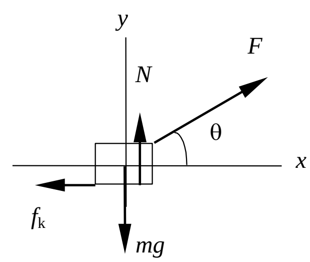
$\boxed{8}$. $W = F\cos\theta\, d$, ☞ $F = \dfrac{W}{d\cos\theta} = \dfrac{50\text{ J}}{(10\text{ m})\cos 0^\circ} = \boxed{5.0\text{ N}}$.

9. The friction force is $f_k = \mu_k N = \mu_k mg$, and the angle between the friction force and displacement is 180°.

So $W = F\cos\theta\, d = \mu_k mg\cos\theta\, d = 0.20(5.0\text{ kg})(9.80\text{ m/s}^2)\cos 180^\circ\,(10\text{ m}) = \boxed{-98\text{ J}}$.

$\boxed{14}$. $\Sigma F_y = N + F\sin\theta - mg = 0$, $N = mg - F\sin\theta$.



$\Sigma F_x = F\cos\theta - f_k = 0$, or $F\cos\theta = \mu_k N = \mu_k(mg - F\sin\theta) = 0$.

So $F = \dfrac{\mu_k mg}{\cos\theta + \mu_k\sin\theta} = \dfrac{0.20(35\text{ kg})(9.80\text{ m/s}^2)}{\cos 30^\circ + 0.20\sin 30^\circ} = 71.0\text{ N}$.

Therefore $W = F\cos\theta\, d = (71.0\text{ N})\cos 30^\circ\,(10\text{ m}) = \boxed{6.1\times 10^2\text{ J}}$

20. $f_k = \mu_k N = = \mu_k mg = (0.600)(100\text{ kg})(9.80\text{ m/s}^2) = 588\text{ N}$.

$f_s = \mu_s N = = \mu_s mg = (0.750)(100\text{ kg})(9.80\text{ m/s}^2) = 735\text{ N}$.

A force equal to $f_s = 735$ N is required to move the desk.

Once the desk starts moving, the applied force creates acceleration, because the friction force is kinetic now.

$\Sigma F = 735\text{ N} - 588\text{ N} = 147\text{ N} = ma$, ☞ $a = \dfrac{147\text{ N}}{100\text{ kg}} = 1.47\text{ m/s}^2$.

$d = (x - x_o) = v_o t + \frac{1}{2}at^2 = 0 + \frac{1}{2}(1.47\text{ m/s}^2)(5.00\text{ s})^2 = 18.375\text{ m}$.

$W = F\cos\theta\, d = (735\text{ N})\cos 0^\circ\,(18.375\text{ m}) = \boxed{1.35\times 10^4\text{ J}}$.

23. $\boxed{\text{No}}$, it takes more work. This is because the $\boxed{\text{force increases as the spring stretches}}$, according to Hooke's law: $F_s = -kx$. Also the displacement is greater.

24. (d) $W = \frac{1}{2}k(x^2 - x_o^2)$, ☞ $\dfrac{W_2}{W_1} = \dfrac{x_2^2 - x_1^2}{x_1^2 - x_o^2} = \dfrac{4.0^2 - 2.0^2}{2.0^2 - 0^2} = 3$ so $\boxed{\text{three times as much}}$.

25. $F_s = -kx$, ☞ $k = \left|\dfrac{F_s}{x}\right| = \dfrac{4.0\text{ N}}{0.050\text{ m}} = \boxed{80\text{ N/m}}$.

$\boxed{26}$. $W = \frac{1}{2}kx^2 = \frac{1}{2}(30\text{ N/m})(0.020\text{ m})^2 = \boxed{6.0\times 10^{-3}\text{ J}}$.

27. $W = \frac{1}{2}kx^2$, ☞ $k = \dfrac{2W}{x^2} = \dfrac{2(400\text{ J})}{(0.0800\text{ m})^2} = \boxed{1.25\times 10^5\text{ N/m}}$.

33. (a) $W = \frac{1}{2}kx^2 = \frac{1}{2}(2.5\times 10^3\text{ N/m})(0.060\text{ m})^2 = \boxed{4.5\text{ J}}$.

(b) The difference in work is $\Delta W = \frac{1}{2}k(x_2^2 - x_1^2) = \frac{1}{2}(2.5\times 10^3\text{ N/m})[(0.080\text{ m})^2 - (0.060\text{ m})^2] = \boxed{3.5\text{ J}}$.

35. Work is equal to the area under the force versus displacement curve. There are two areas.

The first one is a triangle starting from the origin.

$W_1 = \frac{1}{2}(20 \text{ N})(0.30 \text{ m}) = 3.0 \text{ J}$.

