8        |  | $360 \div 24 [= 15]$ oe or<br>$24 \times 180 - 360 [= 3960]$ or<br>$(2 \times 24 - 4) \times 90 [= 3960]$ or<br>$(24 - 2) \times 180 [= 3960]$ oe |        | 3    | M1 for a correct method to find an exterior angle or total of the interior angles. Implied by seeing 15 or 3960 or 165   |
|          |  | $180 - "15"$ or $\frac{3960}{24}$ oe  |        |      | M1 dep on M1 correct method to find one interior angle. This may be implied by seeing 165  |
|          |  | <i>Correct answer scores full marks (unless from obvious incorrect working)</i>   | 165    |      | A1 cao do <b>not</b> ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining. |
|          |  |   |        |      | <i>Total 3 marks</i>   |

| Question |  | Working   | Answer               | Mark | Notes   |
|----------|--|---|----------------------|------|---|
| 9        |  | $T^2 = \frac{2r}{g}$ or $T^2 g = 2r$ or $\sqrt{g} = \frac{\sqrt{2r}}{T}$        |                      | 2    | M1 correctly remove square root sign or make root g the subject.  |
|          |  | <i>Correct answer scores full marks (unless from obvious incorrect working)</i> | $g = \frac{2r}{T^2}$ |      | A1 cao Condone missing "g =" on answer line if fully correct expression seen in working. Allow $g = \left(\frac{\sqrt{2r}}{T}\right)^2$ or $g = 2rT^{-2}$ |
|          |  |   |                      |      | <i>Total 2 marks</i>  |

| Question | Working   | Answer              | Mark | Notes   |
|----------|---|---------------------|------|---|
| 10       | $[x^2(3x+1) = ]3x^3 + x^2$  |                     | 3    | M1 correct expansion of brackets before differentiating. eg $3x^3 + 1x^2$ |
|          | $[ \frac{dy}{dx} = ]20x^3 + 9x^2 + 2x$  |                     |      | M1 at least one correct term  |
|          | <i>Correct answer scores full marks (unless from obvious incorrect working)</i> | $20x^3 + 9x^2 + 2x$ |      | A1 oe eg $20x^3 + 9x^2 + 2x^1$  |
|          |   |                     |      | <i>Total 3 marks</i>  |

| Question | Working   | Answer      | Mark | Notes  |
|----------|---|-------------|------|--|
| 11       | $\frac{120}{360} \pi r^2 = 48\pi [ \Rightarrow r = 12 ]$                        |             | 3    | M1 for forming an equation involving the radius using the given area. eg $\frac{1}{3} \pi r^2 = 48\pi$ or $\frac{1}{3} r^2 = 48$   |
|          | $[ \text{Arc length} = ] \frac{120}{360} \times 2\pi \times "12" [= 8\pi]$      |             |      | M1 Find an expression for the arc length $ABC$ , ft their radius. Allow awrt 25.1 May be seen as part of working eg $\frac{1}{3} \times 2 \times \pi \times "12" + 2 \times "12"$ where 12 is their radius |
|          | <i>Correct answer scores full marks (unless from obvious incorrect working)</i> | $8\pi + 24$ |      | A1 oe eg $8(3 + \pi)$ <b>allow</b> awrt $15.6\pi$ (need not be simplified) eg $\frac{120}{360} \times 2\pi \times 12 + 12 + 12$ <b>ISW</b>   |
|          |   |             |      | <i>Total 3 marks</i>   |

