

## **Principal Learning**

## **Engineering**

Unit **F563**: Mathematical techniques and applications for engineers

OCR Level 3 Principal Learning

## **Mark Scheme for January 2015**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

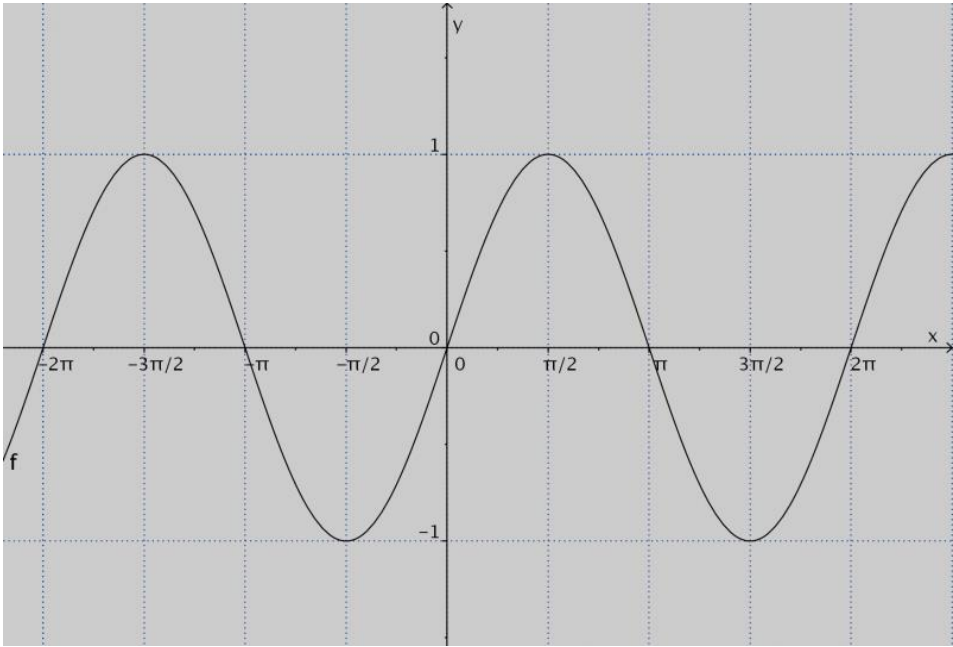
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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| Section A |            |  |            |  |
|-----------|------------|--|------------|--|
| 1         |            | $6(4x + 5) - 8x = 24x + 30 - 8x = 16x + 30$ $16x$ $30$   | [1]<br>[1] |  |
| 2         |            | $x^2 - 10x + 24 = (x - 4)(x - 6)$ $(x - 4)$ $(x - 6)$  | [1]<br>[1] |  |
| 3         |            | $[(x + 5)/12] - (x - 4)/3 = (x + 5 - 4x + 16)/12$ $= (-3x + 21)/12 = (7 - x)/4$ $(7 - x)$ $4$  | [1]<br>[1] | Accept $-3x + 21$ for one mark and 12 for one mark.  |
| 4         |            | $5(2x - 4) = 3(3x - 2)$ $10x - 20 = 9x - 6$ $x = 14$   | [1]<br>[1] |  |
| 5         | (a)<br>(b) | $\pi \text{ radians} = \pi \times (360/2 \pi) = 180^\circ$ $60^\circ = 60 \times (2 \pi/360) = \frac{1}{3} \pi = 1.0472 \text{ radians}$ | [1]<br>[1] | Award one mark for correct numerical results with or without the unit.<br>Accept $\frac{1}{3} \pi$ or answers between 1.04 and 1.05 radians or any equivalent. |

| Section A |  |  |
|-----------|--|--|
| 6         |  <p>1</p>  | <p>[2] Award one mark for the sine wave shape and one mark for evidence of understanding <math>+1</math>, <math>-1</math>, <math>\pi</math> and <math>-\pi</math>.</p> |
| 7         | <p>Given angle <math>A = 30^\circ</math>, angle <math>B = 70^\circ</math> and side <math>b = 2</math> m.</p> <p>Then side <math>a = (b \sin A)/\sin B</math></p> $= (2 \sin 30^\circ)/\sin 70^\circ$ $= 1.064 \text{ m}$ | <p>[1] Award two marks for correct numerical result seen with or without the unit.</p> <p>[1] Accept answers between 1.06 and 1.07.</p>                                |
| 8         | <p>Given <math>\sin x = 4/5</math>.<br/>         observation the right-angled triangle will have sides of 3, 4 and 5 units long.<br/>         So <math>\tan x = 4/3</math></p> <p style="text-align: right;">By</p>      | <p>[1] Award one mark for correct diagram and one mark for <math>\tan x = 4/3</math> or 1.333.</p> <p>[1] Award two marks for correct answer.</p>                      |

