W6.01

Energy

Quick-Hit Work & Energy

1. A 75.0-kilogram firefighter climbs a flight of stairs 10.0 meters high.
    a. How much work is required?
    b. If she does this in 7.8 seconds, how much power is she exerting?

2. Neglecting air resistance, how high will a 0.325-kilogram rock go if thrown straight up by someone who does 115 J of work on it?

3. A hammerhead with a mass of 2.0 kilogram is allowed to fall onto a nail from a height of 0.40 meters.
    a. What is the maximum amount of work it could do on the nail?
    b. Why do people not just "let it fall" but add their own force to the hammer as it falls?

4. At room temperature, an oxygen molecule, with a mass of 5.31×10^{-26} kilograms, typically has a kinetic energy of about 6.21×10^{-21} joules. How fast is it moving?

5. A 1,200-kilogram car traveling at 110 kilometers per hour (30.55 m/s) comes to a stop.
    a. How much work (negative) was done on the car?
    b. Where the car's kinetic energy go?

6. A baseball (m = 0.140 kilograms) traveling at 35 meters per second moves a fielder's glove backwards 0.25 meters when the ball is caught and brought to rest. What is the average force exerted by the ball on the glove?

7. A soccer player (m = 63 kilograms) is running at 6.2 meters per second. She then slides on the ground, coming to rest.
    a. How much work did she do on the ground.
    b. Where the player's kinetic energy go?

8. Jane, looking for Tarzan, is running at top speed (5.6 m/s) and grabs a vine hanging vertically from a tall tree in the jungle.
    a. How high can she swing upward?
    b. Does the length of the vine affect your answer?

9. In the high jump, the kinetic energy of an athlete is transformed into gravitational potential energy. With what minimum speed must the athlete leave the ground in order to lift her center of mass 2.10 meters across the bar with a speed of 0.70 meters per second?

10. Two railroad cars, each of mass 6,500 kilograms and traveling at 17 meters per second, collide head-on and come to rest. How much thermal energy is produced in this collision?

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1. a) 7,500 joules
   b) 961.538 watts

2. 35.38 m

3. a) 8 joules
   b) The person adds more energy.

4. 483.63 m/s

5. a) 560,185.18 joules
   b) Heat & sound (thermal energy).

6. F_{glove}=343 N [85.75 joules "lost"]

7. a) 1,210.86 joules
   b) Heat & sound (thermal energy).

8. a) 1.568 meters [KE converted into GPE & mass cancels]
   b) Independent of length [$1/2(v)^2=gh$]

9. 6.52 m/s [KE_{bottom} converted into GPE_{top} + KE_{top} Note: mass cancels]

10. 1,878,500 joules [939,250 joules each]