| Question | Working  | Answer | Mark | Notes  |
|----------|--|--------|------|--|
| 12       | eg $2(x+2)+3(x-3)=60$ or<br>$4(x+2)+6(x-3)=120$ or<br><br>$\frac{2(x+2)}{12}+\frac{3(x-3)}{12}[=5]$ or<br>$\frac{4(x+2)}{24}+\frac{6(x-3)}{24}[=5]$ or<br><br>$\frac{x}{6}+\frac{1}{3}+\frac{x}{4}-\frac{3}{4}[=5]$ oe |        | 3    | M1 Clear intention to multiply all terms by a multiple of 12<br>If correct expression with brackets in is not seen allow a maximum of one incorrect term if the brackets are expanded <b>or</b><br><br>express the LHS as two fractions over a multiple of 12 or as a single fraction with a denominator which is a multiple of 12 eg $\frac{2(x+2)+3(x-3)}{12}=5$ If correct expression with brackets in is not seen allow a maximum of one incorrect term if the brackets are expanded No need for = 5 <b>or</b><br><br>expressing the LHS as 4 fractions. No need for = 5 |
|          | $5x=60-4+9$ or $10x=120-8+18$<br>$\frac{5x}{12}=5-\frac{1}{3}+\frac{3}{4}$ oe  |        |      | M1 indep for a correct equation with the terms in x combined<br>eg $\frac{5x-5}{12}=5$ or $5x=65$ or $\frac{5}{12}x=\frac{65}{12}$   |
|          | <i>Working required</i>  | $x=13$ |      | A1 dependent on at least one M mark being awarded  |
|          |  |        |      | <b>Total 3 marks</b>   |

| Question | Working   | Answer    | Mark | Notes   |
|----------|---|-----------|------|---|
| 13       |   | $p = 15$  | 3    | B1 cao  |
|          | $-5 - 2p$ or $-5 - 2 \times "15"$<br>or $-5b - 2pb = qb$<br>or $2p + q = -5$ oe |           |      | M1 compare coefficients of <b>b</b> Allow one sign error in $-5 - 2p$ eg $-5 + 2p$ or allow ft of their $p$ value and one sign error ie $5 - 2 \times "15"$ or $-5 + 2 \times "15"$ or $-5b + 2pb = qb$ or $5b - 2pb = qb$ or $-5b - 2pb = -qb$ oe Allow $p = "15"$ subst |
|          | Correct answer scores full marks (unless from obvious incorrect working)        | $q = -35$ |      | A1  |
|          |   |           |      | SC if $p$ and $q$ are correct but not written on the answer line, at least one must be labelled in their working to award full marks. If both values are correct but neither labelled or they are on the wrong answer lines they get 2/3 marks                            |
|          |   |           |      | Total 3 marks   |

| Question | Working | Answer  | Mark | Notes   |
|----------|---------|---|------|---|
| 14       | (a)     | $0.07y$   | 1    | B1 cao oe $\left(\frac{7}{100}y\right)$   |
|          | (b)     | number bottle $B = 0.12y$<br>increase = $0.05y$ or $5\%$  | 1    | M1 for sight of $0.12y$ or $\frac{12}{100}y$ or $0.05y$ or $\frac{5}{100}y$ or $5\%$ $12\% - 7\%$ or $12\%y - 7\%y$ |
|          |         | $0.12y - "0.07y" = 60$ or<br>$0.05y = 60$ or<br>$60 \div 5 \times 100$ or<br>$5\% = 60$ or $5\%y = 60$ or<br>$12\% - 7\% = 60$ or $12\%y - 7\%y = 60$ | 1    | M1 oe follow through their result from part (a)   |
|          |         | 1200  | 1    | A1 cao Must come from a correct equation<br>Correct answer with no working gains full marks                         |
|          |         |   |      | Total 4 marks   |

