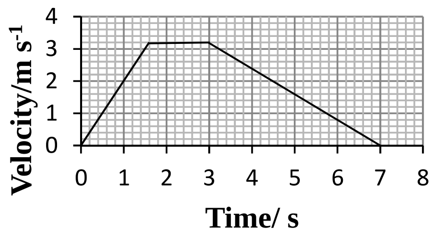
Question Number	Answer	Mark
1(a)	Sketch a vector diagram Correct diagram – closed polygon, accept a triangle using the resultant of lift and weight, but arrows must follow correctly. Must show sequence of tip-to-tail arrowed vectors.	**(1)**
1(b)	Find the tension in the string. Use of trigonometrical function for the horizontal angle (allow mark for vertical angle if correct and shown on dia) Correct answer for <u>horizontal</u> angle (32.8°) Use of Pythagoras or trigonometrical function for the tension Correct answer for tension magnitude (7.1 N) <u>Example of calculation</u> weight – lift = 3.86 N from horizontal, tan (angle) = 3.86 N/ 6.0 N angle = 32.8° $T^2 = F_h^2 + F_v^2$ $= (6.0\ \text{N})^2 + (3.86\ \text{N})^2$ $T = 7.1$ N	**(1)** **(1)** **(1)** **(1)**
1(c) (i)	Calculate the work done by the girl. Use of $W = Fs$ Correct answer (150 J) <u>Example of calculation</u> $W = Fs = 6.0$ N x 25 m = 150 J	**(1)** **(1)**
1(c) (ii)	Calculate rate at which work is done Finds time Correct rate (12 W) <u>Example of calculation</u> $t = s/v = 25\ \text{m} / 2.0\ \text{m s}^{-1} = 12.5\ \text{s}$ $P = 150\ \text{J} / 12.5\ \text{s}$ = 12 W	**(1)** **(1)**
	Total for question	**9**

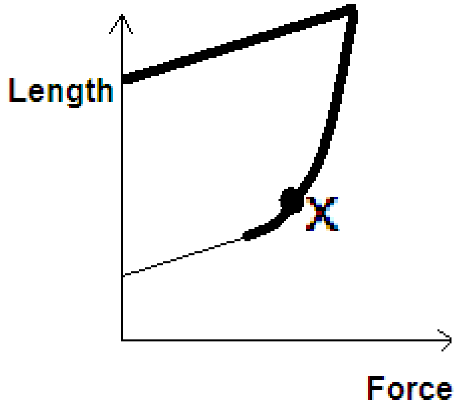
Question Number	Answer	Mark
2 (a)	Explain whether the spring obeys Hooke's law. States: Straight line shown / constant gradient (So) extension or change in length proportional to force (accept Δx or Δl or e proportional to F) / k constant (Yes, because extension or change in length proportional to force gets 2)	 **(1)** **(1)**
2 (b)	Show that the stiffness of the spring is about 20 N m^{-1} Indication of use of (inverse) gradient, e.g. $k = F/\Delta x$ or with values obtainable from graph (accept extension/force for first mark) Substitution of values as force/extension Correct answer (16 (N m^{-1})) <u>Example of calculation</u> $k = F/\Delta x$ k = 1.6 N / (0.51 m – 0.41 m) k = 1.6 N / 0.1 m = 16 N m^{-1}	 **(1)** **(1)** **(1)**
2 (c) (i)	Calculate force on spring Use of $F = k\Delta x$ (must be extension, not length) Correct answer (5.1 N) [ecf] <u>Example of calculation</u> $F = k\Delta x$ = 16 N m^{-1} x (0.41 m – 0.09 m) = 5.1 N (Use of 20 N m^{-1} → 6.4 N)	 **(1)** **(1)**
2 (c) (ii)	Calculate energy stored Use of E = ½ $F\Delta x$ = = ½ $k(\Delta x)^2$ Correct answer (0.82 J) <u>Example of calculation</u> $E = 1/2\ F\Delta x$ = 0.5 x 5.1 N x (0.41 m – 0.09 m) = 0.82 J	 **(1)** **(1)**

2 (d)	Explain effect on spring QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Change in length greater / compression greater More force More elastic energy / more strain energy / more energy stored / more potential energy / greater ½ $k(\Delta x)^2$ / more work done (on spring) Greater acceleration (Therefore) more kinetic energy (and) greater speed	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **max 3**
	Total for question	**12**

Question Number	Answer	Mark
3	Addition of words (order essential) photon metal energy (allow mass, charge, momentum) (photo)electron work function (of the metal)	 **1** **1** **1** **1** **1**
	Total for question	**5**

