Energy Transfers

Questions

Q1.

A cyclist has a mass of 64 kg.

(i) The cyclist rides from a flat road to the top of a hill.

The top of the hill is 24 m above the flat road.
Calculate the gain in gravitational potential energy, ΔGPE, of the cyclist.
Use g = 10 N/kg
Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

(2)

gain in gravitational potential energy = ... J

(ii) The cyclist returns to the flat road.

The mass of the cyclist is 64 kg.
Calculate the kinetic energy of the cyclist when the cyclist is travelling at 6.0 m/s.
Use the equation

$$KE = \tfrac{1}{2} \times m \times v^2$$

(3)

kinetic energy = ... J

(iii) The cyclist then uses the brakes on the bicycle to stop.

Explain what happens to the kinetic energy of the cyclist.

(2)

....

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....

(Total for question = 7 marks)

Q2.

A model train has a mass of 8.0 kg.
It travels at a speed of 1.5 m/s.

Calculate the kinetic energy of the model train.

Use the equation

$$\text{kinetic energy} = \tfrac{1}{2} \times \text{mass} \times (\text{speed})^2$$

(3)

kinetic energy = ... J

(Total for question = 3 marks)

Q3.

(i) Which of these would be a typical speed for a racing cyclist travelling down a steep straight slope?

(1)

☐ **A** 0.2 m/s

☐ **B** 2 m/s

☐ **C** 20 m/s

☐ **D** 200 m/s

(ii) A cyclist travels down a slope.
The top of the slope is 20 m vertically above the bottom of the slope.
The cyclist has a mass of 75 kg.

Calculate the change in gravitational potential energy of the cyclist between the top and the bottom of the slope.

The gravitational field strength, g, is 10 N/kg.

(3)

change in gravitational potential energy = ... J

(Total for question = 4 marks)

Q4.

Figure 7 shows a skier going down a hill.

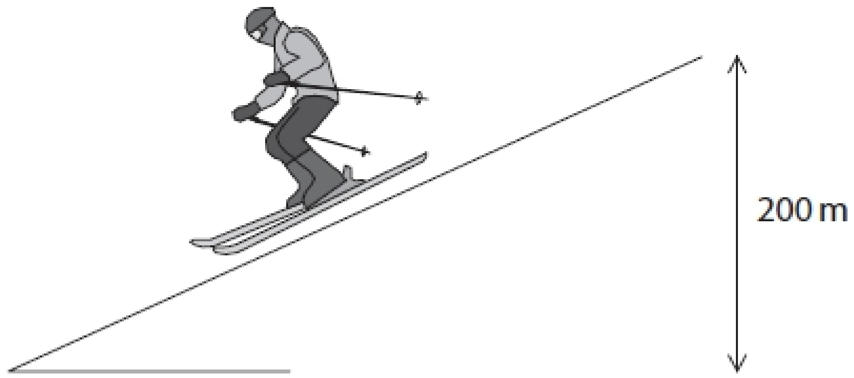

Figure 7

She descends through a vertical height of 200 m.

The skier's mass is 65 kg.

(i) Calculate the change in gravitational potential energy.

Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

Take the gravitational field strength, *g*, as 10 N / kg.

(2)

change in gravitational potential energy = ... J

(ii) At the bottom of the slope her speed was 36 m/s.

Calculate her kinetic energy at the bottom of the slope.
Use the equation

$$KE = \frac{1}{2} \times m \times v^2$$

(3)

kinetic energy = ... J

(Total for question = 5 marks)

Q5.

Electricity can be generated using a water turbine.

(i) Water gains kinetic energy by falling from the top of a dam.

Calculate the minimum height that 7.0 kg of water must fall to gain 1300 J of kinetic energy.

(3)

minimum height = ... m

(ii) As water enters the turbine at the bottom of the dam, the kinetic energy of 8.0 kg of moving water is 1100 J.

Calculate the speed of the moving water as it enters the turbine.

(3)

speed = ... m/s

(Total for question = 6 marks)

Q6.

