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	E = ½ x k x e^2 = 0.5 × 20 × $(0.2)^2$ = 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 change 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 energy/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 the first bounce measure heights with a ruler/video analysis measure mass with a digital balance	accept energy is wasted/dissipated accept change to either kinetic or potential energy	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 precisely/accurately use a video camera to video the experiment		1 1	AO2 4.1.1.2
03.3	<u>plan:</u> • 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 transferred to the floor/surroundings		1 1 1 1 1	AO1 4.1.1.2
03.4	**either** yes because the energy 'wasted'/dissipated/transferred to the surroundings **or** no because the ball is not doing anything useful in terms of energy	justification must match the answer	1 1	AO3 4.1.2.1
04.1	$E_K = 0.5 \times \text{mass} \times (\text{speed})^2$	accept $E_k = 0.5mv^2$	1	AO1 4.1.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
04.2	$E_K = 0.5 \times 40 \times (10)^2$ = 2000 J		1 1	AO2 4.1.1.2
04.3	elastic potential energy = 0.5 × spring constant × extension^2 $2000 = 0.5 \times 20\,000 \times e^2$ $e^2 = \frac{2000}{0.5 \times 20000}$ $e^2 = 0.2$ e = 0.45m		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 = 0.5 × spring constant × extension^2 $= 0.5 \times 10^5 \times (0.05)^2$ = 125 J		1 1	AO2 4.1.1.2
05.3	video analysis	accept any sensible suggestion	1	AO2

Question	Answers	Extra information	Mark	AO / Specification reference
05.4	less energy is stored than predicted because the extension is less than 5 cm/the spring constant is less than 10^5 N/kg		1	AO2 AO3 4.1.1.2
05.5	the thermal energy store 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	E_K = 0.5 × mass × $(\text{speed})^2$	accept $E_k = 0.5mv^2$	1	AO1
06.3	$E_K = 0.5 \times 700\,000 \times (90)^2$ = 2 835 000 000 J = 2 835 000 kJ = 2 840 000 kJ		1 1 1 1	AO2 4.1.1.2
06.4	2 840 000 kJ	accept 2 835 000 000 (J)	1	AO2
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	accept gpe = mgh	1	AO1
08.2	height = 4 floors = 4 × 3 = 12 m gpe = mgh = 1220 × 9.8 × 12 = 143 472 = 145 000 (J)		1 1	AO2 4.1.1.2
08.3	efficiency = $\frac{\text{usefuloutputenergytransfer}}{\text{totalinputenergytransfer}}$		1	AO1 4.1.2.2
08.4	280 kJ = 280 000 J efficiency = $\frac{143472}{280000} \times 100$ = 51(.2)(%)	accept 51% with no working shown 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 energy = 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 $\text{efficiency} = \frac{\text{useful power output}}{\text{total input power}}$		1 1 1 1 1 1	AO2 4.1.2.2
08.6	sensible suggestion such as: • difficult to measure time exactly • floors may be different heights • difficult to measure distance travelled exactly		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	$15000 = \frac{30000}{\text{time}}$ $\text{time} = \frac{30000}{15000}$ = 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 = 1.07 (m) 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	efficiency = $\frac{\text{usefuloutputenergytransfer}}{\text{totalinputenergytransfer}}$		1	AO1
11.3	efficiency = $\frac{12}{20}$ = 0.6	accept 0.6 with no working for two marks accept 60% for one mark	1 1	AO2 4.1.2.2
11.4	car B has a lower efficiency, so wastes more energy		1 1	AO3 4.1.2.2
12.1	the trolley is moving too fast light gate/motion sensor		1 1	AO1
12.2	gravitational potential energy = mass × gravitational field strength × height	accept gpe = mgh	1	AO1
12.3	gravitational potential energy = 0.25 × 9.8 × 0.12 = 0.294 (J)		1 1	AO2 4.1.1.2

Question	Answers	Extra information	Mark	AO / Specification reference
12.4	no, the student is incorrect because 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	use loft insulation		1	AO1 4.1.2.1
13.2	the thicker the layer of bricks, the slower the energy is transferred/the rate of energy transfer is less/less energy is transferred per second		1	AO1 AO2 4.1.2.1