The second one is a triangle plus a rectangle.

$W_2 = \frac{1}{2}(20 \text{ N})(0.10 \text{ m}) + (20 \text{ N})(0.10 \text{ m}) = 3.0 \text{ J}$.

Therefore the total work is 3.0 J + 3.0 J = $\boxed{6.0 \text{ J}}$.

38. (b), because $\cos\theta < 0$ for $90° < \theta < 270°$ and $W = F\cos\theta\, d = \Delta K$. So K decreases.

39. (c). The kinetic energy of each car is the same, and let's assume it is K. For the two cars colliding head on, the total kinetic energy is $2K$, and that amount is shared by the two cars, so each gets K and that energy causes certain amount of damage. For the car that crashed into a wall, the total kinetic energy is K, but that is shared by the car and the wall. So the car into the wall absorbs less energy and therefore less damage.

40. (a). $K = \frac{1}{2}mv^2$.

$K_a = \frac{1}{2}(4m)v^2 = 2mv^2$; $K_b = \frac{1}{2}(3m)(2v)^2 = 6mv^2$;

$K_c = \frac{1}{2}(3m)(3v)^2 = 13.5mv^2$; $K_d = \frac{1}{2}(2m)(3v)^2 = 9mv^2$.

41. $\boxed{\text{Reducing speed}}$ by half. Since $K = \frac{1}{2}m\,v^2$, reducing the speed by half will reduce K by ¾, whereas reducing the mass by half will only reduce K by half.

$\boxed{46}$. (a) 90 km/h = 25 m/s. $K_o = \frac{1}{2}m\,v_o^2 = \frac{1}{2}(1.2 \times 10^3 \text{ kg})(25 \text{ m/s})^2 = \boxed{3.8 \times 10^5 \text{ J}}$.

(b) $W = \frac{1}{2}m\,v^2 - \frac{1}{2}m\,v_o^2 = 0 - 3.8 \times 10^5 \text{ J} = \boxed{-3.8 \times 10^5 \text{ J}}$.

51. For an object on an incline, the normal force is equal to $n = mg\cos\theta$. (See Exercise 4.61b.)

$f_k = \mu_k N = \mu_k mg\cos\theta = (0.30)(5000 \text{ kg})(9.80 \text{ m/s}^2)\cos 15° = 1.42 \times 10^4 \text{ N}$.

Two forces are doing non-zero work, the frictional force and the gravitational force.

$W = \frac{1}{2}m\,v^2 - \frac{1}{2}m\,v_o^2$, ☞ $f_k\cos 180°\, x + mg\cos(90 - \theta)\, x = \frac{1}{2}m\,v^2 - \frac{1}{2}m\,v_o^2 = 0 - \frac{1}{2}m\,v_o^2$.

$-(1.42 \times 10^4 \text{ N})x + (5000 \text{ kg})(9.80 \text{ m/s}^2)(\sin 15°)x = -\frac{1}{2}(5000 \text{ kg})(35.0 \text{ m/s})^2$,

solving, $x = \boxed{2.0 \times 10^3 \text{ m}}$.

56. $U = \frac{1}{2}kx^2$, so $\Delta U = \frac{1}{2}k(x^2 - x_o^2) \propto \boxed{x^2 - x_o^2}$.

57. They will have the $\boxed{\text{same potential energy}}$ at the top because they have the same height. ($U = mgy$)

58. $U = mgy$, ☞ $\Delta U = mg\Delta y = (1.0 \text{ kg})(9.80 \text{ m/s}^2)(1.2 \text{ m} - 0.90 \text{ m}) = \boxed{2.9 \text{ J}}$.

65. (a) The component of the weight, *mg*, of the object along the incline (parallel to the spring) is equal to *mg* sin *θ*. (See Exercise 4-69.) This is the force that stretches the spring.

$x = \left|\frac{F_s}{k}\right| = \frac{mg \sin\theta}{k} = \frac{(1.50\text{ kg})(9.80\text{ m/s}^2)\sin 30°}{175\text{ N/m}} = 0.0420\text{ m}.$

$\Delta U_s = \frac{1}{2}k x^2 - \frac{1}{2}k x_o^2 = \frac{1}{2}(175\text{ N/m})(0.0420\text{ m})^2 - 0 = \boxed{0.154\text{ J}}.$

(b) The vertical distance the mass moves down is equal to $x \sin\theta = (0.0420\text{ m})\sin 30° = 0.0210\text{ m}$.

