A Level AQA Physics

7 Force, energy, and momentum 2– answers

Question	Answers	Extra information	Mark	AO	Spec reference
01.1	$v = 30\,\text{km hr}^{-1} = \frac{130 \times 1000\,\text{m}}{60 \times 60} = 36\ (36.1)\,\text{m s}^{-1}$ Use of $v = u + at$ and $u = 0$ $a = \frac{v-u}{t} = \frac{36}{1.9} = 19\,\text{m s}^{-2}$		1 1	2	3.4.1.3
01.2	$s = ut + \frac{1}{2}at^2$ or $v^2 = u^2 + 2as$ $s = \frac{1}{2} \times 19 \times 1.9^2 = 34\,\text{m}$	Allow e.c.f. here for answer to part 01.1.	1 1	2	3.4.1.3
01.3	E_K at the top = E_K at bottom – E_p $\frac{1}{2}mv_2{}^2 = \frac{1}{2}mv_1{}^2 - mgh$ $v_2{}^2 = v_1{}^2 - 2gh = 36^2 - (2 \times 9.81 \times 62.5)$ $v_2 = 8.4\,\text{m s}^{-1}$	Must use change in energy not equations of motion	1 1 1	2	3.4.1.7
01.4	Any three from: • the magnetic flux linkage with the copper fins • causes e.m.f. to be induced in the copper – Faraday's law • this causes a magnetic field which opposes the change – Lenz's law • which slows down the car Safety: • this would work even in a power cut • cannot stop car completely as relies on movement	For full marks answer must include relevant comment about safety	max 4	3	3.7.5.4
02.1	Kinetic energy is conserved		1	1	3.4.1.6
02.2	Momentum before $= mu = 2.0 \times 10^{-26}\,\text{kg} \times 500\,\text{m s}^{-1}$ OR Velocity after collision equal but opposite direction $\Delta mv = mv - (-mu) = 2 \times 10^{-23}$ kg m s^{-1}	allow N s	1 1 1	2	3.4.1.6 3.4.1.1

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02.3	Distance = 2 × 0.02 = 0.04 m Time = $\frac{0.04}{500} = 8\times10^{-5}$ s		1	1	
02.4	$F = \frac{\Delta mv}{\Delta t}$ $F = \frac{2\times10^{-23}}{8\times10^{-5}}$ s = 2.5×10^{-19} N	Allow e.c.f. from 02.2 and 02.3	1 1	2	3.6.2.3
02.5	$P = \frac{F}{A} = \frac{2.5\times10^{-19}\text{ N}}{0.02^2} = 6.25\times10^{-16}$ (N m^{-2}) Number of molecules = $\frac{101\,000}{6.25\times10^{-16}} = 6.6\times10^{20}$		1 1	2	3.6.2.3
03.1	GWh is a unit of energy/power × time = 11×10^{9} W × 60 × 60 = 3.96×10^{13} J	2 marks for calculation in joules	1 1	1	3.1.1
03.2	$\rho = \frac{m}{V}$ $m = \rho V$ Mass per second = 390 000 kg s^{-1} $P = \frac{\Delta W}{\Delta t} = \frac{mgh}{\Delta t}$ = 9.81 × 390 000 × 500 = 1.9×10^{9} W		1 1 1	2	3.4.1.7 3.4.2.1
03.3	Capacity = 3.96×10^{13} J Time = $\frac{3.96\times10^{13}\text{ J}}{1.9\times10^{9}\text{ W}}$ = 20 842 s = 5 hours 50 mins OR 350 mins		1 1	2	
03.4	Efficiency = $\frac{\text{useful power output}}{\text{input power}}$ Efficiency = $\frac{1.7\times10^{9}}{1.9\times10^{9}}$ = 0.89 or 89%		1	2	3.4.1.7
03.5	The generators work less efficiently as pumps/example of named transfer of energy		1	3	3.4.1.8

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04.1	Same shape graph Inverted		1 1	2	3.4.5.1
04.2	Area under graph = change in momentum $(0.6\times10^{-3} \times 0.5 \times 2.2\times10^{3}) + (2.2\times10^{3} \times 0.3\times10^{-3})$ $+ (2.2\times10^{3} \times 0.5 \times 0.6\times10^{-3}) = 1.98\,\text{N s}$	OR trapezium method $A = \frac{h(a+b)}{2}$ $= \frac{2.2\times10^{-3} \times (1.5+0.3)\times10^{-3}}{2}$	1 1	2	3.4.1.6
04.3	Impulse = change in momentum $1.98 = 0.14 \times v$ $v = 14\,\text{m s}^{-1}$		1 1	2	3.4.1.6
04.4	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	3.4.1.6
05.1	Accept any reliable method for measuring acceleration: • including use of $v^2 = 2as$ – light gate and timing card to measure velocity and ruler to measure s/combinations of two light gates/one light gate, etc. • increasing falling mass connected to trolley • labelled diagram For accuracy: • mention of friction compensated slope • falling masses taken from on top of trolley so that mass of system says constant • repeats to identify anomalies	For full marks must have at least one accuracy point	max 4	1	PS 4.1

