# Motion Graphs

## Mark Scheme 4

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| **Level** | International A Level |
| **Subject** | Physics |
| **Exam Board** | CIE |
| **Topic** | Kinematics |
| **Sub Topic** | Motion Graphs |
| **Paper Type** | Theory |
| **Booklet** | Mark Scheme 4 |

**Time Allowed:** **48 minutes**

**Score:** **/40**

**Percentage:** **/100**

| A* | A | B | C | D | E | U |
|---|---|---|---|---|---|---|
| >85% | '77.5% | 70% | 62.5% | 57.5% | 45% | <45% |

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|---|---|---|---|---|
| 1 | **(a** | (work =) force × distance <u>moved</u> / displacement in the direction of the force<br>OR when a force moves in the direction of the force work is done | B1 | [1] |
| | **(b)** | kinetic energy = ½ $mv^2$<br>= <u>½ 0.4 $(2.5)^2$ = 1.25 / 1.3 J</u> | C1<br>A1 | <br>[2] |
| | **(c) (i)** | area under graph is work done / work done = ½ $Fx$<br>1.25 = (14 $x$) / 2<br>$x$ = 0.18 (0.179) m [allow $x$ = 0.19 m using kinetic energy = 1.3 J] | C1<br>C1<br>A1 | <br><br>[3] |
| | **(ii)** | smooth curve from $v$ = 2.5 at $x$ = 0 to $v$ = 0 at Q<br>curve with increasing gradient | M1<br>A1 | <br>[2] |
| 2 | **(a (i)** | acceleration = change in velocity / time (taken)<br>or acceleration = rate of change of velocity | B1 | [1] |
| | **(ii)** | a body continues at constant velocity unless acted on by a resultant force | B1 | [1] |
| | **(b) (i)** | distance is represented by the area under graph<br>distance = ½ × 29.5 × 3 = 44.3 m (accept 43.5 m for 29 to 45 m for 30) | C1<br>A1 | <br>[2] |
| | **(ii)** | resultant force = weight – frictional force<br>frictional force increases with speed<br>at start frictional force = 0 / at end weight = frictional force | B1<br>B1<br>B1 | <br><br>[3] |
| | **(iii)** | **1.** frictional force increases | B1 | [ |
| | | **2.** frictional force (constant) and then decreases | B1 | [1] |
| | **(iv)** | **1.** acceleration = ($v_2$ – $v_1$) / $t$ = (20 – 50) / (17 – 15)<br>= (–) 15 m $s^{-2}$ | C1<br>A1 | <br>[2] |
| | | **2.** $W$ – $F$ = $ma$<br>$W$ = 95 × 9.81 (= 932)<br>$F$ = (95 × 15) + 932 = 2400 (2360) (2357) N | C1<br>C1<br>A | <br><br>[3] |

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| 3 | **(a)** | weight = 452 × 9.81 | | |
| | | component down the slope = 452 × 9.81 × sin 14° | M1 | |
| | | = 1072.7 = 1070 N | A0 | [1] |
| | **(b)** **(i)** | $F = ma$ | C1 | |
| | | $T$ – (1070 + 525) = 452 × 0.13 | C1 | |
| | | $T$ = 1650 (1653.76) N *any forces missing 1/3* | A1 | [3] |
| | **(ii)** **1.** | $s = ut + ½at^2$ hence $10 = 0 + ½ \times 0.13t^2$ | C1 | |
| | | $t = [(2 \times 10) / 0.13]^{1/2}$ = 12.4 or 12 s | A1 | [2] |
| | **2.** | $v = (0 + 2 \times 0.13 \times 10)^{1/2}$ = 1.61 or 1.6 m s$^{-1}$ | A1 | [1] |
| | **(c)** | straight line from the origin | B1 | |
| | | line down to zero velocity in short time compared to stage 1 | B1 | |
| | | line less steep negative gradient | B1 | |
| | | final velocity larger than final velocity in the first part – at least 2× | B1 | [4] |

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| 4 | **(a)** | **(i)** | scatter of points (about the line) | B1 | |
| | | **(ii)** | intercept (on $t^2$ axis) | B1 | **[2]** |
| | | | *(note that answers must relate to the graph)* | | |
| | **(b)** | **(i)** | gradient = $\Delta y / \Delta x$ = (100 – 0)/(10.0 – 0.6) | C1 | |
| | | | gradient = 10.6 (cm s$^{-2}$) *(allow ±0.2)* | A1 | **[2]** |
| | | | (Read points to within $\pm\frac{1}{2}$ square. Allow 1 mark for 11 cm s$^{-2}$ | | |
| | | | *i.e. 2 sig fig, -1. Answer of 10 scores 0/2 marks)* | | |
| | | **(ii)** | $s = ut + \frac{1}{2}at^2$ | B1 | |
| | | | so acceleration = 2 x gradient | B1 | |
| | | | acceleration = 0.212 m s$^{-2}$ | B1 | **[3]** |
| | | | **Total** | | **[7]** |