Moving air can be used to generate electricity using a wind turbine.

Figure 8 is a graph of kinetic energy against wind speed for a mass of moving air.

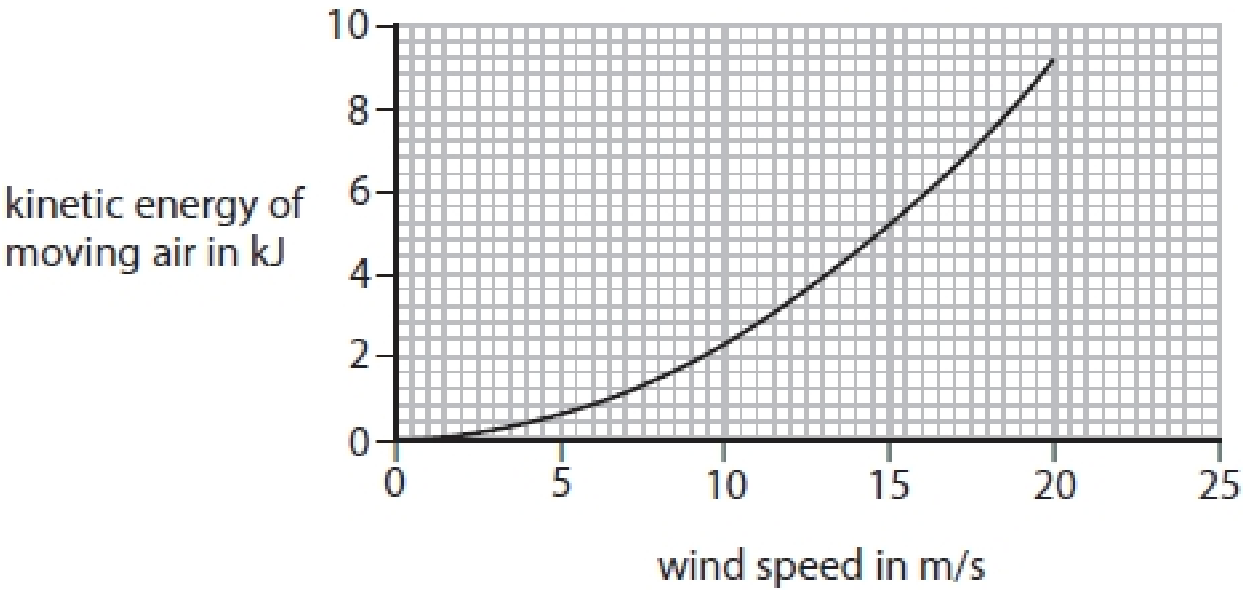

Figure 8

Just before the air reaches a wind turbine it has a wind speed of 15 m/s.

When the air has gone through the turbine it has a wind speed of 13 m/s.

As the air moves through the turbine some of its kinetic energy is transferred to the turbine.

Use the graph to determine the percentage of the kinetic energy transferred to the turbine from the air.

(3)

percentage of kinetic energy transferred from the air = ... %

(Total for question = 3 marks)

Q7.

Figure 5 shows a way of projecting a small trolley up a sloping track.

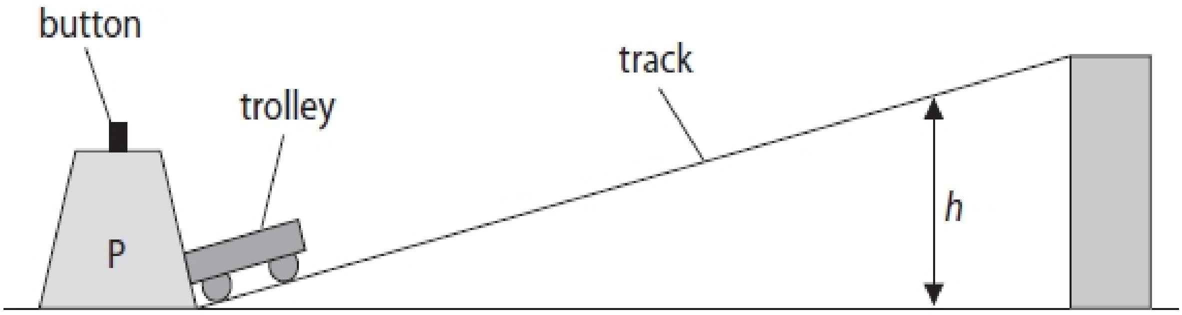

Figure 5

When the button is pressed, a spring is released in P that projects the trolley up the track.

