AQA
Realising potential

AS and A-level
FURTHER MATHS
Momentum and collisions
Mark scheme

Specification content coverage: MB1, MB2, MB3

Question	Solutions	Mark
1	1.0 m s⁻¹	1
	Total	**1**
2	$\mathbf{I} = 0.2(-3\mathbf{i} + 7\mathbf{j}) - 0.2(2\mathbf{i} + 5\mathbf{j})$	1
	$\mathbf{I} = -\mathbf{i} + 0.4\mathbf{j}$ Ns	1
	Total	**2**
3	CoM: $6\,m - 3\,m = 1\,m + v_B m$	1 (must have 'm')
	$v_B = 2$ m s⁻¹	1
	NEL: $e = \dfrac{2-1}{6+3}$	1
	$e = \dfrac{1}{9}$	1
	Total	**4**
4	$\dfrac{1}{2}mv^2 = \dfrac{1}{3} \times \dfrac{1}{2}mu^2$	
	$\dfrac{v^2}{u^2} = \dfrac{1}{3}$	1
	$e = \dfrac{v}{u}$ used	
	$e = \dfrac{1}{\sqrt{3}}$	1
	Total	**2**

5 (a)	Collision between *A* and *B*: CoM: $15 + 0 = 3v_A + 2v_B$	1	
	NEL: $\dfrac{v_B - v_A}{5} = 1$	1	
	$v_A = 1, v_B = 6$	1	
	Collision between *B* and *C*: CoM: $12 + 0 = 2v_{B'} + v_C$	1	
	NEL: $\dfrac{v_C - v_{B'}}{6} = 1$		
	$v_{B'} = 2, v_C = 8$	1	
	Speed of *A*, *B* and *C* after collision with *B* and *C* are 1 m s^{-1}, 2 m s^{-1} and 8 m s^{-1}	1	
	Total	**6**	
5 (b)	No, because *C* is moving faster than *B* which is moving faster than *A*, all in the same direction.	1	
	Total	**1**	
6	$\mathbf{F} \times 4 = 5(5\mathbf{i} - 3\mathbf{j}) - 5(2\mathbf{i} - \mathbf{j})$ $\qquad (= 15\mathbf{i} - 10\mathbf{j})$	1	
	$\mathbf{F} = 3.75\mathbf{i} - 2.5\mathbf{j}$	1	
	Magnitude of force = 4.51 N (3sf)	1	
	Direction of force = 33.7º below **i**	1 (−33.7° or equivalent)	
	Total	**4**	
7	$\downarrow v^2 = 0^2 + 2 \times 10 \times 2.5$	1	
	$v = \sqrt{50}$ m s^{-1} (or equivalent)		
	$1500\sqrt{50} = 2000v'$ $\left(v' = \dfrac{3}{4}\sqrt{50}\right)$	1	
	$20\,000 - 50\,000 = 2000a$ ($a = -15$ m s^{-2})	1	
	$0^2 = \dfrac{9}{16} \times 50 + 2 \times (-15) \times s$	1	
	Distance into the ground = 0.9 m (1sf)	1	
	Total	**5**	

8 (a)	$v^2 = 2g \times 1$ Speed when first hits ground $= \sqrt{2g}$		1
	Speed after first hits ground $= e\sqrt{2g}$		1
	Speed when hits ground second time $= e\sqrt{2g}$ Speed after hits ground second time $= e^2\sqrt{2g}$		1
	$0^2 = e^4 \times 2g - 2gh_2$ Height reached after second impact $= e^4\,\mathrm{m}$		1
		Total	**4**
8 (b)	Total distance travelled $= 1 + 2e^2 + 2e^4 + \ldots$		1
	$= 1 + 2e^2\left(1 + e^2 + e^4 + \ldots\right)$		
	$= 1 + 2e^2\left(\dfrac{1}{1-e^2}\right)$ using geometric series		1
	$= \dfrac{1+e^2}{1-e^2}$ **and** justifying geometric series as $e^2 < 1$		1
		Total	**3**

AQA Education (AQA) is a registered charity (number 1073334) and a company limited by guarantee registered in England and Wales (number 3644723). Our registered address is AQA, Devas Street, Manchester M15 6EX.

3 of 3