Energy Conservation, problems 10-13 solutions

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10. A 5-kg projectile is launched straight up with a speed of 80 m/sec.

(a) What is its initial K?
(b) How high will it go? (Ignore air resistance.)
(c) If the projectile only goes 120 meters high, what percentage of the initial energy of the projectile was "stolen" by air resistance, ending up as heat?

11. If the projectile in the previous problem is viewed from the ground, a distance of 50 meters from the launcher, then what angle will it make at the moment it's at its apogee?

(10) (a) $K_i = \frac{1}{2} m v_i^2 = \frac{1}{2}(5\text{kg})(80\ \text{m/sec})^2 = 16000\text{J}$
$= 16\text{ kJ}$

(b) $E_{initial} = E_{final}$

$U_{gi} + K_i = U_{gf} + K_f$ ($U_{gi} \to 0$, $K_f \to 0$)

$\frac{1}{2} m v_i^2 = mgh_f$

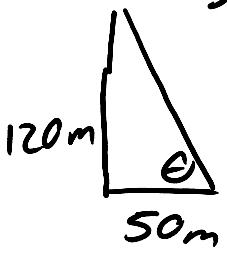
$h_f = \frac{v_i^2}{2g} = \frac{(80\ \text{m/sec})^2}{2(9.8\ \text{m/sec}^2)} = 330\text{ m}$

(c) It has a U_g at apogee of...

$U_g = mgh = 5\text{kg}\ 9.8\ \text{m/sec}^2\ 120\text{m}$
$= 5900\text{J}$

so it has only $\frac{5900}{16000} = 37\%$ of its initial energy, so it must have lost 63%

(11)



$\theta = \tan^{-1}\left(\frac{120}{50}\right) = 67°$

12. When a bow and arrow is pulled back, what kind of energy are you giving it by way of your work?

13. A roller coaster car is pulled up the first (biggest) hill, 32 meters above the ground. Assuming there's no friction, how fast would the car be moving at the top of a loop-the-loop, 18 meters above the ground?

(12) elastic potential energy

(13) $E_{initial} = E_{final}$

$K_i + U_{gi} = K_f + U_{gf}$

$K_i \to 0$

$mgh_i = \frac{1}{2}mv_f^2 + mgh_f$

$gh_i = \frac{1}{2}v_f^2 + gh_f$

$v_f^2 = (gh_i - gh_f) \cdot 2$

$v_f^2 = 2g(h_i - h_f)$

$v_f = \sqrt{2g(h_i - h_f)} = \sqrt{2\left(9.8\frac{m}{sec^2}\right)(32m - 18m)}$

$= 17\frac{m}{sec}$