from the graph Spring constant = $(3.5 \text{ to } 3.6) \times 10^4 \text{ N m}^{-1}$ (1) Example of calculation Gradient = $\frac{3.6 \times 10^3 \text{ N}}{102 \times 10^{-2} \text{ m}}$ Spring constant = 3500 N m^{-1} 21 (1b)(i) Use of $E = \frac{12}{2} F \triangle x$ Or use of work done = area under graph Using the correct region of the graph (trapezium under graph from 3 to 9 cm) Work done by the child on the spring = $126 \cdot 128 \text{ (J)}$ (1) Example of calculation Work done in compressing spring = $(\frac{1}{2} \times (3.2 \times 10^3 \text{ N}) \times (9 \times 10^{-2} \text{ m})) \cdot (\frac{1}{2} \times (1.05 \times 10^3 \text{ N}) \times (3 \times 10^{-2} \text{ m}))$ Work done by the child on the spring = 128 J 3 1(b)(ii) Elastic potential energy to kinetic energy and gravitational potential energy (1) (accept EPE, E_{cl} , GPE, E_{grav} , KE, E_{k}) (only penalise once the omission of potential from gravitational or elastic potential energy) 1(b)(iii) Use of $E_{grav} = mgh$ Use of work done by child on spring = $E_{grav} + E_{k}$ (1) Use of E _{grav} = $\frac{1}{2}$ (1) $v = 2.5 \text{ m s}^{-1}$ (ef from part (b)(i)) Example of calculation $E_{grav} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{grav} = 2.48 \text{ m s}^{-1}$ *I(c) (QWC - work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick (1) Due to NI/N2 the pogo-stick accelerates (upwards) (1)	Question Number	Answer		Mark
	1(a)		(1)	
Gradient = $\frac{3.6 \times 10^3 \text{ N}}{10.2 \times 10^2 \text{ km}}$ Spring constant = 35300 N m^{-1} Use of $E = \frac{1}{2}F\triangle x$ Or use of work done = area under graph (1) Using the correct region of the graph (trapezium under graph from 3 to 9 cm) (1) Work done by the child on the spring = $126 \cdot 128 \text{ (I)}$ (1) $\frac{\text{Example of calculation}}{\text{Work done in compressing spring}} = (\frac{1}{2} \times 3.2 \times 10^3 \text{ N}) \times (9 \times 10^{-2} \text{ m})) - (\frac{1}{2} \times (1.05 \times 10^3 \text{ N}) \times (3 \times 10^{-2} \text{ m}))} \text{Work done by the child on the spring} = 128 \text{ J}$ 3 1(b)(ii) Elastic potential energy to kinetic energy (1) and gravitational potential energy (1) (accept EPE, E_{el} , GPE, E_{grav} , KE, E_{k}) (only penalise once the omission of potential from gravitational or elastic potential energy) 1(b)(iii) Use of $E_{\text{grav}} = \text{mgh}$ (1) Use of work done by child on spring = $E_{\text{grav}} + E_{\text{k}}$ (1) Use of $E_{\text{k}} = \frac{1}{2} \text{mgh}$ (1) $v = 2.5 \text{ m s}^{-1}$ (cef from part (b)(i)) Example of calculation $E_{\text{grav}} = 35 \text{ kg } 9.8 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{\text{k}} = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$ $v = \frac{2}{38 \text{ kg}}$ $v = 2.48 \text{ m s}^{-1}$ *1(c) QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Or there is an unbalanced upwards force on the pogo-stick (1) Due to N1/N2 the pogo-stick accelerates (upwards)		Spring constant = $(3.5 \text{ to } 3.6) \times 10^4 \text{ N m}^{-1}$	(1)	
Spring constant = 3 5300 N m ⁻¹ Use of $E = \frac{1}{2} F \triangle x$ Or use of work done = area under graph Using the correct region of the graph (trapezium under graph from 3 to 9 cm) Work done by the child on the spring = 126 -128 (J) Example of calculation Work done in compressing spring = $(\frac{1}{2} \times (3.2 \times 10^3 \text{ N}) \times (9 \times 10^{-2} \text{ m})) - (\frac{1}{2} \times (1.05 \times 10^3 \text{ N}) \times (3 \times 10^{-2} \text{ m}))$ Work done by the child on the spring = 128 J I(b)(ii) Elastic potential energy to kinetic energy and gravitational potential energy (accept EPE, E_{el} , GPE, E_{grav} , KE, E_{k}) (only penalise