AS/A LEVEL
(former Cambridge linear syllabus)

MATHEMATICS/
FURTHER MATHEMATICS

MARK SCHEME FOR COMPONENTS
TAKEN IN JUNE 2000
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Mill Street
BIRMINGHAM
B6 4BU
**MATHEMATICS 9200**

*Component threshold marks*

<table>
<thead>
<tr>
<th>Component</th>
<th>Maximum Mark</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>N</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>120</td>
<td>82</td>
<td>71</td>
<td>61</td>
<td>51</td>
<td>42</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>120</td>
<td>89</td>
<td>79</td>
<td>68</td>
<td>58</td>
<td>48</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>85</td>
<td>75</td>
<td>66</td>
<td>57</td>
<td>49</td>
<td>41</td>
<td>0</td>
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<tr>
<td>4</td>
<td>120</td>
<td>91</td>
<td>82</td>
<td>72</td>
<td>62</td>
<td>53</td>
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</table>

*Overall Threshold Marks*

<table>
<thead>
<tr>
<th>Option</th>
<th>Maximum Mark</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>N</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (1,2)</td>
<td>240</td>
<td>171</td>
<td>149</td>
<td>129</td>
<td>109</td>
<td>90</td>
<td>71</td>
<td>0</td>
</tr>
<tr>
<td>B (1,3)</td>
<td>240</td>
<td>164</td>
<td>144</td>
<td>125</td>
<td>107</td>
<td>89</td>
<td>71</td>
<td>0</td>
</tr>
<tr>
<td>C (1,4)</td>
<td>240</td>
<td>171</td>
<td>150</td>
<td>131</td>
<td>113</td>
<td>95</td>
<td>77</td>
<td>0</td>
</tr>
</tbody>
</table>

