WORK.ENERGY.POWER

Challenging **MCQ** questions by The Physics Cafe

Compiled and selected by The Physics Cafe

1 A mass *m*, attached to the end of an unstretched spring, is initially supported by a platform as shown in Fig. 3.1.

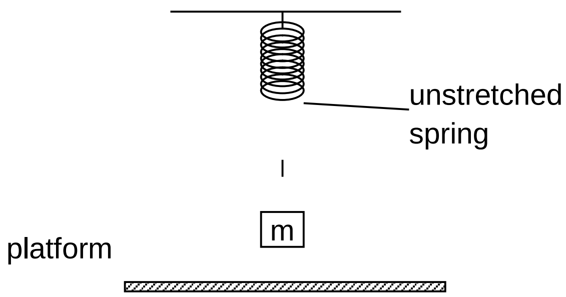

Fig. 3.1

The platform is then removed and the spring-mass system starts to oscillate.

Describe the energy changes taking place from the instant the platform is removed until the spring is first fully extended.

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Ans From instant of release to first fully extended,

<u>GPE decreases</u> from <u>max</u> value to <u>min</u> value,

<u>EPE increases</u> from <u>zero to max</u> value &

<u>KE increases</u> from <u>zero to a max</u> value (at equilibrium point when weight is equal to the tension by the spring) & <u>decreases back to zero</u>.

2 Trolley A of mass **400 g** is moving at a constant speed of **2.5 m s^{-1}** to the right as shown in Fig. 1.1.

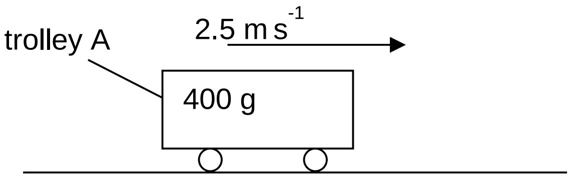

Fig. 1.1

(a) Show that the kinetic energy of trolley A is 1.3 J.

[1]

Trolley A hits a spring of force constant ***k* = 20 N m^{-1}** and compresses the spring from its equilibrium position before coming to rest momentarily.

(b) (i) Define *elastic potential energy*.

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……………………………………………………………………………………………….. [1]

(ii) Calculate the maximum compression of the spring.

compression = ……………………………… m [2]

(iii) The length of the spring is then cut in half. Trolley A is, again, travelling with speed of 2.5 m s^{-1} and hits the spring.

Suggest and explain the change, if any, on the maximum compression of the spring.

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(c) Two identical trolleys, A and B, start from rest at the same height above the ground and travel to the right on two frictionless tracks as shown in Fig. 1.2.

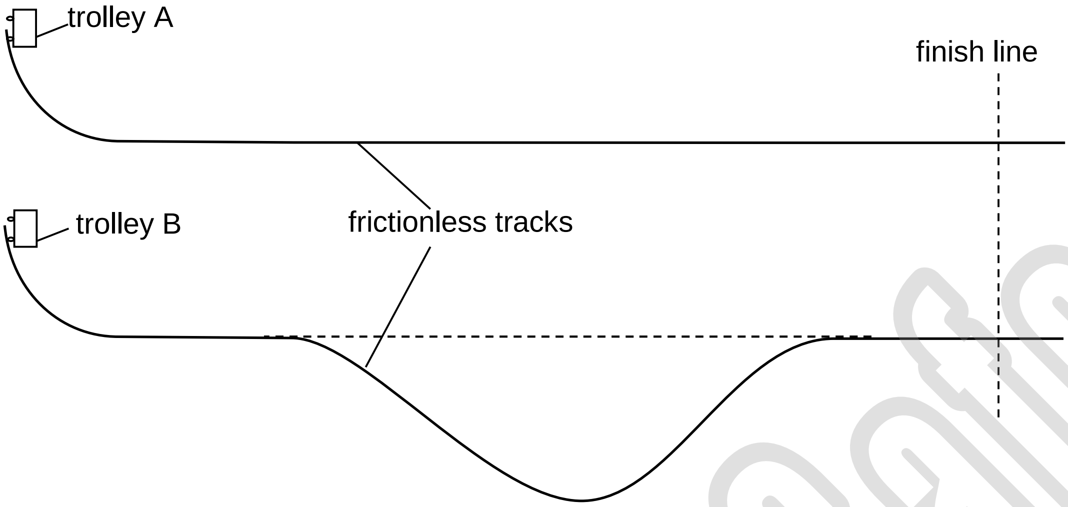

Fig. 1.2

State and explain which trolley will reach the finish line first.

