O Level Combined Physics Structured

Energy, Work Done and Power Test 2.0

Q1

Fig. 4.1 shows a children's ride. A carriage containing children is pulled up the slope by a motor. The carriage stops at A and then runs through B and C without further input of energy. The height of the ride is 30 m at A and 10 m at C. Assume that the friction of the track is negligible.

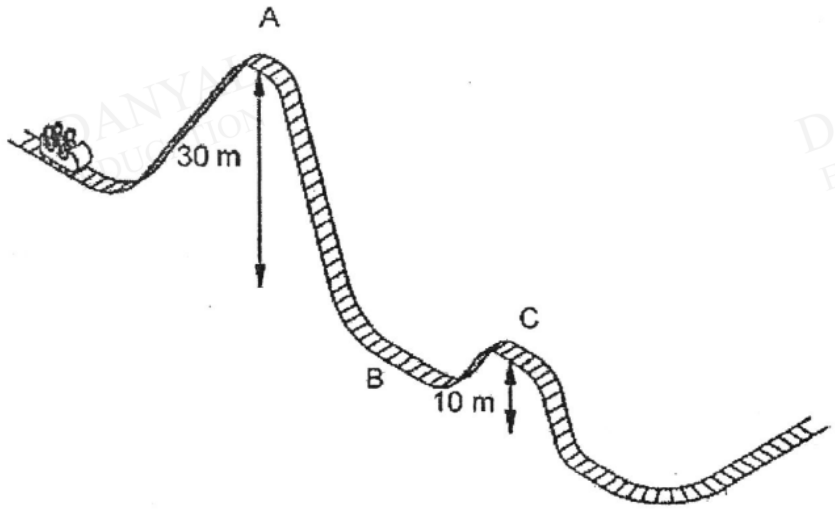

Fig. 4.1

The mass of the carriage and the children is 500 kg.

(a) Calculate the gravitational potential energy of the carriage and children at A.

gravitational potential energy = ... J [1]

(b) Using your answers in **(a)**, calculate the kinetic energy of the carriage and children at C.

kinetic energy = ... J [2]

(c) Hence, calculate the speed of the carriage and the children at C.

speed = ... m/s [2]

Q2

In an experiment, a 5 kg block is initially at rest as shown in Fig. 2.1. In regions *AB* and *BC*, the surfaces are frictionless. An external force of 12 N is acting on the block.

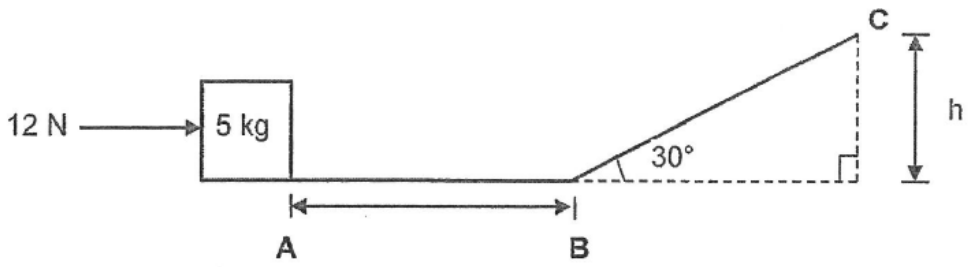

Fig. 2.1

(a) Find the acceleration of the block in region *AB*.

acceleration = ...m/s² [2]

(b) If it takes 0.9 s for the block to travel from point *A* to point *B*, find the velocity of the block at point *B*

velocity = ...m/s [2]

(c) Calculate the kinetic energy of the block at point *B*.

kinetic energy = ...J [1]

(d) If the 12 N force is removed at point *B* and the block continues to move to point *C* before it comes to a momentary stop, calculate the height, h.

h = ...m [2]

Q3

Fig 5.1 shows a motor in a crane slowly lifting a 50 kg bucket of rubble. The bucket was initially 5 m above the ground, and the motor raises it through a vertical height of 10 m in 2 minutes before stopping.