The percentage of candidates awarded each grade was as follows

<table>
<thead>
<tr>
<th>Grade</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>N</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>36.8</td>
<td>16.1</td>
<td>13.3</td>
<td>12.7</td>
<td>8.6</td>
<td>7.1</td>
<td>5.3</td>
</tr>
<tr>
<td>Cumulative %</td>
<td>36.8</td>
<td>52.9</td>
<td>66.3</td>
<td>79.0</td>
<td>87.6</td>
<td>94.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The total candidature was 1395
Markscheme 9200/1
June 2000
<table>
<thead>
<tr>
<th>Question Number</th>
<th>Mark scheme details</th>
<th>Part Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Obtains ( r = 5 ) OR ( \sqrt{25} ); Obtains (centre) ((0,1)) AEF</td>
<td>B1 B1 2</td>
</tr>
<tr>
<td>2</td>
<td>Obtains ( y = 3x - 1 )</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>Substitutes correctly into own linear equation ( (1)s^3 = 3(1s) - 1 )</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains ( t = 3s^2 - s^2 ) OR ( t = -s^3 + 3s^2 ) OR ( t = s^2(3 - s) ) or other factorised form</td>
<td>A1 2</td>
</tr>
<tr>
<td>3</td>
<td>(i) Obtains correct graph with numerical evidence for correct stretch s.f. ( \frac{1}{2} )</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>(ii) Obtains correct reflection in x-axis of given graph with numerical evidence</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>(iii) Obtains correct reflection of given graph in line ( y = x ) with numerical evidence</td>
<td>B1 1</td>
</tr>
<tr>
<td>4</td>
<td>(i) Obtains values 7,11,15</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>(ii) Substitutes numbers in ( u_n = a + (n - 1)d ) OR ( u_n = a + nd )</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains ( u_n = 3 + 4(n - 1) ) OR ( 4n - 1 ) AEF</td>
<td>A1 2</td>
</tr>
<tr>
<td></td>
<td>(iii) States ( u_n ) convergent AND satisfactory reason such as ( &quot;u_n ) divergent&quot; OR ( &quot;v_n ) tends to zero&quot; OR ( &quot;u_n ) tends to infinity&quot;</td>
<td>B1 1</td>
</tr>
<tr>
<td>5</td>
<td>Method to obtain ( 1 \pm 6 ), with possible numerical or ( x \leftrightarrow y ) errors only, seen or implied</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains ( -5 &lt; y &lt; 7 ) OR ( -5 &lt; y ) and ( y &lt; 7 ) OR ( -5 &lt; y, y &lt; 7 ) CWD AEF</td>
<td>A1 2</td>
</tr>
<tr>
<td></td>
<td>(M1 A0 for ( -5 &lt; x &lt; 7 ) etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Method to obtain ( x\ln2 = \ln y ) OR ( x\ln2 &lt; \ln y ) etc. OR ( x\log2 = \log y )</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains ( \ln y ) / ( \ln 2 ) with no intermediate step involving ( \ln (y/2) ) (FT only on ( y &gt; 0 ))</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Obtains ( x &lt; \ln 7/\ln 2 ) ONLY having obtained positive and negative roots in first part</td>
<td>A1 3</td>
</tr>
</tbody>
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<tr>
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<tbody>
<tr>
<td>6</td>
<td>2 – \tan 1 = 0.4 AND 2.4 – \tan 1.2 = -0.2 or better</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Clear identification of sign change AND deductive statement</td>
<td>M1 2</td>
</tr>
<tr>
<td></td>
<td>{f'(x)} = 2 – \sec^2 x  AEF</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Attempts 1.1 – f(1.1)/f'(1.1)</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains 1.18 (=1.182243....)</td>
<td>A1 3</td>
</tr>
<tr>
<td>7</td>
<td>Valid complete attempt to find partial fractions seen or implied</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains (1/2)/(x – 2) – (1/2)/(x) AEF</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Integrates to form A\ln(x – 2) + B\ln x  AEF</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains (1/2)\ln(x – 2) – (1/2)\ln x or better</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Obtains (1/2)\ln</td>
<td>x - 2</td>
</tr>
<tr>
<td>8</td>
<td>(i) Sine rule used AND attempt to obtain \sin \theta</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains 0.4 OR 2/5</td>
<td>A1 2</td>
</tr>
<tr>
<td></td>
<td>(ii) \sin^2 \theta + \cos^2 \theta = 1 OR Pythagorean equivalent used AND attempt to obtain \cos \theta</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains \sqrt{21}/5 AEEF (exact working only)</td>
<td>A1 2</td>
</tr>
<tr>
<td></td>
<td>(iii) Obtains \cos BDC = 3/5 AND \sin BDC = 4/5  AEEF</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>(iv) Indicates intention to use \sin \phi \cos \phi \pm \cos \phi \sin \phi</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Substitution of 3/5 (✓ for \cos \phi), 4/5 (✓ for \sin \phi) and own \sin \theta, \cos \theta into attempted \sin(\theta \pm \phi)</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains (6 + 4\sqrt{21})/25 AEEF</td>
<td>A1 3</td>
</tr>
<tr>
<td>9</td>
<td>(a) Obtains (A =) 4</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Sufficient equations for B, C, AND attempt to solve for B OR C</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains (B =) 5; (C =) -1</td>
<td>A1 A1 4</td>
</tr>
<tr>
<td></td>
<td>SR: only B = 5 or only C = -1 written down can score B1 for max B1 B1 M0 2/4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Obtains y = 2</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Method to solve quadratic or cubic equation using correct formula or otherwise</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains y = 4/3 OR 1.3; y = 8/3 OR 2.7</td>
<td>A1 A1 4</td>
</tr>
<tr>
<td>Question Number</td>
<td>Mark scheme details</td>
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<td>-----------------</td>
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</tbody>
</table>
| 10              | (i) Obtains scalar product \( \pm 5.05 \) OR obtains three correct lengths \( 25.01, 5.25, 20.16 \) B1  
Omits \( \cos AOB = \frac{\pm(-3.1+4.2+0.1 \times 0.5)}{\sqrt{(-3)^2+4^2+0.1^2}} \sqrt{[1^2+2^2+0.5^2]} \approx 0.4407 \ldots \) M1  
Obtains \( AOB = 63.851^\circ \) with 3dp required \( \approx 63.85068 \) A1 3  
(ii) Obtains \(-3, 4, 0\) AND \((1, 2, 0)\) (allow position vectors or omission of 0) B1 1  
(iii) Obtains \( \cos A'OB' = \frac{\pm(-3.1+4.2)}{\sqrt{(-3)^2+4^2}} \sqrt{[1^2+2^2]} \) B1  
Obtains \( A'OB' = 63^\circ \) or better \( \approx 63.43494 \ldots \) B1  
Method for \( \pm(\cos AOB - A'OB') / A'OB' \) M1  
Obtains 0.66% AG \( \approx 0.6533 \ldots \) OR 0.6557... A1 4 8  |
| 11              | (i) Obtains \( R = 25; \) \( \alpha = 74^\circ \approx 73.73979 \ldots \) B1 B1 2  
Attempt to use inverse sine to find one value of \( \theta + \alpha \) for \( \sin(\theta + \alpha) = -3/R \) M1  
Obtains any \( \theta \) satisfying \( \sin(\theta + \alpha) = -3/R \) for own values of \( R \) and \( \alpha \) A1  
Obtains \( \theta = -81^\circ, 113^\circ \approx -80.631 \ldots \approx 113.1523 \ldots \) A1 A1 4  
SR: -A1 mark for all extra solutions in range  |
| 11              | (ii) (a) Method to add 10° to previous solution(s) M1  
Obtains \( x = \theta + 10 \) within range specified \( \approx 123^\circ = 123.1523 \ldots \) A1 ✓ 2  
(b) Method for \( 90 - y = \theta \) M1  
Obtains \( y = 90 - \theta \) ✓ within range specified \( \approx 171^\circ = 170.639 \ldots \) A1 ✓ 2  
SR: Fresh starts for (a) and (b) earn M1 for full correct method, A1 correct answer 10 |
| 12              | Uses \( dx = \pm \cos \theta \ (d \theta) \) correctly M1  
Obtains \( \pm \sin^2 \theta \cos \theta \) correctly M1  
Change of limits and use of double angle formula to obtain given integral AG A1 3  
Obtains \( \int a + b \cos 4 \theta \ (d \theta) \) M1  
Obtains \( \frac{1}{8} \left( \theta - \frac{1}{4} \sin 4 \theta \right) \) AEF A1  
Obtains \( A = \frac{1}{8} \left( \frac{\pi}{6} - \frac{\sqrt{3}}{8} \right) \) AEEF \( \approx 0.038386 \) A1 3  
Use of \( \int y^2 \ dx \) where \( y = x^2 \sqrt{1 - x^2} \) M1  
\( \pi \int x^4 (1 - x^2) \ (dx) \) seen A1  
Attempts to evaluate \[ ax^5 + bx^7 \] M1  
Obtains \( V = \) \( 23 \pi/4480 \) AEEF A1 4 10 |
<table>
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<tr>
<th>Question Number</th>
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<tbody>
<tr>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Obtains $y - 6 = m(x + 1)$ for some $m$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $m = -2$</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Obtains $2x + y - 4 = 0$</td>
<td>A1</td>
</tr>
<tr>
<td>(ii)</td>
<td>Complete method to solve equations $l$ and $l'$ simultaneously</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $x = 3$ AND $y = -2$</td>
<td>A1</td>
</tr>
<tr>
<td>(iii)</td>
<td>Complete method for magnitude of displacement from $P$ to intersection (ii)</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains correctly $4\sqrt{5}$ AG ($=\sqrt{4^2 + 8^2}$)</td>
<td>A1</td>
</tr>
<tr>
<td>(iv)</td>
<td>Obtains $(QR = \sqrt{320})$ AEEF</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Any complete method for area of triangle PQR</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains 80 by an exact method</td>
<td>A1</td>
</tr>
<tr>
<td>OR</td>
<td>Any complete exact method for area of triangle</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $A = 16 \times 13 - 3 \times 13 - 5 \times 5 - 8 \times 8$ AEEF</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>or $A = \frac{1}{2}((-1 \times -7) + (-7 \times 1) + (9 \times 6) - (6 \times -7) - (-7 \times 9) - (1 \times -1))$ AEEF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obtains 80 by an exact method</td>
<td>A1</td>
</tr>
<tr>
<td>14</td>
<td>$\frac{dm}{dt} = -km$ OR $km$ with $k &lt; 0$ stated AEF</td>
<td>B1 B1</td>
</tr>
<tr>
<td></td>
<td>NB: Allow B1 B0 if finds $\frac{dm}{dt}$ from AG</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Separation of variables and attempt to integrate</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $lnm = \pm kt + c$ consistent with first part</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Obtains $c = \pm ln m_0$ or equivalent and attempts to substitute and exponentiate correctly</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains correctly $m = m_0e^{kt}$ AG</td>
<td>A1</td>
</tr>
<tr>
<td>OR</td>
<td>Uses $\frac{dm}{dt} \pm km = 0$ and find integrating factor $e^{kt}$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $m e^{kt} = c$</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Obtains $c = m_0$ and rearranges</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains correctly $m = m_0e^{kt}$ AG</td>
<td>A1</td>
</tr>
<tr>
<td>SR</td>
<td>Obtains $m = e^{kt}$ can score B1 B1 M1 B1 max. 4/6</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>Graph with positive gradient and gradient decreasing</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Graph passes through $M(0) &gt; 0$ and limiting from below (ignore all labels)</td>
<td>B1</td>
</tr>
<tr>
<td>(ii)</td>
<td>States that $M$ tends to $A$</td>
<td>B1</td>
</tr>
<tr>
<td>(iii)</td>
<td>Uses $\frac{dM}{dt} = -\frac{dm}{dt}$ or equivalent</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Complete correct substitution to obtain given differential equation AG</td>
<td>A1</td>
</tr>
<tr>
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</tr>
<tr>
<td>15</td>
<td>Uses $r^2 \theta / 2$ and two radii</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $A = 14 \theta$ (cm$^2$)</td>
<td>A1 2</td>
</tr>
<tr>
<td>(i)</td>
<td>Attempts to differentiate own $A$ with respect to $r$ and use 0.1</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains 1.4 (cm$^2$s$^{-1}$) CWD</td>
<td>A1 2</td>
</tr>
<tr>
<td>(ii)</td>
<td>$(P = 2+2+8\theta+6\theta \text{ OR } 4 + 14\theta \text{ OR } NP + MQ = 14\theta \text{ and } MN, PQ \text{ constant})$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains 1.4 (cm$^2$s$^{-1}$) from correct $P$ CWD</td>
<td>A1 2</td>
</tr>
<tr>
<td>(iii)</td>
<td>Uses completely correct cosine rule in triangle including $\theta$ and $L$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $L^2 = 100 - 96\cos \theta$ AG</td>
<td>A1 2</td>
</tr>
<tr>
<td></td>
<td>Uses $\frac{dL}{dt} = \frac{dL}{d\theta} \frac{d\theta}{dt}$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $2L$ in denominator or $\frac{1}{2}(100 - 96\cos \theta)^{-1}K$</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Obtains $96\sin \theta d\theta/dt$ OR $96\sin \theta(0.1)$ AEF</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Substituting for $\theta$, $d\theta/dt$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $(6\sqrt{39})/65 \text{ OR } 0.58 = (0.57646...)$ (cm$^{-1}$)</td>
<td>A1 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>13</strong></td>
</tr>
<tr>
<td>16</td>
<td>(a) Obtains $4p + 16q = 1$</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>$(dy/dx =) 2px + 4qx^3$</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Substitutes to obtain $\sqrt{2} (a(4p + 16q))$</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Demonstrates using $4p + 16q = 1$ that $2p(\sqrt{2}) + 4q(\sqrt{2})^3 = \sqrt{2}/2$ AG</td>
<td>B1 3</td>
</tr>
<tr>
<td>(b)</td>
<td>Obtains $a = 5/36 \text{ OR } 0.14 = (0.13888...)$</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>Obtains first non zero term $ax^2 \checkmark (= 5x^2/36 = 0.14 x^2)$</td>
<td>B1 ✓ 2</td>
</tr>
<tr>
<td></td>
<td>Obtains second non zero term $ax^4/9 \checkmark (= 5x^4/324 = 0.015 x^4)$</td>
<td>B1 ✓ 2</td>
</tr>
<tr>
<td>(c)</td>
<td>Obtains $k = 0.181 = (0.181015...)$</td>
<td>B1 1</td>
</tr>
<tr>
<td></td>
<td>Attempt to substitute up to $x^4$ term for $e^x \text{ AND, using } -x, \text{ for } e^{-x}$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains $kx^2 + kx^4/12 + ... \text{ or better } (= 0.181 x^2 + 0.0151 x^4)$</td>
<td>A1 2</td>
</tr>
<tr>
<td>(ii)</td>
<td>Show clearly that 40 comes from 2 x 20 (where 20 can be assumed)</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>Expands series with $e^x$ and states $x = 0.1r$</td>
<td>B1</td>
</tr>
<tr>
<td></td>
<td>OR</td>
<td><strong>15</strong></td>
</tr>
<tr>
<td></td>
<td>Shows sum of individual terms at start (before seeing summation sign) ie see $e^{0.1} + e^{0.2} + ... + e^{-0.1} + e^{-0.2} + ...$</td>
<td>B1 2</td>
</tr>
<tr>
<td></td>
<td>Identifies a G.P. and its common ratio correctly</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Attempts valid method for both summations with $\langle r \rangle = e^{0.1} \text{ AND } e^{-0.1}$</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Obtains (sum =) 6.4 $= (6.40...)$</td>
<td>A1 3</td>
</tr>
</tbody>
</table>
1