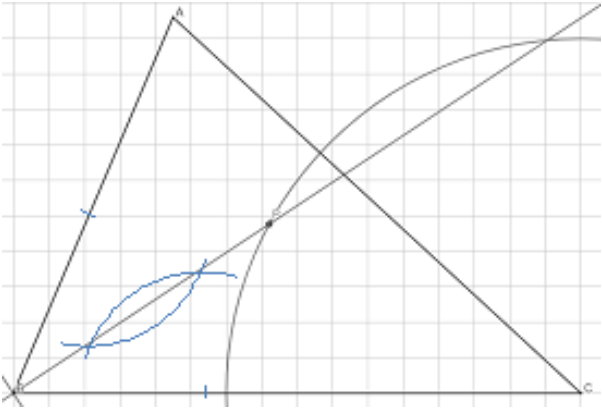
| Question | Working  | Answer                                 | Mark | Notes  |
|----------|--|--|------|--|
| 15       | $\begin{array}{rcl} 20x + 7y = 4 & 40x + 14y = 8 \\ \underline{20x - 20y = -50} & \underline{14x - 14y = -35} \\ 27y = 54 & 54x = -27 \end{array}$ <p>or</p> $20\left(\frac{2y-5}{2}\right) + 7y = 4 \text{ or}$ $20x + 7\left(\frac{2x+5}{2}\right) = 4 \text{ or}$ $2\left(\frac{4-7y}{20}\right) - 2y = -5 \text{ or}$ $2x - 2\left(\frac{4-20x}{7}\right) = -5 \text{ oe}$ |  | 4    | <p>M1 eliminating either <math>x</math> or <math>y</math> (equate coefficient and use correct operation) Allow 1 error either one incorrect term in equating the coefficients eg <math>-4</math> instead of <math>8</math> <b>or</b> one error when eliminating either <math>x</math> or <math>y</math></p> <p><b>or</b></p> <p>substitute for <math>x</math> or <math>y</math> to form an equation in only one variable. Allow 1 sign slip only</p> |
|          |  | $x = -\frac{1}{2} \text{ or}$ $y = 2$  |      | A1 dep on M1   |
|          | $20 \times "-\frac{1}{2}" + 7y = 4 \text{ or}$ $20x + 7 \times "2" = 4 \text{ or}$ $2 \times "-\frac{1}{2}" - 2y = -5 \text{ or}$ $2x - 2 \times "2" = -5 \text{ oe}$  |  |      | <p>M1dep on previous method mark</p> <p>For repeating first method (allow one sign error) or substitute their <math>x</math> or <math>y</math> into a correct equation</p>   |
|          | <i>Working required</i>  | $x = -\frac{1}{2}$ $\text{and } y = 2$ |      | A1 dep on M1 M1  |
|          |  |  |      | <b>Total 4 marks</b>   |

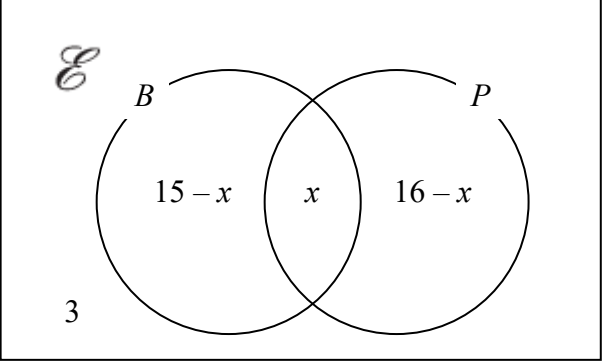
| Question | Working  | Answer | Mark | Notes   |
|----------|--|--------|------|---|
| 16       | Let $t$ = total number of students and $c$ = number of students who travel by car Allow any letters for $t$ and $c$  |        |      |   |
|          | $[t =] \frac{208}{0.104}$ <b>or</b><br>$[t =] 718 + 0.896t - 510$ <b>or</b><br>$\frac{208}{208 + 510 + c} = 0.104$ <b>or</b><br>$[c =] \frac{208}{0.104} - 208 - 510$ <b>or</b><br>$[c =] 0.896 \times \frac{208}{0.104} - 510$ <b>or</b> $[c =] \frac{208}{0.104} - 718$<br><b>or</b> $0.896 \times (718 + c) = 510 + c$ <b>or</b><br>$\frac{510}{208} \times 10.4$ |        | 4    | M1 correct method to find $t$ or $c$ <b>or</b> correct equation (any form) in terms of $t$ or $c$ <b>or</b> correct method to find the % that represents 510 students<br>May be implied by seeing 25.5 or 1282 or 2000  |
|          | $[t =] 2000$ or $[c =] 1282$ or 25.5   |        |      | A1 correct value for $t$ <b>or</b> $c$ <b>or</b> percentage   |
|          | $\frac{"1282"}{2000} \times 100$ or $\frac{"1282"}{"1282" + 208 + 510} \times 100$ or<br>$\frac{1282}{"2000"} \times 100$ or $100 - 10.4 - "25.5"$ or<br>$100 - 10.4 - \frac{510}{"2000"} \times 100$  |        |      | M1 For an attempt at a correct method to find the percentage.<br>Allow $\frac{n}{2000} \times 100$ <b>or</b> $\frac{n}{n + 718} \times 100$ where $n < 2000$ <b>or</b><br>$\frac{1282}{m} \times 100$ where $m > 1282$ <b>or</b> $\frac{r - 718}{r} \times 100$ where $r > 718$ <b>or</b><br>$100 - 10.4 - \frac{510}{"p"} \times 100$ where $p > 510$ or $100 - 10.4 - q$<br>where $20 < q < 30$ may be implied by 64.1 Condone rounded figures. |
|          | Correct answer scores full marks (unless from obvious incorrect working)   | 64.1   |      | A1 cao Allow 64 Do <b>not</b> ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining.   |
|          |  |        |      | Total 4 marks   |



