CHAPTER FIVE SOLUTIONS

HOMEWORK SET #6 SOLUTIONS

Review (a) Using energy concepts: Choose final level of the object as zero PE level. $(KE + PE)_{\text{initial}} + W_{nc} = (KE + PE)_{\text{final}}$ with $y_i = 4.0 \sin 30° = 2.0$ m and $y_f = 0$

$$\frac{1}{2} m v_i^2 + mgy_i + (Fs - fs) = \frac{1}{2} m v_f^2 + mgy_f$$

$$0 + 10(9.80)2.0 + (80(4.0) - 20(4.0)) = \frac{1}{2}(10)\, v^2 + 0$$

which yields $v_f = 9.3$ m/s

(b) Applying Newton's second law to the motion parallel to the incline: $F_{net} = ma$ gives $F + mg\sin\theta - f = ma$,

or $80 + 10(9.80)\sin 30° - 20 = 10a$

This yields $a = 10.9$ m/s^2. Then the final velocity is found by $v^2 = v_o^2 + 2as = 0 + 2(10.9)4.0$, which yields $v = 9.3$ m/s

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5.5 (a) The force of gravity is given by $mg = 5.0(9.80) = 49$ N and is directed downwards. The angle between the force of gravity and the direction of motion is $\theta = 90° - 30° = 60°$, and so the work done by gravity is given as $W_g = 49(2.5) \cos 60° = 61$ J.

(b) The normal force exerted on the block by the incline is

$N = mg\cos 30° = 42.4$ N,

so the friction force is $f_k = \mu_k N = 0.436(42.4 \text{ N}) = 18.5$ N. This force is directed opposite to the displacement (i.e. $\theta = 180°$). Therefore the work it does is

$W_f = f_k s \cos\theta = (18.5 \text{ N})(2.5 \text{ m})(\cos 180°)$, giving $W_f = -46$ J.

(c) Since the normal force is perpendicular to the displacement, the work done by the normal force is zero.

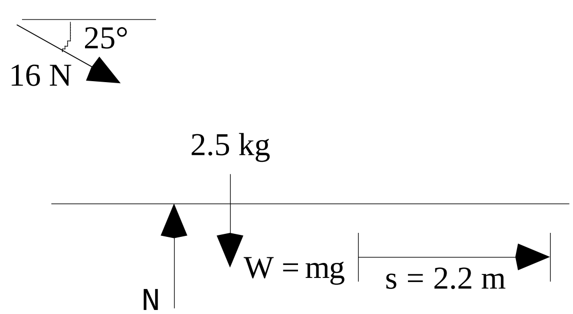
5.16 The initial kinetic energy of the sled is $KE_i = \frac{1}{2}(10 \text{ kg})(2.0 \text{ m/s})^2 = 20$ J,

and the force of friction is, $f = \mu_k N = (0.1)(98 \text{ N}) = 9.8$ N.

$W = fs(\cos 180°) = KE_f - KE_i$, or

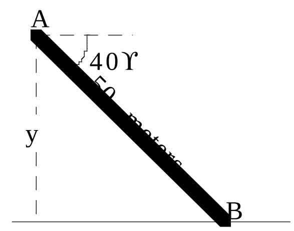
$(9.8 \text{ N})s(-1) = 0 - 20$ J,

from which, $s = 2.0$ m.



5.24 (a) We take the zero level for potential energy at the level of point B, and use $\frac{1}{2} m v_i^2 + mgy_i = \frac{1}{2} m v_f^2 + mgy_f$ to obtain

$0 + (0.400 \text{ kg})g(5.00 \text{ m}) = \frac{1}{2}(0.400 \text{ kg})\, v_B^2 + 0$. From this, $v_B = 9.90$ m/s.



(b) At point C,with the starting point at A, we again use

$\frac{1}{2}\ mv_i^2 + mgy_i = \frac{1}{2}\ mv_f^2 + mgy_f$ and obtain

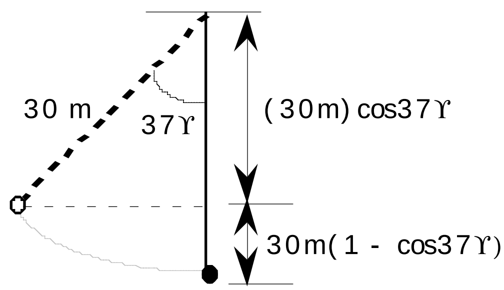
$0 + (0.400\ \text{kg})g(5.00\ \text{m}) = \frac{1}{2}(0.400\ \text{kg})\ v_c^2 + (0.400\ \text{kg})g(2.00\ \text{m}),$

giving $v_c = 7.67$ m/s.