| Section A |  |   |   |                   |
|-----------|--|---|---|-------------------|
| 9         |  | Given $y = \sqrt{x^3}$<br>$x^{3/2}$<br>$x^{0.5}$<br>gives $dy/dx = 1.5 \sqrt{x}$<br>1.5   | Then $y =$<br>So $dy/dx = 1.5$<br>which<br>$\sqrt{x}$ | [1]<br>[1]        |
| 10        |  | Given $y = 2 e^{6x} + \sin x$<br>Then $dy/dx = 12 e^{6x} + \cos x$<br>$12 e^{6x}$<br>$\cos x$   |   | [1]<br>[1]        |
| 11        |  | $\int \sin 3x \, dx = -\frac{1}{3} \cos 3x + C$<br>$-\frac{1}{3} \cos 3x$<br>$+C$   |   | [1]<br>[1]        |
| 12        |  | $\int_1^3 15 x^4 \, dx = \left[ \frac{15 x^5}{5} \right]_1^3 = \left[ 3 x^5 \right]_1^3 = 729 - 3 = 726$<br>$\left[ \frac{15 x^5}{5} \right]_1^3$<br>$\left[ 3 x^5 \right]_1^3$ or $[3 \cdot 3^5] - [3 \cdot 1^5]$<br>726 |   | [1]<br>[1]<br>[1] |
| 13        |  | Normal distribution curve , Central tendency , Statistical distribution,<br>Even distribution, Symmetrical , Bell, Probability distribution<br>Gaussian distribution etc.   |   | [1]               |

Do not accept error carried forward if incorrect integration is used.

Accept for one mark with or without limits.

| Section A |  |  |                       |   |
|-----------|--|--|-----------------------|---|
| 14        |  | <p>Mean = <math>(30 + 27 + 26 + 28 + 29)/5 = 28</math></p> <p>Values arranged in order of magnitude:</p> <p>26 27 <u>28</u> 29 30</p> <p>Median point = 28</p>   | <p>[1]</p> <p>[1]</p> |   |
| 15        |  | <p>When <math>P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)</math></p> <p><math>P(A \text{ or } B)</math> = probability that event A or event B occurs</p> <p><math>P(A \text{ and } B)</math> = probability that event A and event B both occur.</p> | <p>[1]</p> <p>[1]</p> | <p>Allow reference to Venn diagram.</p> <p>Do not allow .... 'but not both'....</p> <p>Do not allow ... 'but not together'...</p> |
|           |  | <b>Total</b>   | <b>[30]</b>           |   |

| Question         | Expected Answer | Mark   | Rationale/Additional Guidance |  |
|------------------|-----------------|--|-------------------------------|--|
| <b>Section B</b> |                 |  |                               |  |
| 1                | (a)             |  |                               |  |
|                  |                 | Given $A = \pi d^2/4$ .<br>Substitute $d = 10$ .<br>Then $A = \pi d^2/4$<br>$= 100 \pi/4$<br>$= 78.54$   | [1]                           | Accept $(100 \pi)/4$ or $25 \pi$ or answers between 78 and 79. |
| 1                | (b)             |  |                               |  |
|                  |                 | Given that $V = V_0(1 + 3aT)$<br>Open the brackets then $V = V_0 + 3aT V_0$<br>Then $3aT V_0 = V - V_0$<br>So $T = (V - V_0)/3a V_0$   | [1]<br>[1]<br>[1]             | Accept any other correct method.                               |
| 1                | (c)             |  |                               |  |
|                  |                 | Given $F = m(V^2 - U^2)/2$<br>Divide both sides by $m/2$<br>Then $2F/m = V^2 - U^2$<br>Then $U^2 = V^2 - (2F/m)$<br>Square root both sides<br>So $U = \pm \sqrt{V^2 - (2F/m)}$ | [1]<br>[1]<br>[1]             | Accept any other correct method.                               |
| 1                | (d)             |  |                               |  |
|                  |                 | Given $y = x/(x + 1)$<br>Multiply both sides by $(x + 1)$ then $xy + y = x$<br>So $x - xy = y$<br>Then $x(1 - y) = y$<br>So $x = y/(1 - y)$ or $x = -y/(y - 1)$                | [1]<br>[1]<br>[1]             | Accept any other correct method.                               |
|                  |                 | <b>Total</b>   | <b>[10]</b>                   |  |