The trolley travels up the track, stops and then rolls back down.

The spring in P always exerts the same force when projecting the trolley.

A student investigates how the mass of the trolley affects the maximum vertical height, *h*, reached by the trolley.

State the measurements the student should make to complete the investigation.

You should make use of the equipment shown in Figure 5 and any other equipment that is needed.

(4)

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(Total for question = 4 marks)

Q8.

A student lifts a toy car from a bench and places the toy car at the top of a slope as shown in Figure 16.

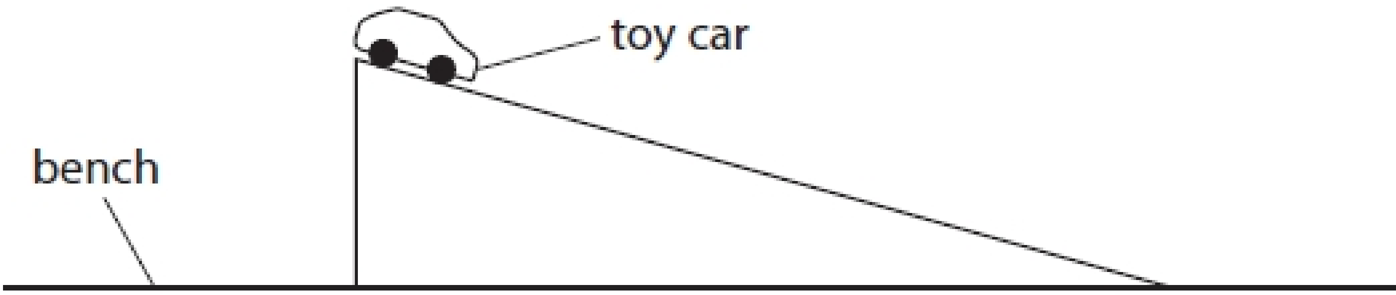

Figure 16

The student needs to develop the experiment to determine the loss in potential energy and the gain in kinetic energy as the toy car is rolling down the slope.

State the other measurements the student must make.

(2)

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(Total for question = 2 marks)

Q9.

Figure 6 is a graph of the student's results.