| Question |     | Working  | Answer | Mark | Notes   |  |
|----------|-----|--|--------|------|---|--|
| 17       | (a) | eg $\frac{16.1}{48}$ [= 0.335] or $\frac{1610}{48}$ or<br>$\frac{16.1}{12\cancel{25}} \text{ or } \frac{x}{16.1} = \frac{1}{48} \text{ or } \frac{x}{1610} = \frac{1}{48}$<br>or $\frac{x}{16.1} = \frac{25}{12}$ oe |        | 2    | M1 correct method or equation to find length in m or cm. Implied by 0.335   |  |
|          |     | <i>Correct answer scores full marks (unless from obvious incorrect working)</i>  | 33.5   |      | A1 awrt 33.5  |  |
|          | (b) | $48^3$ [= 110 592] or<br>$0.48^3$ [= 0.110 592]  |        | 3    | M1 Consideration of cube of scale factor seen. eg $\left(\frac{16.1}{(a)}\right)^3$ or<br>$\left(\frac{1610}{(a)}\right)^3$ or $\frac{995}{V} = \frac{(a)^3}{1610^3}$ | M2 for $\frac{995}{100^3} \times 48^3$ |
|          |     | $\frac{995}{100^3}$ [= 0.000995] or<br>[995×"110 592"]÷100 <sup>3</sup><br>$0.48^3$ [= 0.110 592]  |        |      | M1 for unit conversion by dividing by 100 <sup>3</sup>  |  |
|          |     | <i>Correct answer scores full marks (unless from obvious incorrect working)</i>  | 110    |      | A1 awrt 110   |  |
|          |     |  |        |      | <b>Total 5 marks</b>  |  |

| Question |  | Working | Answer                                | Mark | Notes   |
|----------|--|---------|---------------------------------------|------|---|
| 18       |  |         | angle bisector constructed accurately | 4    | B2 for a line within the limits and a pair of suitable arcs. One arc centred on a point $D$ on $BC$ and one centred on the point $E$ on $AB$ such that $BE = BD$ <b>or</b> 2 arcs centred at $B$ with the cross to find the middle.<br>(B1 for a line within the limits (Can be any length - does not need to cross $AC$ but should remain within the guidelines if it were to be extended) <b>or</b> a pair of suitable arcs |
|          |  |         | Accurate arc drawn from $C$           |      | B1 for an arc within the limits indicated. It does not need to cross $AC$ or $BC$   |
|          |  |         | $P$ correctly labelled                |      | B1ft dependent on at least B1 for the angle bisector and B1 for the arc. Must clearly identify it is the point.   |
|          |  |         |                                       |      | <b>Total 4 marks</b>  |



| Question |     | Working   | Answer          | Mark | Notes   |
|----------|-----|---|-----------------|------|---|
| 19       | (a) |  |                 | 2    | <p>B2 <math>15 - x</math>, <math>16 - x</math> and 3 in correct regions on Venn diagram</p> <p>B1 2 of <math>15 - x</math>, <math>16 - x</math> and 3 in correct regions or all 3 values correct, one in correct region.</p> <p>Allow 11 for <math>15 - x</math> and 12 for <math>16 - x</math></p> <p><b>SC</b> B1 <math>x</math> is replaced with a number <math>x \neq 4</math> and they use this incorrect value, to find <math>15 - x</math> and <math>16 - x</math></p> |
|          | (b) | $3 + "15 - x" + x + "16 - x" = 30$ oe   |                 | 2    | <p>M1 Correct equation formed, in <math>x</math>, ft their values for <math>B' \cap P</math> and <math>B \cap P'</math> May see only one of these values used eg <math>3 + 15 + "16 - x" = 30</math></p>  |
|          |     | Correct answer scores full marks (unless from obvious incorrect working)          | 4               |      | A1 cao  |
|          | (c) |   | $\frac{11}{30}$ | 1    | <p>B1 ft follow through their answer to part (b), if <math>0 &lt; \text{part(b)} &lt; 15</math> only ie <math>\frac{15 - "their(b)"}{30}</math> with numerator a single number. Allow awrt 0.367</p>  |
|          |     |   |                 |      | Total 5 marks   |

