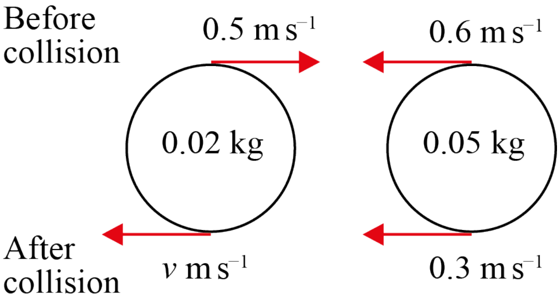
Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1a	States or uses $I = F \times t$	M1	1.2	TBC
	$I = 5 \times 0.4 = 2$ N s Answer must include units.	A1	1.1b	
		(2)		
1b	Starts with $F = m \times a$ and $v = u + at$ Substitutes to get $Ft = m(v - u)$	M1	2.1	TBC
	Cue ball begins at rest $u = 0 \Rightarrow Ft = mv$	M1	2.1	
	Speed of ball after impact is $v = \frac{Ft}{m} = \frac{I}{m}$ States final conclusion: snooker player is correct.	A1	2.3	
		(3)		
1c	States or uses $I = mv - mu$ $2 = m \times 8 \Rightarrow m = 0.25$ kg	B1	1.1b	TBC
	Momentum = $mv = 0.25 \times 8 = 2$ kg m s^{-1}	B1	1.1b	
		(2)		
				(7 marks)

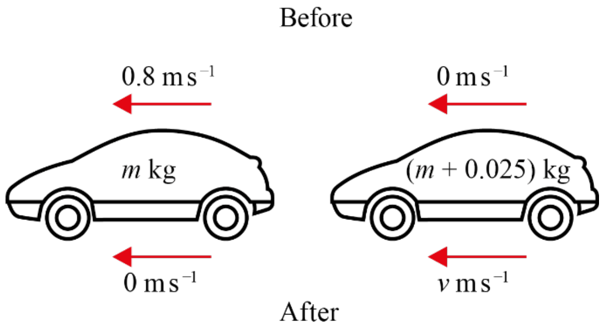
Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
2a	 Well labelled diagram.	**M1**	3.3	TBC
	States conservation of momentum equation $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$	**M1**	3.1a	
	$0.01 - 0.03 = 0.02v - 0.015$	**M1**	1.2	
	So $v = -0.25 = 0.25$ m s^{-1} in opposite direction to initial motion.	**A1**	3.2a	
		(4)		
2b	$I = mv - mu$	**M1**	1.1a	TBC
	Impulse on lighter marble $= 0.02 \times 0.5 - (0.02 \times -0.25)$ $= 0.015$ N s	**A1**	1.1b	
		(2)		
2c	Allow any valid assumption. For example, assume that there is no resistance to forward motion due to friction.	**B1**	3.5b	TBC
		(1)		
				(7 marks)

Notes

2b

Allow calculation of impulse on heavier marble if student states that magnitude of impulse is the same because of Newton's Third Law. (**M1**)

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	 Diagram modelling situation.	M1	3.3	TBC
	States or implies conservation of momentum. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$	M1	3.1a	
	Substitutes correctly to find $m \times 0.8 + (m + 0.025) \times 0 = m \times 0 + (m + 0.025) \times v$	M1	1.2	
	Rearranges to get $v = \dfrac{0.8m}{m+0.025}$	A1	1.1b	
		(4)		
3b	States or implies that only force is constant resistive force so constant acceleration formulae apply.	M1	2.4	TBC
	$s < 0.1$ because lighter car stopped when string taut at 10 cm. $u = \dfrac{0.8m}{m+0.025}$ $v = 0$ because heavier car comes to rest $a = \dfrac{20}{m+0.025}$ using $F = ma$ for heavier car	M1	3.3	
	Substitutes into $v^2 = u^2 + 2as$ Rearranges to $0.64m^2 - 4m - 0.1 < 0$	M1	1.1b	
	Uses quadratic formula to get $m < 6.27$ kg (3 s.f.)	A1	3.2	
		(4)		
				(8 marks)

Notes

Alternative method

Separate impulse diagrams for lighter and heavier cars. **(M1)**

Impulse on lighter car = $0 - (m \times 0.8) = -0.8m$ **(M1)**

States or implies that impulse on heavier car is equal and opposite.

Impulse on heavier car = $0.8m = (m + 0.025) \times v$ (**M1**)

Rearranges to get $v = \dfrac{0.8m}{m + 0.025}$ (**A1**)

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
4a	Ball thrown upwards under gravity only so $u = 7$, $s = 1.8$, $a = -9.8$ Uses $v^2 = u^2 + 2as$ to get $v = 3.704$	M1	3.1b	TBC
	Magnitude of impulse on apple = magnitude of impulse on ball $= (0.1 \times 3.704) - (0.1 \times -1)$ $= 0.4704$ N s	M1	1.1b	
	Substitutes values for I and t into $I = F \times t$ $0.4704 = F \times 0.8$	M1	1.1b	
	Calculates $F = 0.588$ N States that the force is greater than 0.5 N so the apple will be dislodged.	A1	3.2	
		(4)		
4b	Conservation of momentum. $(0.1 \times 3.704) + (0.25 \times 0) = (0.1 \times -1) + 0.25v$ Solve to get $v = 1.8816$	M1	3.1b	TBC
	$u = 1.8816$, $v = 0$, $a = -9.8$ Find s	M1	1.2	
	Uses $v^2 = u^2 + 2as$ $19.6s = (1.8816)^2$ $s = 0.1806\ldots$	M1	1.1b	
	Hence $x = 18$ cm	A1	3.2a	
		(4)		
				(8 marks)

Notes

4b

Could also use impulse–momentum principle with answer from part **a**. $0.4704 = 0.25v - (0.25 \times 0)$