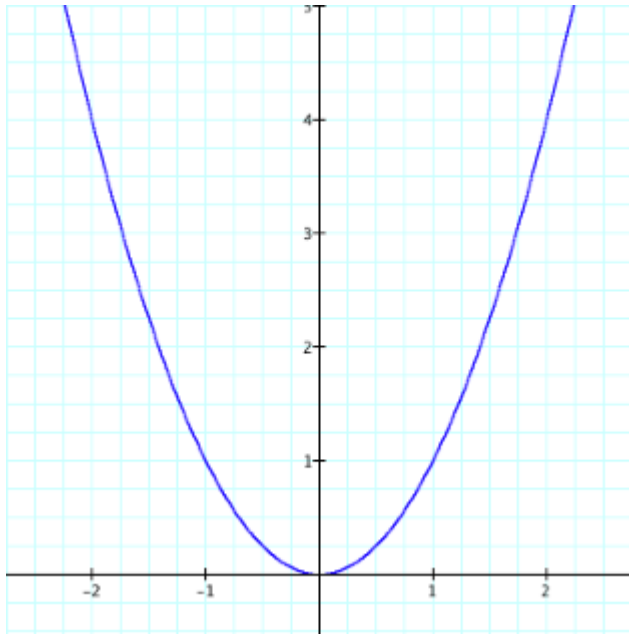
| Question | Expected Answer  | Mark   | Rationale/Additional Guidance  |
|----------|--|--|--|
| 2 (a)    | Given $0.5 I_1 + 0.6 I_2 = 7$ eqn. 1<br>$1.2 I_1 + 0.4 I_2 = 9$ eqn. 2<br>Multiply eqn. 1 by 4 then $2 I_1 + 2.4 I_2 = 28$ eqn. 3<br>Multiply eqn. 2 by 6 then $7.2 I_1 + 2.4 I_2 = 54$ eqn.4<br>Subtract eqn. 3 from eqn. 4<br>So $5.2 I_1 = 26$<br>Then $I_1 = 26/5.2 = 5$<br>Substitute $I_1 = 5$ into eqn. 1<br>Then $2.5 + 0.6 I_2 = 7$<br>So $0.6 I_2 = 7 - 2.5 = 4.5$<br>So $I_2 = 4.5/0.6 = 7.5$   | <br><br><br><br><br><br><br><br><br><br>[1]<br><br><br><br><br><br><br><br><br><br>[1]<br><br><br><br><br><br><br><br><br><br>[1]<br><br><br><br><br><br><br><br><br><br>[1] | Accept error carried forward from $I_1$ or $I_2$ .<br><br>Accept any other correct method. .<br><br>Allow up to three marks for finding $I_1$ or $I_2$<br>then<br>up to two marks for finding $I_2$ or $I_1$ . |
| 2 (b)    | Given formula $\Theta = \tilde{\omega}t + 0.5\alpha t^2$<br>Where $\Theta = 5$ , $\tilde{\omega} = 4$ and $\alpha = 0.6$<br>So $5 = 4t + 0.3t^2$<br>Then $0.3t^2 + 4t - 5 = 0$<br>Solution of quadratic equation by formulae<br>$t = [-b \pm \sqrt{(b^2 - 4ac)}]/2a$<br>where $a = 0.3$ , $b = 4$ and $c = -5$<br>so $t = [-4 \pm \sqrt{(4^2 - [4 \times 0.3 \times -5])}] / (2 \times 0.3)$<br>$t = -14.48$ or $1.151$ s<br>(Take $t$ as $1.151$ s) | <br><br><br><br><br><br><br><br><br><br>[1]<br><br><br><br><br><br><br><br><br><br>[1]<br><br><br><br><br><br><br><br><br><br>[1]<br><br><br><br><br><br><br><br><br><br>[1] | Do not accept error carried forward if incorrect quadratic equation formula is used.<br><br><br><br><br><br><br><br><br><br>Accept answers between 1.1 and 1.2 with or without the unit.                       |
|          | <b>Total</b>   | <b>[10]</b>  |  |