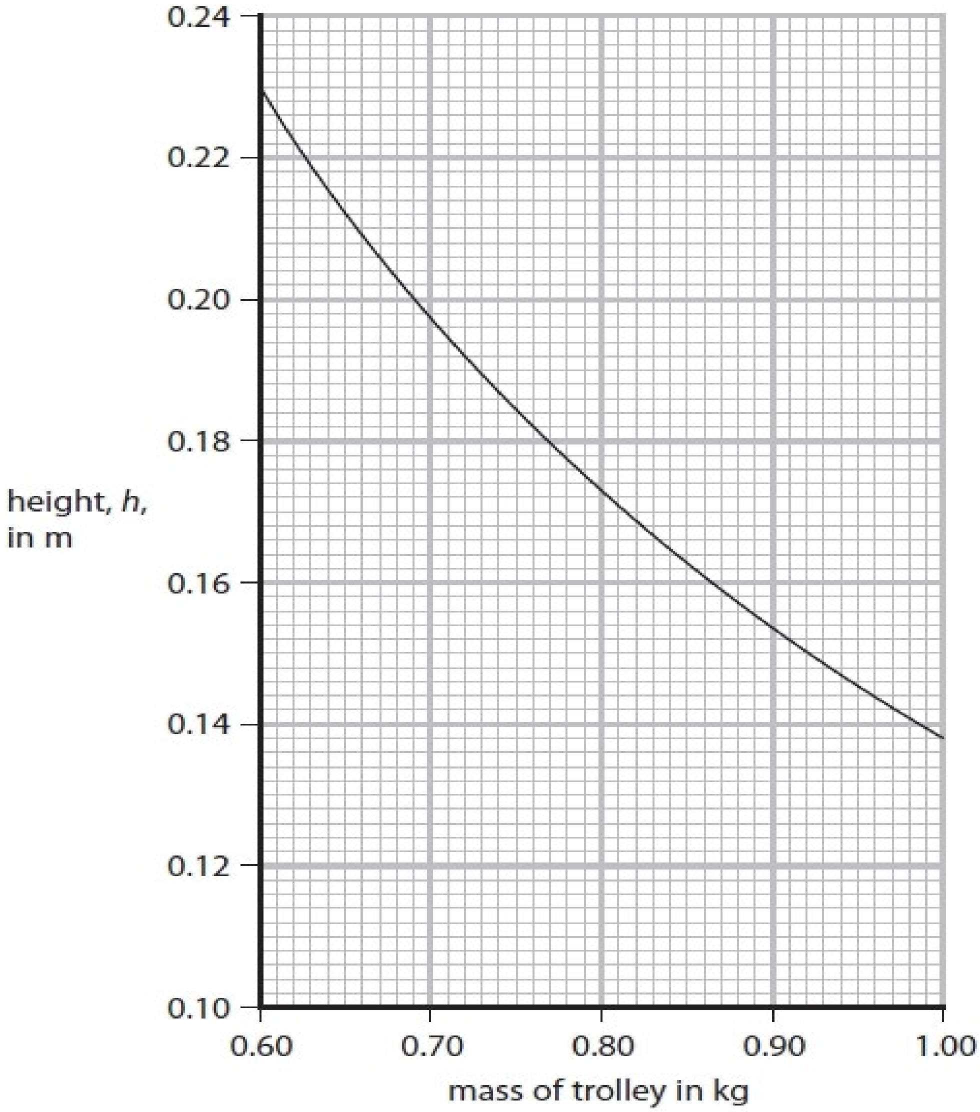

Figure 6

The student states that the energy transferred by the spring is the same each time it is used.

Use data from any two points on the graph in Figure 6 to support this statement.

(3)

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....

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(Total for question = 3 marks)

Q10.

Figure 11 shows a wind turbine.

