

| Question number | Answer   | Notes   | Marks |
|-----------------|--|---|-------|
| 1 (a) (i)       | work done = force $\times$ distance (moved);   | Accept correct symbols e.g.<br>$W = F \times d$<br>$W = F \times s$   | 1     |
| (ii)            | substitution;<br>evaluation;<br><br>e.g. (work =) $140 \times 39$<br>$5500$ (J)  | 5460  | 2     |
| (iii)           | same answer as 5(a)(ii)  | allow 'the same'  | 1     |
| (b) (i)         | X in line with the weight arrow and vertically between the tail of the arrow and the top of the wheelbarrow (not including the logs);  | judge alignment with weight arrow by eye  | 1     |
|                 |  |   |       |
| (ii)            | moment = force $\times$ (perpendicular) distance (from pivot);   | condone<br>$M = F \times d$<br>$M = F \times s$   | 1     |
| (iii)           | principle of moments (stated or implied);<br>total distance hand to pivot calculated;<br><br>substitution showing either correct moment (or both);<br>final rearrangement and evaluation;<br><br>e.g. (total) clockwise (moment) = (total) anticlockwise (moment)<br>(distance) = $0.6 + 0.8 = 1.4$ m<br>$470 \times 0.6 = F \times 1.4$<br>$F = 470 \times 0.6 / 1.4 = 200$ (N) | accept 1.4 or<br>$0.6 + 0.8$ seen in working<br>accept 282 seen in working<br><br>allow 201, 201.43<br><br>350, 352, 353,<br>352.5 gets 2 marks | 4     |

Total 10 marks



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|-----------------|--|--|-------|
| 2 (a) (i)       | momentum = mass x velocity;  | w rds or correct symbols<br>$p = m \times v$<br>reject M for momentum  | 1     |
| (ii)            | substitution;<br>evaluation;<br>e.g.<br>(p =) $0.50 \times 3.1$<br>(p =) 1.6 (kg m/s)  | ignore - signs<br><br>allow 1.55<br>1 mark max for 1.5   | 2     |
| (iii)           | substitution into correct equation;<br><br>evaluation;<br>e.g.<br>$F = 1.55(- 0) \div 0.070$<br>(F =) 22 (N)   | no mark for equation as given in paper<br>allow ECF from (ii)<br>ignore - signs<br><br>allow F in range 22-23 (N) inclusive<br><br>allow method using $F=ma$ . | 2     |
| (b)             | any two of:<br><br>MP1. (forces) equal;<br>MP2. (forces) opposite OR up <u>and</u> down;<br>MP3. mention of Newton's <u>third</u> law;                       | ignore references to balanced forces<br><br>'every action has an equal and opposite reaction' scores 2 marks   | 2     |
| (c)             | any two of:<br>MP1. pressure is force / area;<br><br>MP2. forces (on wood and hammer) are equal;<br>MP3. smaller area of nail is in contact with wood / ORA; | allow pressure is inversely proportional to area<br><br>award if clear which end of the nail has the smaller area  | 2     |

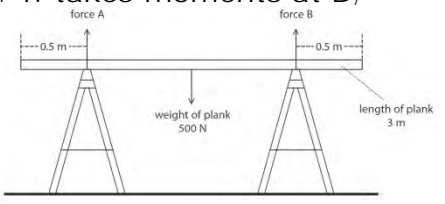
Total 9 marks

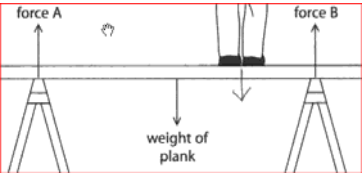
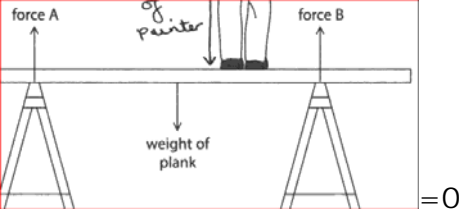
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|-----------------|---|---|-------|
| 3 (a)           | A - Force X 7.5 N, Force Y 7.5 N ;                          |   | 1     |
| (b)             | idea that force X decreases;<br><br>from 15 (N) / to 0 (N); | ignore references to force Y and moments<br><br>'it goes from 15 to 0' gets 2 marks | 2     |