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Ans

(a) KE = $\frac{1}{2}mv^2 = \frac{1}{2}(0.4)(2.5)^2$ M1 [1]

(b) (i) <u>ability to do work</u> as a result of a <u>change of shape</u> of object B1 [1]

(b) (ii) loss in KE = gain in EPE

$1.3 = \frac{1}{2}(20)(x^2)$ C1

$x = 0.36\text{ m}$ A1 [2]

(b) (iii) spring constant increases (by 2 times) C1

maximum compression reduces (is now 0.25 m) A1 [2]

(c) <u>horizontal distance</u> is the same for both tracks
average <u>horizontal speed</u> of trolley B is higher than that of A, M1
trolley B first as (horizontal) speed of B is faster down the valley A1 [2]

3 Fig. 5.1 shows the graph of force against extension for a rubber band.

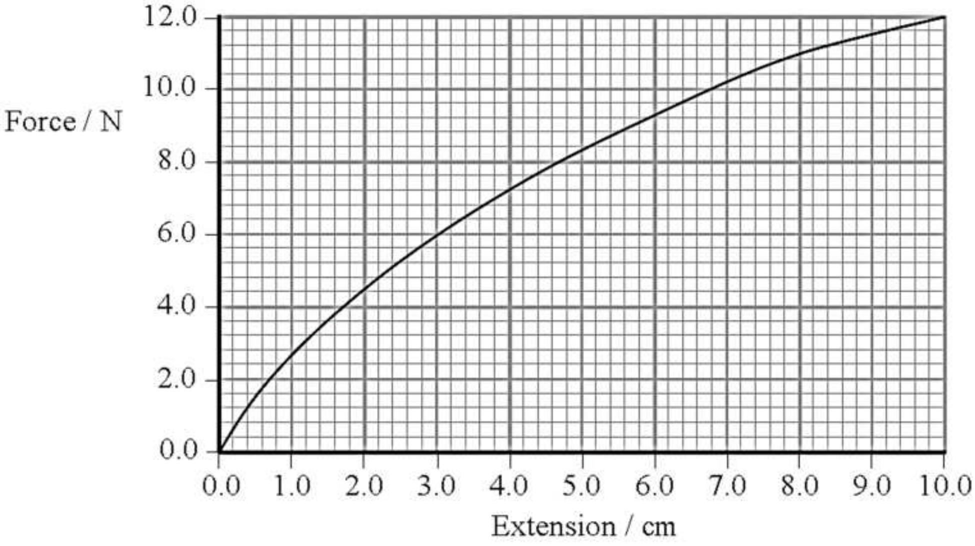

Fig. 5.1

(a) Explain whether the rubber band obeys Hooke's law.

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.... **[2]**

(b) Use the graph to show that the elastic potential energy stored in the rubber band when it has an extension of **10.0 cm** is less than **0.8 J**.

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[2]

(c) Fig. 5.2 shows a graph with two lines. Measurements were obtained by increasing the force on the rubber band to **12 N** and then decreasing the force.