| Question | Working  | Answer | Mark | Notes   |  |
|----------|--|--------|------|---|--|
| 20       | Throughout this question condone mis-labelling. eg if they label the volume of the cone as being the hemisphere  |        |      |   |  |
|          | $\frac{2}{3}\pi \times 10^3 \left[ = \frac{2000\pi}{3} = 2094.395... \right]$  |        | 5    | M1 Allow for $\frac{4}{3}\pi \times 10^3 \left[ = \frac{4000\pi}{3} = 4188.790... \right]$<br>Allow sight of 4189, awrt 4190 or awrt 2090 or exact fraction<br>May be embedded within other working. Ignore labelling   |  |
|          | $\frac{1}{3}\pi \times 10^2 x \left[ = \frac{100\pi}{3} x = 104.719...x \right]$   |        |      | M1 or $\frac{1}{3}\pi 10^2 (h-10)$ Allow sight of 104, awrt 105 or exact fraction.<br>Allow any letter for x. (Condone h for x) Ignore labelling  |  |
|          | $\frac{1}{3}\pi \times 10^2 x = \frac{3}{4} \times \left( \frac{2}{3}\pi \times 10^3 \right)$ or<br>" $\frac{100\pi}{3}$ " x = $\frac{3}{4} \times \left( " \frac{2000\pi}{3} " \right)$ or<br>$\frac{\frac{1}{3}\pi \times 10^2 x}{\frac{2}{3}\pi \times 10^3} = \frac{3}{4}$ oe  |        |      | M1 using $V_{\text{cone}} = \frac{3}{4} \times V_{\text{hemisphere}}$ oe<br>with at least one of the volumes correct<br>Allow h – 10 or any letter for x (condone h)<br>You may ft their values eg<br>"2094" x = $\frac{3}{4} \times$ "105" <b>NB</b> x = 15<br><b>NB useful number</b><br>$\frac{3}{4} \times \left( \frac{2}{3}\pi \times 10^3 \right) = 1570.795...$ | $M2 \text{ for } \frac{\frac{1}{3}\pi 10^2 (h-10)}{\frac{2}{3}\pi \times 10^3} = \frac{3}{4}$<br><br>or $\frac{\frac{100\pi}{3} (h-10)}{\frac{2000\pi}{3}} = \frac{3}{4}$ oe |
|          | "15"+10  |        |      | M1 For using h – 10 anywhere<br><b>OR</b> if all 3 previous method marks awarded allow for "their x" + 10   |  |
|          | Correct answer scores full marks<br>(unless from obvious incorrect working)  | 25     |      | A1 awrt 25  |  |
|          | <b>SC</b> r = 10 not substituted could get <b>M1 M1 M0 M1 A0</b><br>1 <sup>st</sup> M1 for $\frac{\frac{1}{3}\pi r^2 x}{\frac{2}{3}\pi r^3 x} = \frac{3}{4}$ (allow sphere)    2 <sup>nd</sup> M1 $\frac{x}{2 \times r} = \frac{3}{4}$ or $\frac{x}{4 \times r} = \frac{3}{4}$ 4 <sup>th</sup> M1 for using h – 10 or adding 10 A0 |        |      |   |  |
|          |  |        |      | <b>Total 5 marks</b>  |  |

