

IGCSE Physics - Section 1– Forces and motion – Mark scheme and Examiner Feedback.

| Q | Content | Marks |
|----|---|-------|
| 1 | Distance-time graph | 7 |
| 2 | Terminal velocity | 5 |
| 3 | Hooke's law practical | 11 |
| 4 | Velocity-time graph | 11 |
| 5 | Hooke's law practical | 14 |
| 6 | Moments | 3 |
| 7 | Momentum, forces and acceleration | 9 |
| 8 | Motion practical | 11 |
| 9 | Forces, velocity-time graphs, distance, speed and time. | 13 |
| 10 | Moments | 7 |

Question 1.

| Question number | Answer | Notes | Marks |
|-----------------|--|--|-------|
| 4 (a) (i) | 6.1 (m); | | 1 |
| (ii) | any two from:- MP1. (on distance-time graph,) flat line means zero speed / eq MP2. (so) count when slope is zero; MP3. 7 (times); | allow flat or horizontal for zero slope | 2 |
| (b) (i) | (average) speed = $\frac{\text{(total) distance moved}}{\text{(total) time taken}}$ | allow defined symbols ignore 'triangles' | 1 |
| (ii) | Substitution; Calculation; Matching unit; e.g. Average speed = $\frac{6.1}{(7 \times 60)}$ = 0.0145 = 0.015 m/s | allow both substitution and calculation marks for a correct value without working allow 6.1, or ecf for distance 7 for time allow alternatives with compatible unit, e.g. 1.45 cm/s OR 1.5 cm/s 14.5 mm/s OR 15 mm/s 0.87 m/minutes 87 cm/minute 870 mm/minute Allow for 1 mark 6 / 7 or 0.9 | 3 |

Total 7 marks

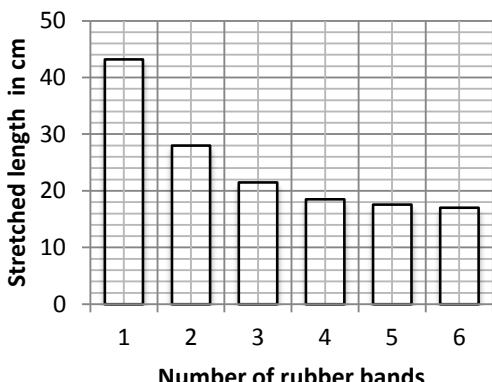
Question 2.

| Question number | Answer | Notes | Marks |
|-----------------|---|--|-------|
| 12 (a) | Terminal (velocity / speed); | allow bald 'terminal' | 1 |
| (b) | <p>Any four of -</p> <p>MP1. weight acts downwards;</p> <p>MP2. drag/friction acts upwards;</p> <p>MP3. Idea that forces are balanced;</p> <p>MP4. reference to $f_{(R)} = ma$;</p> <p>MP5. Idea that when forces are balanced then acceleration is zero;</p> <p>MP6. constant velocity = no acceleration;</p> | <p>ignore</p> <ul style="list-style-type: none"> • motion before terminal velocity • gravity <p>allow</p> <ul style="list-style-type: none"> • force of gravity • air resistance • acts to oppose motion • drag = weight • force up = force down • no resultant force <p>Allow answers in terms of N I</p> <p>forces may be shown on diagram</p> | 4 |

Total 5 marks

Question 3.

| Question number | Answer | Notes | Marks |
|-----------------|---|---|-------|
| 4 (a) (i) | 18.7 ± 0.5 (cm); | accept any value between 18.2 and 19.2 | 1 |
| (ii) | Any two of - MP1 Mention of <u>parallax</u> error; MP2 Idea of zero error; MP3 End of ruler is worn; MP4 Hook is curved; MP5 Hook stretches bands to different lengths; MP6 Bands are not close to ruler; MP7 Bands are not parallel to ruler; MP8 Bands are twisted; | Ignore human error Ignore inaccurate scale Ignore anomaly, no average, references to Hooke's law | 2 |
| (b) | Idea of a controlled variable; e.g. force kept constant temperature kept constant | Allow properties of bands, e.g. type, brand, material, thickness, elasticity, original length Ignore idea of consistent technique, e.g. using same equipment | 1 |

