Physics 7AW Homework 8 — Conservation of Energy

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Physics 7AW - WAT 2020 edition

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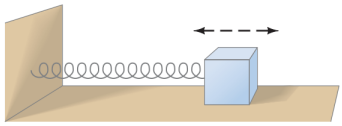
1
Recall from lecture that $F = -\frac{d}{dx}V(x)$ where $V(x)$ is the potential energy.

a) Use this to find the potential energy of a spring that is governed by Hooke's law $F = -kx$



A block attached to a spring is stretched from its equilibrium position by $\Delta x = A$

b) What is the total energy of the block on the spring? Ignore friction.

c) What is the maximum speed the block can travel once released?
Hint: Conservation of Energy

d) (optional) Newton's second law for this system reads $F = m\ddot{x} = -kx$ so then we can rewrite this equation as

$$\ddot{x(t)} + \omega^2 x(t) = 0 \tag{1}$$

where $\omega = \sqrt{\frac{k}{m}}$ Remember x(t) is the position of the block as a function of time. Think about what the motion would look like in real life. What could be a solution to this equation, or rather what could $x(t)$ equal?

2 A box sits on an incline that is $\theta = \frac{\pi}{4}$ radians from the horizontal. If you push the box with a constant force F parallel to the incline upwards a distance H:

a) How much work did you do?

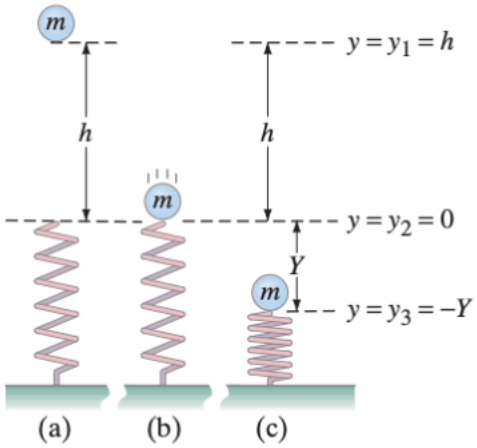
b) How much work did gravity do?

3 A glass sphere of mass M falls from a height h and shatters into two pieces of mass m_1 and m_2.

a) With what speed did the glass sphere with the ground?

b) If the velocity of m_2 is v_2, what is the velocity v_1 of the mass m_1?

4 Consider again the spring example from lecture:



Suppose the spring constant is k and the mass of the ball is m.

a) From what height h should the ball be dropped above the spring to compress it a distance A from its equilibrium?

b) If the spring is compressed a distance $\frac{A}{2}$ by dropping the ball, from what height did you drop it?

5 Recall the force of gravity is given by:

$$F(r) = \frac{GMm}{r^2} \tag{2}$$

a) What is the potential energy at a distance r?

b) In order to leave Earth you need to overcome this potential energy. In other words, the kinetic energy you need to leave has to equal the potential. What is the minimum your velocity must be if you have a mass m and the earth has mass M and radius r to go to space?
Hint: $V(r) = \frac{1}{2}m(v^2)$

Practice Final Questions

Note: The final is intended to be easier than the homework. Nonetheless it is fair game for me to ask you anything from the homework (with the exception of problems 5,6 from homework 3) I will post problems here that I think are good to understand before you take the final tomorrow. Take these recommendations seriously. If you can do these problems I'm sure you'll do great on the final

1 Motion 1D

Homework 1 Questions: 7
Homework 2 Questions: 1

2 Motion in 2D

Homework 3 Questions: 2, 3, 4

3 Forces

Homework 4 Questions: 1, 2, 5
Homework 5 Questions: 3, 4, 6

4 Circular Motion

Homework 7 Questions: 2, 3