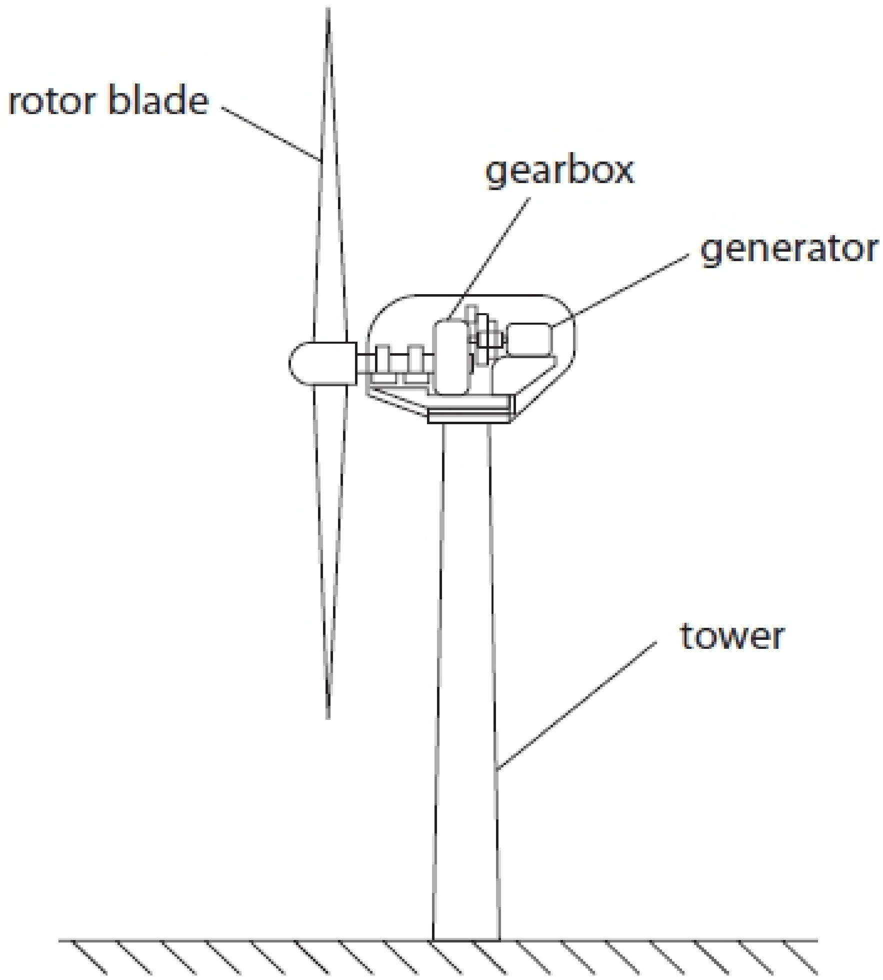

Figure 11

Explain how unwanted energy transfers could be reduced in the gear box.

(2)

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(Total for question = 2 marks)

Q11.

A student lifts a toy car from a bench and places the toy car at the top of a slope as shown in Figure 16.

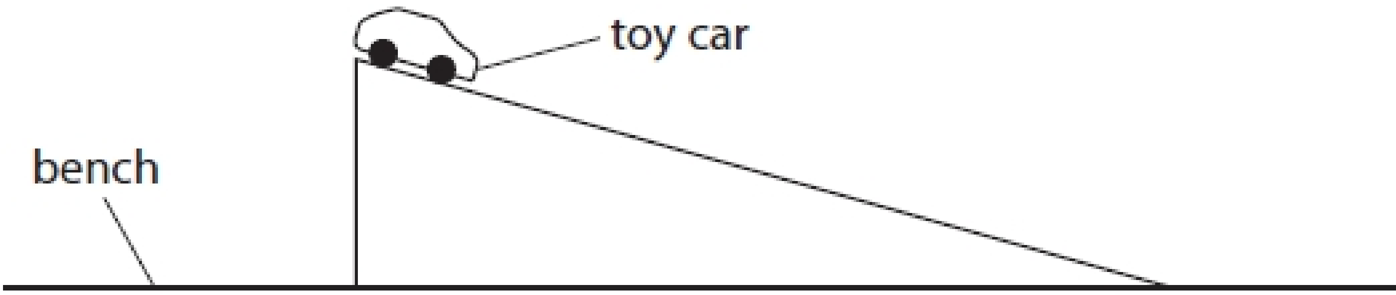

Figure 16

Describe an energy transfer that occurs when the student lifts the toy car from the bench and places the toy car at the top of the slope.

(2)

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....

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....

(Total for question = 2 marks)

Q12.

Figure 6 shows a spinning flywheel.

