Physics 06-04 Work and Conservation of Energy **Name: ___________________**

Work done by external force

$$E_0 + W_{net} = E_f$$

Law of Conservation of Energy

The total energy is _______________ in any process. It may __________ form or be _______________ from one system to another, but the total __________ the __________.

A rocket starts on the ground at rest. Its final speed is 500 m/s and height is 5000 m. If the mass of the rocket stays approximately 200 kg, find the work done by the rocket engine.

A 1500-kg car's brakes failed and it coasts down a hill from rest. The hill is 10 m high and the car has a speed of 12 m/s at the bottom of the hill. How much work did friction do on the car?

Captain Proton's rocket pack provides 800,000 J of work to propel him from resting on his ship which is near the earth to 50 m above it. Captain Proton's mass is 90 kg. What is his final velocity?

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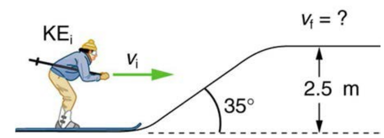
Practice Work

1. List four different forms or types of energy. Give one example of a conversion from each of these forms to another form.
2. A basketball player makes a jump shot. The 0.600-kg ball is released at a height of 2.00 m above the floor with a speed of 7.20 m/s. The ball goes through the net 3.10 m above the floor at a speed of 4.20 m/s. What is the work done on the ball by air resistance, an external force? (Cutnell 6.46) **−3.8 J**
3. A projectile of mass 0.750 kg is shot straight up with an initial speed of 18.0 m/s. (a) How high would it go if there were no air friction? (b) If the projectile rises to a maximum height of only 11.8 m, determine the magnitude of the average force due to air resistance. (Cutnell 6.48) **16.5 m, 2.9 N**
4. The external force pulling a 1500-kg car up a mountain road does 4.70×10^6 J of work on the car. The car starts from rest at sea level and has a speed of 27.0 m/s at an altitude of 200 m above sea level. Obtain the work done on the car by the combined forces of friction and air resistance, both of which are nonconservative forces. (Cutnell 6.49) $\mathbf{-1.21 \times 10^6}$ **J**
5. A 60.0-kg skier with an initial speed of 12.0 m/s coasts up a 2.50-m high rise as shown in the figure. Find her final speed at the top, given that the coefficient of friction between her skis and the snow is 0.0800. (Hint: Find the distance traveled up the incline assuming a straight-line path as shown in the figure.) (OpenStax 7.24) **9.46 m/s**



6. (a) How high a hill can a car coast up (engine disengaged) if work done by friction is negligible and its initial speed is 110 km/h? (b) If, in actuality, a 750-kg car with an initial speed of 110 km/h is observed to coast up a hill to a height 22.0 m above its starting point, how much thermal energy was generated by friction? (c) What is the average force of friction if the hill has a slope 2.5° above the horizontal? (OpenStax 7.25) **47.6 m,** $\mathbf{1.88 \times 10^5}$ **J, 374 N**
7. Using energy considerations and assuming negligible air resistance, show that a rock thrown from a bridge 20.0 m above water with an initial speed of 15.0 m/s strikes the water with a speed of 24.8 m/s independent of the direction thrown. (OpenStax 7.27) **24.8 m/s**
8. If the energy in fusion bombs were used to supply the energy needs of the world, how many of the 9-megaton variety would be needed for a year's supply of energy (using data from Table 7.1)? This is not as farfetched as it may sound—there are thousands of nuclear bombs, and their energy can be trapped in underground explosions and converted to electricity, as natural geothermal energy is. (Annual world energy use = 4×10^{20} J; Large fusion bomb (9 megaton) = 3.8×10^{16} J) (OpenStax 7.28) $\mathbf{1 \times 10^4}$ **bombs**
9. Use of hydrogen fusion to supply energy is a dream that may be realized in the next century. Fusion would be a relatively clean and almost limitless supply of energy. To illustrate this, calculate how many years the present energy needs of the world could be supplied by one millionth of the oceans' hydrogen fusion energy. (Fusion of all the hydrogen in Earth's oceans = 10^{34} J; Annual world energy use = 4×10^{20} J) (OpenStax 7.29) $\mathbf{2.5 \times 10^7}$ **years**