| Question number | Answer | Notes | Marks | | | | | | | | | | | | | | |
|------------------------|--|---|------------------------|------------------------|---|------|---|------|---|------|---|----------|---|------|---|------|--|
| 4 (c) (i) | Discrete/discontinuous; OR Independent; | Allow non-continuous, categoric | 1 | | | | | | | | | | | | | | |
| (ii) | Axes labelled - quantities and distance unit; Suitable scale chosen - longest bar occupies at least half the grid; All 5 bars for given data correctly plotted;; | Ignore orientation Ignore the 4 band value Bar length plotted to nearest small square. Deduct one mark for each plotting error (max -2) Data plotted correctly, but only as floating "x's" gets maximum of one mark for plotting Reject both plotting marks if a line graph is drawn (only scale and axes marks are available in this case) | 4 | | | | | | | | | | | | | | |
| |  | <table border="1" data-bbox="997 1108 1300 1467"> <thead> <tr> <th>Number of rubber bands</th> <th>Stretched length in cm</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>43.2</td> </tr> <tr> <td>2</td> <td>28.0</td> </tr> <tr> <td>3</td> <td>21.5</td> </tr> <tr> <td>4</td> <td>(Ignore)</td> </tr> <tr> <td>5</td> <td>17.6</td> </tr> <tr> <td>6</td> <td>17.0</td> </tr> </tbody> </table> | Number of rubber bands | Stretched length in cm | 1 | 43.2 | 2 | 28.0 | 3 | 21.5 | 4 | (Ignore) | 5 | 17.6 | 6 | 17.0 | |
| Number of rubber bands | Stretched length in cm | | | | | | | | | | | | | | | | |
| 1 | 43.2 | | | | | | | | | | | | | | | | |
| 2 | 28.0 | | | | | | | | | | | | | | | | |
| 3 | 21.5 | | | | | | | | | | | | | | | | |
| 4 | (Ignore) | | | | | | | | | | | | | | | | |
| 5 | 17.6 | | | | | | | | | | | | | | | | |
| 6 | 17.0 | | | | | | | | | | | | | | | | |
| (iii) | MP1 Idea of inverse relationship; MP2 Idea of non linearity; | Allow: pattern statements negative correlation Accept ecf "curved line" | 2 | | | | | | | | | | | | | | |

Total 11 marks

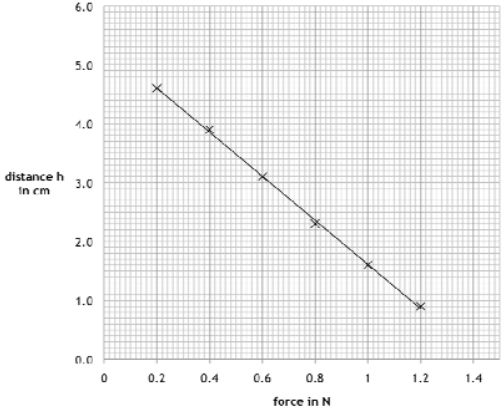
Question 4.

| Question number | Answer | Notes | Marks |
|-----------------|---|--|-------|
| 2 (a) (i) | 6 (m/s); | | 1 |
| (ii) | 10 (s); | | 1 |
| (b) (i) | Acceleration = change in velocity ; time (taken) | allow accepted symbols | 1 |
| (ii) | Substitution in correct equation; Evaluation; Unit; e.g. $12 \div 10$ $= 1.2$ m/s^2 | ms^{-2} condone m/s/s | 3 |
| (c) (i) | (average) speed = <u>distance (moved)</u> ; time | allow accepted symbols | 1 |
| (ii) | Substitution in correct equation; Evaluation; e.g. $390 \div 60$ 6.5 (m/s) | $(388.5 \div 60 = 6.475)$ | 2 |
| (d) | MP1 Idea that distance is given by area under the graph; MP2 Comparison of the two <i>areas</i> (<i>by eye or by calculation</i>); | ignore steepness of lines, velocity, acceleration, width NOTE: a valid comparison that includes MP1 +MP2 gains both marks e.g. the first 30s area is larger than the last 30s | 2 |

Total 11 marks

Question 5.