EITHER: Attempt quotient rule (or equivalent) allowing sign errors for this mark
(products reversed only)

Obtain any correct unsimplified expression, e.g. \(\frac{(2x+1)x-1-(x-2)x}{2}\)

Obtain simplified answer \(\frac{5}{(2x+1)^2}\) correctly

[Product rule also requires chain rule (both applied correctly for M1)]

OR: Express the function as \(\frac{1}{2} \cdot \frac{5}{2(2x+1)}\)

Use chain rule to differentiate \(\frac{k(2x+1)^{-1}}{(2x+1)^2}\) (result \(-k(2x+1)^{-2}\) is M0)

Obtain simplified answer \(\frac{5}{(2x+1)^2}\) correctly

[Accept final answer in the form \(\frac{5}{4x^2 + 4x + 1}\)]

M1
A1
A1
B1
M1
A1
A1
3

2

EITHER: State or imply correct cosine rule (in any form) involving 2, 3, 4 and
either B or C

Obtain \(\cos B = -\frac{1}{3}\) (aef) or \(B = 104.5^\circ\) or \(104^\circ\) or \(105^\circ\) or \(C = \frac{7}{8}\) (aef)

or \(C = 29^\circ\)

State or imply correct formula for \(AD^2\) involving 2, 4 and their numerical
\(\cos B\) or 1, 4 and their numerical \(\cos (180 - C)\) or \(-\cos C\)

Obtain answer \(\sqrt{24}\) or \(2 \sqrt{6}\) or 4.9

OR:

[E is the foot of the perpendicular from A to CB produced]

Use Pythagoras in triangles \(ACE\) and \(ABE\) to obtain an equation for \(BE\) or
\(AE\)

Obtain \(BE = \frac{1}{2}\) or \(AE^2 = \frac{15}{4}\)

Apply Pythagoras (or trig) with numerical \(BE\) and/or \(AE\) to find \(AD^2\) (or
\(AD\))

Obtain answer \(\sqrt{24}\) or \(2 \sqrt{6}\) or 4.9

M1*
A1
M1 (dep *)
A1
M1*
A1
M1 (dep *)
A1
4

3

(i) Multiply two relevant probabilities for a 'Yes' branch

Add the two relevant two-factor cases, i.e. \(\frac{2}{3}p + \frac{1}{3}(1-p)\)

Obtain given answer \(\frac{1}{3}(1+p)\) correctly

(ii) \(\frac{1}{3}(1+p)\) and find \(p = 0.05\)

Divide attempted \(P('No' \text{ and 'Truthful'})\) by \(P('No')\)

State or imply answer is \(\frac{2}{3}(1-0.05)\)

Obtain answer 0.97 or \(\frac{38}{39}\) or equivalent fraction

[M1 is for a fraction with numerical numerator \(\frac{2}{3}\) or denominator \(1-0.35\)
(or equivalent); ft only if \(0 < p < 1\)]

M1*
M1 (dep *)
A1
3
B1
1
M1
A1 ft
A1
3
4. (a) (i) State 'pie chart' or 'bar chart' or 'pictogram' or 'line diagram.'
   (ii) State 'histogram' or 'stem and leaf diagram' or 'frequency polygon' or
        'cumulative frequency diagram.'
   (iii) State 'double bar chart' or 'two bar charts with common scales on a single
        diagram.'
(b) (i) Read off at least one relevant result
   Obtain any one answer 32, 38, 43
   Obtain all three correct values of the median and quartiles, identifying the
   median
   State interquartile range is 11
   (ii) Show linear scale from 0 to 60 with 0 and 60 marked and with ends of
        whiskers located at 5 and 60
        Show box extending between their quartile values
        Show median line in box at their median value

   [Location of 5, medians and quartiles to be reasonably consistent with a linear scale.]

5. EITHER: Use the connected formula \( s = ut + \frac{1}{2} at^2 \)
   Obtain equation \( 6 = 15t - \frac{1}{2} gt^2 \)
   Solve a quadratic equation for \( t \)
   Obtain roots 0.47 and 2.6
   OR: Use the correct formula \( v^2 = u^2 + 2as \) to find \( v \)
   State correct expression \( \sqrt{(15^2 - 2g \times 5)} \) for speed at height 6m
   Use a correct formula to evaluate a relevant time
   Obtain answers 0.47 and 2.6

   [Treat 'time above 6m' as a MR and give maximum possible on scheme.]

6. (i) Show three corrected line segments with 2 correctly signed gradients
    Show or imply \( t \) and \( v \) axes with relevant points (10, 40), (15, 30) and (20, 0)
    identified and graph of correct shape
    Carry out complete method for the area calculation, e.g. two triangles and one
    trapezium (or equivalent use of constant acceleration formulas)
    Obtain answer 450
   (ii) Sketch a graph starting at \( O \) having positive, decreasing gradient

7. Equate total momentum before and after
   State or imply a correct equation \( 20000 \times 1.5 + 10000 \times 1 = (20000 + 10000)v \)
   Obtain answer \( \frac{4}{3} \), or equivalent, correctly
   (i) State either \( 5000 = (\pm)30000a \) or both of \( 5000 - P = (\pm)10000a \) and
       \( P = (\pm)20000a \)
       Obtain answer \( (\pm)\frac{1}{6} \), or equivalent, for the deceleration
   (ii) Use a Newton II equation for one of the trucks with their numerical \( a \) (or
        numerical \( v \) and \( t \)) to find \( P \)
       Obtain answer \( (\pm)3333 \frac{1}{3} \) or 3300 only