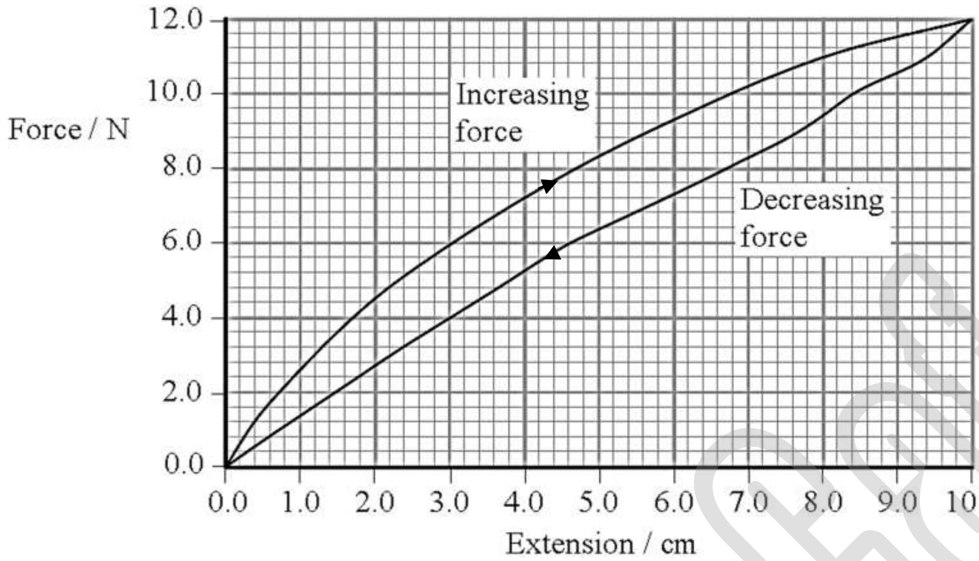

Fig. 5.2

Describe the energy transfers taking place when the force on the rubber band is increased and then decreased.

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.... **[2]**

(d) Fig. 5.3 shows the rubber band being used to launch a model aeroplane.

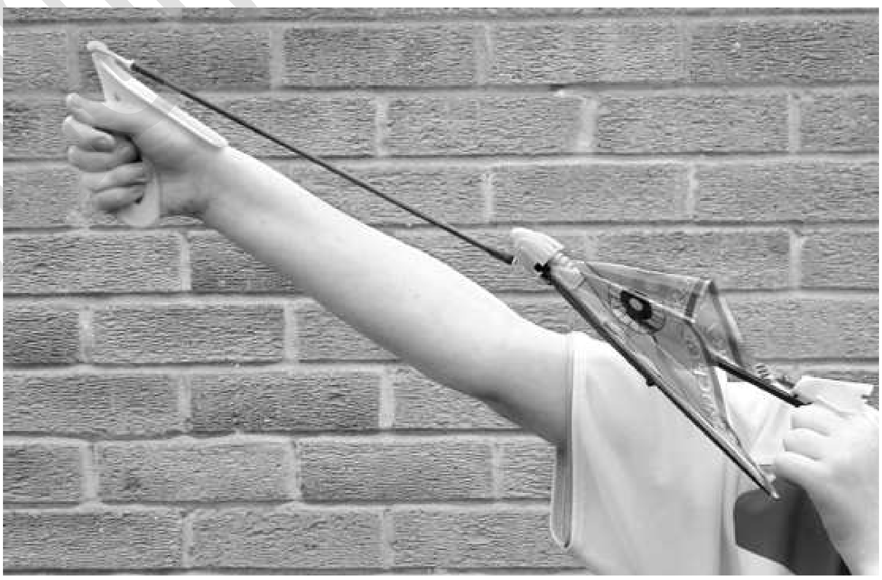

Fig. 5.3

(i) The rubber band is extended by **10.0 cm** before being released to launch the aeroplane. Calculate the maximum possible initial speed of the aeroplane given that the mass of aeroplane is **0.027 kg**

maximum possible initial speed of the aeroplane = ______________ m s^{-1} [2]

(ii) The maximum speed of the aeroplane will be less than that calculated in in **(i).**

Without further calculation, suggest reasons why this is so using Fig. 5.2 as reference.

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.... [3]

Ans

(a)	No. Line is not straight / line curves / gradient is not constant / k is not constant	**B1**
	(But) Hooke's law states extension or change in length is directly proportional to the force applied O R Extension is not proportional to force	**B1**
(b)	Indication of use of area (could be marks on graph) / use of ½ *Fx*	**B1**
	More detailed estimation, e.g. counting squares, for correct answer = 0.76 J (accept answers above from 0.7 J to just below 0.8 J)	**B1**
(c)	During loading, energy is transferred to elastic potential energy of band (and some heat).	**B1**
	During unloading (when the force is decreased), elastic potential energy decreases and some energy is transferred to heat/ internal energy.	**B1**
(d)(i)	Equates stored energy with initial kinetic energy of aeroplane	**M1**
	Use of KE = 1/2 mv^2 0.76 J = 1/2 mv^2 v = √(2 x 0.76 J / 0.027 kg) = 7.5 m s^{-1}	**A1**
(d)(ii)	Area under graph for increasing force > area for decreasing force OR one line higher than the other OR there is a gap between lines.	**B1**
	Work done by rubber band is less than calculated energy stored OR energy stored > energy retrieved OR area between lines is energy transferred to heat OR area between lines is energy dissipated	**B1**
	Not all energy is transferred to kinetic energy, hence smaller maximum speed	**B1**