Total 3 marks



| Question number |   |    | Answer   | Notes  | Marks |
|-----------------|---|----|--|--|-------|
| 4               | a | i  | moment = force x (perpendicular) distance (from pivot)   | in words or accepted symbols   | 1     |
|                 |   | ii | MP1. calc of 1 correct moment (about the pivot);<br>MP2. stated equivalence of clockwise moment= anticlockwise moment /principle of moments;<br>MP3. final value;<br><br>e.g.<br>$2 \times 60 = 120$ (one mark)<br>$2 \times 60 = 10 \times F_N$ (two marks)<br>$F_N = \frac{2 \times 60}{10}$<br>$= 12 \text{ (N)}$ (three marks) | in words or in numbers<br><br>allow working in cm or m                               | 3     |
|                 | b |    | MP1. Increases (force on newtonmeter);<br><br>MP2. (because) weight of bar has a moment;<br><br>MP3. in same direction (clockwise) as 2 N weight;  | may be shown by a calculation<br><br>allow<br>$F_N = 62 \text{ (N)}$ for three marks | 3     |
|                 |   |    |  | total = 7 marks  |       |

| Question number | Answer  | Notes  | Marks |
|-----------------|---|--|-------|
| 5 (a)           | B   |  | 1     |
| (b)<br>(i)      | <p>#1. states principle of moments ;</p> <p>#2. moment= force X (perpendicular) distance from pivot:</p> <p>#3. calculates one moment about either A or B;</p> <p>#4. takes moments at B;</p>  <p>e.</p> <p>moments clockwise = moments anticlockwise</p> <ul style="list-style-type: none"> <li>• moment = weight x distance</li> <li>• <math>500 \times 1</math></li> <li>• <math>1 \times 500 = Ax2</math></li> </ul> | <p>Ignore bald '500/2 =250'</p> <p>Accept for #2:<br/>in words or in recognisable symbols or in numbers from the diagram</p> <p>Accept qualitative alternative for last 2 marking points:<br/>'2 forces so divide weight in half' OWTTE = 1 mark<br/>if then qualified by distance consideration = 2 marks</p> | 4     |
| (ii)            | Upward Force at point B<br>250(N);  | allow arrow for clockwise or anticlockwise   | 1     |

| Question number | Answer   | Notes  | Marks    |
|-----------------|--|--|----------|
| (c) i           | Arrow down from painter; (vertical, below feet)                          | <br> | 1        |
| ii              | Both forces increase;<br><br>Force at B larger than force at A / $R_A$ ; | ignore:<br><ul style="list-style-type: none"> <li>• both moments increase</li> <li>• 'force B is larger'</li> </ul>  | 2        |
| Total           |  |  | <b>9</b> |



| Question number | Answer   | Notes  | Marks |
|-----------------|--|--|-------|
| 6 (a) i         | Any ONE sensible suggestion from<br>ensuring good contact;<br>increasing friction;<br>increasing pressure; | allow:<br><ul style="list-style-type: none"><li>to prevent slipping sideways</li><li>make it easier to control</li></ul> | 1     |
| ii              | Keep a fair test / controlled variable;  | allow: it not an independent variable<br>ignore: all mention of accuracy   | 1     |