   [If \( g \) appears in the momentum equation deduct A1 but allow A1 for answer \( \frac{4}{3} \) or
   equivalent.]
<table>
<thead>
<tr>
<th>Page</th>
<th>Statement</th>
<th>Marks</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Resolve vertically, i.e. $2T\cos\theta = W$ or use trig in correct triangle or use Lami</td>
<td>M1</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Obtain answer $41^\circ$ following correct use of $T = \frac{2}{3} W$</td>
<td>M1*</td>
<td></td>
</tr>
<tr>
<td>EITHER:</td>
<td>Attempt a resolving equation, with 3 terms</td>
<td>A1</td>
<td>M1*</td>
</tr>
<tr>
<td></td>
<td>Obtain a correct equation in $T$ and trig ratios of one angle, e.g. one of $T\cos\theta + T\sin\theta = W$, $T\cos\theta - T\sin\theta = \frac{1}{2} W$, $T = \frac{1}{2} W\cos\theta + W\sin\theta$, $T = W\cos\theta - \frac{1}{2} W\sin\theta$ (allow $\cos(90 - \theta)$ for $\sin\theta$ etc)</td>
<td>A1</td>
<td>M1</td>
</tr>
<tr>
<td></td>
<td>Attempt a second independent 3-term resolving equation</td>
<td>A1</td>
<td>M1 (dep *)</td>
</tr>
<tr>
<td></td>
<td>Obtain a second correct equation in $T$ and trig ratios of previous angle</td>
<td>A1</td>
<td></td>
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<tr>
<td></td>
<td>Obtain an equation in $\theta$ (or $T$) only</td>
<td>A1</td>
<td></td>
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<tr>
<td></td>
<td>Obtain angle $18^\circ$ or $72^\circ$</td>
<td>A1</td>
<td></td>
</tr>
<tr>
<td>OR:</td>
<td>State resultant of $W$ forces has magnitude $\frac{\sqrt{5}}{2} W$ or equivalent</td>
<td>B1</td>
<td></td>
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<tr>
<td></td>
<td>Combine $T$ forces and equate resultants</td>
<td>B1</td>
<td></td>
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<tr>
<td></td>
<td>Obtain a correct equation, e.g., $2T\cos45^\circ = \frac{\sqrt{5}}{2} W$</td>
<td>M1</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Obtain $T = 0.79 W$ or equivalent</td>
<td>M1</td>
<td></td>
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<tr>
<td></td>
<td>State resultant of $W$ forces makes $\tan^{-1}\left(\frac{1}{2}\right)$ with the vertical or $\tan^{-1}(\frac{2}{1})$ with the horizontal</td>
<td>A1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Equate directions and obtain an equation in $\theta$, using $45^\circ$ or $135^\circ$</td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obtain angle $18^\circ$ or $72^\circ$</td>
<td>M1</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>[SR: Use of $Wg$ for the weight $W$ can score M1 A0 then M3 and an A1.]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>EITHER: State a correct equation from which $T$ or $\frac{1}{2} T$ can be found,</td>
<td>M1</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>e.g., $0 = V\sin\theta t - \frac{1}{2} gt^2$ or $0 = V\sin\theta - gt$</td>
<td>A1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obtain any correct expression for $R$ in terms of $V$, $\theta$ and $g$</td>
<td>A1</td>
<td></td>
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<tr>
<td></td>
<td>Obtain given answer $R = \frac{V^2\sin2\theta}{g}$ correctly</td>
<td>A1</td>
<td></td>
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<tr>
<td>OR:</td>
<td>Using the equation of trajectory, state or imply equation</td>
<td>M1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0 = R\tan\theta - \frac{gR^2}{2V^2\cos^2\theta}$, or equivalent</td>
<td>A1</td>
<td></td>
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<tr>
<td></td>
<td>Obtain any correct expression for $R$ in terms of $V$, $\theta$ and $g$</td>
<td>A1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obtain given answer $R = \frac{V^2\sin2\theta}{g}$ correctly</td>
<td>A1</td>
<td></td>
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<tr>
<td></td>
<td>State any one suitable assumption, e.g., no air resistance, constant acceleration, etc</td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td>(i)</td>
<td>State both $D - 100 = \frac{U^2\sin2\theta}{g}$ and $D + 100 = \frac{U^2\sin50^\circ}{g}$ or equivalent</td>
<td>M1</td>
<td>A1</td>
</tr>
<tr>
<td></td>
<td>Eliminate $D$ and solve for $U^2$</td>
<td>M1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obtain given answer $121$ correctly</td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Obtain $D = 1400$ (1392.82)</td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Substitute values of $U$ and $D$ in range equation and solve for $\sin2\theta$</td>
<td>M1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Obtain answer $34^\circ$ (34.4547... or $35^\circ$)</td>
<td>A1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[SR: use of GA to show $U = 121$ and $D = 1400$ are consistent can get B1 M0 A0 B1 M1 A1.]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10. (a) (i) State any one Newton II equation, e.g. \(0.3g - T = 0.3a, T - 0.2g = 0.2a, 0.1g = 0.5a\) 
State two of the above equations correctly 
Solve a relevant pair of equations to find \(T\) 
Obtain answer \(T = 2.4\) 
(ii) State or use \(a = \frac{1}{3}g\) in this part of the question 
Use \(v = u + at\) with \(u = 0\) and \(a = g\) to find \(t\) 
Obtain answer \(t = 2.0\) 
[Answers to (i) and (ii) left as \(6g/25\) and \(20/g\) are penalised once, scoring A0 A1] 
[NB: if \(g\) is omitted only the M marks are available.] 
(b) EITHER: State equation or inequality, with 3 force terms, for motion parallel to the plane for either particle 
Resolve perpendicular to the plane for either particle, and use \(F = \mu R\) 
State one correct equation/inequality, e.g. 
\(0.3g\sin30^\circ - 0.3\mu g\cos30^\circ \cdot T = 0.3a\) (or \(0 = 0\)) 
State a second correct equation/inequality, e.g. 
\(T - 0.2g\sin30^\circ - 0.2\mu g\cos30^\circ = 0.2a\) (or \(0 = 0\)) 
Eliminate \(T\) from a pair of equations or inequalities and solve for \(\mu\) 
Obtain the given inequality \(\mu < \frac{1}{\sqrt{3}}\) correctly and not via decimals 
OR: State ‘system’ equation or inequality involving both weight components and both friction forces 
Resolve perpendicular to the plane for both particles, and use \(F = \mu R\) 
State any correct equation/inequality, e.g. \(0.1g\sin30^\circ - 0.5\mu g\cos30^\circ = 0.5a\) (or \(0 = 0\)) 
Solve this equation/inequality for \(\mu\) 
Obtain given inequality \(\mu < \frac{1}{\sqrt{3}}\) correctly and not via decimals 

11. State procedure A is better 
Indicate that early customers may not be typical of customers in general 
[for the justification mark, it’s no good merely saying ‘not random’ or ‘biased’.] 
State any sensible idea, involving e.g. useful criticisms from people who don’t use her shop, useful ideas for attracting new customers, etc., etc. 
[For this mark it is not enough merely saying ‘to be more random’ or ‘to avoid bias’] 

12. Form an expression for \(\Sigma x^2p\) 
Subtract \((\Sigma xp)^2\) from the above 
Obtain correct expression \(6p - 16p^2\) for the variance 
Equate variance (not s.d.) to \(\frac{1}{2}\) and solve for \(p\) 
Obtain values \(p = \frac{1}{4}\) and \(p = \frac{1}{8}\) 
Deduce both values 1 and \(\frac{1}{2}\) for \(E(x)\) 
[The fit is only on 2 \(p\) values with \(0 < p < 1\)] 

13. (i) State or imply one of the two binomial terms, \(\binom{50}{1}(0.88)^{49}(0.12)^1\) and 
\(\binom{50}{2}(0.88)^{48}(0.12)^2\) 
Add the correct three binomial terms (and no others) 
Obtain answer 0.051 
(ii) State or imply \(\mu = 50 \times 0.12\) 
State or imply value \(50 \times 0.12 \times 0.88\) relating to variance/s.d. 
Evaluate \(9.5 - 6\) \(\sqrt{5.28}\) and use tables 
Obtain answer 0.064 
[The M1 is not lost for missing continuity correction, or for cc of on the wrong side, 
but the denominator must be \(\sqrt{npq}\) not npq.] 
[Use of exact binomial terms scores M0; incorrect use of Poisson approximation can 
score B1 for \(\mu = 6\) and is allowed B1 for final answer 0.084.] 
[Treat the use of \(p = \frac{12}{50}\) as a MR.] 
[If \(p, q\) interchanged, all M marks and a B1 are available.]
<table>
<thead>
<tr>
<th>14</th>
<th>(i) State value 8900 for ( \hat{\mu} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>State or imply expression ( \frac{1}{74} \left( 5.978 \times 10^9 - \frac{(6.675 \times 10^5)^2}{75} \right) ), or equivalent</td>
</tr>
<tr>
<td></td>
<td>Obtain answer 503000 for ( \sigma^2 )</td>
</tr>
<tr>
<td></td>
<td>[If done by calculator with no working shown, the mark for the variance estimate is effectively B2 or B0. The biased estimate gets 0/2]</td>
</tr>
<tr>
<td></td>
<td>(ii) Use of ( \hat{\mu} \pm z \times \sqrt{\frac{\sigma^2}{75}} ), with numerical values throughout</td>
</tr>
<tr>
<td></td>
<td>Use of correct z-value, i.e. 1.96</td>
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<tr>
<td></td>
<td>Obtain correct interval correctly 8740 &lt; ( \mu ) &lt; 9060 (allow 8900 ± 160)</td>
</tr>
<tr>
<td></td>
<td>[The M mark can also be earned for ( \sqrt{\frac{\sigma^2}{75}} ), where ( \sigma^2 ) is the biased variance estimate; for this mark, ( \sigma^2 ) must be numerical tabular value. However the use of ( \sqrt{\frac{\sigma^2}{75}} ) can only earn M1 B1 A0.]</td>
</tr>
<tr>
<td></td>
<td>State or use the correct z-value –1.28(2)</td>
</tr>
<tr>
<td></td>
<td>Form an equation ( \frac{\sigma^2}{\sqrt{503000}} = z ), where ( z ) is a tabular value (ignore a sign error in ( z ) here)</td>
</tr>
<tr>
<td></td>
<td>Obtain answer 7990</td>
</tr>
<tr>
<td>15</td>
<td>Show evidence of substituting relevant numbers into a correct formula</td>
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<td></td>
<td>Obtain answer 0.99 correctly</td>
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<td></td>
<td>[If done by calculator with no working, the marks are B3 or B0]</td>
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<td></td>
<td>Make a sensible comment, e.g. consistent with a linear relationship, strong positive correlation</td>
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<tr>
<td></td>
<td>Use the ( \sigma^2 ) data correctly to find the line of ( d ) on ( v )</td>
</tr>
<tr>
<td></td>
<td>Obtain equation ( d = -25.5 + 1.64v )</td>
</tr>
<tr>
<td></td>
<td>[If done by calculator with no working, the marks are B2 or B0]</td>
</tr>
<tr>
<td></td>
<td>Show axes with required scaling</td>
</tr>
<tr>
<td></td>
<td>Show the six points plotted correctly</td>
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<tr>
<td></td>
<td>Show the calculated line correctly</td>
</tr>
<tr>
<td></td>
<td>[For the final B mark check that the ( v )-intercept and ordinate at ( v = 40 ) are accurate to ( \pm \frac{1}{2} ) square, or make a similar check]</td>
</tr>
<tr>
<td></td>
<td>Use the equation or plot of the regression line and obtain ( d = 65 ) or 64 completely correctly</td>
</tr>
<tr>
<td></td>
<td>Make any sensible comment, e.g. plot of data shows evidence of a non-linear relationship. Regression line overestimates ( d ) when ( v = 55 ) OR value of coefficient (or data plot) suggests use of line will be suitable</td>
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<td>---</td>
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</tr>
<tr>
<td>16</td>
<td>(i) State numerical expression of the form ( \frac{3}{4} \left( \frac{1}{4} \right) ) with ( n = 3 ) or 4</td>
</tr>
<tr>
<td></td>
<td>Obtain answer ( \frac{27}{256} ) or 0.11</td>
</tr>
<tr>
<td></td>
<td>(ii) EITHER: Attempt addition of relevant terms ( \frac{3}{4} \left( \frac{1}{4} \right) )</td>
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<tr>
<td></td>
<td>Obtain answer ( \frac{1087}{65536} ) or 0.32</td>
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<tr>
<td></td>
<td>OR: Attempt relevant subtraction ( \frac{3}{4} \left( \frac{1}{4} \right) ) ( \frac{3}{4} \left( \frac{1}{4} \right) )</td>
</tr>
<tr>
<td></td>
<td>Obtain answer ( \frac{21087}{65536} ) or 0.32</td>
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<tr>
<td></td>
<td>(iii) State expression ( \left( \frac{3}{4} \right) \left( \frac{1}{4} \right) ) for one case</td>
</tr>
<tr>
<td></td>
<td>Add probabilities for the two cases FSS, SFS (or equivalent)</td>
</tr>
<tr>
<td></td>
<td>Obtain answer ( \frac{3}{32} ) or 0.094</td>
</tr>
<tr>
<td></td>
<td>State or imply value 4 for mean ( \mu ) of ( X )</td>
</tr>
<tr>
<td></td>
<td>State or imply value 12 for variance ( \sigma^2 ) of ( X )</td>
</tr>
<tr>
<td></td>
<td>Show numerical calculation ( \frac{5-\mu}{\text{st.error}} ) where the attempted denominator involves both</td>
</tr>
<tr>
<td></td>
<td>their 12 and 60</td>
</tr>
<tr>
<td></td>
<td>Show correct expression ( \frac{5-4}{\sqrt{\frac{12}{60}}} )</td>
</tr>
<tr>
<td></td>
<td>Obtain answer 0.013 correctly</td>
</tr>
</tbody>
</table>
June 2000

