# Mark Scheme

Q1.

| Question Number | Acceptable answers | Additional guidance | Mark |
|---|---|---|---|
| | **The only correct answer is C**<br><br>A *is not correct because acceleration is 0* as *v* constant<br>B *is not correct because there is a resistive force opposing weight*<br>D *is not correct because there is a weight* | There is a resultant force acting on the object. | **1** |

Q2.

| Question Number | Answer | Mark |
|---|---|---|
| | A | **1** |

Q3.

| Question Number | Answer | | Mark |
|---|---|---|---|
| * (a) | **(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)**<br><br>**Max 5**<br><br>Solid ($CO_2$) exerts a force on the gas ($CO_2$)<br>N3 means (gas exerts) a force on the solid/X<br>Force is in opposite direction on the solid/gas<br><br>There is a resultant/unbalanced force (on the solid)<br>N2/1 means the (solid) accelerates (accept changes velocity/speed)<br>Rapid because mass/friction is small<br><br>(No mark for a statement of Newton's Laws) | (1)<br>(1)<br>(1)<br><br>(1)<br>(1)<br>(1) | **5** |
| (b) | More than one jet<br><br>Zero/no resultant force **Or** forces balanced/cancel | (1)<br><br>(1) | **2** |
| | **Total for question** | | **7** |

Q4.

| Question Number | Answer | Mark |
|---|---|---|
| (a) | This can be marked in terms of the train either initially stationary or moving with constant speed.<br><br>State N1in terms of ΣF =/> 0<br>e.g. An unbalanced/net/resultant/total/ΣF force of zero gives constant speed/velocity/motion (1)<br><br>(the friction between floor and feet) accelerate the feet<br>**Or** (friction between floor and feet) creates an unbalanced/net/resultant/total force on feet (1)<br><br>the train accelerates but the man continues travelling at the original/constant speed<br>**Or** the top half has no (resultant) force as the train accelerates<br>**Or** the man's speed relative to the train is lower<br>**Or** (All of the) man needs to accelerate at the same rate as the train (1) | 3 |
| * (b) | (QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)<br><br>Man pulls (backward) on the support (1)<br><br>Due to N3 the support exerts a (opposite) force on the man (1)<br><br>This force is a resultant/unbalanced/net force on man (1)<br><br>Due to N1/N2 the man will accelerate (1)<br><br>With the same acceleration/speed/velocity as the train (1) | 5 |
| | **Total for question** | 8 |

Q5.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| (a) | Four forces correctly labelled<br><br>(1 force correctly labelled scores one mark<br><br>2 or 3 forces correctly labelled scores two marks<br><br>4 forces correctly labelled scores three marks) | (normal) contact force **Or** reaction (force) **Or** *N* **Or** *R* **Or** force of ground on child<br><br>*F* /Friction (between ground and child)<br><br>Force/pull of rope on child **Or** tension/*T*<br><br>Weight/*W*/*mg* **Or** gravitational force | 3 |

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|---|---|---|---|
| (b) * | This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.<br><br>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.<br><br>The following table shows how the marks should be awarded for indicative content.<br><br>**Indicative content**<br>• The idea that the rope is under tension<br><br>• Team A exerts a force on the rope and due to N3 the rope exerts a force on Team A<br><br>• Force of rope on team A > frictional force for Team A<br><br>• Team A now has a resultant force (to the right)<br><br>• Team A accelerates (to the right) due to N1/2 | The following table shows how the marks should be awarded for structure and lines of reasoning<br><br>Accept tension for 'force of rope on team'<br><br>MP4: accept 'unbalanced' for 'resultant' | 6 |

| Number of indicative marking points seen in answer | Number of marks awarded for indicative marking points |
|---|---|
| 6 | 4 |
| 5-4 | 3 |
| 3-2 | 2 |
| 1 | 1 |
| 0 | 0 |

| | Number of marks awarded for structure of answer and sustained line of reasoning |
|---|---|
| Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout | 2 |
| Answer is partially structured with some linkages and lines of reasoning | 1 |
| Answer has no linkages between points and is unstructured | 0 |

| | | | |
|---|---|---|---|
| | • (This is because) the frictional force between Team B and the ground is larger **Or** Team B applies a greater<br>• force (on the rope) than team A | Accept converse for MP6 but a reference to both Team A and Team B is required for MP6 | |

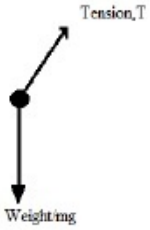
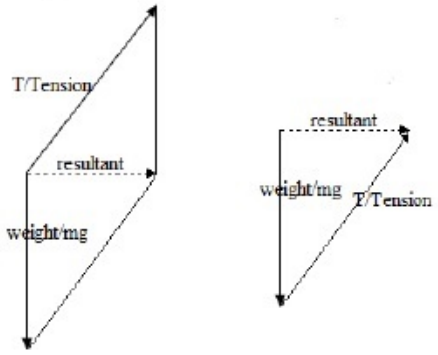
Q6.

