Energy Changes

Total marks:21

Q1.

Figure 10 shows a toy used to launch a ball.

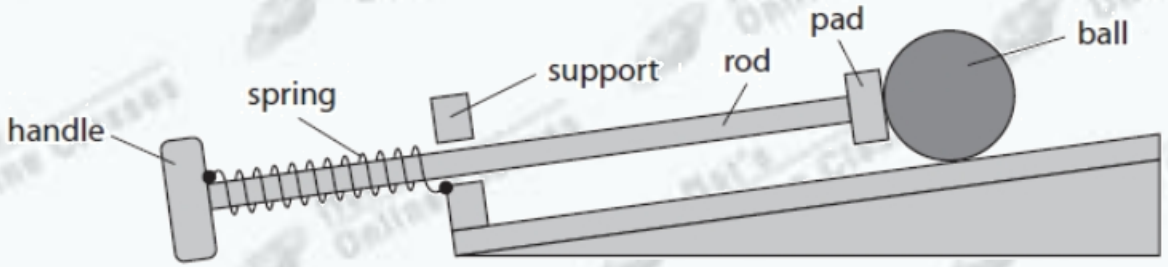

Figure 10

One end of the spring is fixed to the handle.

The other end of the spring is fixed to the support.

The child pulls the handle until the pad is against the support as shown in Figure 12.

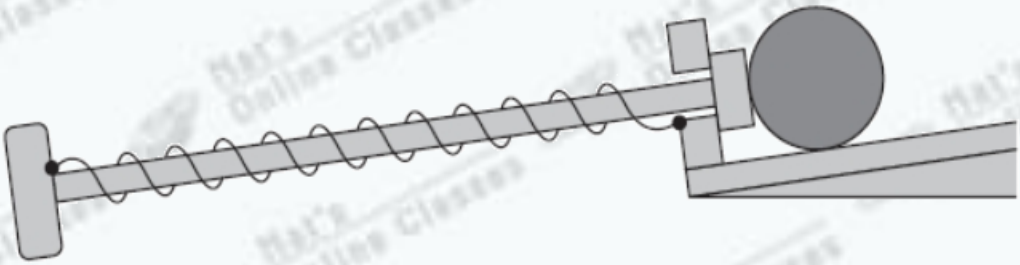

Figure 12

(i) The extension of the spring is 0.09 m.

The spring constant (k) is 20 N/m.
Calculate the work done in extending the spring by 0.09 m.
Use the equation

$$\text{work done} = \tfrac{1}{2} \times k \times (\text{extension})^2$$

(2)

work done = ... J

(ii) The child lets go of the handle.

The ball starts to move.
The spring returns to its original length.
Describe the energy transfer that takes place when the ball starts to move.

(2)

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(iii) The child can only stretch the spring until the pad is pressing against the support.

Explain how the design of the toy prevents the spring from becoming damaged.

(2)

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(Total for question = 6 marks)

Q2.

A cyclist is riding a bicycle at a steady velocity of 12 m/s.

The cyclist and bicycle have a total mass of 68 kg.

Calculate the kinetic energy of the cyclist and bicycle.

Use the equation

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

(2)

kinetic energy = ... J

(Total for question = 2 marks)

Q3.

This question is about energy changes.

Figure 12 shows a person pushing a box from the bottom of a slope to the top of the slope.

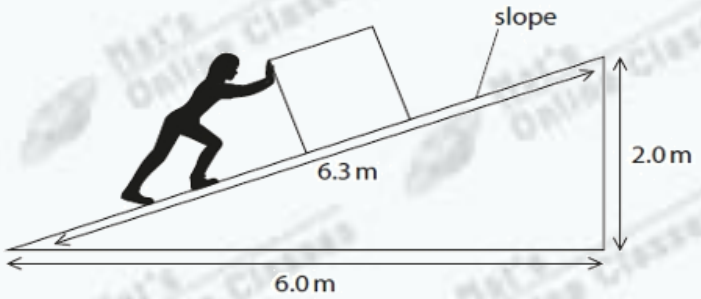

Figure 12

Explain which one of the three distances shown in Figure 12 should be used to calculate the work done against the force of friction between the box and the slope.

(2)

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(Total for question = 2 marks)

Q4.

Figure 8 shows part of a cart.

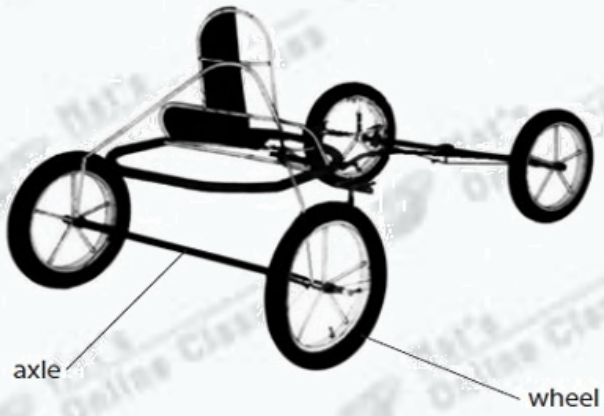

Figure 8

When the wheels turn the axles become warm.

(i) Explain why the axles become warm when the wheels turn.

(2)

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(ii) Give **one** way of reducing the heating of the axles when the wheels turn.

(1)

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(Total for question = 3 marks)

Q5.

Two cyclists ride on a hilly road and go through points P, Q, R and S.

The diagram in Figure 16 shows how the vertical height of the road changes during the journey from P to S.

