MECHANICS REVISION 04 JUNE 2013

Lesson Description

In this lesson we revise:

- Graphs of Motion
- Momentum
- Work-Energy Theorem

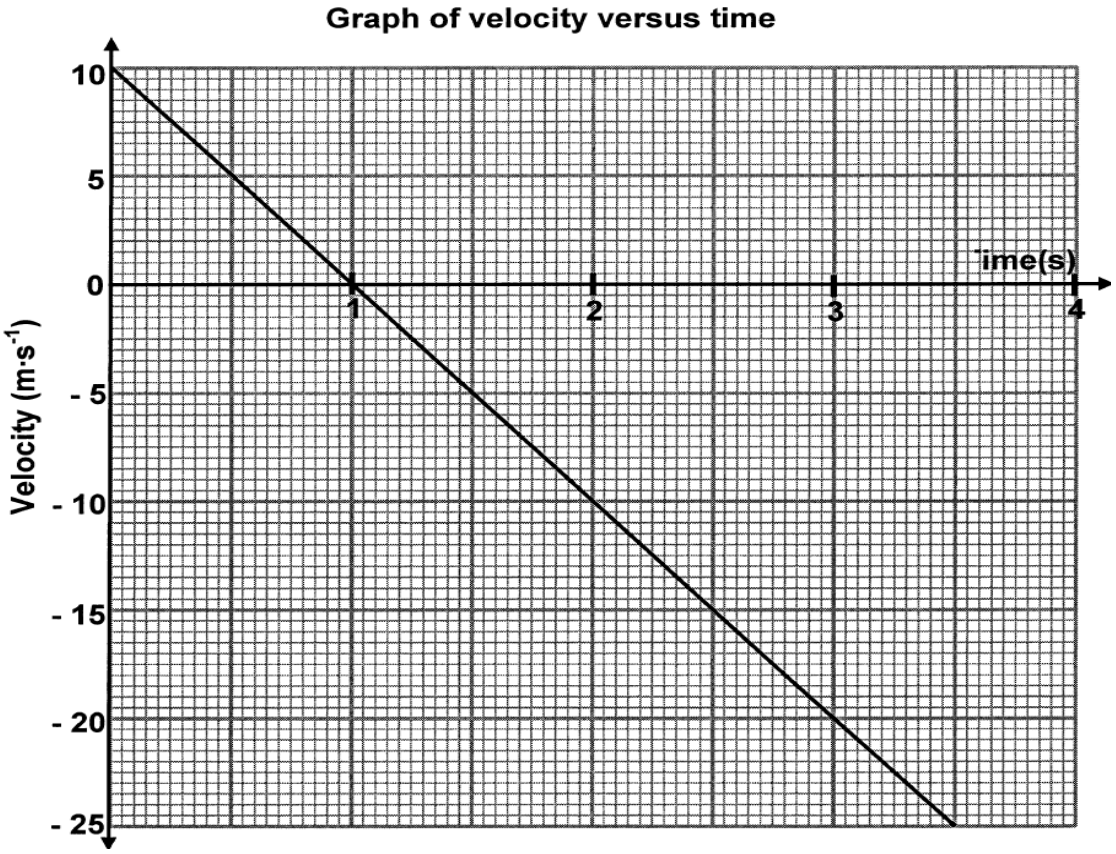
Questions

Graphs of Motion

Question 1

(Adapted from Nov 2008, Paper 1, Question 6)

A boy stands at the edge of a high cliff. He throws a stone vertically upwards with an initial velocity of 10 $m \cdot s^{-1}$. The stone strikes the ground at a point below the cliff after 3.5 s. The velocity-time graph below was obtained from measurements made during the motion of the stone.



Use the information on the graph to answer the following questions:

a.) Calculate the acceleration of the stone between times t = 2 s and t = 3 s. (3)

b.) At which time(s) is the stone at a speed of 5 $m \cdot s^{-1}$? (2)

c.) After how many seconds does the stone reach its highest point? (1)

d.) Determine the height of the cliff from which the stone was thrown. (4)

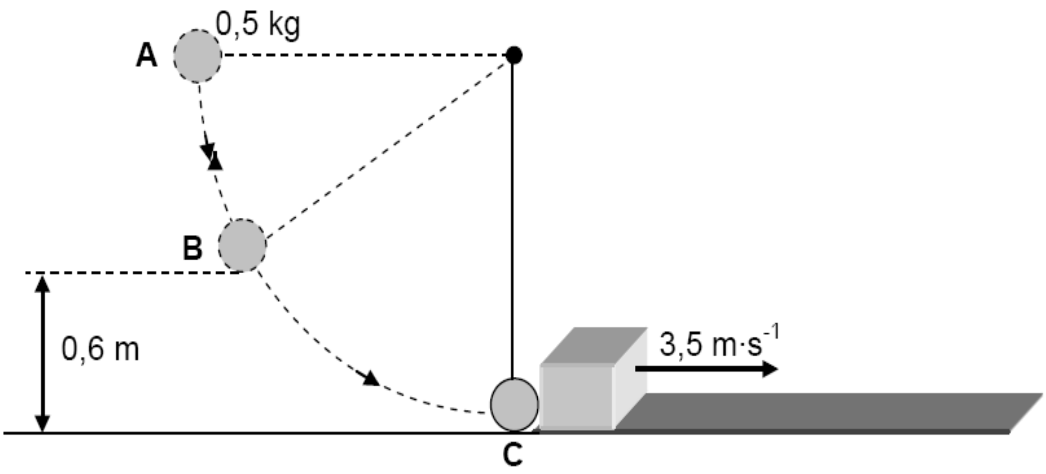
e.) Using the top of the cliff as the initial position of the stone, sketch the position-time graph (displacement-time graph) for the motion of the stone **from its highest point until it reaches the ground**. Only indicate relevant time values on the x-axis. (3)

Momentum & Energy

Question 2

(Adapted from Nov 2010, Paper 1, Question 4)

A steel ball of mass 0,5 kg is suspended from a string of negligible mass. It is released from rest at point **A,** as shown in the sketch below. As it passes through point **B,** which is 0,6 m above the ground, the magnitude of its velocity is 3 $m \cdot s^{-1}$. (Ignore the effects of friction.)



a.) Write down the principle of the conservation of mechanical energy in words. (2)

b.) Calculate the mechanical energy of the steel ball at point **B.** (4)

As the steel ball swings through its lowest position at point **C**, it collides with a stationary crate of mass 0,1 kg. Immediately after the collision, the crate moves at a velocity of 3,5 $m \cdot s^{-1}$ to the right.