| Question number  | Answer   | Notes  | Marks   |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
|------------------|--|--|---------|-----------|-----|------|-----|------------------|-----|----------------|-----|-----|-----|--|-----------------|---------|-----------|-----|------|-----|------------------|-----|----------------|-----|-----|-----|---|
| 6 (b) (i)        | (Type of) surface(s);  | do not accept:<br>• a (single) named surface | 1       |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
|                  | (ii) 4.5;  | • type of block<br>• material of block       | 1       |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| (iii)            | <p>Axes labelled- quantity and unit;</p> <p>Linear scale such that longest bar occupies at least half the grid;</p> <p>Plotting---ignore order of bars<br/>5 bars correctly plotted;;<br/>If only 3 bars correctly plotted allow 1 mark for plotting</p> <div data-bbox="327 686 1188 1298" style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th>Type of surface</th> <th>Average</th> </tr> </thead> <tbody> <tr> <td>chipboard</td> <td>3.0</td> </tr> <tr> <td>wood</td> <td>2.5</td> </tr> <tr> <td>coarse sandpaper</td> <td>4.5</td> </tr> <tr> <td>fine sandpaper</td> <td>5.7</td> </tr> <tr> <td>ice</td> <td>0.5</td> </tr> </tbody> </table> </div> | Type of surface                              | Average | chipboard | 3.0 | wood | 2.5 | coarse sandpaper | 4.5 | fine sandpaper | 5.7 | ice | 0.5 | <p>allow<br/>force (N)<br/>force/N</p> <p>tolerance is +/- 0.5 small sq</p> <p>allow ecf from table</p> <p>ALL data plotted correctly as floating "x's" gets only one mark for plotting</p> <p>Reject both plotting marks if a line graph is drawn (only scale and axes marks are available in this case)</p> <div data-bbox="1465 987 1906 1309" style="border: 1px solid black; padding: 5px; margin: 10px auto;"> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Type of surface</th> <th>Average</th> </tr> </thead> <tbody> <tr> <td>chipboard</td> <td>3.0</td> </tr> <tr> <td>wood</td> <td>2.5</td> </tr> <tr> <td>coarse sandpaper</td> <td>4.5</td> </tr> <tr> <td>fine sandpaper</td> <td>5.7</td> </tr> <tr> <td>ice</td> <td>0.5</td> </tr> </tbody> </table> </div> | Type of surface | Average | chipboard | 3.0 | wood | 2.5 | coarse sandpaper | 4.5 | fine sandpaper | 5.7 | ice | 0.5 | 4 |
| Type of surface  | Average  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| chipboard        | 3.0  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| wood             | 2.5  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| coarse sandpaper | 4.5  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| fine sandpaper   | 5.7  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| ice              | 0.5  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| Type of surface  | Average  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
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| wood             | 2.5  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| coarse sandpaper | 4.5  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| fine sandpaper   | 5.7  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |
| ice              | 0.5  |  |         |           |     |      |     |                  |     |                |     |     |     |  |                 |         |           |     |      |     |                  |     |                |     |     |     |   |



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| 6 (c)           | <p>Any two of the following five ideas:</p> <p>#1 different experimental set-up;<br/>e.</p> <ul style="list-style-type: none"> <li>• different masses/weights</li> <li>• different kind of wooden block</li> <li>• different speed of pull</li> </ul> <p>#2 variable friction;<br/>e.</p> <ul style="list-style-type: none"> <li>• the surfaces were not uniformly smooth</li> <li>• the wooden block did not move evenly across the surface</li> </ul> <p>#3 errors in the force meter reading;<br/>e.</p> <ul style="list-style-type: none"> <li>• errors recording the force on the N-meter</li> <li>• faulty scale on N-meter</li> <li>• zero errors / different ranges of N-meters used</li> <li>• different angle of N-meter</li> </ul> <p>#4 different contact;<br/>e.</p> <ul style="list-style-type: none"> <li>• the weights on the block may not have been evenly placed on the block</li> <li>• the block was not pressed down onto the surface evenly</li> </ul> <p>#5 friction reduces as the experiment progresses;<br/>e.</p> <ul style="list-style-type: none"> <li>• the wooden block becomes smoother as the experiment proceeds</li> <li>• it moves over the surface more easily as the experiment progresses</li> <li>• lubricant on block</li> </ul> | <p>Ignore:</p> <ul style="list-style-type: none"> <li>• unqualified 'broken N-meter'</li> <li>• human error</li> <li>• 'strength of pull'</li> <li>• anomalous results</li> <li>• surface area of surface</li> </ul> | 2     |

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| 6 (d)           | Any two from:<br>Pressure less;<br><br>Area larger;<br><br>Use of formula $P = F/A$ ;   | Load is the same/wood is thinner   | 2         |
| (e)             | Any TWO sensible suggestions;;<br><br>e.<br>place a lubricant between the two surfaces<br><br>make the surfaces smoother<br><br>decrease weights /masses on block | allow:<br><ul style="list-style-type: none"> <li>• named lubricants</li> <li>• change the surfaces so that are not so rough</li> <li>• reduce the area (of contact)</li> <li>• decrease mass of block</li> </ul> | 2         |
|                 |   | Total  | <b>14</b> |