| Question |   | Working   | Answer   | Mark | Notes   |                                       |
|----------|---|---|--|------|---|---------------------------------------|
| 21       | (a)   | $[AG^2 = ]12^2 + 4^2 (=160)$ or<br>$[AC^2 = ]12^2 + 3^2 (=153)$ or<br>$[AE^2 = ]4^2 + 3^2 (=25)$  |  | 3    | M1 A correct method to find $AG^2, AC^2, AE^2, AG, AC$ or $AE$ . Allow use of trig but must be fully correct method eg<br>$[\angle GAB = ]\tan^{-1}\left(\frac{4}{12}\right)[=18.434....]$ <b>and</b><br>$[AG = ]\frac{12}{\cos"18.434..."}$ Ignore incorrect labels labels   | M2 for<br>$[AF^2 = ]3^2 + 12^2 + 4^2$ |
|          |   | $[AF^2 = ]3^2 + "160"$ or $3^2 + ("4\sqrt{10}")^2$<br>$[AF^2 = ]4^2 + "153"$ or $4^2 + ("3\sqrt{17}")^2$<br>$[AF^2 = ]12^2 + "25"$ or<br>$[AF^2 = ]169$ | M1 full method to find $AF^2$<br>For this mark allow values correct to 3sf. but condone truncation eg $4^2 + (\text{awrt } 12.3)^2$ or $3^2 + (\text{awrt } 12.64)^2$ Ignore incorrect labels<br><b>NB</b> $\sqrt{160} = 12.649...$ $\sqrt{153} = 12.369...$ |      |   |                                       |
|          |   | <i>Working required</i>   | 13   |      | A1 dependent on both method marks awarded. For a full method to find $AF$ with no incorrect working seen and 13 stated<br>Must see 169 or a correct expression for $AF^2$ with exact values used.   |                                       |
|          | (b)   | $\sin GAF = \frac{3}{"13"}$ or $\tan GAF = \frac{3}{"\sqrt{160}"}$<br><br>or $\cos GAF = \frac{"\sqrt{160}"}{"13"}$ oe                                  |  | 2    | M1 A correct method to find $\angle GAF$ or trig ratio of $\angle GAF$<br>May ft values from part (a) including their $AF$ if it is not 13 if it is clearly labelled or comes from a correct calculation<br><br>Allow ( $\tan AFG = \frac{\sqrt{160}}{3}$ <b>or</b> $\sin AFG = \frac{\sqrt{160}}{13}$ <b>or</b> $\cos AFG = \frac{3}{13}$ ) <b>and</b><br><br>$90 - \angle AFG$<br><br>Allow use of cosine or sine rule eg $3^2 = 160 + 13^2 - 2 \times \sqrt{160} \times 13 \cos GAF$ |                                       |
|          | <i>Correct answer scores full marks (unless from obvious incorrect working)</i> |   | 13.3   |      | A1 awrt 13.3 Allow awrt 13.4  |                                       |
|          |   |   |  |      | <i>Total 5 marks</i>  |                                       |

| Question | Working   | Answer | Mark | Notes  |
|----------|---|--------|------|--|
| 22       | $(-k)^3 + 4(-k)^2 - 20(-k) - (-k) [= 0]_{\text{or}}$<br>$-k^3 + 4k^2 + 20k + k [= 0]_{\text{oe}}$   |        | 5    | M1 substitutes $x = -k$ Allow 1 sign error if brackets removed or<br>long division to obtain 2 correct terms $x^2 + (4 - k)x + (-20 - 4k + k^2)$<br>or two of 1 <b>or</b> $4 - k$ <b>or</b> $-20k - 4k + k^2$<br>attempt to expand $(x + k)(x^2 + gx + 1)$ with at least 4 out of 6 terms<br>correct cubic is $x^3 + kx^2 + gx^2 + gkx + x + k_{\text{oe}}$  |
|          | $-k^3 + 4k^2 + 21k = 0$ or<br>$-20 - 4k + k^2 = 1$ or<br>$k + g = 4$ and $1 + kg = -20_{\text{oe}}$ |        |      | A1 correct simplified 3 term cubic equation or a correct quadratic equation or both correct equations from comparing $x^2$ and $x$ coefficients.   |
|          | $(k)(-k^2 + 4k + 21) = 0$ or<br>$k^2 - 4k - 21 = 0_{\text{oe}}$                                     |        |      | M1 dep on first M mark. Divide by or take $k$ out as a common factor from a cubic in $k$ to form a 3-term quadratic equation. An answer of 7 or $-3$ can imply this mark   |
|          | $(k)(-k + 7)(k + 3) = 0$ or<br>$(k - 7)(k + 3) = 0$   |        |      | M1 dep on second M mark. Correct method for solving their 3-term quadratic – either by formula, completing the square or factorising.<br>By factorising: brackets must expand to give 2 out of 3 correct terms<br>By formula: correct substitution into fully correct formula (allow 1 sign error)<br>By completing the square: must see $(k - 2)^2 \pm \dots$<br>An answer of 7 or $-3$ can imply this mark |
|          | Correct answer scores full marks (unless from obvious incorrect working)                            | 7, -3  |      | A1 cao (both) condone 0, 7, $-3$ but do not allow any other incorrect extras   |
|          |   |        |      | <b>Total 5 marks</b>   |