once the omission of potential from gravitational or elastic potential energy) 1(b)(iii) Use of work done by child on spring = $E_{\text{grav}} + E_{\text{k}}$ (1) Use of $E_{\text{grav}} = mgh$ (1) Use of $E_{\text{k}} = \frac{1}{2} m n^2$ (1) $v = 2.5 \text{ m s}^{-1}$ (cef from part (b)(i)) Example of calculation $E_{\text{grav}} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{\text{k}} = 128 J - 20.60 \text{ J} = 106.4 \text{ J}$ $v = \sqrt{\frac{2 \times 106.41}{35 \text{ kg}}}$ $v = 2.48 \text{ m s}^{-1}$ *1(c) (QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Or there is an unbalanced upwards force on the pogo-stick Or there is an unbalanced upwards force on the pogo-stick (I) Due to N1/N2 the pogo-stick accelerates (upwards)		Example of calculation 3.6 × 10 ³ N		
Using the correct region of the graph (trapezium under graph from 3 to 9 cm) (1) Work done by the child on the spring = $126 - 128$ (J) (1) $\frac{\text{Example of calculation}}{\text{Work done in compressing spring}} = (\frac{1}{2} \times (3.2 \times 10^{3} \text{ N}) \times (9 \times 10^{-2} \text{ m})) - (\frac{1}{2} \times (1.05 \times 10^{3} \text{ N}) \times (3 \times 10^{-2} \text{ m}))}{(\frac{1}{2} \times (1.05 \times 10^{3} \text{ N}) \times (3 \times 10^{-2} \text{ m}))} \text{Work done by the child on the spring} = 128 \text{ J}$ 3 $1(b)(ii)$ Elastic potential energy to kinetic energy (1) $(accept EPE, E_{el}, GPE, E_{grav}, KE, E_{k})$ $(only penalise once the omission of potential from gravitational or elastic potential energy) (2) 1(b)(iii) Use of E_{grav} = mgh (1) 1(b) = \frac{1}{2} \text{Use of } E_{grav} = \frac{1}{2} \text{ m} e^{-1} \text{ m} \text{ m} e^{-1} \text{ m} e^{$		Spring constant = 35300 N m^{-1}		2
Work done by the child on the spring = $126 - 128$ (J) Example of calculation	1(b)(ii)	Use of $E = \frac{1}{2} F \triangle x$ Or use of work done = area under graph	(1)	
		Using the correct region of the graph (trapezium under graph from 3 to 9 cm)	(1)	
Work done in compressing spring = $(\frac{1}{2} \times (3.2 \times 10^{3} \text{ N}) \times (9 \times 10^{-2} \text{ m})) - (\frac{1}{2} \times (1.05 \times 10^{3} \text{ N}) \times (3 \times 10^{-2} \text{ m}))$ Work done by the child on the spring = 128 J 3 1(b)(ii) Elastic potential energy to kinetic energy and gravitational potential energy (1) (accept EPE, E_{el} , GPE, E_{grav} , KE, E_{k}) (only penalise once the omission of potential from gravitational or elastic potential energy) 1(b)(iii) Use of $E_{grav} = mgh$ (1) $V = 2.5 \text{ m s}^{-1} \text{ (ecf from part (b)(i))}$ (1) Example of calculation $E_{grav} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{k} = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$ $V = \sqrt{\frac{2 \times 106.41}{35 \text{ kg}}}$ $V = 2.48 \text{ m s}^{-1}$ 4 *1(c) (QWC - work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick Due to N1/ N2 the pogo-stick accelerates (upwards) (1)		Work done by the child on the spring = 126 -128 (J)	(1)	
1(b)(ii)Elastic potential energy to kinetic energy and gravitational potential energy(1)(accept EPE, E_{el} , GPE, E_{grav} , KE, E_k) (only penalise once the omission of potential from gravitational or elastic potential energy)21(b)(iii)Use of $E_{grav} = mgh$ Use of $work$ done by child on spring = $E_{grav} + E_k$ (1) 		Work done in compressing spring = $(\frac{1}{2} \times (3.2 \times 10^3 \text{ N}) \times (9 \times 10^{-2} \text{ m}))$ - $(\frac{1}{2} \times (1.05 \times 10^3 \text{ N}) \times (3 \times 10^{-2} \text{ m}))$		