| Question |     |       | Expected Answer  | Mark                       | Rationale/Additional Guidance   |
|----------|-----|-------|--|----------------------------|---|
| 3        | (a) | (i)   | Given $i = I \sin 314.2 t$ .<br>then $2\pi f = 314.2$<br>so $f = 314.2/2\pi = 50$  | [1]                        |   |
| 3        | (a) | (ii)  | Given $i = I \sin 314.2 t$ and $I = 20 \text{ A}$ and $t = 0.002 \text{ s}$<br>then $i = 20 \sin (314.2 \times 0.002)$<br>so $i = 20 \sin (0.6284) = 11.76 \text{ A}$  | [1]<br>[1]                 | Accept answers between 11 and 12 with or without the unit.<br>Remember the angle is in radians.   |
| 3        | (a) | (iii) | Given $i = I \sin 314.2 t$ so $I = i / \sin 314.2t$<br><br>$I = 4/(\sin 314.2 \times 0.008) = 6.8 \text{ A}$   | [1]<br>[1]<br>[1]          | Do not accept error carried forward if incorrect formula is used.<br>Accept answers between 6.5 and 7 with or without the unit.<br>Remember the angle is in radians.        |
| 3        | (b) | (i)   | Cosine rule: $\cos B = (a^2 + c^2 - b^2)/2ac$<br><br>Where side $a = 3 \text{ m}$ , side $b = 5 \text{ m}$ and side $c = 6 \text{ m}$ .<br><br>$\cos B = (3^2 + 6^2 - 5^2)/(2 \times 3 \times 6) = 20/36$<br><br>$B = \cos^{-1} 20/36 = 56.25^\circ$ | [1]<br><br><br><br><br>[1] | Do not accept error carried forward if incorrect formula is used.<br><br><br>Accept answers between 56 and 56.5 with or without the unit.                                   |
| 3        | (b) | (ii)  | Area = $\sqrt{s(s-a)(s-b)(s-c)}$<br><br>$s = \frac{1}{2}(a+b+c) = \frac{1}{2}(3+5+6) = 7$<br><br>Area = $\sqrt{7(7-3)(7-5)(7-6)} = 7.48 \text{ m}^2$   | [1]<br><br><br>[1]         | Do not accept error carried forward if incorrect formula is used.<br>Accept any alternative correct method.<br>Accept answers between 7.2 and 7.6 with or without the unit. |
|          |     |       | <b>Total</b>   | <b>[10]</b>                |   |

| Question    | Expected Answer  | Mark   | Rationale/Additional Guidance   |
|-------------|--|--|---|
| 4 (a)       | <p>Given <math>\sin^2 x - \cos^2 x = \frac{1}{4}</math></p> <p>But <math>\sin^2 x + \cos^2 x = 1</math> so <math>\sin^2 x = 1 - \cos^2 x</math></p> <p>Then <math>(1 - \cos^2 x) - \cos^2 x = \frac{1}{4}</math></p> <p>So <math>1 - 2 \cos^2 x = \frac{1}{4}</math></p> <p><math>1 - \frac{1}{4} = 2 \cos^2 x</math></p> <p><math>\frac{3}{4} = 2 \cos^2 x</math></p> <p>So <math>\cos^2 x = \frac{3}{8}</math></p> <p><math>\cos x = \sqrt{\frac{3}{8}} = 0.6124</math></p> <p>Angle <math>x = \cos^{-1} 0.6124 = 52.24^\circ</math></p> <p>Since the cosine may be positive or negative there will be one solution in each quadrant, ie. <math>52.24^\circ</math>, <math>127.76^\circ</math>, <math>232.24^\circ</math> and <math>307.76^\circ</math></p> | <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> | <p>Award marks for any other correct response.</p> <p>Accept answers between: 52 and 52.5, 127.5 and 128, 232 and 232.5. 307.5 and 308.</p> |
| 4 (b) (i)   | Dimension AC = $3 \cos 30^\circ = 2.598$ cm.   | [1]  | <p>Accept answers between 2.5 and 2.7.</p> <p>Award one mark for correct numerical result with or without the unit.</p>                     |
| 4 (b) (ii)  | Dimension BC = $3 \sin 30^\circ = 1.5$ cm.   | [1]  | Award one mark for correct numerical result with or without the unit.   |
| 4 (b) (iii) | Angle between the lines DA and DC = $\tan^{-1} 2.598/4 = 33^\circ$   | [1]  | <p>Accept answers between 32.5 and 33.5.</p> <p>Award one mark for correct numerical result with or without the unit.</p>                   |

