proprep™

Workbook

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Work and Energy

Energy Conservation and the Work Energy Theorem Part A

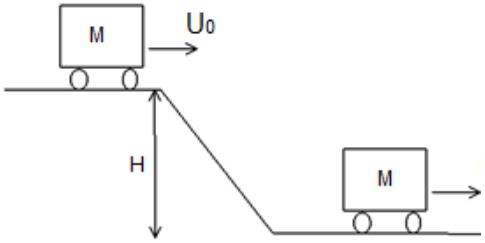
Questions

1) Conservation of Energy.

A cart is moving along a frictionless surface. The cart begins above a slope of a height H with an initial velocity of U_0.

Given: H, U_0.

Find the velocity of the cart at the bottom of the slope.



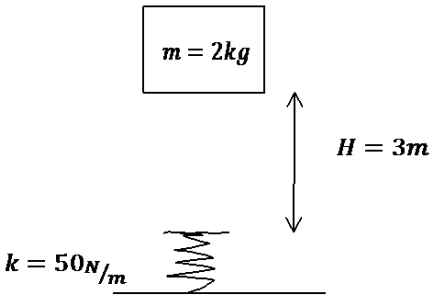
2) An Object is dropped above a Vertical Spring.

A massless spring with a spring constant of $50\,\mathrm{N/m}$ is attached to the ground.

An object with a mass of $2\mathrm{kg}$ is released from a stationary position $3\mathrm{m}$ above the spring.

a. Find the maximal compression of the spring.

b. What is the maximal height the object will reach after hitting the spring?



3) One Mass on a Slope Tied to Another Mass Hanging Vertically.

A mass m_1 is sitting on an incline with an $\measuredangle\theta°$.

The mass is resting on a spring with a spring constant of k compressed to $\triangle x = d$.

There is a string tird to the mass which passes over an ideal pulley and is attached to the mass m_2, which is sitting at a height H above the ground.

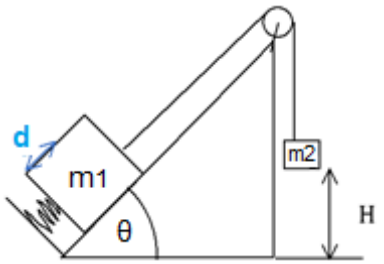
Given Values:

$m_1 = 1\mathrm{kg}$, $m_2 = 2\mathrm{kg}$, $H = 3\mathrm{m}$,

$k = 100\,\mathrm{N/m}$, $\measuredangle\theta = 30°$, $\mathrm{d} = 30\mathrm{cm}$.

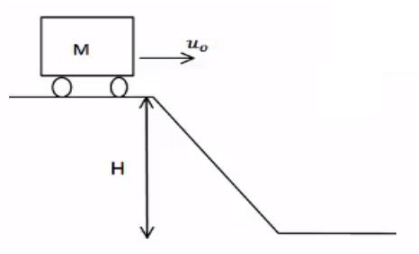
The system is released from a resting position.

Find the velocity with which m_2 hits the ground.



Energy Conservation and the Work Energy Theorem Part B

4) A cart is moving on a surface with friction.
The cart begins above a slope with a height H and an initial velocity of u_0.
Given: u_0, H.
Find the velocity of the cart the bottom of the slope.



Calculating Work When Force is not Constant

5) Calculate the Work exerted by the force $F = x\hat{x} + yx\hat{y}$ between the points $\mathrm{A}(0,0)$ and $\mathrm{B}(2,4)$, with the following trajectories:

a. The trajectory is a straight line between the two points.
b. The trajectory is parallel to the x-axis until point $\mathrm{C}(2,0)$ and then parallel to y-axis until point B.
c. The trajectory is $y = x^2$.
d. The trajectory is $x(t) = 2t$, $\mathrm{y}(t) = 4t^2$.

How to check if a Force is Conservative

6) The force F is given: $F = 2xy\hat{x} + \left(x^2 + z\right)\hat{y} + y\hat{z}$.
Is the force F conservative?

Calculating Potential Energy from Conservative Forces

7) Find the potential energy of the force: $F = 2xy\hat{x} + \left(2 - x^2\right)\hat{y}$,
if you are given: $\mathrm{U}(0,0) = 0$.

Answer Key

1) $v_f = \sqrt{u_0^2 + 2gH}$

2) a. $\Delta x = 2\text{m}$ b. Same height it was released from.

3) $5.745\dfrac{\text{m}}{\text{sec}}$

4) $v_f = \sqrt{u_0^2 + 2gH\left(1 - \mu_k \cot\theta\right)}$

5) a. $W_{A\to B} = \dfrac{4}{2} + \dfrac{4\cdot 8}{3}$ b. $W_{A\to B} = 18$ c. $W_{A\to B} = 2 + \dfrac{64}{5}$ d. Same as part c.

6) Yes.

7) $U = x^2 y - 2y$