| Question number | Answer | Notes | Marks |
|-----------------|---|--|-------|
| 5 (a) | Any two of - MP1. mention of no zero error; MP2. Mention that ruler is should be vertical; MP3. use of a fiducial marker; MP4. use of ruler with finer calibrations; MP5. means to reduce parallax; MP6. use of calliper ; | Ignore (more) accurate ruler e.g. a pin Allow <ul style="list-style-type: none"> • more detailed ruler • smaller intervals ignore proximity | 2 |
| (b) (i) | Distance | | 1 |
| (ii) | Any two of - MP1. Idea of weight is the force on the mass / $W=mg$; MP2. change grams to kilogram; MP3. 1N of force for every 100g; MP4. g is 10 (N/kg); | in any form including numerical Accept $\div 1000$ Ignore $\div 100$ without further explanation Allow idea of gravitational field strength Accept $\times 10$ | 2 |

| Question number | Answer | Notes | Marks | | | | | | | | | | | | | | |
|---------------------|--|--|------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| 5 (b) (iii) (iv) | Suitable linear scale chosen (>50% of grid used); Axes labelled with quantities and unit; Plotting correct to nearest half square (minus one for each plotting error);; Line of best fit acceptable;  | no awkward scale Orientation unimportant i.e. two plotting errors = no marks for plotting i.e. straight line <table border="1" data-bbox="903 461 1232 752"> <thead> <tr> <th>Force in N</th> <th>Distance h in cm</th> </tr> </thead> <tbody> <tr><td>0.2</td><td>4.6</td></tr> <tr><td>0.4</td><td>3.9</td></tr> <tr><td>0.6</td><td>3.1</td></tr> <tr><td>0.8</td><td>2.3</td></tr> <tr><td>1.0</td><td>1.6</td></tr> <tr><td>1.2</td><td>0.9</td></tr> </tbody> </table> | Force in N | Distance h in cm | 0.2 | 4.6 | 0.4 | 3.9 | 0.6 | 3.1 | 0.8 | 2.3 | 1.0 | 1.6 | 1.2 | 0.9 | 5 |
| Force in N | Distance h in cm | | | | | | | | | | | | | | | | |
| 0.2 | 4.6 | | | | | | | | | | | | | | | | |
| 0.4 | 3.9 | | | | | | | | | | | | | | | | |
| 0.6 | 3.1 | | | | | | | | | | | | | | | | |
| 0.8 | 2.3 | | | | | | | | | | | | | | | | |
| 1.0 | 1.6 | | | | | | | | | | | | | | | | |
| 1.2 | 0.9 | | | | | | | | | | | | | | | | |
| (iv) | straight line seen extended to the force axis; $1.40 \leq F \leq 1.46$ (N); | F value to 3 SF unless line goes through 1.40 accept force = 1.4 Answer in range = two marks Allow | 2 | | | | | | | | | | | | | | |
| (v) | NO mark for Yes/No answer Any two of - MP1. Correct statement of Hooke's law; MP2. graph shows equal decrements for distance with force MP3. (line goes down because) different distance has been measured; MP4. graph does not pass through the origin; | extension is (directly) proportional to force <ul style="list-style-type: none"> • equal steps • the line is straight ignore graph is <ul style="list-style-type: none"> • directly proportional • inversely proportional • negative correlation <ul style="list-style-type: none"> • the "wrong" distance is measured • extension can be worked out from data • more force = larger extension | 2 | | | | | | | | | | | | | | |

Total 14 marks

Question 6.

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

Total 3 marks

| | | | |
|-----|---|--|---|
| (c) | <p>explanation in terms of momentum OR acceleration OR pressure</p> <p>momentum - any 3 of:</p> <p>MP1. idea of increased time (of impact); MP2. same change in momentum; MP3. force is rate of change in momentum; MP4. reduces force (on knee);</p> <p>OR</p> <p>acceleration - any 3 of:</p> <p>MP1. idea of increased distance/time (to slow down); MP2. same change in velocity / speed; MP3. reduces acceleration; MP4. reduces force (on knee);</p> <p>OR</p> <p>pressure - any 3 of:</p> <p>MP1. idea of increased area (in contact with ground / knee); MP2. reduced force; MP3. pressure = force ÷ area; MP4. reduces pressure (on knee);</p> | <p>allow $F = \text{change in momentum} \div \text{time}$</p> <p>allow same force symbols</p> | 3 |
|-----|---|--|---|

Total 9 marks

Question 8.