$\Delta U_g = mg\Delta y = (1.50\text{ kg})(9.80\text{ m/s}^2)(-0.0210\text{ m} - 0) = \boxed{-0.309\text{ J}}.$

76. The total mechanical energy is conserved, because there are no non-conservative forces that are doing work.

When *m* falls 1.00 m, *M* will move up the incline 1.00 m and therefore move up (vertically) a distance of (1.00 m) sin 5° = 0.0872 m. $\frac{1}{2}Mv^2 + \frac{1}{2}mv^2 + \Delta U_M + \Delta U_m = 0.$ So,

$\frac{1}{2}(1.00\text{ kg} + 0.200\text{ kg})v^2 + (1.00\text{ kg})(9.80\text{ m/s}^2)(0.0872\text{ m}) - (0.200\text{ kg})(9.80\text{ m/s}^2)(1.00\text{ m}) = 0.$

Solving, $v = \boxed{1.36\text{ m/s}}.$

79. (a) $\frac{y_1}{y_o} = \frac{E_1}{E_o} = 0.820,$ ☞ $y_1 = 0.820\,y_o = (0.82)(1.25\text{ m}) = \boxed{1.03\text{ m}}.$

(b) $y_2 = 0.82y_1 = (0.820)(1.025\text{ m}) = \boxed{0.841\text{ m}}.$

(c) The kinetic energy of the ball must be equal to the lost mechanical energy.

$K_o = 0.180\,E_o = 0.180\,(K_o + U_o),$ so $K_o = \frac{0.180\,U_o}{0.820} = 0.2195U_o = 0.2195\,mg\,(1.25\text{ m}) = \frac{1}{2}m v_o^2.$

Therefore $v_o = \sqrt{2(0.2195)(9.80\text{ m/s}^2)(1.25\text{ m})} = \boxed{2.32\text{ m/s}}.$

88. When *m* moves with 1.50 m/s, *M* also moves with the same speed. Mechanical energy is conserved here. If *m* moves down a distance *y*, *M* will move up (vertically) a distance of *y* sin 20°, and the spring will stretch a distance of *y*.

$K_{oM} + K_{om} + U_{oM} + U_{om} + U_{os} = K_M + K_m + U_M + U_m + U_s.$

$K_M = K_m = 0$ (coming to rest). $\frac{1}{2}(M + m)v_o^2 = mg(-y) + Mgy(\sin 20°) + \frac{1}{2}k y^2.$

Reducing to quadratic equation: $12.5\,y^2 + 2.96y - 1.17 = 0.$

Solving, $y = \boxed{0.21\text{ m}}.$

91. $\boxed{\text{No, paying for energy}}$ because kWh is the unit of power × time = energy.

$2.5\text{ kWh} = 2500\text{ Wh} = (2500\text{ Wh}) \times \frac{3600\text{ s}}{1\text{ h}} = \boxed{9.0 \times 10^6\text{ J}}.$

101. (a) $P = \frac{W}{t} = \frac{Fd}{t} = \frac{mgd}{t} = \frac{(70\text{ kg})(9.80\text{ m/s}^2)(8.0\text{ m})}{10\text{ s}} = \boxed{5.5 \times 10^2\text{ W}}.$

(b) $(5.5 \times 10^2 \text{ W}) \times \dfrac{1 \text{ hp}}{746 \text{ W}} = \boxed{0.74 \text{ hp}}$.

103. 850 km/h = 236.1 m/s. The work required is

$W = \Delta E = K + U = \frac{1}{2}(3.25 \times 10^3 \text{ kg})(236.1 \text{ m/s})^2 + (3.25 \times 10^3 \text{ kg})(9.80 \text{ m/s}^2)(10.0 \times 10^3 \text{ m})$

$= 4.091 \times 10^8$ J.

The energy output is $E = Pt = (1500 \text{ hp})(746 \text{ W/hp})(12.5 \text{ min})(60 \text{ s/min}) = 8.393 \times 10^8$ J.

So the efficiency is $\varepsilon = \dfrac{4.091}{8.393} = \boxed{48.7\%}$.

109. Choose the bottom of the swing as the reference level for gravitational potential energy. The total initial mechanical energy is all gravitational potential.

$E_o = mgy_o$.

From Exercise 5-82, the initial height relative to the bottom of the swing is $y_o = L(1 - \cos\theta)$.

When he stops, the mechanical energy is zero, and this is due to the work done by the kinetic frictional force (non-conservative force). The friction force is equal to $f_k = \mu_k N = \mu_k mg$.

$W_{nc} = E - E_o$, ☛ $f_k \cos 180° \, d = -\mu_k mgd = 0 - mgL(1 - \cos\theta)$.

So $d = \dfrac{L(1 - \cos\theta)}{\mu_k} = \dfrac{(15.0 \text{ m})(1 - \cos 60°)}{0.75} = \boxed{10 \text{ m}}$.