Momentum - Mark Scheme

Q1.

Question Number	Answer	Mark
	Max 4 • Initial momentum (of the child, ball and skateboard/total) is zero (1) • Due to conservation of momentum, the total momentum before the ball is thrown = total momentum after the ball is thrown (so final total momentum is zero) (1) • The momentum of the child/skateboard is equal to the momentum of the ball (1) • The momentum of the child/skateboard is opposite in direction to the momentum of the ball (1) • As the mass of the child/skateboard greater (than the mass of ball), the velocity (of the child/skateboard) will be lower (1) (all symbols to be defined, 'mv' to be defined if used for momentum) (MP3 accept to the right/positive for forwards)	**4**
	Total for question	**4**

Q2.

Question Number	Answer	Mark
	D is the correct answer A is not the correct answer as it contradicts Newton's Third Law. B is not the correct answer as it also contradicts Newton's Third Law. C is not the correct answer as the force of Y on X is in the opposite direction to the velocity of X.	**(1)**

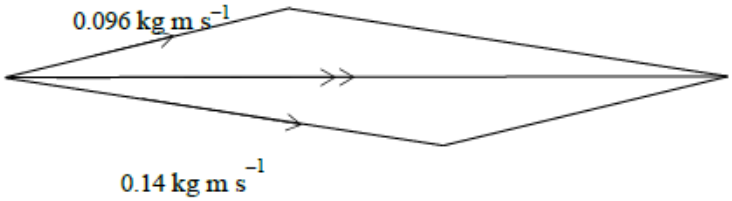
Q3.

Question Number	Answer	Mark
(a)(i)	• Use measurement and scaling factor (1) **(1)** • $h = 3.4 \pm 0.1$ cm **(1)** **OR** • Use of $s = \frac{1}{2}at^2$ with $t = 0.083$ s **(1)** • $h = 3.4$ cm **(1)**	**(2)**

(ii)	• Use of (average) speed = s/t with s = value from part (a)(i) **(1)** • Use of initial speed = 2 × average speed **(1)** • Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** **OR** • Use of $E_g = mgh$ with h = value from (a)(i) **(1)** • Use of $\frac{1}{2}mv^2 = E_g$(initial) **(1)** • Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** **OR** • Use of $v = u + at$ with v = 0 **(1)** • Use of $a = -g$ **(1)** • Speed = 9.81 × 0.083 = 0.81 m s^{-1} **(1)** **OR** • Use of with $s = ut + \frac{1}{2}at^2$ with s = value from part (a)(i) **(1)** • Use of $a = -g$ **(1)** • Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** Example of calculation $u = s/t - \frac{1}{2}at$ $u = 0.034/0.083 + \frac{1}{2} \times 9.81 \times 0.083$ **OR** • Use of $v^2 = u^2 + 2as$ with s = value from (a)(i) and $v = 0$ **(1)** • Use of $a = -g$ **(1)**	

	• Speed = 0.82 m s^{-1} ecf from (a)(i) **(1)** Example of calculation Actual distance travelled by popcorn = 6.2 cm ÷ 1.8 = 3.4 cm (average speed) = $\frac{0.034\ \text{m}}{83 \times 10^{-3}\ \text{s}} = 0.41\ \text{m s}^{-1}$ Initial speed = 2 × average speed = 0.82 m s^{-1}	**(3)**
(b)	• Use of 14% to determine mass (of water/popcorn). **(1)** **Or** $m_{\text{popcorn}}/m_{\text{water}} = 86/14$ • Use of $p = mv$ **(1)** • Use of momentum conservation **(1)** • $v = (-)\ 9.2$ m s^{-1} **(1)** Example of calculation $0 = (0.0946\ \text{g} \times 1.5\ \text{m s}^{-1}) + (0.0154\ \text{g} \times v)$ $v = \frac{-0.0946\ \text{g} \times 1.5\ \text{m s}^{-1}}{0.0154\ \text{g}}$ $v = -9.21\ \text{m s}^{-1}$	**(4)**

Q4.

Question Number	Answer	Mark
(a)	• Construction of correct vector diagram (parallelogram or triangle) with all 3 directions and 0.096 (kg m s^{-1}) and 0.14(kg m s^{-1}) labelled (1) • Momenta correctly scaled (ratio of lengths 0.14 to 0.096 rounds to between 1.40 and 1.50) (1) • Horizontal resultant (to within a slope of 1 small square) (1) • Total momentum = 0.22 to 0.24 (kg m s^{-1}) (1) (Do not award MP4 if this value has been obtained by calculation or from an incorrect diagram)  	4
(b)	• The sum/total momentum before a collision is equal to the sum/total momentum after a collision (1) • Provided no external forces act (on the system) **Or** in a closed system (1)	2
(c)	• Use of $p = mv$ (1) • $v = 1.9$ m s^{-1} (1) ($v = 1.7$ m s^{-1} using show that value and allow ecf from (a), v = 2.0 m s^{-1} if 0.236 kg m s^{-1} used) Example of calculation 0.23 kg m s^{-1} = 0.12 kg × v $v = 1.92$ m s^{-1}	2
	Total for question	8

Q5.

Question Number	Answer	Mark
	C is the correct answer A is not the correct answer as units would be kg m s^{-2} B is not the correct answer as units would be kg m s^{-1} D is not the correct answer as units would be kg m^2 s^{-2}	(1)

Q6.

Question Number	Answer	Mark
(a)	Use of $(\Delta)E_{grav} = Fd$ **Or** Use of $E_k = (\Delta)E_{grav}$ **AND** Use of $v^2=u^2+2as$ with $a = -\frac{F}{m}$ (1) Gradient = $\frac{mg}{F}$ **Or** $\frac{d}{h} = \frac{mg}{F}$ (1) Example of calculation $mgh = Fd$ $\frac{d}{h} = \frac{mg}{F}$	**(2)**
(b)	$u = \sqrt{2gh}$ (1) (Do not allow if suvat used with a=g) Use of $p = mv$ (1) $m_1u = (m_1 + m_2)v$ (either seen or used) (Do not allow if there is an m_2u term unless u=0) (1) Some working leading to the correct expression **AND** statement that the student is correct. (1) Example of calculation $mgh = ½\ mv^2$ $v = \sqrt{2gh}$ $m\sqrt{2gh} = 2mv$ $v = \frac{\sqrt{2gh}}{2} = \sqrt{\frac{gh}{2}}$	**(4)**
	Total for question	**6**