As a skydiver falls at constant terminal velocity, does her total mechanical energy (potential energy plus kinetic energy) remain constant? Why or why not? Is total energy conserved in this situation? Explain.

Energy is always conserved, but different types don't remain constant

The change in gravitational potential energy is -F_g * change in h. He height is changing as she falls. Therefore, **the potential energy would be changing**. So, the addition of potential and kinetic energy would not be constant.

As the skydiver falls, she is facing air resistance. This is causing a frictional force pushing against her. Because of this, the total energy is conserved.

Be careful with wording!

No, her mechanical energy is not conserved, but decreases as she falls. **Since the skydiver is falling at a constant terminal velocity, her kinetic energy remains constant**. However, her potential energy will decrease as she falls, because her displacement is becoming more negative. Since mechanical energy is the sum of kinetic and potential, it will therefore not be **conserved**. Although mechanical energy is not conserved, total energy is conserved in this situation as described by the law of conservation of energy, because **the force of friction from air resistance is doing negative work on the skydiver**.

Another illustration about words!

A skydiver falling at constant terminal velocity implies that they are no longer accelerating and the net force = 0. There are two forces acting on the skydiver: gravity and air resistance. **Because the skydiver is moving steadily, the kinetic energy does not change (1/2mv^2). However, because the diver is changing height, the potential energy is changing. Therefore, her total mechanical energy does not remain constant.** Because air resistance is a non-conservative force, **energy is not conserved in this situation**.

Important: kinetic energy only includes the center of mass motion

Her total mechanical energy is not constant; because as she falls, her gravitational potential energy decreases at a constant but rapid rate while **her kinetic energy only increases slowly from the heat generated via friction with the air passing by her.**

A typical electric bill specifies how much electricity a household consumes in units of kilowatt-hours abbreviated kW-hr (i.e., 1000 watts of power times 1 hour of time). What is the corresponding proper SI unit for the quantity expressed as 1 kW-hr? Calculate the conversion factor between the two units. If the going rate is 10 cents/kW-hr, estimate the cost of raising a piano from street level to a tenth floor apartment, neglecting the cost of labor, pizza, and/or donuts. Please explain your reasoning fully and carefully.

Near perfect answer...except for not using scientific notation

(1 kW* 1 hr)(60 min/ 1hr)(60 s/ 1min)(1000 W/ 1 kW) = (1000 W *3600 s) = (1000 J/s)(3600 s) = 3,600,000 J

1 kW-hr = 3,600,000 J

One floor of an apartment complex is about 3 meters, so **ten floors would be about thirty meters**. A piano might weigh about 200 pounds, or have a mass of about 100 kg. The force of gravity is equal to (9.8 N/kg)(100 kg) = 980 N

Since this force is being applied over 30 meters, **the energy expended is equal to (980 N)(30 m)** which is around 30,000 J. Using the conversion above, this would be (30,000/3,600,000) kW-hr or (1/120) kW-hr. This times (10 cents/kW-hr) would be about **1/12 of a cent.**

Another excellent example, though g is in the wrong units

First, I want to get kW-hr into kW-sec so that the later units can match and cancel. There are 3600 seconds per hour, so if I multiply 1 kW-hr by 3600 sec/hr, I will get 3600 kW-sec. 1 kW equals 1 kJoule/sec, so 3600 kW-sec equals 1 kJoule-sec/sec. The seconds cancel and we are left with **3600 kJ.**

Assuming there is a wench or lift of some kind to elevate the piano 10 floors vertically, **I would estimate it would take a standard lift maybe 90 seconds to go up 10 floors**. A single floor (estimating using the rough height of my room) is probably around 3 meters including the thickness of the ceiling. So ten of these floors would be around 30 meters in height. The change in potential energy from ground level to the 10th floor would be the difference between the potential energies of height = 30 meters and height = 0m. The potential energy at ground level would be 0 joules, and the potential energy at height = 30 meters would be the mass of the piano (around 250 kg) **times the acceleration due to gravity (10 m/s^2)** times the height (30 meters). The change in potential energy is around 75,000 joules, or 75 kJ. From the previous problem, I know that 1 kW-hr equals 3600 kJ, so if I divide the change in potential energy by 3600 kJ, I can find the kW-hr used to move the piano. **75 goes into 3600 almost 50 times, so the inverse of that is 1/50, or 0.02 kW-hr.** If the rate is 10 cents per kW-hr, and 0.02 kW-hr was used, then the total cost of using that power would be roughly **0.2 cents.**

Which of the following doesn't involve a conservative force?

a. Friction
b. Gravity
c. Springs
d. Republicans
e. Tories