Impulse and Momentum 2 - Mark Scheme

Q1.

Question Number	Answer	Mark
	C	1

Q2.

Question Number	Answer		Mark
(a)(i)	Use of $p = mv$ (mass may be left as m or justify ignoring mass, e.g. by cancelling) See either × cos 29° or × cos 61° A correct value of momentum for at least one ball, or total, after collision (see 0.036 N s **Or** 0.55 (m) **Or** 0.011 (N s) **Or** 0.17 (m) **Or** 0.048 (N s) **Or** 0.72(m)) Calculated momentum before = calculated momentum after **and** states that momentum is conserved **Or** Calculated momentum before = calculated momentum after **and** states that momentum before = momentum after <u>Example of calculation</u> p_1 = 0.066 kg × 0.72 m s^{-1} = 0.0475 N s = 0.048 N s (2 sf) Components in direction of u_1 = (0.066 kg × 0.63 m s^{-1} × cos 29°) + (0.066 kg × 0.35 m s^{-1} × cos 61°) = 0.0364 N s + 0.0112 N s = 0.0476 N s = 0.048 N s (2 sf) Momentum before = momentum after, so satisfies principle of conservation of momentum	**(1)** **(1)** **(1)** **(1)**	**4**

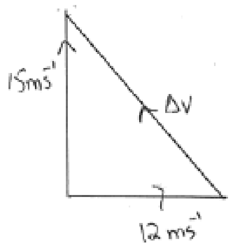
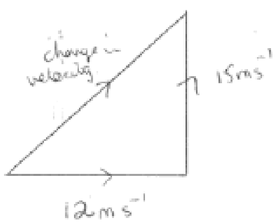
(a)(ii)	Use of $E_k = ½ mv^2$ **Or** E_k α v^2 Initial E_k = 0.017 (J) (v^2 = 0.52 (m^2 s^{-2})) Calculation of final E_k = 0.017 (J) and statement that E_k conserved (final v^2 = 0.52 (m^2 s^{-2})) <u>Example of calculation</u> $E_k = ½ mv^2$ Before: Ball 1, E_k = ½ × 0.066 kg × (0.72 m s^{-1})^2 = 0.0171 J After: Ball 1, E_k = ½ × 0.066 kg × (0.63 m s^{-1})^2 = 00131 J Ball 2, E_k = ½ × 0.066 kg × (0.35 m s^{-1})^2 = 0.0040 J Total = 0.0171 J, so kinetic energy conserved	**(1)** **(1)** **(1)**	**3**

(b)(i)	The time intervals between images The scale of the photograph (accept the diameter of the balls)	**(1)** **(1)**	**2**
(b)(ii)	φ = 45° to 52° Use of graph with their angle to determine total kinetic energy after the collision Statement that it is an inelastic collision **Or** Statement that kinetic energy is not conserved (dependent on candidate attempting MP1 and MP2)	**(1)** **(1)** **(1)**	**3**
	Total for question		**14**

Q3.

	Answer	Mark
	B	**1**

Q4.

Question Number	Answer		Mark
(a)	Sum of momenta before (collision) = sum of momenta after (collision) **Or** the total momentum before (a collision) = the total momentum after (a collision) **Or** total momentum remains constant **Or** the momentum of a system remains constant Provided no external/unbalanced/resultant force acts **Or** in a closed/isolated system	**(1)** **(1)**	**2**
(b)	Force equals rate of change of momentum **Or** force is proportional to rate of change of momentum **Or** $F = \Delta(mv)/ \Delta t$ with terms defined **Or** $F = \Delta p/ \Delta t$ with terms defined	**(1)**	**1**
(c)(i)	Line at right angles to drawn vector, arrow upwards and labelled. Resultant vector joined and arrow in correct direction. **Correct diagram**  **Wrong direction** (vector addition rather than subtraction: can score 1 mark here but allow full ecf in (c)(ii)  	**(1)** **(1)**	**2**

(c)(ii)	Use of Pythagoras Or trig. Change in velocity = 19 m s^{-1} Direction 51° from horizontal. (accept θ = 51° if θ correctly added to diagram) <u>Example of calculation</u> $\Delta v = \sqrt{15^2 + 12^2}$ Δv = 19.2 m s^{-1} Tan θ = 15/12 θ = 51°	(1) (1) (1)	3
(c)(iii)	Use of $p=mv$ and $F = \Delta p/t$ F = 7100 N or 7200 N ecf their value from (c)(ii) <u>Example of calculation</u> $F = \Delta p/t$ F = 1500 kg × 19.2 m s^{-1} / 4.0 s 7200 N	(1) (1)	2
	Total for Question		**10**

Q5.

Question Number	Answer	Mark
	C – resultant force	**1**
	Incorrect Answers: A – acceleration is the gradient of a velocity-time graph B – kinetic energy could be determined from the area under a force-displacement graph D – speed is the gradient of a distance-time graph	

Q6.

Question Number	Answer		Mark
(a)	Evidence of $E_k = ½ mv^2$ and $p = mv$ Correct algebraic link to $E_k = p^2/2m$	(1) (1)	2
(b)	Use of eV conversion Use of $E_k = p^2/2m$ Use of $\lambda = h/p$ $\lambda = 2.09 \times 10^{-13}$ m <u>Example of calculation</u> E_k = 18 800 eV ×1.6 × 10^{-19} C = 3.01 × 10^{-15} J 3.01 × 10^{-15} J = p^2/2 × 1.67 × 10^{-27} kg p = 3.17 × 10^{-21} N s λ = 6.63 × 10^{-34} J s ÷ 3.17 × 10^{-21} N s λ = 2.09 × 10^{-13} m	(1) (1) (1) (1)	4
	Total for question		**6**