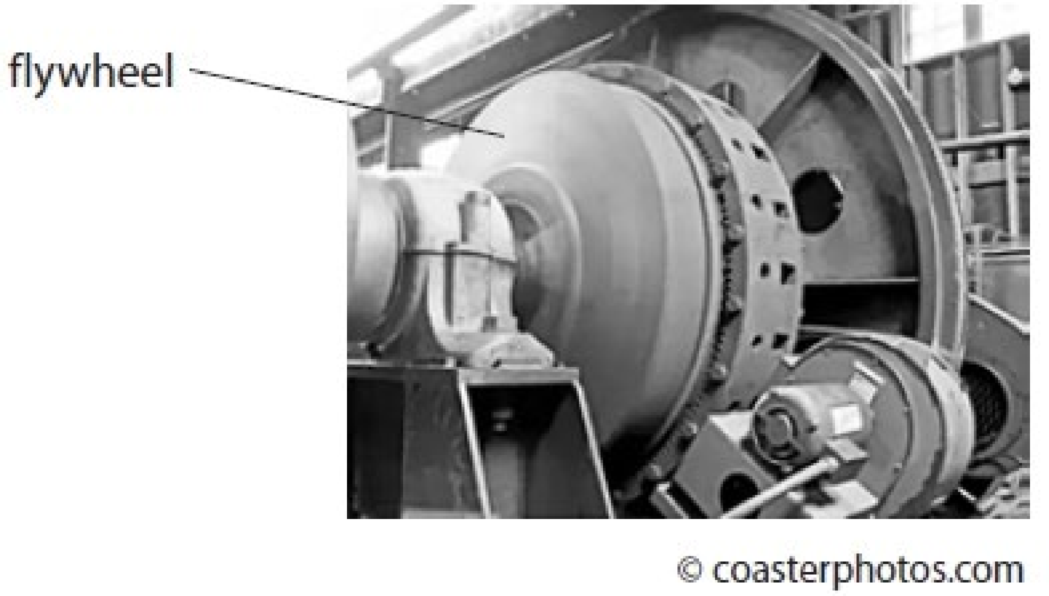

Figure 6

(i) State how energy is stored in a spinning flywheel.

(1)

....

(ii) State **one** way to increase the amount of energy stored in the flywheel.

(1)

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(Total for question = 2 marks)

Q13.

Before a car brakes it has kinetic energy.
The kinetic energy decreases as it brakes.

State what happens to the kinetic energy during braking.

(1)

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....

(Total for question = 1 mark)

Mark Scheme – Energy Transfers

Q1.

Question number	Answer	Additional guidance	Mark
(i)	substitution (1) (ΔGPE =) 64 x 10 x 24 evaluation (1) 15 000 (J)	accept 15 360(J) or 15 400(J) award full marks for correct answer without working.	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
(ii)	substitution (1) (KE=) ½ x 64 x $6^{(2)}$ calculation of 6^2 (1) evaluation (1) 1200 (J)	accept 1152(J) award full marks for correct answer without working. 192 (J) scores 2 marks	**(3)** **AO2**

Question number	Answer	Additional guidance	Mark
(iii)	an explanation linking any **two** from: the kinetic energy (store)/it decreases (to zero) (1) (the energy) has dissipated (1) to the surroundings (1) thermal energy (store) increases (1)	 transferred to ground/brake(s) pads make the brakes hot	**(2)** **AO2**

Q2.

Question Number	Answer	Additional guidance	Mark
	substitution (1) ½ x 8 x 1.5(^{2}) calculation of v^2 (1) 2.25 evaluation (1) 9(.0) (J)	9000 (J) scores 2 marks 6(.0)(J) scores 2 marks 6000 (J) scores 1 mark award full marks for the correct answer without working	**(3)**

Q3.

Question Number	Answer	Mark
(i)	The only correct answer is **C 20 m/s** A is not correct because 0.2 m/s is too slow B is not correct because 2 m/s is too slow D is not correct because 200 m/s is too fast	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	recall (1) (ΔGPE) = m × *g* × Δh substitution (1) (ΔGPE =) 75 x 10 x 20 evaluation (1) 15 000 (J)	NO PoT error NO ecf from wrong equation mgh or m x g x h 75 x 10 x 20 scores the first 2 marks accept 14700 (J) from using g = 9.8 (N/kg) award full marks for the correct answer without working	**(3)**

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	substitution (1) (ΔGPE =) 65 x 10 x 200 evaluation (1) 1.3 x 10^5 / 130 000 (J)	allow substitution mark with 65000 (g) allow 1 mark for answers that round to 1.3 with any other power of ten do not allow 13000 award full marks for the correct answer without working	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	substitution (1) (KE) $\frac{1}{2} \times 65 \times 36(^2)$ squaring (1) 36^2 (=1296) (completing) evaluation (1) 42 120 / 4.2(1) x 10^4 (J)	using 36 → 1170 (J) OR 36x2 → 2340 (J) scores 2 marks (apply power of ten error as well if occurring e.g. 117000 (J) gets 1 mark) award full marks for the correct answer without working allow 2 marks for answers that round to 4.2 with any other power of ten omitting ½ gives 84240(J) scores 2 marks	(3) AO 2 1

