

Physics 1



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Work and Energy

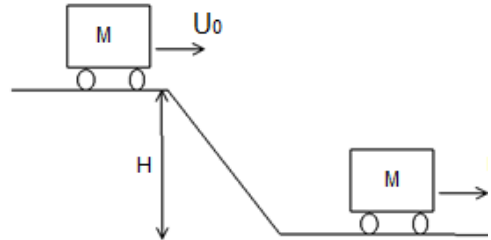
Energy Conservation and the Work Energy Theorem Part A

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.

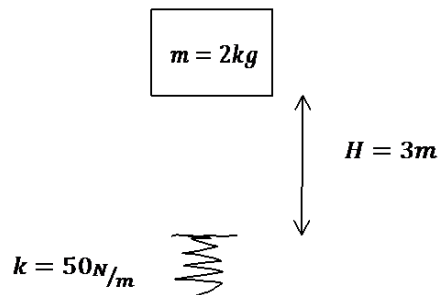


2) An Object is dropped above a Vertical Spring.

A massless spring with a spring constant of 50 N/m is attached to the ground.

An object with a mass of 2 kg is released from a stationary position 3 m above the spring.

- Find the maximal compression of the spring.
- 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 angle θ .

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

There is a string tied 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.

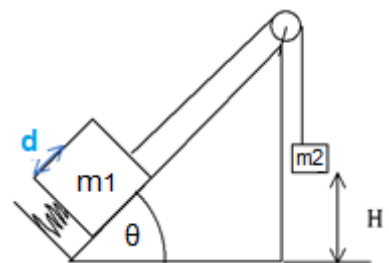
Given Values:

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

$$k = 100 \text{ N/m}, \theta = 30^\circ, d = 30 \text{ cm}.$$

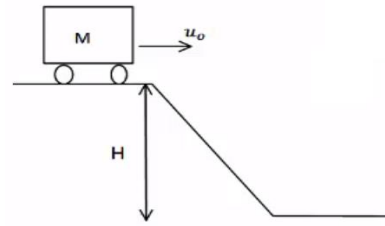
The system is released from a resting position.

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 $A(0,0)$ and $B(2,4)$ with the following trajectories:
- The trajectory is a straight line between the two points.
 - The trajectory is parallel to the x -axis until point $C(2,0)$ and then parallel to y -axis until point B.
 - The trajectory is $y = x^2$.
 - The trajectory is $x(t) = 2t, y(t) = 4t^2$.

How to check if a Force is Conservative

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

Calculating Potential Energy from Conservative Forces

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

Answer Key:

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

2) a. b.

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

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

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

6) Yes.

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