| Question |     | Working  | Answer                       | Mark | Notes   |
|----------|-----|--|------------------------------|------|---|
| 23       | (a) | $[ON^2 = ]19.5^2 - 18^2$ or $19.5^2 = ON^2 + 18^2$<br>or $39^2 - 36^2$ or $[ON = ]19.5 \cos(67.3801\dots)$<br>or $[ON = ]19.5 \sin(22.6198\dots)$ oe                               |                              | 2    | M1 use of Pythagoras <b>or</b> trig seen – allow angles given to at least 3sf<br>Allow $XD = \sqrt{39^2 - 36^2}$ where $BX$ is the diameter   |
|          |     | Working required   | $\sqrt{19.5^2 - 18^2} = 7.5$ |      | A1 allow $\sqrt{56.25} = 7.5$ or $19.5 \cos(67.3801\dots) = 7.5$ or $\frac{\sqrt{39^2 - 36^2}}{2}$ oe or $19.5 \sin(22.6198\dots) = 7.5$ or $ON^2 = 56.25 \Rightarrow ON = 7.5$ Allow angles given to 3sf   |
|          |     |  |                              |      | <b>NB</b> verification using 7.5 is M0 A0   |
|          | (b) | $EN = 36 - 18 - 8 [= 10]$ <b>or</b> $EN = \frac{36}{2} - 8$<br>$AE \times EC = 8 \times 28$ <b>or</b> $AE \times EC = 224$<br>$\frac{AC}{2} + 7.5$ and $\frac{AC}{2} - 7.5$        |                              | 4    | M1 Find $EN$ either labelled or comes from correct working may be seen on diagram <b>or</b> $AE \times EC = 224$ or $AC/2 + 7.5$ and $AC/2 - 7.5$ identified as $AB$ and $BC$ or used in a formula.<br>Allow $x + 7.5$ and $x - 7.5$ may be implied by the 2 <sup>nd</sup> M1       |
|          |     | $[AM^2 = ]19.5^2 - "10"'^2 [= 280.25]$ or<br><br>$\left(\frac{AC}{2} + 7.5\right)\left(\frac{AC}{2} - 7.5\right) = 8 \times 28$  |                              |      | M1 correct use of Pythagoras involving $AM$ where $M$ is the mid-point of $AC$ <b>NB</b> $AM = \sqrt{280.25} [= 16.7406\dots]$<br>ft their 10 if clearly labelled or comes from $36 - 18 - 8$<br>Correct use of intersecting chord theorem Allow $(x + 7.5)(x - 7.5) = 8 \times 28$ |
|          |     | $[AC] = 2 \times \sqrt{19.5^2 - "10"'^2}$ or<br>$[AC = ]\frac{8 \times 28}{("16.7406\dots" + 7.5)} + ("16.7406\dots" + 7.5)$<br><br>$\left(\frac{AC}{2}\right)^2 = 224 + 7.5^2$ or |                              |      | M1 dep on previous method marks awarded. For using $AC = 2 \times$ "their $AM$ " ft their 10 if clearly labelled or comes from $36 - 18 - 8$ or their awrt 16.7 if clearly labelled or comes from $\sqrt{19.5^2 - "10"'^2}$<br>find value for $\left(AC/2\right)^2$                 |
|          |     | Correct answer scores full marks (unless from obvious incorrect working)   | 33.5                         |      | A1 awrt 33.5  |
|          |     |  |                              |      | <b>Total 6 marks</b>  |