9200/03 A Level Linear Mathematics

<table>
<thead>
<tr>
<th>Question</th>
<th>Mark scheme</th>
</tr>
</thead>
</table>
| 1 | EITHER: Attempt quotient rule (or equivalent) allowing sign errors for this mark (products reversed only)  
Obtain any correct unsimplified expression, e.g. \( \frac{(2x+1) \times 1 - (x-2) \times 2}{(2x+1)^2} \)  
Obtain simplified answer \( \frac{5}{(2x+1)^2} \) correctly  
[Product rule also requires chain rule (both applied correctly for M1)]  
OR: Express the function as \( \frac{1}{2} \frac{5}{2(2x+1)} \)  
Use chain rule to differentiate \( k(2x + 1)^{-1} \) (result \( -k(2x + 1)^{-2} \) is M0)  
Obtain simplified answer \( \frac{5}{(2x+1)^2} \) correctly  
[Accept final answer in the form \( \frac{5}{4x^2 + 4x + 1} \)] |
| A1 | M1 | A1 | 3 |
| 2 | EITHER: State or imply correct cosine rule (in any form) involving 2, 3, 4 and either \( B \) or \( C \)  
Obtain \( \cos B = -\frac{1}{4} \) (aef) or \( B = 104.5^\circ \) or 104\(^\circ\) or 105\(^\circ\) or \( \cos C = \frac{7}{8} \) (aef)  
or \( C = 29^\circ \)  
State or imply correct formula for \( AD^2 \) involving 2, 4 and their numerical \( \cos B \) or 1, 4 and their numerical \( \cos(180 - C) \) or \( -\cos C \)  
Obtain answer \( \sqrt{24} \) or \( 2\sqrt{6} \) or 4.9  
OR: [\( E \) is the foot of the perpendicular from \( A \) to \( CB \) produced]  
Use Pythagoras in triangles \( ACE \) and \( ABE \) to obtain an equation for \( BE \) or \( AE \)  
Obtain \( BE = \frac{1}{2} \) or \( AE = \frac{15}{4} \)  
Apply Pythagoras (or trig) with numerical \( BE \) and/or \( AE \) to find \( AD^2 \) (or \( AD \))  
Obtain answer \( \sqrt{24} \) or \( 2\sqrt{6} \) or 4.9 |
| A1 | M1* | A1 | 1 |
| 3 | (i) Multiply two relevant probabilities for a 'Yes' branch  
Add the two relevant two-factor cases, i.e. \( \frac{1}{2} p + \frac{1}{2} (1-p) \)  
Obtain given answer \( \frac{1}{2} (1+p) \) correctly  
(ii) (Solve \( \frac{1}{2} (1+p) \) and) find \( p = 0.05 \)  
Divide attempted \( P('No' \) and 'Truthful') by \( P('No') \)  
State or imply answer is \( \frac{5}{1-0.05} \)  
Obtain answer 0.97 or \( \frac{38}{39} \) or equivalent fraction |
| A1 | M1* | A1 ft | 3 |
4  
| (a) (i) | State ‘pie chart’ or ‘bar chart’ or ‘pictogram’ or ‘line diagram’  
| (ii) | State ‘histogram’ or ‘stem and leaf diagram’ or ‘frequency polygon’ or ‘cumulative diagram’  
| (iii) | State ‘double bar chart’ or ‘two bar charts with common scales on a single diagram’  

| (b) (i) | Read off at least one relevant result  
| (ii) | Obtain any one answer 32, 38, 43  
| (iii) | Obtain all three correct values of the median and quartiles, identifying the median  
| (iv) | State interquartile range is 11  
| (v) | Show linear scale from 0 to 60 with 0 and 60 marked with ends of whiskers located at 5 and 60  
| (vi) | Show box extending between their quartile values  
| (vii) | Show median line in box at their median value  

[Location of S, medians and quartiles to be reasonably consistent with a linear scale.]

5  EITHER: Use the correct formula \( s = ut + \frac{1}{2} at^2 \)

| Obtain equation \( 6 = 15t - \frac{1}{2} gt^2 \) | M1 *  
| Solve a quadratic equation for \( t \) | A1  
| Obtain roots 0.47 and 2.6 | M1 (dep *)  

OR: Use the correct formula \( v^2 = u^2 + 2as \) to find \( v \)

| State correct expression \( (15^2 - 2g \times 6) \) for speed at height 6m | A1  
| Use a correct formula to evaluate a relevant time | M1 (dep *)  
| Obtain answers 0.47 and 2.6 | A1

[Treat ‘time above 6m’ as a MR and give maximum possible on scheme.]

6  
| (i) | Show three corrected line segments with 2 correctly signed gradients  
| (ii) | Show or imply \( t \) and \( v \) axes with relevant points (10, 40), (15, 30) and (20, 0) identified and graph of correct shape  
| (iii) | Carry out complete method for the area calculation, e.g. two triangles and one trapezium (or equivalent use of constant acceleration formulas) | M1  
| (iv) | Obtain answer 450 | A1  
| (v) | Sketch a graph starting at \( O \) having positive, decreasing gradient | B1

7  
| (i) | State moments equation about \( A \): \( F \times 2\sin BAC = W \times \frac{1}{2} AC \), or equivalent  
| (ii) | State or imply any correct trig result, e.g. \( \tan BAC = \frac{1}{2} \), or perp distance from \( B \) to \( AC = \frac{2}{\sqrt{5}} \), or equivalent | M1  
| (iii) | Obtain answer \( F = \frac{5}{4} W \) correctly | B1

| (iv) | Obtain \( \tan \theta = \frac{W}{2W} \left( \text{or } \frac{\text{perp distance from } B \text{ to } AC}{\frac{1}{2} AC} \right) \) | A1  
| (v) | Obtain \( R = \sqrt{\frac{25}{16} W^2 + W^2} \) (or from \( R = \frac{F}{\cos \theta} \)) | B1 ft  
| (vi) | Obtain \( R \times \frac{\sqrt{16}}{4} = (1.6W) \text{ AND } \theta = 39^\circ \) (with \( R \) clearly in the correct direction) | B1

8  
| Equate total momentum before and after  
| State or imply a correct equation \( 20000 \times 1.5 + 10000 \times 1 = (20000 + 10000)\nu \)  
| Obtain answer \( \frac{1}{3} \), or equivalent, correctly | M1  
| (i) State either \( 5000 = (\pm)30000a \) or both of \( 5000 - P = (\pm)10000a \) and \( P = (\pm)20000a \)  
| Obtain answer \( (\pm)\frac{1}{9} \), or equivalent, for the deceleration | M1  
| (ii) Use a Newton II equation for one of the trucks with their numerical \( a \) (or numerical \( v \) and \( t \)) to find \( P \)  
| Obtain answer \( (\pm)3333 \frac{1}{3} \) or 3300 only | M1

[If \( g \) appears in the momentum equation deduct A1 but allow A1 for answer or equivalent.]
9

Use Hooke's law in equilibrium equation \(0.5g = \frac{1.24}{0.6}\)

Obtain \(x = \frac{1}{4}g\) or \(2.5(2.4525)\)

State energy equation involving KE and at least one of EE, PE

Show correct PE term \(0.5 \times g \times 1.8\)

Show correct KE term \(\frac{1}{2}g \times 1.2^2}{2 \times 0.6} = (0.3g)\)

State unsimplified equation, e.g. \(0.25v^2 + 0.3g = 0.9g\) (signs correct)

Answer \(v = 4.8\) or 4.9 correctly

[For the B marks for the PE and EE terms, ignore signs.]

