| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(a)** | stopwatch /stopclock (1)<br><br>{trundle/measuring} wheel/measuring tape or tape measure (1)<br><br>ignore speedometer/speed camera/radar | (electronic) timer<br>timing app (on 'phone)<br><br>clock and watch on their own are insufficient<br><br>any suitable length measuring device<br>e.g. accept metre {rule(r)/stick}<br><br>but ruler on its own is insufficient<br><br>**Answers may be in either order** | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(b)(i)** | white (car) (1) | Allow the use of other columns that identify correct car<br>e.g. 5.6(s) | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(b)(ii)** | substitution (1)<br>80 ÷ 4.3<br><br>evaluation (1)<br>19 (m/s)<br><br>Throughout the paper do not penalise<br>answers to many places of decimal<br>e.g. here 18.604651 gets both marks | Allow full marks for correct answer with no working seen.<br><br>accept 18.6 (m/s)<br><br>ignore 18 and 18.0 as incorrect rounding<br><br>accept any power of 10 error for 1 mark | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(b)(iii)** | 40 (miles per hour) (1) | accept answers in range<br>39 – 43 (miles per hour)<br><br>ecf from b(ii)<br>multiply bii by 2.222 range +/- 2.0 | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **1(c)** | {steady/constant} speed (at first) (1)<br><br>(then) slows down (1) | accept velocity for speed<br>ignore as time increases distance travelled increases<br><br>(then) slower/less speed/decelerates/negative acceleration | **(2)** |

Total for Question 1 = 8 marks

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(a)** | 20(m) | value between 18 and 22 | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(b)** | substitution (1)<br>100/9.8<br><br>evaluation (1)<br>10<br><br><br><br>unit (1)<br>m/s | <br><br><br><br>**Accept** 10.2<br><br>give 2 marks for correct answer, no working<br>accept for 1 mark 9.65 or 9.7<br><br>mps | <br><br><br><br><br><br><br><br>**(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(c)** | An explanation linking the following points<br><br>• speed changes (1)<br><br>• (because) slower to begin with / faster at the end (1) | <br><br>not the same speed throughout<br><br>slows down after 100 m<br><br>he speeds up=2 | <br><br><br><br><br><br>**(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(d)(i)** | **B** slowing down | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **2(d)(ii)** | speed in a stated direction | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(a)** | | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(b)** | distance travelled = area under graph (1)<br><br>substitution (1)<br>½ x 20 x 2<br><br>evaluation (1)<br>20 (m) | distance = average speed x time<br><br>= 10 × 2<br><br>20 (m)<br><br>allow (distance) = speed × time<br>or 20 x 2 for 1 mark<br><br>give full marks for correct answer, no working | **(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **3(c)** | An explanation linking the following points<br><br>• velocity is a vector (1)<br><br>• (whereas) speed is not (1) | velocity has magnitude and direction<br>velocity has direction<br><br>speed is a scalar<br>speed has {no direction}/{magnitude only}<br><br>allow for 2 marks<br>velocity is speed in a straight line<br>velocity = $\frac{\text{displacement}}{\text{time}}$<br><br>NOTE answers in terms of momentum must still refer to vectors or direction to gain credit | **(2)** |