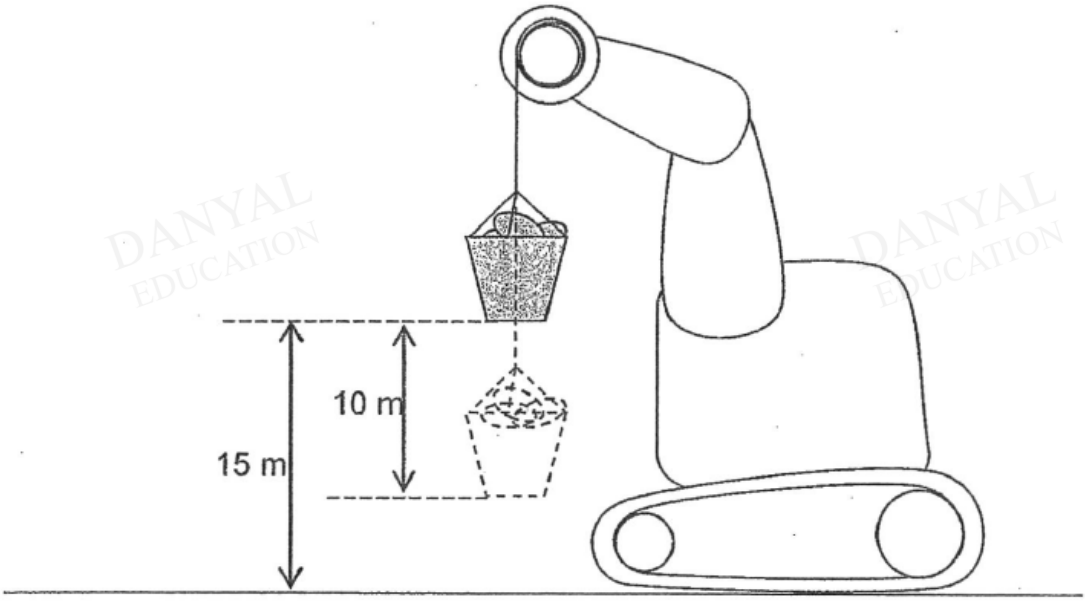

Fig. 5.1

(a) (i) Calculate the increase in gravitational potential energy of the bucket from its initial position.

increase = ... J [2]

(ii) Calculate the power of the motor in the crane to lift the bucket.

power = ... W [2]

(b) The cable holding the bucket snaps when the bucket is at rest 15m above the ground. Using the principle of conservation of energy, calculate the velocity of the bucket just before it hits the ground.

velocity = ... m/s [2]

Q4

A water slide has a height of 3.5 m and a total length of 18 m as shown in Fig. 3.1.
A boy of mass 50 kg starts from rest at the top and slides down the water slide.
Take the acceleration due to gravity g to be 10 m s^{-2}.

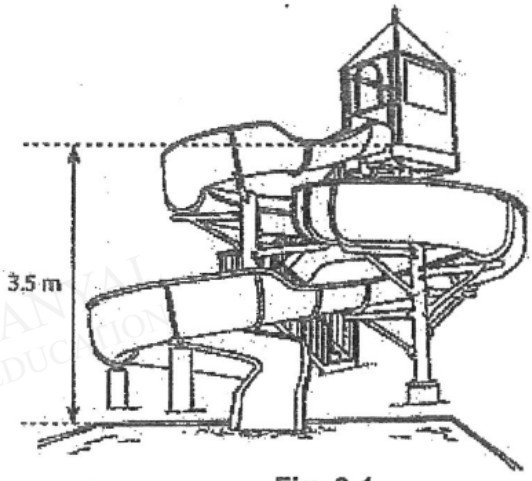

Fig. 3.1

(a) State the *principle of conservation of energy*.

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_____

_____ [1]

(b) Calculate the gravitational potential energy of the boy at the top of the slide.

gravitational potential energy = _____ J [2]

(c) A frictional force that averages 10 N acts on the boy while he slides down. Calculate the speed of the boy when he reaches the bottom of the slide.

speed = _____ m/s [2]

(d) Suggest, with explanation, a reason why the slide operates with water flowing continuously down the slide.

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_____ [1]

Q5

Fig. 11.1 shows a ball of mass 2 kg accelerating down a rough slope from a high point.