10

Resolve vertically, i.e. \(2T \cos \theta = W\) or use trig in correct triangle or use Lami

Answer 41° following correct use of \(T = \frac{2}{3}W\)

EITHER:

Obtain a correct equation in \(T\) and trig ratios of one angle, e.g. one of

\(7 \cos \theta + 7 \sin \theta = W, 7 \cos \theta - 7 \sin \theta = \frac{1}{2}W, T = \frac{1}{2}W \cos \theta + W \sin \theta\)

\(T = W \cos \theta - \frac{1}{2}W \sin \theta\) (allow \(\cos(90 - \theta)\) for \(\sin \theta\) etc.)

Attempt a second independent 3-term resolving equation

Obtain a second correct equation in \(T\) and trig ratios of previous angle

Obtain an equation in \(\theta\) (or \(T\)) only

Obtain angle 18° or 72°

Obtain \(T = 0.79W\) or equivalent

OR:

State resultant of \(W\) forces has magnitude \(\frac{\sqrt{3}}{2}W\) or equivalent

Combine \(T\) forces and equate resultants

Obtain a correct equation, e.g. \(2T \cos 45° = \frac{\sqrt{3}}{2}W\)

Obtain \(T = 0.79W\) or equivalent

State resultant of \(W\) forces makes \(\tan^{-1} \left(\frac{1}{2}\right)\) with the vertical or \(\tan^{-1}(2)\) with the horizontal

Equate directions and obtain an equation in \(\theta\), using 45° or 135°

Obtain angle 18° or 72°

[SR: Use of \(\vec{W}\) for the weight \(W\) can score M1 A0 then M3 and as A1.]

11

EITHER:

State a correct equation from which \(T\) or \(\frac{1}{2}T\) can be found,

\(e.g. 0 = v \sin \theta - \frac{1}{2}gt^2\) or \(0 = v \sin \theta - gt\)

Obtain any correct expression for \(R\) in terms of \(V, \theta\) and \(g\)

Obtain given answer \(R = \frac{V^2 \sin 2\theta}{g}\) correctly

OR:

Using the equation of trajectory, state or imply equation

\(0 = R \tan \theta - \frac{gR^2}{2V^2 \cos^2 \theta}\), or equivalent

Obtain any correct expression for \(R\) in terms of \(V, \theta\) and \(g\)

Obtain given answer \(R = \frac{V^2 \sin 2\theta}{g}\) correctly

State any one suitable assumption, e.g. no air resistance, constant acceleration, etc

(i) State both \(D = 100 = \frac{U^2 \sin 60°}{g}\) and \(D + 100 = \frac{U^2 \sin 90°}{g}\) or equivalent

Eliminate \(D\) and solve for \(U^2\)

Obtain given answer 121 correctly

(ii) Obtain \(D = 1400 = (1392.82)\)

Substitute values of \(U\) and \(D\) in range equation and solve for \(\sin 2\theta\)

Obtain answer 34° (34.4547°) or 35°

[SR: Use of GA to show \(U = 121\) and \(D = 1400\) are consistent can get B1 M0 A0 B1 M1 A1.]
12  EITHER: State \( mg = T \cos \alpha \)
Equate \( 7 \sin \alpha \) to \( m \times \text{circular acceleration formula} \)
State correct equation \( 7 \sin \alpha = ma^2 \sin \alpha \)
Eliminate \( T \) and obtain given answer \( \cos \alpha = \frac{L}{a^2} \) correctly
OR: Equate \( mg \sin \alpha \) to \( m \times \text{circular acceleration formula} \times \cos \alpha \)
State correct equation \( mg \sin \alpha = ma^2 \sin \alpha \cos \alpha \)
Obtain given answer \( \cos \alpha = \frac{L}{a^2} \) correctly

(i) Use Hooke's law to express \( T_{RQ} \) in terms of \( m, g, l, \theta \)
Cancel \( l \) and obtain correct expression \( mg(2 \sin \theta - 1) \) or equivalent
(ii) State a 3-term Newton II equation \( T_{DQ} \sin \theta + T_{RQ} = mr \times \frac{2g}{l} \) (ie \( w^2 = \frac{2g}{l} \) used)
Use \( T_{DQ} \cos \theta = mg \) and eliminate both tensions
State correct equation involving \( m, g, l, \theta \) only (at most), e.g.
\[
\frac{mg}{\cos \theta} \sin \theta + \frac{mg(\sin \theta - \frac{1}{2})}{1} = m \sin \theta \times \frac{2g}{l} \quad \text{(FT on } T_{RQ})
\]
Simplify and obtain answer \( \theta = \frac{1}{4} \pi \) or \( 45^\circ \) correctly

13  State or imply no sliding if \( W \sin \alpha \leq \mu W \cos \alpha \) (or =)
Obtain given answer \( \mu \geq \frac{3}{4} \) correctly
[For a direct quote of \( \mu \geq \tan \alpha \) allow B2]
Resolve parallel to the plane for 'sliding up' (allow sign and trig errors)
Obtain \( P = W \sin \alpha + \mu W \cos \alpha \)
Obtain given answer \( P = \frac{1}{2} (3 + 4 \mu) W \) correctly
Take moments about bottom right for 'toppling up' (allow trig errors) (\( R \) and \( F \) must act through bottom right)
Obtain \( P_l = \frac{1}{2} W \sin \alpha + \frac{1}{2} W \cos \alpha \) or \( P_l = W \frac{1}{2} l \sqrt{2} \) \( \cos (45^\circ - \alpha) \) (or equiv in \( P, W \), \( l, \alpha \))
Substitute for \( \alpha \) (allow use of \( \cos 8.1301...^\circ \)) and obtain given answer \( P = \frac{7}{10} W \)

EITHER: Find the least possible value of \( P \) for sliding and compare with \( \frac{7}{10} W \)
State that as \( \frac{7}{10} W < \frac{9}{4} W \), toppling occurs first
OR: Find the least possible value of \( \mu \) for toppling to occur before sliding and compare with \( \frac{3}{4} \)
State that as \( \frac{1}{8} < \frac{3}{4} \), toppling occurs first
14 (a) (i) State any one Newton II equation, e.g. $0.3g - T = 0.3a$, $T - 0.2g = 0.2a$,
$0.1g = 0.5a$
State two of the above equations correctly
Solve a relevant pair of equations to find $T$
Obtain answer $T = 2.4$
(ii) State or use $a = \frac{1}{5} g$ in this part of the question
Use $v = u + at$ with $u = 0$ and $a = g$ to find $t$
Obtain answer $t = 2.0$
[Answer to (i) and (ii) left as 6g/26 and 20/g are penalised once, scoring A0 A1]
[NB: if $g$ is omitted only the M marks are available.]
(b) EITHER: State equation or inequality, with 3 force terms, for motion parallel to
the plane for either particle
Resolve perpendicular to the plane for either particle, and use $F = \mu R$
State one correct equation/inequality, e.g.
$0.3gsin30° - 0.3\mu gcoss30° - T = 0.3a$ (or $0 > 0$ or $= 0$)
State a second correct equation/inequality, e.g.
$T - 0.2gsin30° - 0.2\mu gcoss30° = 0.2a$ (or $0 > 0$ or $= 0$)
Eliminate $T$ from a pair of equations or inequalities and solve for $\mu$
Obtain the given inequality $\mu < \frac{1}{5\sqrt{3}}$ correctly and not via decimals
OR: State ‘system’ equation or inequality involving both weight
components and both friction forces
Resolve perpendicular to the plane for both particles, and use $F = \mu R$
State any correct equation/inequality, e.g. $0.1gsin30° - 0.5\mu gcoss30°$
$= 0.5a$ (or $0 > 0$ or $= 0$)
Solve this equation/inequality for $\mu$
Obtain given inequality $\mu < \frac{1}{5\sqrt{3}}$ correctly and not via decimals