| Question |     |      | Expected Answer  | Mark        | Rationale/Additional Guidance  |
|----------|-----|------|--|-------------|--|
| 4        | (b) | (iv) | Dimension DC = $\sqrt{4^2 + 2.598^2} = 4.77$ cm.                       | [1]         | Accept answers between 4.5 and 5.<br>Award one mark for correct numerical result with or without the unit.     |
| 4        | (b) | (v)  | Angle between the lines DC and DB = $\tan^{-1} 1.5/4.77 = 17.46^\circ$ | [1]         | Accept answers between 17.3 and 17.6.<br>Award one mark for correct numerical result with or without the unit. |
|          |     |      | <b>Total</b>   | <b>[10]</b> |  |

| Question  | Expected Answer   | Mark | Rationale/Additional Guidance              |      |    |   |   |   |      |   |   |   |   |     |   |   |   |      |   |     |   |
|-----------|---|------|--|------|----|---|---|---|------|---|---|---|---|-----|---|---|---|------|---|-----|---|
| 5 (a)     | <table border="1" data-bbox="349 304 1099 376"> <tr> <td>x</td> <td>-2</td> <td>-1.5</td> <td>-1</td> <td>0</td> </tr> <tr> <td>y</td> <td>4</td> <td>2.25</td> <td>1</td> <td>0</td> </tr> </table><br><table border="1" data-bbox="349 408 1032 480"> <tr> <td>x</td> <td>1</td> <td>1.5</td> <td>2</td> </tr> <tr> <td>y</td> <td>1</td> <td>2.25</td> <td>4</td> </tr> </table> | x    | -2   | -1.5 | -1 | 0 | y | 4 | 2.25 | 1 | 0 | x | 1 | 1.5 | 2 | y | 1 | 2.25 | 4 | [1] | Graph – award one mark for correct left hand side and one mark for right hand side. |
| x         | -2  | -1.5 | -1   | 0    |    |   |   |   |      |   |   |   |   |     |   |   |   |      |   |     |   |
| y         | 4   | 2.25 | 1  | 0    |    |   |   |   |      |   |   |   |   |     |   |   |   |      |   |     |   |
| x         | 1   | 1.5  | 2  |      |    |   |   |   |      |   |   |   |   |     |   |   |   |      |   |     |   |
| y         | 1   | 2.25 | 4  |      |    |   |   |   |      |   |   |   |   |     |   |   |   |      |   |     |   |
| 5 (b) (i) |  <p data-bbox="349 1289 427 1326">Fig. 3</p>   | [2]  | Allow error carried forward from part (a). |      |    |   |   |   |      |   |   |   |   |     |   |   |   |      |   |     |   |

| Question     |     |       | Expected Answer   | Mark              | Rationale/Additional Guidance   |
|--------------|-----|-------|---|-------------------|---|
| 5            | (b) | (ii)  | At $x = -1.5$ , gradient will be $= -3$   | [1]               | Check that a tangent has been drawn at $x = -1.5$<br>Accept answers between $-2.8$ and $-3.2$ . |
| 5            | (c) | (i)   | Given $s = 2t^3 + 4t^2 + 6t$ .<br><br>Velocity = $ds/dt = 6t^2 + 8t + 6$<br>At initial velocity $t = 0$<br>Then velocity = $0 + 0 + 6 = 6 \text{ ms}^{-1}$                                  | [1]<br>[1]<br>[1] | Award one mark for correct numerical result with or without the unit.                           |
| 5            | (c) | (ii)  | Given $s = 2t^3 + 4t^2 + 6t$ .<br><br>Velocity = $ds/dt = 6t^2 + 8t + 6$<br>When $t = 5 \text{ s}$<br>Then velocity = $150 + 40 + 6 = 196 \text{ ms}^{-1}$                                  | [1]               | Award one mark for correct numerical result with or without the unit                            |
| 5            | (c) | (iii) | Given $s = 2t^3 + 4t^2 + 6t$ .<br>Velocity = $ds/dt = 6t^2 + 8t + 6$<br>Acceleration = $d^2s/dt^2 = 12t + 8$<br>When $t = 3 \text{ s}$<br>Then acceleration = $36 + 8 = 44 \text{ ms}^{-2}$ | [1]<br>[1]        | Award one mark for correct numerical result with or without the unit                            |
| <b>Total</b> |     |       |   | [10]              |   |