| Question Number | Answer | | Mark |
|---|---|---|---|
| (a) | Static domino now has an unbalanced force acting on it<br>so starts to move/fall **Or** falls from rest **Or** accelerates<br><br>**Or**<br>Before it is hit, the static domino has no unbalanced force on it<br>(so) remains at rest | (1)<br>(1)<br><br><br>(1)<br>(1) | **2** |
| (b) | **(QWC – work must be clear and organised in a logical manner using technical terminology where appropriate)**<br><br><u>The bottom coin is knocked out from under the stack</u><br>Only the bottom coin is given a force **Or** bottom coin has an unbalanced force on it<br>Bottom coin starts to move **Or** accelerates<br><br><u>The flicked coin stops</u><br>Stacked/bottom coin gives the flicked coin a force **Or** force on flicked coin due to N3.<br>The resultant force on the flicked coin is opposite to the direction of motion **Or** the flicked coin decelerates<br><br><u>The stack drops down</u><br>The remaining stacked coins do not receive any horizontal force (so stay still horizontally)<br>The stacked coins now have an unbalanced vertical force (and drop) **Or** there is now only weight acting (vertically) | <br><br><br>(1)<br>(1)<br><br><br><br>(1)<br><br>(1)<br><br><br>(1)<br><br>(1) | **6** |
| (c) | The idea that the direction of the (force of the flicked) coin on the stack is in a different direction (to initial direction of travel)<br><br>The idea that the force from stack on (flicked) coin is in a different direction (to initial direction of travel)<br>(Accept a labelled diagram indicating an off-centre collision) | (1)<br><br>(1) | **2** |
| | **Total for question** | | **10** |

Q7.

| Question Number | | | Mark |
|---|---|---|---|
| **(a) (i)** | Use of equation of motion suitable for a, e.g. $v = u + at$ | (1) | |
| | $a$ = 16.3 m s$^{-2}$ (2.1 ×10$^5$ km h$^{-2}$ or 58.7 km h$^{-1}$ s$^{-1}$ ) | (1) | **2** |
| | Example of calculation<br>$a = \frac{37.5 \text{ m s}^{-1} - 0}{2.3 \text{ s}}$<br>$a$ = 16.3 m s$^{-2}$ | | |
| **(a) (ii)** | Use of $E_k = ½ mv^2$ | (1) | |
| | Use of $P = E/t$ | (1) | |
| | Power = 3.1×10$^6$ W | (1) | |
| | **Or** | | |
| | Use of $F = ma$ (must be $a$ from (i)) **and** Use of equation to find distance **and** use of work done = Fd | (1) | |
| | Use of $P = E/t$ | (1) | |
| | Power = 3.1 × 10$^6$ W<br>(distance = 43 m) | (1) | **3** |
| | Examples of calculations<br>$E_k$ = ½ × 10 000 kg × (37.5 m s$^{-1}$)$^2$ = 7.03 ×10$^6$ J<br>Power = 7.03 × 10$^6$ J / 2.3 s = 3.1 × 10$^6$ W | | |
| **(a) (iii)** | Energy transferred by heating<br>**Or** energy transferred due to friction<br>**Or** work done against friction<br>**Or** idea that more energy required (due to energy transfer) due to friction. | (1) | **1** |
| | (do not accept 'lost' but accept air resistance as an alternative to friction) | | |
| ***(b)** | (QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) | | |
| | larger force is needed **Or** the (same) force is insufficient | (1) | |
| | need same acceleration/ (max) velocity **OR** acceleration/(max) velocity is too small | (1) | |
| | more energy needed (to reach top) **Or** insufficient energy (to reach top) | (1) | **3** |
| **(c)** | Viscosity of oil decreases (with increasing temperature) **Or** the (warm) oil is less viscous<br>(accept a reverse argument e.g. when cold oil is more viscous) | (1) | |
| | Lower frictional/resistive force **Or** less viscous drag | (1) | **2** |
| | **Total for question** | | **11** |

Q8.