15 (i) State driving force $= \frac{10000}{25}$
State 3-term Newton II equation $\frac{10000}{25} - 200 = 400a$
Obtain answer $a = \frac{1}{2}$
(ii) Obtain answer 20 (i.e. $\frac{10}{\text{answer (i)}}$)
(iii) Use $a = \frac{dv}{dt}$ to set up DE, and attempt separation of variables
Obtain $\int \frac{2v^2}{50 - v}dv = \int dr$, or equally integrable equivalent
Obtain both $2\{-v - 50ln(50 - v)\}$ and $r$ correctly
Obtain given answer 20.5 correctly, either via limits or $+ c$
[Follow through on wrong factor of 2 only]
(iv) Set up and separate new DE: $\int \frac{2v^2}{50 - v}dv = \int dr$, or equally integrable equivalent
Obtain $2\{-\frac{1}{2}v^2 - 50v - 50\ln(50 - v)\}$ and $s$ correctly
Obtain answer 527
[Follow through on wrong factor of 2 only]
(v) State equation involving WD by engine, WD against resistance, KE
State or imply work done by engine is 10 000 ft
State or imply work done against resistance is 200 s
Prove given answer correctly
Markscheme 9200/4
June 2000
### June 2000

**9200/04 A Level Linear Mathematics**

| 1 | EITHER: Attempt quotient rule (or equivalent) allowing sign errors for this mark (products reversed only)  
Obtain any correct unsimplified expression, e.g. \(\frac{(2x+1)\times 1−(x−2)\times 2}{(2x+1)^2}\)  
Obtain simplified answer \(\frac{6}{(2x+1)^2}\) correctly  
[Product rule also requires chain rule (both applied correctly for M1)]  
OR: Express the function as \(\frac{\frac{6}{2(2x+1)}}{2}\)  
Use chain rule to differentiate \(k(2x+1)^{-4}\) (result \(-k(2x+1)^{-3}\) is M0)  
Obtain simplified answer \(\frac{5}{(2x+1)^2}\) correctly  
[Accept final answer in the form \(\frac{5}{4x^2+4x+1}\).] | M1 | A1 | A1 |
| 2 | EITHER: State or imply correct cosine rule (in any form) involving 2, 3, 4 and either B or C  
Obtain \(\cos B = -\frac{1}{4}\) (aef) or \(B = 104.5^\circ\) or \(104^\circ\) or \(105^\circ\) or \(\cos C = \frac{7}{8}\) (aef)  
or \(C = 29^\circ\)  
State or imply correct formula for \(AD^2\) involving 2, 4 and their numerical \(\cos B\) or 1, 4 and their numerical \(\cos(180 - C)\) or \(-\cos C\)  
Obtain answer \(\sqrt{24}\) or \(2\sqrt{6}\) or 4.9  
OR: \([E\text{ is the foot of the perpendicular from } A \text{ to } CB \text{ produced}].\)  
Use Pythagoras in triangles \(ACE\) and \(ABE\) to obtain an equation for \(BE\) or \(AE\)  
Obtain \(BE = \frac{1}{2}\) or \(AE = \frac{12}{4}\)  
Apply Pythagoras (or trig) with numerical \(BE\) and/or \(AE\) to find \(AD^2\) (or \(AD\))  
Obtain answer \(\sqrt{24}\) or \(2\sqrt{6}\) or 4.9 | M1*  
A1  
M1 (dep *) |  
A1  
A1 |
| 3 | (i) Multiply two relevant probabilities for a ‘Yes’ branch  
Add the two relevant two-factor cases, i.e. \(\frac{\frac{2}{3}p + \frac{1}{3}(1-p)}{1}\)  
Obtain given answer \(\frac{1}{3}(1+p)\) correctly  
(ii) (Solve \(\frac{1}{3}(1+p)\) and) find \(p = 0.05\)  
Divide attempted \(P(\text{No}’\) and ‘Truthful’) by \(P(\text{No}')\)  
State or imply answer is \(\frac{2}{5}(1-0.05)\)  
\[\frac{1}{1-0.35}\]  
Obtain answer 0.97 or \(\frac{38}{39}\) or equivalent fraction  
[M1 is for a fraction with numerical numerator \(\frac{2}{3}(1-p)\) or denominator \(1-0.35\) (or equivalent); ft only if \(0 < p < 1\)] | M1*  
M1 (dep *) |  
A1  
B1  
M1 |  
A1 ft  
A1  
3 |
| 4 | (a) (i) State 'pie chart' or 'bar chart' or 'pictogram' or 'line diagram'  
(ii) State 'histogram' or 'stem and leaf diagram' or 'frequency polygon' or 'cumulative frequency diagram'  
(iii) State 'double bar chart' or 'two bar charts with common scales on a single diagram'  
(b) (i) Read off at least one relevant result  
Obtain any one answer 32, 38, 43  
Obtain all three correct values of the median and quartiles, identifying the median  
State interquartile range is 11  
(ii) Show linear scale from 0 to 60 with 0 and 60 marked and with ends of whiskers located at 5 and 60  
Show box extending between their quartile values  
Show median line in box at their median value  
[Location of 5, medians and quartiles to be reasonably consistent with a linear scale.] | B1 | 1  
| | B1 | 1  
| | B1 | 1  
| | M1 | 1  
| | A1 | 1  
| | A1 | 1  
| | A1 ft | 4  
| | B1 | 3  
| | B1 ft | 3  
| 5 | State procedure A is better  
Indicate that early customers may not be typical of customers in general  
[For the justification mark, it's no good merely saying 'not random' or biased.]  
State any sensible idea, involving e.g. useful criticisms from people who don't use her shop useful ideas for attracting new customers, etc, etc.  
[not enough to say 'not random' or 'to avoid bias'] | B1 | 2  
| | B1 | 1  
| 6 | Form an expression for \( \sum x^2p \)  
Subtract \((\sum x)p)^2\) from the above  
Obtain correct expression \(6p - 16p^2\) for the variance  
Equate variance (not s.d.) to \(1\) and solve for \(p\)  
Obtain values \(p = \frac{1}{4}\) and \(p = \frac{1}{8}\)  
Deduce both values 1 and \(\frac{1}{2}\) for \(E(X)\) The fit is only 2 \(p\) values \(0 < p < 1\) | M1 | 6  
| | M1 (dep *) |  
| | A1 |  
| | M1 |  
| | A1 |  
| 7 | (i) State or imply one of the 2 binomial terms \( \binom{30}{1}(0.88)^{49}(0.12)^1 \)  
or \( \binom{30}{2}(0.88)^{48}(0.12)^2 \)  
Add the correct three binomial terms (and no others)  
Obtain answer 0.051  
(ii) State or imply \(\mu = 50 \times 0.12\)  
State or imply value \(50 \times 0.12 \times 0.88\) relating to variance/s.d.  
Evaluate \(9.56 - 6\) \(\sqrt{5.28}\) and use tables  
Obtain answer 0.064  
[The M1 is not lost for missing continuity correction, or for c.c. of \(\frac{1}{2}\) on the wrong side, but the denominator must be \(\sqrt{npq}\) not npq.] | M1 | 3  
| | M1 |  
| | A1 |  
| | B1 |  
| | B1 |  
| | M1 |  
| | A1 |  
| 8 | (i) Use correct Poisson formula with \(\mu = 4\), i.e. \(e^{-4} \frac{4^4}{3!}\)  
Obtain answer 0.20  
(ii) Add correct Poisson cases 0, 1, 2  
Obtain answer 0.24  
State or imply Poisson with \(\mu = 5\) is a suitable model OR if 2 distributions considered separately, consider all cases  
Calculate \(1 - (P(0) + P(1) + P(2) + P(3))\)  
Obtain answer 0.73 or 0.74 (0.73497...) | M1 | 2  
| | A1 |  
| | M1 |  
| | A1 |  
| | B1 |  
| | M1 |  
| | A1 |  

**Note:** The OCR text appears to contain some errors or inconsistencies. The table structure and some of the mathematical expressions may need to be reviewed and corrected for accuracy.
### Question 9
(i) EITHER: Express \( C > 40 \) in terms of \( X \) (the number of hours)
State or imply that equivalent inequality if \( X > \frac{1}{2} \)
Calculate \( \pm \frac{(0.5 - 0.9)}{0.2} \) and use tables
Obtain answer 0.98
OR: Evaluate mean and s.d. of \( 30 + 20X \)
Obtain 48 and 4
Calculate \( \pm \frac{(40 - 48)}{4} \) and use tables
Obtain answer 0.98
OR: Evaluate mean and s.d. of \( 20X \)
Obtain 18 and 4
Calculate \( \pm \frac{(10 - 18)}{4} \) and use tables
Obtain answer 0.98