| Question Number | | Indicative Content | Mark |
|---|---|---|---|
| **QWC** | ***5(d)** | An explanation linking some of the following<br><br>**Forces acting**<br>• weight down<br>• air resistance up (opposing motion)<br><br>**Forces during fall**<br>• weight constant<br>• air resistance increases<br>• with speed<br>• resultant force = W – R<br><br>**Effect on shape of graph**<br>• at start, resultant force is large so acceleration large / gradient steep<br>• mid resultant force decreasing so acceleration decreasing / gradient decreasing<br>• terminal velocity, resultant force is zero so acceleration zero / gradient zero | **(6)** |
| **Level** | **0** | No rewardable content | |
| **1** | **1 -2** | • a limited explanation linking a few facts from the indicative content. E.g. at terminal velocity, forces are equal so constant speed.<br>• the answer communicates ideas using simple language and uses limited scientific terminology<br>• spelling, punctuation and grammar are used with limited accuracy | |
| **2** | **3 -4** | • a simple explanation linking some of the indicative content to the shape of the graph e.g At the start weight > air resistance so acceleration and at the end weight = air resistance so no acceleration.<br>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately<br>• spelling, punctuation and grammar are used with some accuracy | |
| **3** | **5 -6** | • a detailed explanation linking most of the indicative content to the complete shape of the graph e.g. At the start weight > air resistance so acceleration. Then air resistance increases (with speed) so acceleration decreases. At the end weight = air resistance so no acceleration.<br>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately<br>• spelling, punctuation and grammar are used with few errors | |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(a)** | D | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(b)(i)** | 12 (m/s)<br>(1) | Range from 11(m/s) to 14 (m/s) | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4(b)(ii)** | Substitution (1)<br>$\frac{20-0}{5}$<br><br>evaluation (1)<br>4 ($m/s^2$) | <br>$\frac{20}{5}$<br><br>Full marks for correct answer with no working<br><br>Allow answers between 3.6 and 4.7 for 2 marks to reflect readings taken from the graph | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4b(iii)** | • velocity/ speed (measured in) m/s (1)<br><br>• <u>divided</u> by time in s (1) | velocity/ speed (measured in) $ms^{-1}$<br><br>acceleration is rate of change of velocity<br><br>m/s/s m per s per s<br>[accept per for divide]<br><br>do not accept m/s <u>times</u> time | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **4b(iv)** | at constant vel<br>• distance = 60 (m) (1)<br><br>slowing down<br>• distance = ½×2×20 (1)<br>• = 20 (m) (1) | correct answer scores 2 marks | **(3)** |

Total for question 3=10 marks

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5 (a) (i)** | 16 (s)<br>(1) | Sixteen/<br>sixteen seconds/<br>16 s/<br>16 seconds | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5 (a) (ii)** | Downward arrow starting at centre of the block<br>(1) | Mark by eye ie ruler not required.<br>Accept freehand lines and gaps between dot and line less than half the distance between dot and bottom of block by eye.<br>Accept lines that are not quite vertical | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5 (a) (iii)** | D zero | | **(1)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5 (a) (iv)** | Substitution<br>3 / 2<br>(1)<br>Evaluation<br>1.5<br>(1)<br><br>Unit<br>$m/s^2$<br>(1) | <br><br><br><br><br><br>$ms^{-2}$ or m/s/s<br><br>bald 1.5 x $10^n$ $m/s^2$<br>gains 2 marks<br>eg bald 150 = 1 mark (BOD for correct substitution)<br>150 $m/s^2$ gains 2 marks<br><br>give full marks for correct numerical answer, 1.5 $\underline{m/s^2}$ even if no working | **(3)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5 (a) (v)** | An explanation to include two of the following points<br><br>• (At first/in first 2 seconds Block is) accelerating (1)<br><br>• Which requires a (resultant) force (1)<br><br>• In addition to the force needed to balance the weight of the block (1)<br><br>• (In next 4 seconds) forces are balanced (1)<br>• (Because) velocity is constant (1) | (block is) speeding up/increasing velocity<br><br>there is an unbalanced force/ forces are not balanced<br><br>(Because) speed is steady | **(2)** |

| Question Number | Answer | Acceptable answers | Mark |
|---|---|---|---|
| **5 (b)** | An explanation to include<br><br>Information taken from the graph (1)<br><br>A valid conclusion (1) | Ignore air resistance<br><br>(Overall) time is less OR velocity/speed is greater OR acceleration is greater OR bigger/faster change in velocity/speed<br><br>So (same amount of) work is done more quickly/energy is transferred faster | **(2)** |