Question Number	Answer		Mark
4(a)	Use of $v = u + at$ **Or** use of area under the graph (for either area) $v = 3.2$ (m s^{-1}) <u>Example of calculation</u> $v = 0 + (2 \text{ m s}^{-2} \times 1.6 \text{ s})$ $v = 3.2 \text{ m s}^{-1}$	(1) (1)	 **2**
4(b)	Diagonal line from 0 to 3.2 m s^{-1} over first 1.6 s (allow show that value or candidate's values for v and t from (a)) Region of constant, non-zero velocity (from 1.6 s to 3 s) Deceleration from candidate's maximum positive velocity to 0 over last 4 s  	(1) (1) (1)	 **3**
4(c)	Use of area under their graph in (b) **Or** use of correct equation(s) of motion Correct values substituted into a method for calculating the area under their graph e.g. trapezium method $3.2 \times \frac{1.4+7}{2}$ $s = 13$ m (Full ecf from (b)) ($s = 12.6$ m using the show that value of 3 m s^{-1} for max velocity) <u>Example of calculation</u> $s = (½ \times 3.2 \text{ m s}^{-1} \times 1.6 \text{ s}) + (3.2 \text{ m s}^{-1} \times 1.4 \text{ s}) + (½ \times 3.2 \text{ m s}^{-1} \times 4 \text{ s})$ $s = 2.56 + 4.48 + 6.4 = 13.4$ m	 (1) (1) (1)	 **3**
4(d)(i)	Use of $E_k = ½ mv^2$ $E_k = 0.61$J (ecf for velocity from (a)) (Show that value gives 0.54 J) <u>Example of calculation</u> $E_k = ½ \times 0.12 \text{ kg} \times (3.2 \text{ m s}^{-1})^2$ $E_k = 0.61$ J	(1) (1)	 **2**
4(d)(ii)	Use of power = energy/time $P = 0.38$ W (ecf from (d)(i)) ($P = 0.34$ W using the show that value of $v = 3$ m s^{-1}) <u>Example of calculation</u> $P = \frac{0.61 \text{ J}}{1.6 \text{ s}}$ $P = 0.38$ W	(1) (1)	 **2**
	Total for Question		**12**

Question Number	Answer		Mark
5(a)	Statement showing that the candidate has realised that this graph is of length and not extension [e.g. subtract starting length for extension this graph is for length not extension the spring has a length between 2.0 and 3.0cm if the line (for this graph) had passed through the origin then the spring would not have any length] (To obey Hooke's law) Force $\propto$ extension **Or** extension *v* force (or vice-versa) graph should go through the origin	**(1)** **(1)**	**2**
5(b)	Use of $F = k\Delta x$ [Either evidence of attempt at $\frac{1}{\text{gradient}}$ with sensible values that could have been obtained from the graph or selection of a pair of values and the original length, 2.5 cm (accept range from 2.0 to 3.0 cm) subtracted from the length] k = 27 – 29 (N m^{-1}) Example of calculation $K = \frac{\Delta F}{\Delta x} = \frac{8\text{N}}{(0.310\text{ m} - 0.025\text{ m})} = 27.68\text{ N m}^{-1}$	**(1)** **(1)**	**2**
5(c)(i)	Use of 1/2 $F\Delta x$ **Or** use of ½ $k\Delta x^2$ [Allow F = 5.7 to 5.9 N] Energy = 0.59(J) Example of calculation Energy = ½ × 5.8 N × (0.23 m – 0.025 m) = 0.59 J) Or Energy = ½ $k\Delta x^2$ = ½ × 27.68 N m^{-1}× (0.23m – 0.025 m)^2= 0.59 (J)	**(1)** **(1)**	**2**
5(c)(ii)	energy stored → gpe **Or** energy stored = *mgh* seen or substituted into Use of stored energy = *mgh* height = 12 m Example of calculation 0.59 J = 0.005 kg × 9.81 m s^{-2} × *h* *h* = 12.0 m	**(1)** **(1)** **(1)**	**3**

<table>
<tr><td>5(d)</td><td>


Max 3 for the graph

Line continues from where graph for spring A ends and curves (1)
Direction of graph curves upwards (1)
Line continued back to show an extended length [Gradient of line not important] (1)
Elastic limit Or the yield point marked and labelled or identified in response.(X on the diagram) (1)

[Candidates that decide to start a new line are omitting themselves from getting marking point 1]

Max 3 for description of graph

More force used/masses added with spring C (1)
Spring A not extended past elastic limit or yield point
Or Spring C is extended past elastic limit or yield point (1)
Spring A shows elastic (behaviour/deformation) (1)
Spring C shows plastic (behaviour/deformation) (1)
Spring C permanently extended/ did not return to its original length (when force removed) and spring A returns to original length (when the force is removed) (1)

</td><td>6</td></tr>
<tr><td></td><td>Total for question</td><td>15</td></tr>
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