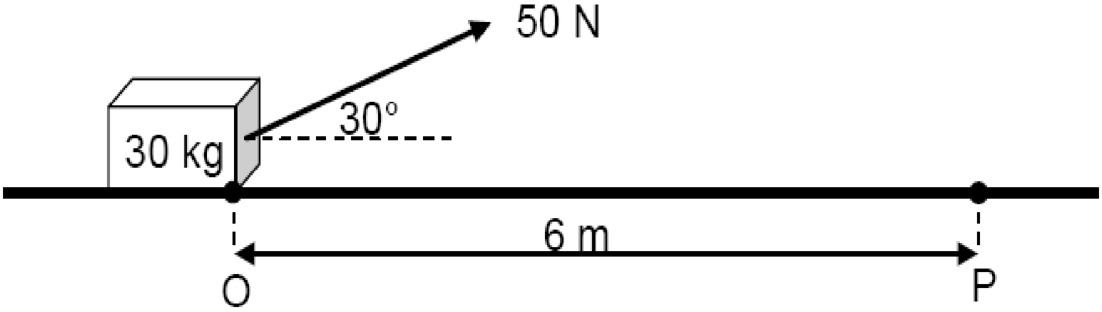
c.) Calculate the velocity of the steel ball immediately after the collision. (7)

Work - Energy Theorem

Question 3

(Adapted from Nov 2010, Paper 1, Question 5)

A worker pulls a crate of mass 30 kg from rest along a horizontal floor by applying a constant force of magnitude 50 N at an angle of 30°to the horizontal. A frictional force of magnitude 20 N acts on the crate whilst moving along the floor.



a.) Draw a labelled free-body diagram to show ALL the forces acting on the crate during its motion. (4)

b.) Give a reason why each of the vertical forces acting on the crate do NO WORK on the crate. (2)

c.) Calculate the net work done on the crate as it reaches point P, 6 m from the starting point O. (4)

d.) Use the work-energy theorem to calculate the speed of the crate at the instant it reaches point P. (3)

e.) The worker now applies a force of the same magnitude, but at a SMALLER ANGLE to the horizontal, on the crate.

How does the work done by the worker now compare to the work done by the worker in QUESTION (c.)? Write down only GREATER THAN, SMALLER THAN or EQUAL TO.

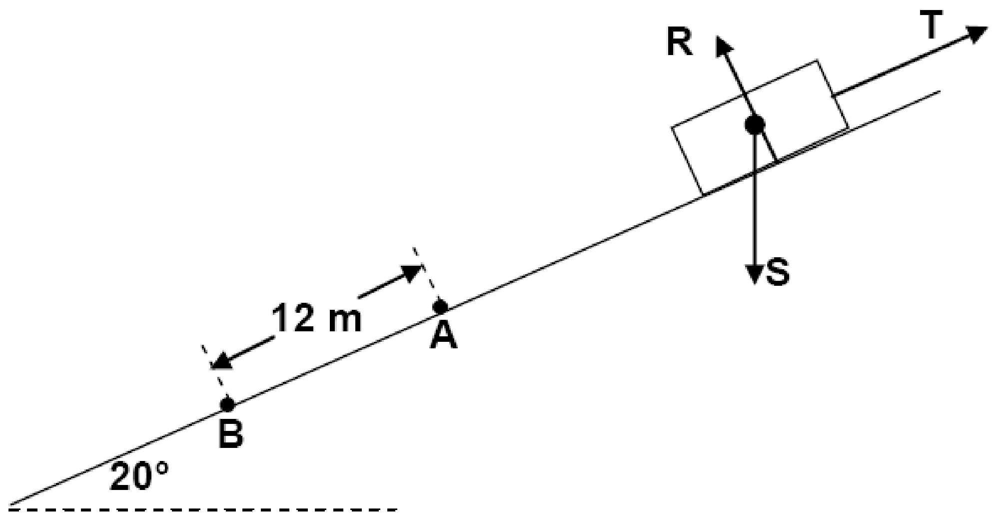
Give a reason for the answer. (No calculations are required.) (2)

Work - Energy Theorem (Inclined plane)

Question 4

(Adapted from Feb/Mar 2011, Paper 1, Question 5)

A crate of mass 70 kg slides down a rough incline that makes an angle of 20°with the horizontal, as shown in the diagram below.The crate experiences a constant frictional force of magnitude 190 N during its motion down the incline. The forces acting on the crate are represented by **R**, **S** and **T**.



a.) Label the forces **R, S** and **T.** (3)

b.) Give a reason why force **R** does no work on the crate. (2)

The crate passes point **A** at a speed of 2 m·s^{-1} and moves a distance of 12 m before reaching point **B** lower down on the incline.

c.) Calculate the net work done on the crate during its motion from point **A** to point **B.** (5)

d.) Write down the work-energy theorem in words. (2)

e.) Use the work-energy theorem to calculate the speed of the crate at point **B**. (4)