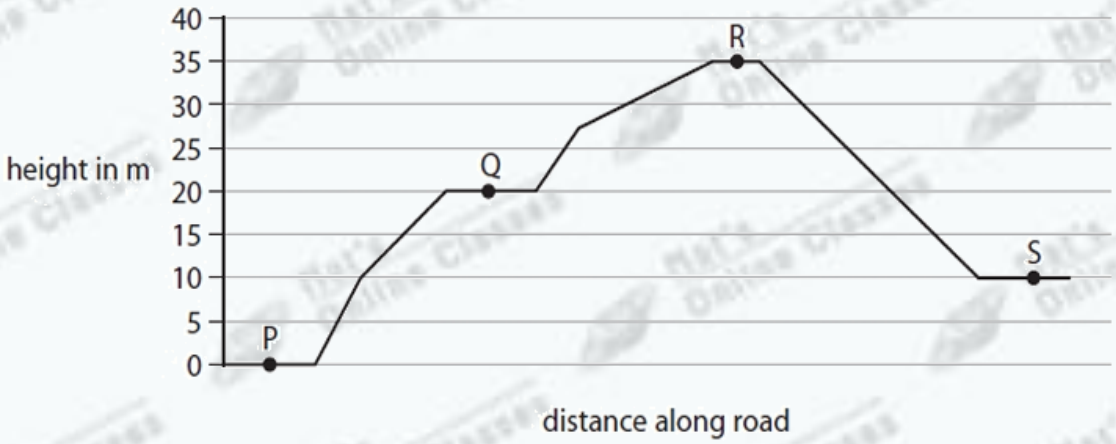

Figure 16

(i) The greatest overall change in gravitational potential energy for each cyclist is between which two points on the journey?

(1)

- ☐ **A** P and Q
- ☐ **B** Q and R
- ☐ **C** P and S
- ☐ **D** R and S

(ii) The total weight of one cyclist and bicycle is 700 N.

Calculate the total amount of work done against gravity when the cyclist travels from point P to point Q in the journey.

(2)

work done = ... J

(iii) The gravitational potential energy of the other cyclist changes by 11 250 J when travelling from point Q to point R.

Calculate the mass of this cyclist.
Gravitational field strength = 10 N / kg
Use the equation

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

(2)

mass = ... kg

(iv) Explain why the total amount of work done by a cyclist between points Q and R is different from the change in gravitational potential energy of the cyclist between points Q and R.

(2)

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(v) The cyclists lubricated the chains and the wheel bearings of their bicycles before setting off.

Lubricating the chains and wheel bearings helps to

(1)

- ☒ **A** decrease the amount of work done against gravity
- ☒ **B** decrease the efficiency of the cyclist and bicycle
- ☒ **C** increase the efficiency of the cyclist and bicycle
- ☒ **D** increase the overall amount of energy transferred by the cyclist

(Total for question = 8 marks)

Mark Scheme:

Q1.

Question number	Answer	Additional guidance	Mark
i	substitution (1) (E =) ½ X 20 x $0.09^{(2)}$ evaluation (1) 0.08(1) (J)	 allow 1 mark for ½ x 20 x 9^2 or answer of 810 (J) or answer of 90 (J) award full marks for the correct answer without working	**(2)**

Question number	Answer	Additional guidance	Mark
ii	a description including mention of one relevant energy store (1) correct transfer in context (1)	 potential/ PE/ kinetic/ KE/ thermal/ heat/ elastic potential energy stored in the spring transferred to kinetic energy of the ball/rod scores 2 marks kinetic energy of rod is transferred to kinetic energy of ball scores 2 marks idea of energy transferred to the surroundings/ thermal scores 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
iii	an explanation linking two from (controls the maximum) extension (1) idea of keeping below the elastic limit (1) (which would result in) spring being permanently stretched (1)	ignore damaging the spring (given in stem) stretch prevents spring being over-stretched / extended too far scores 2 marks allow distorted/ break	(2)

Q2.

Question Number:	Answer	Additional guidance	Mark
	substitution (1) (KE =) ½ x 68 x 12^2 evaluation (1) 4900 (J)	 ½ x 68000 x 12^2 scores 1 mark accept values that round to 4900(J) e.g. 4896(J) award full marks for correct answer without working	(2) AO 2 1

Q3.

Question number	Answer	Additional guidance	Mark
	Explanation linking **two** from: choice of distance (1) 6.3 m (calculations of work done need) the distance moved in the direction of the force (1) (friction acts) along the slope / hypotenuse (1)	 accept pushed up the slope	**(2)** **AO3**

Q4.

Question Number:	Answer	Additional guidance	Mark
(i)	an explanation linking: wheel rubs on axle (as it rotates) OR friction (between the wheel and the axle) (1) causes heating/transfer of (thermal) energy/ work being done (1)	 allow generates heat	**(2)** AO 1 1

Question Number:	Answer	Additional guidance	Mark
(ii)	any one from: lubrication/oil (1) (ball) bearings / ball-race (1) go slower (1)	 anything that lubricates – grease etc.	**(1)** AO 1 1

Q5.

Question number	Answer	Additional guidance	Mark
(i)	D R and S A, B and C are incorrect because the difference in vertical positions are all less than that shown by R and S		**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
(ii)	recall (1) work done = force x distance substitution and evaluation (1) (work done =) 14,000 (J)	(work done) = 700 x 20 award full marks for the correct answer without working	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) 11250 = m x 10 x 15 rearrangement and evaluation (1) (mass=) 75 (kg)	 award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers of 0.013 (substitution mark using h = 15)	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
(iv)	An explanation linking some work is done to overcome friction/air resistance (1) energy is dissipated /transferred to the environment (1)	 allow energy is lost thermal energy	(2) AO1

Question number	Answer	Additional guidance	Mark
(v)	C increase the efficiency of the cyclist and bicycle A is incorrect because lubrication has no effect on work done against gravity B is incorrect because lubrication will increase efficiency D is incorrect because the overall energy transfer will not increase		(1) AO1