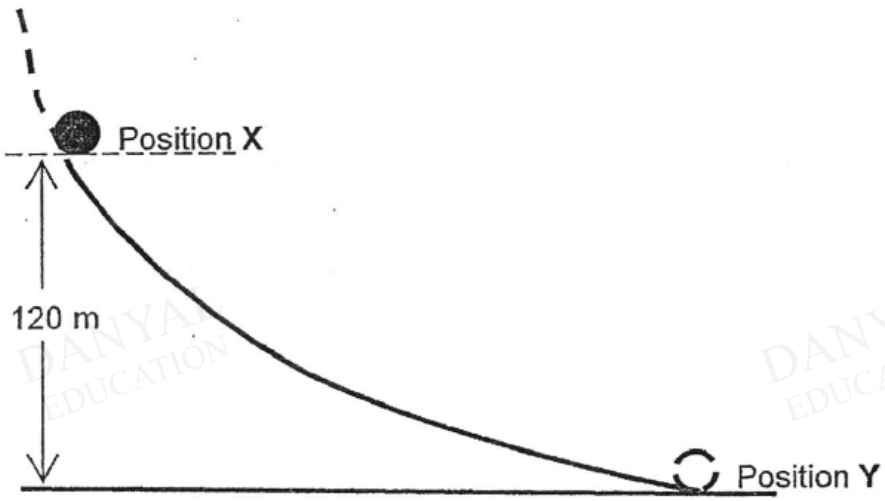

Fig. 11.1

(a) Describe and explain how the gravitational potential energy of the ball changes as it moves from Position **X** to Position **Y**.

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[2]

(b) Describe and explain how the kinetic energy of the ball changes as it moves from Position **X** to Position **Y**.

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[2]

Use the following information for subsequent parts of this question:

*Take total energy of the ball at Position **X** to be 3900 J.*

Take gravitational field strength, g, to be 10 N/kg

(c) Show that the gravitational potential energy of the ball at position X is 2400 J

[1]

(d) Derive the kinetic energy of the ball at position X and thus calculate the speed of the ball at this position.

kinetic energy = ... J [1]

speed = ... m /s [2]

(e) As the ball moves down the slope, it is experiencing irregular frictional force.

(i) Suggest a reason why the frictional force experienced by the ball is irregular.

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[1]

(ii) A part of the ball's mechanical energy is lost to the surround due to the frictional force. Account for this loss.

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[1]

Answers

Energy, Work Done and Power Test 2.0

Q1

(a) GPE = m x g x h = 500 x 10 x 30 J = 150000 J	1
(b) GPE = m x g x h = 500 x 10 x 10 J = 50000 J Loss in potential energy = Gain in kinetic energy = (150 000 – 50 000) = 100 000 J	1 1
(c) 100 000 = ½ x 500 x v^2 (100 000 x 2) / 500 = v^2 v = 20 m/s	1 1

Q2

(a)	F = ma 12 = 5a a = 2.4 m s^{-2}	[M1] [A1]
(b)	a = (v - u)/t 2.4 = (v - 0)/0.9 v = 2.16 m s^{-1}	[M1] [A1]
(c)	KE = ½ mv^2 = ½ (5) $(2.16)^2$ = 11.7 J	[A1]
(d)	KE lost = PE gained 11.7 = mgh h = 11.7/(5)(10) = 0.234 m	[M1] [A1]

Q3

(a)(i)	PE = mgh = (50 kg) (10 m/s^2) (10 m) =5000 J	[M1] [A1]
(a)(ii)	Power = Work Done/time taken Work Done = increase in potential energy = 5000 J Power = 5000 J/120 s = 41.7W	[M1] [A1]
(b)	By Principle of Conservation of Energy, PE = KE Mgh = ½ mv^2	 [M1]
	$v = \sqrt{2gh}$ $= \sqrt{2 \times 10 \times 15}$ = 17.3 m/s	 [A1]

Q4

(a) Principle of conservation of energy states that energy cannot be created nor destroyed. It can be converted from one form to another or transferred from one body to another. Total energy in an isolated system is constant.	[1]
(b) GPE = (50)(10)(3.5) = 1750 J	[1] [1]
(c) 1750 = (10)(18) + ½(50)v^2 v = 7.92 m/s	[1] [1]
(d) This is to <u>reduce friction</u> on the slide so that the boy can <u>slide down the slide smoothly.</u>	[1]

Q5

a	The ball is reducing in height when it moves down the slope. Since GPE = mgh, the gravitational potential energy of car is reducing.	[1] [1]
b	The speed of ball is increasing as it is accelerating down the slope. Since KE = ½ mv², the kinetic energy of the ball is increasing.	[1] [1]
c	E_P = m g h = 2 kg x 10 N/kg x 120 m = 2400 J	[1]
d	$E_K = E_T - E_P$ = 3900 J – 2400 J = 1500 J $E_K = ½ m v^2$ 1500 J = ½ x 2 kg x v^2 $v = \sqrt{\frac{2 \times 1500}{2}}$ m/s = 38.7 m/s	[1] [1] [1]
ei	The roughness of the slope is not uniform throughout.	[1]
eii	Some energy is converted to heat and sound due to friction between the ball and the slope.	[1]