| Question number | Answer | Notes | Marks | | | | | | | | | | | | | | |
|-----------------|---|---|-------|------------|--|------------|--|-------------|---|-------|-----|-----------|---|-------------|--|---|---|
| 5 (a) (i) | weight (of toy car); | allow mass | 1 | | | | | | | | | | | | | | |
| (ii) | speed (of toy car); | allow: velocity time (to go down the slope) | 1 | | | | | | | | | | | | | | |
| (b) | any 2 of: MP1. angle/gradient/incline/steepness/height of slope; MP2. same car/eq; MP3. surface of slope; MP4. force at launch; MP5. initial speed; MP6. starting height/position/point (of car); MP7. distance travelled/length of slope; | ignore weather conditions | 2 | | | | | | | | | | | | | | |
| (c) | <table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr><td>battery</td><td></td></tr> <tr><td>joulemeter</td><td></td></tr> <tr><td>micrometer</td><td></td></tr> <tr><td>newtonmeter</td><td style="text-align: center;">✓</td></tr> <tr><td>ruler</td><td style="text-align: center;">(✓)</td></tr> <tr><td>stopwatch</td><td style="text-align: center;">✓</td></tr> <tr><td>thermometer</td><td></td></tr> </tbody> </table> <p>one correct tick; two correct ticks;</p> | battery | | joulemeter | | micrometer | | newtonmeter | ✓ | ruler | (✓) | stopwatch | ✓ | thermometer | | <p>allow clear alternative indications e.g. - crosses - shading</p> <p>if more than 2 ticks, -1 for each incorrect tick</p> | 2 |
| battery | | | | | | | | | | | | | | | | | |
| joulemeter | | | | | | | | | | | | | | | | | |
| micrometer | | | | | | | | | | | | | | | | | |
| newtonmeter | ✓ | | | | | | | | | | | | | | | | |
| ruler | (✓) | | | | | | | | | | | | | | | | |
| stopwatch | ✓ | | | | | | | | | | | | | | | | |
| thermometer | | | | | | | | | | | | | | | | | |

| | | | |
|-----|---|--|----------|
| (d) | <p>any 5 of:</p> <p>MP1. measure weight/mass;</p> <p>MP2. measure distance (down slope)/start from same point;</p> <p>MP3. measure time/speed (with light gate);</p> <p>MP4. equation seen or described in words: speed = distance / time;</p> <p>MP5. idea that different weights used;</p> <p>MP6. repeat experiment AND average/remove anomalies;</p> <p>MP7. method to improve accuracy, e.g. use of light gates, reaction time considered;</p> | <p>Allow</p> <p>'find out' for measure</p> | <p>5</p> |
|-----|---|--|----------|

Total 11 marks

Question 9.

| Question number | Answer | Notes | Marks |
|-----------------|---|---|-------|
| 7 (a) (i) | force = mass x acceleration; | in words or in accepted symbols e.g. $F=ma$ | 1 |
| (ii) | substitution; evaluation; e.g. 38×1.5 57 (N) | 57000 (N) scores 1 mark | 2 |
| (iii) | any suitable suggestion; e.g. friction between snow/ground and sledge ground is not level towing rope/direction at an angle to the ground/direction of movement | allow air resistance/drag | 1 |
| (b) (i) | acceleration = <u>change in velocity</u> ; time (taken) | in words or in accepted symbols e.g. $a = \frac{\Delta v}{t}$ $a = \frac{v-u}{t}$ not 's' for 'v' | 1 |
| (ii) | <i>working must be shown</i> rearrangement of equation OR substitution; evaluation to at least 2SF; e.g. $t = \frac{2.8}{1.5}$ = 1.9 (s) | Calculation of velocity or acceleration scores 1 mark max. allow 1.87 no unit required | 2 |

| | | | |
|---------|---|--|---|
| (c) (i) | <p>MP1. statement of total distance = area under graph;</p> <p>MP2. any 1 correct distance for a segment of journey; e.g. calculation of distance during acceleration ($\frac{1}{2} \times 3.25 \times 2.5 = 4.1 \text{ m}$) calculation of distance during constant speed ($3.25 \times 8 = 26 \text{ m}$) calculation of distance during deceleration ($\frac{1}{2} \times 3.25 \times 4 = 6.5 \text{ m}$)</p> <p>MP3. correct total distance 36.6 (m);</p> | <p>may be assumed by an attempt at sum of the areas</p> <p>allow range of 36-37 (m)</p> | 3 |
| (ii) | <p>(average) speed = $\frac{\text{distance (moved)}}{\text{time (taken)}}$;</p> | <p>in words or in accepted symbols e.g. $v=s/t$ condone $s=d/t$</p> | 1 |
| (iii) | <p>substitution; evaluation;</p> <p>e.g. $36.6/14.5$ 2.52 (m/s)</p> | <p>allow ecf from (c)(i) for distance</p> <p>ignore s.f. allow answers that round to 2.5 or 2.6 (m/s)</p> | 2 |

Total 13 marks

Question 10.

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