Question	Answers	Extra information	Mark	AO / Specification reference
01.1	chemical store (associated with/of) the food/in her muscles		1 1	AO2 4.1.1.1
01.2	$\text{elastic strain energy} = \frac{1}{2}ke^2$ $= 0.5 \times 20 \times (0.2)^2$ = 0.4 (J)		1 1	AO2 4.1.1.2
02.1	created or destroyed		1	AO1 4.1.2.1
02.2	there is no net changed to the total energy		1	AO1 4.1.2.1
02.3	is not		1	AO1 4.1.2.1
02.4	energy is transferred out of the system because it no longer has kinetic/potential energy/mechanical energy	accept energy is wasted/dissipated accept change to either kinetic or potential energy	1 1	AO2 4.1.2.1
03.1	the height of the ball when she drops it the mass of the ball the rebound height of the ball after it first bounces measure heights with a ruler/video analysis measure mass of ball with a digital balance		1 1 1 1 1	AO1 4.1.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
03.2	the ball is moving quickly, so the height of the bounce is difficult to measure accurately/precisely use a video camera to video the experiment		1 1	AO2 4.1.1.2
03.3	plan: • use gravitational potential energy = mgh to calculate the initial gravitational potential energy • use initial height, mass and g • use the same equation to calculate the final gravitational potential energy • use height after first bounce, mass and g • subtract the final gravitational potential energy from the initial gravitational potential energy to find the energy		1 1 1 1 1	
03.4	yes because there is energy wasted/dissipated/transferred to the surroundings **or** no because the ball is not doing anything useful in terms of energy	justification must match answer to be awarded the marks	1 1	AO3 4.1.2.1
04.1	kinetic energy = 0.5 × mass × $(\text{speed})^2$	allow $E_k = \frac{1}{2}mv^2$	1	AO1 4.1.1.2
04.2	kinetic energy = 0.5 × 40 × $(10)^2$ = 2000 J		1 1	AO2 4.1.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
04.3	elastic potential energy = 0.5 × spring constant × extension^2 2000 = 0.5 × 20 000 × e^2 $e^2 = \frac{2000}{0.5 \times 2000}$ e^2 = 0.2 e = 0.45 m		1 1 1	AO2 4.1.1.2
04.4	actual compression is less because some energy from the kinetic energy store is transferred by sound/to the thermal energy store of the surroundings		1 1 1	AO3 4.1.1.1
05.1	energy in the elastic potential energy store is transferred to the kinetic energy store energy is transferred due to work done by forces		1 1 1	AO1 AO2 4.1.1.1 4.1.1.2
05.2	elastic potential energy = $\frac{1}{2}$ × spring constant × extension^2 = 0.5 × 10^5 × $(0.05)^2$ = 125 J		1 1	AO2 4.1.1.2
05.3	video analysis	accept any sensible suggestion	1	AO2
05.4	less energy is stored than predicted because the extension is less than 5 cm **or** the spring constant is less than 10^5 N/kg		1	AO2 AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
05.5	the thermal energy of the surroundings		1	AO1 4.1.1.1
06.1	the streamlined shape reduces the energy transferred to the surroundings/dissipated		1	AO2 4.1.2.1
06.2	kinetic energy = 0.5 × mass × $(\text{speed})^2$	accept $E_k = \frac{1}{2}mv^2$	1	AO1
06.3	kinetic energy = 0.5 × 700 000 × $(90)^2$ = 2 835 000 000 = 2 835 000 kJ = 28 400 00 kJ to three significant figures			AO2 4.1.1.2
06.4	2 840 000 kJ	accept 2 835 000 000 (J)	1	AO2 4.1.2.1
07.1	energy is transferred from the gravitational potential energy store to the kinetic energy store		1 1	AO1 AO2 4.1.1.1
07.2	work done by (gravitational) forces		1	AO2 4.1.1.1

Question	Answers	Extra information	Mark	AO / Specification reference
07.3	the gravitational potential energy depends on mass, gravitational field strength and height the mass and height are the same if the gravitational field strength is less then there is less energy in the gravitational potential energy store so less energy is transferred to the kinetic store so the hammer ends up going slower on the Moon than the Earth	accept g on Earth is bigger, so gravitational potential energy is bigger, so kinetic energy is bigger, so speed is bigger	1 1 1 1 1	AO3 4.1.1.1 4.1.1.2
08.1	gravitational potential energy = mass × gravitational field strength × height		1	AO1
08.2	height = 4 floors = 4 x 3 = 12 m *gpe = mgh* = 1220 × 9.8 × 12 = 143 472 J = 145 000 J		1 1	AO2 4.1.1.2
08.3	$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$		1	AO1 4.1.2.2
08.4	280 kJ = 280 000 J $\text{efficiency} = 143\,472 \times \frac{100}{280000}$ = 51(.2)(%)	accept 51(%) with no working for three marks	1 1 1	AO1 AO2 4.1.2.2