| Question | Expected Answer  | Mark                             | Rationale/Additional Guidance  |
|----------|--|----------------------------------|--|
| 6 (a)    | $\int_0^{\pi/6} \cos 3x \, dx$ $= \left[ \frac{\sin 3x}{3} \right]_0^{\pi/6}$ $= \left( \frac{\sin \pi/2}{3} - \frac{\sin 0}{3} \right)$ $= \frac{1}{3}$   | <p>[1]</p> <p>[2]</p> <p>[1]</p> | <p>Do not accept error carried forward if incorrect integration takes place.</p> <p>Award one mark for <math>(\sin \pi/2)/3</math> and one mark for <math>-(\sin 0)/3</math></p> |
| 6 (b)    | <p>Given <math>y = (1 - x)^2</math></p> <p>Then integral = <math>\int (1 - x)^2 \, dx</math></p> $= \int (1 - 2x + x^2) \, dx$ $= x - x^2 + \frac{1}{3}x^3 + C$  | <p>[1]</p> <p>[1]</p>            | <p>Award one mark for correct integration with or without constant C.</p> <p>Accept for two marks <math>y = [-(1 - x)^3]/3 + C</math></p>  |
| 6 (c)    | <p>Given <math>y = (x^3 - 2x)/3x</math></p> <p>Then integral = <math>\int \{(x^3 - 2x)/3x\} \, dx</math></p> $= \int \{(x^3/3x) - (2x/3x)\} \, dx$ $= \int \{(x^2/3) - (2/3)\} \, dx$ $= (x^3/9) - (2x/3) + C$ | <p>[1]</p> <p>[1]</p> <p>[2]</p> | <p>Award one mark for correct integration with or without constant C.</p> <p>Award one mark for <math>(x^3/9)</math> and one mark for <math>-(2x/3)</math></p>                   |
|          | <b>Total</b>   | <b>[10]</b>                      |  |

| Question       |           |           | Expected Answer   |  |  | Mark           | Rationale/Additional Guidance |           |         |          |   |         |           |    |         |      |   |         |         |   |     |   |
|----------------|-----------|-----------|---|--|--|----------------|-------------------------------|-----------|---------|----------|---|---------|-----------|----|---------|------|---|---------|---------|---|-----|---|
| 7              | (a)       | (i)       | <table border="1"> <thead> <tr> <th>Time (minutes)</th> <th>Tally</th> <th>Frequency</th> </tr> </thead> <tbody> <tr> <td>21 – 30</td> <td>IIII III</td> <td>9</td> </tr> <tr> <td>31 – 40</td> <td>IIII IIII</td> <td>10</td> </tr> <tr> <td>41 – 50</td> <td>IIII</td> <td>4</td> </tr> <tr> <td>51 – 60</td> <td>IIII II</td> <td>7</td> </tr> </tbody> </table> |  |  | Time (minutes) | Tally                         | Frequency | 21 – 30 | IIII III | 9 | 31 – 40 | IIII IIII | 10 | 41 – 50 | IIII | 4 | 51 – 60 | IIII II | 7 | [2] | Consider frequency column: award two marks for all correct frequencies .<br>Award one mark for two correct frequencies. |
| Time (minutes) | Tally     | Frequency |   |  |  |                |                               |           |         |          |   |         |           |    |         |      |   |         |         |   |     |   |
| 21 – 30        | IIII III  | 9         |   |  |  |                |                               |           |         |          |   |         |           |    |         |      |   |         |         |   |     |   |
| 31 – 40        | IIII IIII | 10        |   |  |  |                |                               |           |         |          |   |         |           |    |         |      |   |         |         |   |     |   |
| 41 – 50        | IIII      | 4         |   |  |  |                |                               |           |         |          |   |         |           |    |         |      |   |         |         |   |     |   |
| 51 – 60        | IIII II   | 7         |   |  |  |                |                               |           |         |          |   |         |           |    |         |      |   |         |         |   |     |   |