and gravitational potential energy (1) (accept EPE, E_{cl} , GPE, E_{grav} , KE, E_k) (only penalise once the omission of potential from gravitational or elastic potential energy) 2 1(b)(iii) Use of $E_{grav} = mgh$ (1) $V = 2.5 \text{ m s}^{-1} \text{ (ecf from part (b)(i))}$ (1) $E_{xample of calculation}$ $E_{grav} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{k} = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$ $V = \sqrt{\frac{2 \times 106.41}{35 \text{ kg}}}$ $V = 2.48 \text{ m s}^{-1}$ 4 *1(c) (QWC - work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick Due to N1/ N2 the pogo-stick accelerates (upwards) (1)		Work done by the child on the spring = 128 J		3
(only penalise once the omission of potential from gravitational or elastic potential energy) 1(b)(iii) Use of $E_{grav} = mgh$ Use of work done by child on spring $= E_{grav} + E_k$ (1) Use of $E_k = \frac{1}{2}mv^2$ (1) $v = 2.5 \text{ m s}^{-1}$ (ecf from part (b)(i)) $\frac{E_{xample} \text{ of calculation}}{E_{grav} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}}$ $E_k = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$ $v = \sqrt{\frac{2 \times 106.4 \text{ J}}{35 \text{ kg}}}$ $v = 2.48 \text{ m s}^{-1}$ 4 *1(c) (QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick Due to N1/N2 the pogo-stick accelerates (upwards) (1)		1 0,		
Use of $E_{\text{grav}} = mgh$ (1) Use of work done by child on spring = $E_{\text{grav}} + E_k$ (1) Use of $E_k = \frac{1}{2} mv^2$ (1) $v = 2.5 \text{ m s}^{-1}$ (ecf from part (b)(i)) (1) $\frac{\text{Example of calculation}}{E_{\text{grav}} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}}$ $E_k = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$ $v = \sqrt{\frac{2 \times 106.41}{35 \text{ kg}}}$ $v = 2.48 \text{ m s}^{-1}$ *1(c) $\frac{\text{(QWC - work must be clear and organised in a logical manner using technical terminology where appropriate)}}{E_k = 128 \text{ J} + 20.60 \text{ J} + 20.60 \text{ J}}$ $v = \frac{1}{2} \frac{10.64 \text{ J}}{35 \text{ kg}}$ $v = 2.48 \text{ m s}^{-1}$ *1(c) $\frac{\text{(QWC - work must be clear and organised in a logical manner using technical terminology where appropriate)}}{E_k = 10.64 \text{ J}}$ $\frac{\text{(1)}}{\text{(1)}}$		(only penalise once the omission of potential from gravitational or elastic		2
$E_{\rm grav} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{\rm k} = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$ $v = \sqrt{\frac{2 \times 106.4 \text{ J}}{35 \text{ kg}}}$ $v = 2.48 \text{ m s}^{-1}$ *1(c) (QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick (Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick Due to N1/ N2 the pogo-stick accelerates (upwards) (1)	1(b)(iii)	Use of $E_{\text{grav}} = mgh$ Use of work done by child on spring $= E_{\text{grav}} + E_{\text{k}}$ Use of $E_{\text{k}} = \frac{1}{2} mv^2$	(1) (1)	
*1(c) (QWC – work must be clear and organised in a logical manner using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick Due to N1/N2 the pogo-stick accelerates (upwards) (1) 3		$E_{\text{grav}} = 35 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 0.06 \text{ m} = 20.60 \text{ J}$ $E_{\text{k}} = 128 \text{ J} - 20.60 \text{ J} = 106.4 \text{ J}$		
using technical terminology where appropriate) (The pogo-stick pushes down on the ground and) by N3 the ground exerts an upwards force on the pogo-stick (1) Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick Due to N1/N2 the pogo-stick accelerates (upwards) (1) 3		$v = 2.48 \text{ m s}^{-1}$		4
exerts an upwards force on the pogo-stick (1) Upwards force on pogo-stick > weight of pogo-stick Or there is an unbalanced upwards force on the pogo-stick (1) Due to N1/N2 the pogo-stick accelerates (upwards) (1) 3	*1(c)			
unbalanced upwards force on the pogo-stick (1) Due to N1/ N2 the pogo-stick accelerates (upwards) (1) 3			(1)	
			(1)	
Total for Question 14			(1)	