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	recall (1) (ΔPE) = mgh substitution and rearrangement (1) $h = \frac{1300}{7 \times 10}$ evaluation (1) 19 (m)	1300 = 7 x 10 x h work done = force x distance accept answers that round up to 19 (m) (e.g. 18.57 (m)) award full marks for the correct answer with no working	(3) AO 1 1 AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	recall (1) KE = ½ m v^2 substitution and rearrangement (1) v =√(2 x 1100÷8) evaluation (1) 17 (m/s)	$v^2 = \frac{2 \times 1100}{8}$ accept answers that round up to 17 (m/s) (e.g. 16.58 (m/s)) award full marks for the correct answer with no working	(3) AO 1 1 AO 2 1

Q6.

Question Number	Answer	Additional guidance	Mark
	reading energies from graph (1) 5.2 and 3.9 (kJ) substitution (1) e.g. $\frac{1.3 \times (100)}{5.2}$ evaluation (1) 25(%)	accept 5.0 to 5.4 and 3.7 to 4.1 0.18 to 0.32 18 to 32 (%) award full marks for the correct answer with no working	(3) AO 2 1

Q7.

Question Number	Answer	Additional guidance	Mark
	An answer that includes: (measure) mass of the trolley (1) (measure) (vertical) height / h (1) repeat for a range of masses (1) plus **any one** from: method of identifying / measuring h (1) OR repeat firing with same mass (1)	weigh the trolley NOT measure height of ramp e.g. use of reference mark accept "use ruler to measure height/h" for 2 marks NOT "use ruler to measure height of ramp"	**(4)**

Q8.

Question number	Answer	Additional guidance	Mark
	(vertical) height of slope (1) mass (of the toy car) (1)	allow (in this context) weight if no other mark scored allow 1 mark for quoting either equation $(\Delta)GPE = mgh$ OR $KE = \frac{1}{2} mv^2$	**(2)**

Q9.

Question Number	Answer	Additional guidance	Mark
	reference to ΔPE = mg(Δ)h (1) relevant values from graph and one calculation to find energy (1) repeated with 2nd set of values (1)	can be seen in calculations e.g. 0.6 x 10 x 0.230 ≈ 1.4 (J) e.g. 1.0 x (10) x 0.138 ≈ 1.4 (J) must see calculations for mp2 and 3 1 mark for 2 calculations of mh with 'g' omitted (MP3)	**(3)**

Q10.

Question Number	Answer	Additional guidance	Mark
	an explanation linking use of lubrication / oil (1) to reduce friction (between parts) (1)		**(2)** AO 2 1

Q11.

Question number	Answer	Additional guidance	Mark
	A description to include: mention relevant energy store such as GPE or chemical (1) 'correct' transfer in context (1)	allow KE or mechanical or thermal or heat chemical to (G)PE or chemical to KE (in lifting) allow misread GPE to KE/thermal on slope Allow KE to GPE in lifting	**(2)**

Q12.

Question Number	Answer	Additional guidance	Mark
(i)	kinetic (1)	**only** (adding another incorrect alternative negates)	**(1)** AO 2 1

Question Number	Answer	Additional guidance	Mark
(ii)	any one of increase the speed (of spinning) (1) increase the mass / weight (of the flywheel) (1)	accept (idea of) faster ignore make it bigger	**(1)** AO 2 1

Q13.

Question Number	Answer	Additional Guidance	Mark
	one from causes heating of the surroundings (1) transferred to thermal energy of surroundings (1) increases the kinetic energy of molecules in the brake pads (1)	must include destination of final energy increases thermal energy of brake pads / wheels	**(1)**