| Question Number | | Mark |
|---|---|---|
| **(a)(i)** | Weight (1)<br>(accept *W* or mg or gravitational pull/force) ('gravity' doesn't get the mark)<br><br>Tension (1)<br>(accept *T*)<br><br>(Both arrows and labels required for each marking point )<br><br>  <br><br><br>(Arrows must touch mass for marks; ignore any arrows, for correct or incorrect forces, not touching<br><br>(Minus one from maximum possible mark for each additional force (e.g. resultant, pull) or other arrow (e.g. speed or motion) touching mass) | **2** |
| **(a) (ii)** | A triangle or parallelogram with W and T in correct position for vector addition with correct labels and directions. (1)<br><br>Triangle or parallelogram completed correctly with resultant in correct directions. (1)<br>(Can score 2 marks even if the resultant is not horizontal)<br><br>e.g. (scores 2 marks)<br><br>  <br> | **2** |

| | | |
|---|---|---|
| **(a)(iii)** | $ma/mg = \tan\theta$<br>**OR**<br>$T\cos\theta = mg$ **and** $T\sin\theta = ma$ (1)<br>(seen or substituted into)<br><br>$a = 1.2$ (m s$^{-2}$) (1)<br><br>Example of calculation<br>$a = \tan 7° \times g = \tan 7° \times 9.81$ m s$^{-2}$<br>$= 1.2$ m s$^{-2}$ | **2** |
| **(b)(i)** | Straight down (by eye) (1)<br>  | **1** |
| **(b)(ii)** | To left, angle between string and roof to be less than 83° but not horizontal (1)<br>  | **1** |
| **(b)(iii)** | To right, at any angle except horizontal (1)<br>  | **1** |
| **(c)** | Always has weight **Or** gravitational force **Or** force due to gravity (1)<br>so tension needs a vertical component (1)<br><br>**Or**<br>Use of the equation $ma/mg = \tan\theta$ (1)<br>Leading to the idea of infinite value of $\tan\theta$ requiring infinite acceleration (1) | **2** |
| **(d)** | Any correct physics answer that uses the concept of the independence of motion at right angles (1)<br><br>e.g. (to detect movement) in the x,y,z directions/planes/axes<br>**Or** up-down, left-right and forwards-backwards | **1** |
| | **Total for question** | **12** |

Q9.

| Question Number | Acceptable Answers | | Mark |
|---|---|---|---|
| **(a)** | **Laminar**: Continuous lines, not crossing, below the wing, with at least 2 continuing beyond the wing | **(1)** | **2** |
| | **Turbulent:** swirls, crossing lines, changes of direction greater than 90° **only** above the wing, not necessarily attached to the lines from the left | **(1)** | |

| Question Number | Acceptable Answers | | Mark |
|---|---|---|---|
| **(b)(i)** | The idea that a (component of ) lift = weight | **(1)** | **3** |
| | See $L$ cos 20° or $mg$ / cos 20° | **(1)** | |
| | $L$ = 0.66 or 0.7 (N) | **(1)** | |
| | Example of calculation<br>Vertical component of lift = weight<br>$L\cos 20^\circ = 0.063\ \text{kg} \times 9.81\ \text{N kg}^{-1}$<br>$L$ = 0.66 (N) | | |

| Question Number | Acceptable Answers | | Mark |
|---|---|---|---|
| **(b)(ii)** | Find the horizontal component of lift (drag) using trig or Pythagoras<br>($L$ sin 20°, $W$ tan 20°, $\sqrt{L^2 - W^2}$ ) | **(1)** | **3** |
| | Use of $F = ma$ | **(1)** | |
| | Acceleration = (−) 3.6 to 3.7 m s$^{-2}$ (ecf) | **(1)** | |
| | Example of calculation<br>$L_{\text{horizontal}} = -L\sin 20^\circ = -0.66\ \text{N} \times \sin 20^\circ = -0.226$ (N)<br>$\text{acceleration} = \dfrac{-0.226\ \text{N}}{0.063\ \text{kg}}$<br>acceleration = −3.57 m s$^{-2}$ | | |

| Question Number | Acceptable Answers | | Mark |
|---|---|---|---|
| **(c)(i)** | Bird/leg exerts force/push (down) on ground | **(1)** | **4** |
| | N3 ground exerts a force (up) on bird | **(1)** | |
| | Force ≠ / > weight **Or** there is a resultant/unbalanced force | **(1)** | |
| | Due to N2 / N1 bird accelerates | **(1)** | |

| Question Number | Acceptable Answers | | Mark |
|---|---|---|---|
| **(c)(ii)** | Maximum force read from graph = 2.00 N to 2.10 N | **(1)** | **3** |
| | resultant force = $F - W$ (1.37 N to 1.43 N) | **(1)** | |
| | Answer = 23 m $s^{-2}$ | **(1)** | |
| | Example of calculation<br>Maximum force = 2.05 N<br>2.05 N – ( 0.063 kg x 9.81 m $s^{-2}$) = 0.063 kg × $a$<br>$a$ = 22.7 m $s^{-2}$ | | |
| | **Total for question** | | **15** |