A Level OCR Physics

Chapter 9 Newton's laws of motion and momentum

Question	Answers	Extra information	Mark	AO spec reference
1(a)	In an elastic collision all the kinetic energy is conserved. The statement suggests that only a small amount of KE is lost / collision is either completely elastic or completely inelastic, it cannot be almost elastic		1 1	3.5.2 AO1
(b)	m = 0.064 kg $p = mv$ = 0.064 × 0.55 = 0.035 kg m s^{-1}		1 1	3.5.1 AO1
(c)	KE = ½ mv^2 = ½ 0.064 × 0.55^2 = 9.68×10^{-3} J = 9.7 mJ (to 2 s.f.)		1	3.3.2 AO1
(d)	conservation of momentum stated or implied 0.035 = mv v = 1.1 m s^{-1}	Allow idea of ratios, halving mass will double velocity for same change in momentum	1 1	3.5.1 AO2
(e)	KE = ½ mv^2 = ½ 0.032 × 1.1^2 = 0.019 J This is greater than the original ke/kinetic energy is not conserved so this is impossible.		1 1	3.3.2 AO2
2(a)	<u>kinetic</u> energy is conserved		1	3.5.2 AO1
(b)	momentum before = mu = 2.0×10^{-26} kg × 500 m s^{-1} OR velocity after collision equal but opposite direction $\Delta mv = mv - (-mu)$ = 2 × 10^{-23} kg m s^{-1}	Allow change in velocity = 1000 ms^{-1} for a mark	1 1 1	3.5.2 AO2
(c)	Distance = 2 × 0.02 = 0.04 m Time = 0.04/500 = 8×10^{-5} s		1	3.1.1 AO2

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(d)	$F = \Delta mv / \Delta t$ $F = 2\times10^{-23} / 8\times10^{-5}$ s = 2.5×10^{-19} N	allow e.c.f. from 2b and 2c	1 1	3.5.1 AO2
(e)	$P = F/A = 2.5\times10^{-19}$ N / $0.02^2 = 6.25\times10^{-16}$ (N m^{-2}) Number of molecules = 101 000 / $6.25\times10^{-16} = 1.62\times10^{20}$		1 1	3.2.4 AO2
3(a)	$W = mg = 75 \times 9.81 = 740$ N (736 N)		1	3.2.1 AO1
(b)	They are different types of force/should be the same type of force. Both forces act on the same body/Newton's third pairs act on different bodies.	Allow: The weight and normal reaction force just happen to be equal because there is no acceleration. Newton's third law pairs are equal under all circumstances.	1 1	3.5.1 AO1
(c)	The person pulls the Earth towards him/her because of gravity.	description and direction needed for mark	1	3.5.1 AO1
(d)	Graph starting at about 740 N Graph shows a dip down to lower value F then back up to 740 N Increase to higher value of F then back down to 740 N	Value not needed but should NOT start from zero Ignore shape of the dips can be curved or triangular	Max 3	3.5.1 AO2 × 1 AO3 × 2
4(a)	Same shape graph Inverted		1 1	3.5.1 AO2
(b)	Area under graph = impulse /change in momentum $(0.6\times10^{-3} \times 0.5 \times 2.2\times10^{3}) + (2.2\times10^{3} \times 0.3\times10^{-3}) + (2.2\times10^{3} \times 0.5 \times 0.6\times10^{-3}) = 1.98$ kg m s^{-1}		1 1	3.5.1 AO2
(c)	Impulse = change in momentum 1.98 s = $0.14 \times v$		1	3.5.1 AO2

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	v = 14 m s^{-1}			
(d)	velocity would be lower any one from: • change in momentum same but ball had momentum in opposite direction so final momentum less • same impulse equals $mv - (-mu) = (mv + mu)$ so v has to be less		1 1	3.5.1 3.5.2 AO3
5(a)	(Net/resultant) force is proportional to rate of change of momentum	NOT $F = ma$	1	3.5.1 AO1
(b)	$W = mg$ = 98 × 9.81 = 960 N		1	3.2.1 AO1
(c)	Mass flowing in = mass flowing out or using $\rho = m/V$, $\rho V = m$ $\rho Av = m$ when water moving at velocity v $\rho A_H v_H = \rho A_N v_N$ ρ cancels		1 1	3.2.4 AO3
(d)	$\Delta v = v_N - (-v_H) = v_N + v_H$ $A_H v_H = A_N v_N$ $v_H = A_N v_N / A_H$ $\Delta v = v_N + A_N v_N / A_H$	Plus sign must be explained – not magically changed.	1 1	3.5.1 AO2
(e)	F = 960 N $F = \rho v_N^2 A_N (1 + A_N / A_H)$ $v_N^2 = 960 / (\rho A_N (1 + A_N / A_H))$ v_N = 12 m s^{-1}		1 1 1	3.5.1 AO3
6(a)	Momentum before = mu = 0.160 kg × 9 m s^{-1} OR velocity after collision equal but opposite direction		1	3.5.2 AO1

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	$\Delta mv = mv - (-mu) = 2mu = 2 \times 0.16 \times 9 = 2.9$ kg m s^{-1}		1	
(b)	$F = \Delta mv / \Delta t = 2.9/0.002 = 1440$ N	possible ecf here	1	3.5.2 AO1
(c)	1440 N in the opposite direction Newton's 3rd law stated or described.	direction needed for 1st mark	1 1	3.5.1 AO1
(d)	0 kg m s^{-1}		1	3.5.2 AO2
(e)	$m \times 4 \times \sin 40 = m \times v \times \sin 23$ $v = 4 \times \sin 40 / \sin 23 = 6.6$ m s^{-1}	(if using horizontal and assuming initial velocity is 9 gives 6.4)	1 1	3.5.2 AO2
7(a)	${}^{222}_{88}\mathrm{Ra} + {}^{4}_{2}\alpha$	**1** mark for correct mass numbers **1** mark for correct atomic numbers	1 1	6.4.3 AO1
(b)	0 / zero		1	3.5.2 AO1
(c)	Alpha particle is moving faster because its mass is smaller/radium slowest because it has largest mass They have to have same magnitude of momentum, since momentum before was zero Have to move in opposite directions		1 1 1	3.5.2 6.4.3 AO3
(d)	1 alpha decay 2 beta minus decays	Order does not matter	1 1	6.4.3 AO2
8(a)	$p = mv = 1500 \times 22 = 33\ 000$ kg m s^{-1} in the *x* direction		1 1	3.5.1 AO1
(b)	Right-angled triangle drawn with arrows in correct direction Labelled 33 000 kg m s^{-1} and 5000 (5 × 1000) kg m s^{-1}		1 1	3.5.1 AO2

Question	Answers	Extra information	Mark	AO spec reference
(c)	Final momentum p: $p^2 = 33\ 000^2 + 5000^2$ $p = 33\ 377$ $v = p\ /\ m = 33\ 377/2500 = 13$ m s^{-1} tan θ = 33 000/5000 = 81°	allow 9° if reference given	 1 1 1	3.5.2 AO2
(d)	If car 1 had been stationary there would be no momentum in the x direction before the collision. This means there could be no momentum in the x direction after collision. This is not likely to be true.	Marks for explanation not conclusion. Allow other reasonable explanations in terms of conservation of momentum.	1 1 1	3.5.2 AO3