Kinetic Energy

1. Combine the equation for Work (W = Fd) with the Newton’s second law (F=ma) to determine an equation for the work done on an object while accelerating an object. *This will be equation A.*

2. Rearrange the kinematics expression vf2 = vi2 + 2ad to solve for a. *This will be equation B.*

3. Substitute equation B into equation A.

4. Simplify this expression by factoring a ½ and *m* out. Use Δv = vf – vi to further simplify the expression

5. The equation found in part 4 represents a change in energy when something changes velocity. This is called Kinetic Energy.

**Practice Questions:**

* What is the kinetic energy of a 24 kg super rabbit moving at 18 m/s?
* A 20 g bullet, when moving, has 2592 J of energy. What is its velocity?
* The Apophis asteroid is a near earth object that has a 2.7% chance of striking the Earth in 2029. The asteroid has a mass of 2.70 x 1010 kg and has a velocity of approximately 31.2 km/s. Determine the amount of kinetic energy Apophis has. Compare that with the energy released during ALL the nuclear weapon detonations in history (2.1 x 1018 J).

6. The expression that relates work and change in velocity is called the Work-Energy Theorem.

W = ΔK

Fd = ½mΔvf2

**Practice Questions**

* In deep space a probe (m = 400 kg) rocket engine applies a constant 250 mN thrust. If the initial speed was 15 m/s, how fast will the probe be moving after it moves 1.5 x 109 m?
* A downhill skier is coasting down a 300 slope. Near the top of the hill her velocity is 5.0 m/s. Determine how far she travels if her final velocity is 15 m/s.
* If the same skier experiences a constant frictional force of 50 N how fast will she be moving when she has travelled 100 m?

7. Potential Energy is the stored energy of an object based on its position. Gravitational potential energy is found by using W = ΔE. Use the equation W = Fd and substitute the expression for Gravitational Force into this expression.

8. Because the displacement must be in the same line as the force (ie up/down) make the change distance (d) = height (h). What is the new expression?

**Practice Questions**

* A 460 kg rock is raised to a height of 6.5 m. What is the EP of the rock with respect to the ground?
* How much potential energy does a 2.5 x 104 kg airplane have when it is 2.5 km above the ground?
* What has more energy, a 750 kg car travelling on the ground at 20 m/s or a 150 kg hot air balloon floating stationary above the Earth?

9. The expression for 8 only works if *g* is constant during the change in height. For objects that move large distances (like asteroids, spaceships, satellites, planets, etc) the expression for gravitational potential energy is:



And usually requires Potential energy to be calculated at two different points.

Practice Questions

* How much potential energy does a satellite have if it is 250 km above the surface of the Earth? *(rE = 6.4 x 106 m)*