| Question |     |      | Expected Answer   | Mark | Rationale/Additional Guidance |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
|----------|-----|------|---|------|-------------------------------|--|--|--|----|--|--|--|--|----|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|---|--|--|--|--|-----|---|
| 7        | (a) | (ii) | <p>frequency</p> <table border="1"> <tr><td>12</td><td></td><td></td><td></td><td></td></tr> <tr><td>11</td><td></td><td></td><td></td><td></td></tr> <tr><td>10</td><td></td><td></td><td></td><td></td></tr> <tr><td>9</td><td></td><td></td><td></td><td></td></tr> <tr><td>8</td><td></td><td></td><td></td><td></td></tr> <tr><td>7</td><td></td><td></td><td></td><td></td></tr> <tr><td>6</td><td></td><td></td><td></td><td></td></tr> <tr><td>5</td><td></td><td></td><td></td><td></td></tr> <tr><td>4</td><td></td><td></td><td></td><td></td></tr> <tr><td>3</td><td></td><td></td><td></td><td></td></tr> <tr><td>2</td><td></td><td></td><td></td><td></td></tr> <tr><td>1</td><td></td><td></td><td></td><td></td></tr> <tr><td>0</td><td></td><td></td><td></td><td></td></tr> </table> <p style="text-align: center;">20.5      30.5      40.5      50.5      60.5</p> | 12   |                               |  |  |  | 11 |  |  |  |  | 10 |  |  |  |  | 9 |  |  |  |  | 8 |  |  |  |  | 7 |  |  |  |  | 6 |  |  |  |  | 5 |  |  |  |  | 4 |  |  |  |  | 3 |  |  |  |  | 2 |  |  |  |  | 1 |  |  |  |  | 0 |  |  |  |  | [4] | <p>Allow error carried forward.</p> <p>Award one mark for each correct bar.</p> |
| 12       |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 11       |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 10       |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 9        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 8        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 7        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 6        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 5        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 4        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 3        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 2        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 1        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |
| 0        |     |      |   |      |                               |  |  |  |    |  |  |  |  |    |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |   |  |  |  |  |     |   |



| Question | Expected Answer  | Mark                     | Rationale/Additional Guidance  |
|----------|--|--------------------------|--|
| 7 (b)    | First quartile = 23.5<br>Third quartile = 31.5<br>Interquartile range = $31.5 - 23.5$<br>= 8 | [1]<br>[1]<br>[1]<br>[1] | First quartile – accept answers between 23 and 24.<br>Third quartile – accept answers between 31 and 32.<br><br>Interquartile range – accept answers between 7 and 9. Allow error carried forward. |
|          |  | [10]                     |  |

| Question     |     | Expected Answer   | Mark                     | Rationale/Additional Guidance  |
|--------------|-----|---|--------------------------|--|
| 8            | (a) | (i) A <b>trial</b> is any process which, when repeated generates a set of results or observations or a single repetition of an experiment.  | [3]                      | Award one mark for each correct explanation.<br><br>Accept any form of words that gives an adequate explanation.                     |
|              |     | (ii) An <b>outcome</b> is the result of carrying out a trial.   |                          |  |
|              |     | (iii) An <b>event</b> is a set which consists of one or more of the possible outcomes of a trial or a subset of sample space.   |                          |  |
|              | (b) | The first three positions can be filled in 3! ways and the next in 5! ways.<br>Clients with eight-character codes = 3! x 5!<br><br>$= (3 \times 2 \times 1) \times (5 \times 4 \times 3 \times 2 \times 1)$ $= 720$   | [1]<br>[1]               |  |
|              | (c) | (i) Probability of three fives = $(1/6)^3 = 1/216$ or 0.00463<br>(ii) The first dice may be a five with the second and third not or the second a five and the first and third not or the third a five with the first and second not.<br>Probability of one, and only one, five = $3[(1/6) \times (5/6) \times (5/6)] = 25/72$ or 0.347<br>(iii) Probability of obtaining at least one five = 1 – the probability of obtaining no fives<br>$= 1 - (5/6)^3 = 91/216$ or 0.421 | [1]<br>[1]<br>[1]<br>[1] | Accept answers between 0.0045 and 0.0047.<br><br>Accept answers between 0.34 and 0.35.<br><br>Accept answers between 0.42 and 0.425. |
| <b>Total</b> |     |   | <b>[10]</b>              |  |

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