Question	Answers	Extra information	Mark	AO / Specification reference
08.5	measure the mass of an object in the lift/and the lift measure the number of floors it moves up in a certain measured time. **either:** calculate the gravitational potential energy as before calculate the energy transferred using power × time calculate efficiency using $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$ **or** calculate the gravitational potential energy as before calculate the useful power using $\text{power} = \frac{\text{energy}}{\text{time}}$ calculate efficiency using $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$		1 1 1 1 1 1	AO2 4.1.2.2
08.6	**one** from: • difficult to measure time exactly • floors may be different heights • difficult to measure distance travelled early	accept any sensible suggestion	1	AO3
09.1	$\text{power} = \frac{\text{energy transferred}}{\text{time}}$		1	AO1 4.1.1.4

Question	Answers	Extra information	Mark	AO / Specification reference
09.2	$15\,000 = \frac{30000}{\text{time}}$ $\text{time} = \frac{30000}{15000}$ = 2 (seconds)		1 1 1	AO2 4.1.1.4
09.3	the second truck is less powerful than the first truck		1	AO2 4.1.1.4
09.4	gravitational potential energy store		1	AO1 4.1.1.1
10.1	energy is transferred from the gravitational potential energy store to the kinetic energy store		1 1	AO1 AO2 4.1.1.1 4.1.1.2
10.2	light gate		1	AO1 4.5.6.1.1
10.3	time = 820×10^{-3} s speed = 1.3 m/s distance = speed × time = 1.3 × 0.82 = 1.07m assuming the speed of the ball is constant. no, it will not hit the target	convert to s	1 1 1 1 1	AO1 AO2 AO3 4.5.6.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
10.4	raise the height of the ramp to increase the energy in the gravitational potential energy store and kinetic store so the ball is moving faster at B and travels further in the same time		1 1 1 1	AO3 4.1.1.1 4.1.1.2 4.5.6.1.2
11.1	energy that is no longer useful/stored in less useful ways		1	AO1 4.1.2.1
11.2	$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$		1	AO1
11.3	efficiency = $\frac{12}{20}$ = 0.6	accept 0.6 with no working for two marks 60% scores one mark	1 1	AO2 4.1.2.2
11.4	car B it has a lower efficiency, so wastes more energy		1 1	AO3 4.1.2.2
12.1	the trolley is moving too fast light gates/motion sensor		1 1	AO1
12.2	gpe = mgh	Also accept: gpe = mass × gravitational field strength × height	1	AO1
12.3	gpe = 0.25 × 9.8 × 0.12 = 0.298 J		1 1	AO2 4.1.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
12.4	no, the student is incorrect because the energy has been dissipated/wasted as the trolley moves down the ramp and transferred to a thermal energy store	no mark without correct reason	1 1	AO2 4.1.2.1
13.1	the barrier does not behave like a spring/does not behave elastically		1	AO3 4.1.1.2
13.2	car B: kinetic energy before = 0.5 × 1000 × 50^2 = 1 250 000 J kinetic energy after = 0.5 × 1000 × 25^2 = 312 500 J energy transferred = 1 250 000 - 312 500 = 937 500 = 9.4×10^5 J to two significant figures		1 1 1 1 1 1	AO2 4.1.1.2
13.3	car B transfers less energy to the surroundings because it rebounds/does not stop		1 1	AO3
13.4	the kinetic energy depends on speed squared so if the speed is reduced to 50%, the kinetic energy will be reduced to 25%		1 1	AO3 4.1.1.2
14.1	petrol/chemical energy (store)		1	AO2 4.1.1.1
14.2	kinetic energy store		1	AO2 4.1.1.1

Question	Answers	Extra information	Mark	AO / Specification reference
14.3	work done by force of friction/drag		1 1	AO2 4.1.1.1
14.4	motorcycle: the efficiency decreases with speed at a decreasing rate car: the efficiency decreases with speed at a constant rate		1 1 1 1	AO2
14.5	evidence of tangent drawn to the curve at 30 mph correct changes in efficiency/speed the tangent should be drawn as a straight line between 60 on the y-axis and 60 on the x-axis, which touches the motorcycle curve at 30 mph. rate = 60 % per 60 mph		1 1 1	AO3