(ii) EITHER: State or imply that \( E(T) = 480 \) (or 180)
State or imply calculation of \( 10 \times 20^2 \times 0.2^2 \)
Calculate \( \pm \frac{(500 - 480)}{\sqrt{160}} \) (OR \( \pm \frac{200 - 180}{\sqrt{160}} \)) and use tables
Obtain answer 0.057
OR: State or imply \( E(T) = 48 \)
State or imply calculation \( 0.1 \times 20^2 \times 0.2^2 \)
Calculate \( \pm \frac{50 - 48}{\sqrt{1.6}} \) and use tables
Obtain answer 0.057
OR: State or imply that \( E(H) = 9 \)
State or imply calculation of \( 10 \times 0.2^2 \)
Calculate \( \pm \frac{(0.9 - 9)}{\sqrt{0.4}} \) and use tables
Obtain answer 0.057
OR: State or imply that \( E(H) = 0.9 \)
State or imply calculation \( 0.1 \times 0.2^2 \)
Calculate \( \pm \frac{(0.9 - 9)}{\sqrt{0.004}} \) and use tables
Obtain answer 0.057

### Question 10
(i) State value 8900 for \( \bar{\mu} \)
State or imply expression \( \frac{1}{75} \left( 5.978 \times 10^6 - \frac{6.675 \times 10^4}{75} \right) \), or equivalent
Obtain answer 503 000 for \( \bar{s}^2 \)
[If done by calculator with no working shown, the mark for the variance estimate is effectively B2 or B0. The biased estimate gets 0/2]
(ii) Use of \( \bar{\mu} \pm z \times \sqrt{\frac{\bar{s}^2}{75}} \), with numerical values throughout
Use of correct \( z \)-value, i.e. 1.96
Obtain correct interval \( 8740 < \mu < 9060 \)
[The M mark can also be earned for \( \sqrt{\frac{\bar{s}^2}{74}} \), where \( s^2 \) is the biased variance estimate; for this mark, \( z \) must be a numerical tabular value]
SR If \( \frac{s^2}{75} \) used allow M1 B1 A0
State or use the correct \( z \)-value \(-1.28(2)\)
Form an equation \( \frac{a - 8900}{\sqrt{503000}} = z \), where \( z \) is a tabular value (ignore a sign error in \( z \) here)
Obtain answer 7990
11

Show evidence of correct binomial term \( \frac{24}{2} (0.8)^{22}(0.2)^2 \)
Add the three relevant terms for 0, 1, 2 sufferers or 1 - (0, 1, 2 sufferers)
Obtain value 0.11 (consistent with comparison to 0.1) or obtain value 0.89
(consistent with comparison to 0.9)
Compare 0.11 to 0.1 or compare 0.89 to 0.9 and accept NH, i.e. can’t reject \( p = 0.2 \)

**EITHER:** State or use 0.2 and \( \sqrt{\frac{0.2 \times 0.8}{40}} \) as normal mean and s.d.
State observed proportion is \( \frac{12}{40} = 0.3 \)
Calculate \( \frac{0.3 - 0.2}{\sqrt{0.004}} \) and use tables for this z value or use tables for 0.1
Obtain tail probability 0.057 or obtain 1.58 for test statistic and 1.28(2)
Compare tail probability to 0.1 OR compare 1.58 to 1.28(2) and reject NH, i.e. accept \( p > 0.2 \)
[strictly speaking the observed proportion should be taken as \( \frac{11.5}{40} = 0.2875 \); the conclusion is unchanged.]

**OR:** State or use 40 \( \times \) 0.2 as the mean for a normal distribution
State or use \( \sqrt{(40 \times 0.2 \times 0.8)} \) as the s.d.
Calculate \( \frac{2(11.5 - 8)}{6.4} \) and use tables for this z value or use tables for 0.1
Obtain tail probability 0.083 or obtain 1.38 for test statistic and 1.28(2)
Compare tail probability to 0.1 OR compare 1.38 to 1.28(2) and reject NH, i.e. accept \( p > 0.2 \)
[NB no cc or wrong cc can still gain M mark]

**OR:** If binomial test carried out:
One correct Binomial term
Calculate \( 1 - \sum \) relevant terms 0 ... 11 (allow 12 error)
Obtain value 0.087 or 0.088
Compare to 0.1 and reject NH

12

(i) State that the data must be a sample from a normal population
(ii) State or use \( \bar{x} = 27.5 \)
Show correct expression for either unbiased or biased variance estimate
Calculate \( \frac{\pm(27.5 - 36)}{\text{attempted s.e.}} \)
Show correct value \( \frac{27.5 - 36}{\sqrt{\frac{26.28}{10}}} \) or \( \frac{27.5 - 36}{\sqrt{\frac{22.65}{9}}} = -4.46 \)
State or imply 9 degrees of freedom
Demonstrate the given result via comparison 4.46 > 4.297
Equate \( \frac{27.5 - \mu}{\text{attempted s.e.}} \) to numerical t-value
State or use \( t = -1.833 \)
Obtain answer 31
### Question 13

Show evidence of substituting relevant numbers into a correct formula
Obtain answer 0.99 correctly
[If done by calculator with no working, the marks are B3 or B0] 
make a sensible comment, e.g. consistent with a linear relationship, strong positive correlation
use the $d$-$v$ data correctly to find the line of $d$ on $v$
obtain equation $d = -25.5 + 1.64v$
[If done by calculator with no working, the marks are B2 or B0]
Show axes with required scaling
Show the six points plotted correctly
Show the calculated line correctly — check $v$ intercept accuracy $\pm \frac{1}{2}$ square
— check $v = 40$ ($d = 40.1$) accuracy $\pm \frac{1}{2}$ square
or similar
Use the equation or plot of the regression line and obtain $d = 65$ or 64 completely correctly
Make any sensible comment, e.g. plot of data shows evidence of a non-linear relationship, regression line overestimates $d$ when $v = 55$, value of coefficient (or data plot) suggests line will be suitable

### Question 14

(i) State numerical expression of the form $\left(\frac{3}{4}\right)^n \left(\frac{1}{4}\right)$, with $n = 3$ or 4

Obtain answer $\frac{27}{256}$ or 0.11

(ii) EITHER: Attempt addition of relevant terms $\frac{3}{4} + \frac{1}{4}$

Obtain answer $21087$ or 0.32

OR: Attempt relevant subtraction $\frac{3}{4} - \frac{1}{4}$

Obtain answer $21087$ or 0.32

(iii) State expression $\frac{3}{4} \frac{1}{4}$ for one case

Add probabilities for the two cases FSS, SFS (or equivalent)

Obtain answer $\frac{3}{32}$ or 0.094

State or imply value 4 for mean $\mu$ of $X$

State or imply value 12 for variance $\sigma^2$ of $X$

Show numerical calculation $\frac{5 - \mu}{\text{st. error}}$ where the denominator involves their 12 and 60

Show correct expression $\frac{5 - \mu}{\sqrt{12}}$

Obtain answer 0.013 correctly

### Question 15

(i) Calculate all expected frequencies

Obtain all values

<table>
<thead>
<tr>
<th>117.03</th>
<th>50.29</th>
<th>15.04</th>
<th>5.64</th>
</tr>
</thead>
<tbody>
<tr>
<td>131.97</td>
<td>56.71</td>
<td>16.96</td>
<td>6.36</td>
</tr>
</tbody>
</table>

Carry out correct method for calculation of $\chi^2$

Obtain value 3.29 for $\chi^2$

State or imply 3 degrees of freedom

Compare 3.29 with 7.815 and conclude there’s no association

[If 6 or 7 of the expected frequencies are correct, allow A1. For accuracy only to 2 s.f. or nearest whole number allow A1 for all correct to this accuracy]

(ii) State or use $\frac{207}{400} = 0.5175$ or 0.52 for Poisson mean

Use Po(0.5175) to calculate four expected frequencies

Obtain values 238.40, 123.36 or 123.37, 31.92, 6.30 to 6.32 (for 3 or more)

Carry out correct method for calculation of $\chi^2$

Obtain value 7.75 to 7.80

State or imply 2 degrees of freedom

Compare 7.80 with 5.99 and conclude it doesn’t fit

[Special case: candidates whose fourth frequency is 5.51 (for 3) and who incorrectly use this instead of the frequency for 3 or more can score B1 M1 A0 M1 A0 B1 and A1 ft for comparing their $\chi^2 \approx 10.29$ with 5.99]