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OXFORD Revise

Question	Answers	Extra information	Mark	AO	Spec reference
05.2	If force ∝ acceleration, then since $F = W = mg$, falling mass ∝ acceleration $\frac{\text{falling mass}}{\text{acceleration}} = \text{constant}$ $\frac{100}{0.69} = 145$ $\frac{200}{1.38} = 145$ $\frac{300}{2.07} = 145$	1 mark for explanation 1 mark for at least two tests to see if constant	1 1	2	3.4.1.5
05.3	$F = \frac{\Delta mv}{\Delta t}$ If m constant $F = \frac{m\Delta v}{\Delta t}$ or $a = \frac{\Delta v}{\Delta t}$ $F = ma$	1 mark for factorising out m with explanation that m is constant 1 mark for explanation/recall of $a = \frac{\Delta v}{\Delta t}$	1 1	2	3.4.1.6
05.4	The crumple zone/seatbelts/airbags increase the time over which the momentum changes (Δt)/increase impact time This decreases the impact force		1 1	3	3.4.1.6
06.1	No it does not obey Hooke's law Hooke's law states that force is proportional to extension Would expect to see a straight line through the origin (wtte)		1 1 1	1	3.4.2.1
06.2	Work done is area under graph Counting squares = 69 squares ±3 or 1 square $= 0.2\text{ N} \times 0.02\text{ m} = 4\times10^{-3}\text{ J}$ Work done = 0.28 (0.276) J	Allow 0.26 J to 0.29 J	1 1 1	2	3.4.2.1

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OXFORD Revise

Question	Answers	Extra information	Mark	AO	Spec reference
06.3	Work done stretching the spring = kinetic energy of pellet $E_K = \frac{1}{2}mv^2$ $0.28\text{ J} = \frac{1}{2} \times 0.01\text{ kg} \times v^2$ $v = 7.4\text{ m s}^{-1}$	Range of velocity is 7.6 to 7.2	1 1	2	3.4.1.8
06.4	The unloading curve would be lower/less force required for each extension/hysteresis energy has been transferred to the internal energy of the elastic as it was stretched		1 1	3	3.4.2.1
07.1	$^{222}_{88}\text{Ra} + {}^{4}_{2}\alpha$	1 mark for correct mass numbers 1 mark for correct atomic numbers	1 1	1	3.2.1.2
07.2	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 zero Have to move in opposite directions		1 1 1	2	3.4.1.6
07.3	Alpha decay followed by two beta decays		1 1	2	3.2.1.2
08.1	$P = Fv = 10 \times 5 = 50$ J each second		1	2	3.4.1.7
08.2	$P = Fv$ $F = \frac{250}{5} = 50\text{ N}$		1	2	3.4.1.7
08.3	Bike will accelerate – work done per second by cyclist greater than work done against resistance forces OR Frictional force of the road pushing the bike forward is greater than the resistance forces pushing the bike back		1	2	3.4.1.7

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OXFORD Revise

Question	Answers	Extra information	Mark	AO	Spec reference
08.4	Weight arrow acting vertically down Normal reaction arrow perpendicular to slope Drag/resistance arrow parallel to slope Frictional force between bike wheel and road acting forwards	All four arrows labelled The arrows must be on the object, not near it	1 1 1 1	2	3.4.1.5
08.5	Attempt to find resultant of forces parallel to the slope: $(95 \times 9.81)\sin\theta$ or $F = \frac{250}{5} = 50\text{ N}$ or drag = 10 N Equating forces parallel to slope because moving at a constant speed: $(95 \times 9.81)\sin\theta + 10 = 50\text{ N}$ $\sin\theta = \frac{40}{95 \times 9.81}$ $\theta = 2.5°$		1 1 1 1	2	3.4.1.1

Skills box answers

Question	Answer
1	Impulse is area under graph. Split the graph into three shapes (2 triangles and a rectangle) and work out the area of these individually. Area = $(\frac{1}{2} \times 0.6\times10^{-3}\text{ s} \times 2.2\times10^{3}\text{ N}) + (0.3\times10^{-3}\text{ s} \times 2.2\times10^{3}\text{ N}) + (\frac{1}{2} \times 0.6\times10^{-3}\text{ s} \times 2.2\times10^{3}\text{ N})$ = 0.66 N s + 0.66 N s + 0.66 N s = 1.98 N s Therefore, impulse = 1.98 N s
2	force × time = change in momentum. $\Delta(mv) = 420\text{ N} \times 0.01\text{ s} = 4.2\text{ N s}$
3	The change in momentum in both cases will be the same. However, if you move your hands back as you catch the ball, you increase the time that the change in momentum occurs over and so decrease the force required to stop the ball. This means that the ball does not hit your hands as hard as it would do if you just caught it without moving your hands.