5.26 (a) We choose the zero level for potential energy at the bottom of the arc. The initial height of Tarzan above this level is shown in the sketch to be

$(30\text{m})(1 - \cos37°) = 6.04$ m.

We use conservation of mechanical energy.



$\frac{1}{2}\ mv_i^2 + mgy_i = \frac{1}{2}\ mv_f^2 + mgy_f$

$0 + mg(6.04\ \text{m}) = \frac{1}{2}\ mv^2 + 0.$ From which, $v = 10.9$ m/s.

(b) In this case, conservation of mechanical energy becomes

$\frac{1}{2}\ mv_i^2 + mgy_i = \frac{1}{2}\ mv_f^2 + mgy_f$, or

$\frac{1}{2}\ m(4.00\ \text{m/s})^2 + mg(6.04\ \text{m}) = \frac{1}{2}\ mv^2 + 0$, which gives $v = 11.6$ m/s.

5.28 (a) Letting m the the mass of the projectile, k be the spring constant, d be 0.120 m, and $H = 20.0$ m, we have, using conservation of energy

$\frac{1}{2}\ kd^2 = mgH$, or $k = \frac{2mgH}{d^2} = \frac{2(0.02)(9.80)(20.0)}{(0.120)^2} = 544$ N/m.

(b) Here we have $\frac{1}{2}\ kd^2 = mgd + \frac{1}{2}\ mv^2$, so that

$$v = \sqrt{\frac{kd^2}{m} - 2gd} = \sqrt{\frac{(544.4)(0.120)^2}{0.020} - 2(9.80)(0.120)} = 19.7\ \text{m/s}.$$

5.31 (a) Choose the zero level for potential energy at the level of B. Between A and B, we can use $\frac{1}{2}\ mv_i^2 + mgy_i = \frac{1}{2}\ mv_f^2 + mgy_f$ which becomes

$0 + (0.400\ \text{kg})g(5.00\ \text{m}) = \frac{1}{2}(0.400\ \text{kg})\ v_B^2 + 0$, yielding $v_B = 9.90$ m/s.

(b) We choose the starting point at B, the zero level at B, and the end point at C. $W_{nc} = \frac{1}{2}\ mv_f^2 - \frac{1}{2}\ mv_i^2 + mgy_f - mgy_i$ giving

$W_{nc} = 0 - \frac{1}{2}(0.400\ \text{kg})(9.90\ \text{m/s})^2 + (0.400\ \text{kg})g(2.00\ \text{m}) - 0$, or

$W_{nc} = -11.8$ J. Thus, 11.8 J of energy is "lost" overcoming friction.

5.33 We shall take the zero level of potential energy to be at the lowest level reached by the diver under the water.

$W_{nc} = \frac{1}{2}\ mv_f^2 - \frac{1}{2}\ mv_i^2 + mgy_f - mgy_i$

$\bar{F}(5.0\ \text{m})\cos 180° = 0 - 0 + 0 - (70\ \text{kg})g(15\ \text{m})$, or

$\bar{F} = 2.1 \text{ x} 10^3$ N.

5.43 $P = \dfrac{energy\ spent}{\Delta t} = \dfrac{(\Delta m)gh}{\Delta t} = (1.2 \text{ x } 10^6)(9.80)(50)$

$= 5.88 \text{ x } 10^8 \text{ W} = 590 \text{ MW}.$

5.69 Choose $y = 0$ at the river. Then $y_i = 36$ m, $y_f = 4$ m, the jumper falls 32.0m, and the cord stretches 7.0 m. Between bridge and bottom,

$$mgy_i = mgy_f + \frac{1}{2} kx_f^2$$

$$(700 \text{ N})(36.0 \text{ m}) = (700 \text{ N})(4.0 \text{ m}) + \frac{1}{2} k(7.0 \text{ m})^2$$

$$k = 914 \text{ N/m}$$

ANSWERS TO CONCEPTUAL QUESTIONS

4. (a) Kinetic energy is always positive. Mass and speed squared are both positive. (b) Gravitational potential energy can be negative when the object is below, closer to the Earth, the chosen zero level.

10. The effects are the same except for such features as having to overcome air resistance outside. The person must lift his body slightly with each step on the tilted treadmill. Thus, the effect is that of running uphill.

12. As the person runs she gains kinetic energy and this adds to the gravitational potential energy she has at the top of her jump, thus increasing her height. Also, stored elastic potential energy in the pole is converted to gravitational potential energy at the top of the leap.

16. The kinetic energy is a maximum at the instant the ball is released. The gravitational potential energy is a maximum at the top of the flight path.