Solutions to HW15, Chapter 9

NOTE! The problems in masteringphysics.com had their numbers altered slightly for each individual student. The solutions below use the same numbers as those used in the book for that problem!

9.10. Model: Model the girder as a particle with no air resistance.
Visualize: We are given $v_{0y} = -4.0$ m/s and $y_0 = 35$ m, and $y_1 = 0$ m.
Solve: (a) The gravitational force exerted by the earth is $F_G = mg$. The work done is then

$$W = \int_{y_0}^{y_1} F_y dy = F_y \Delta y = -mg\Delta y = -(750 \text{ kg})(9.8 \text{ m/s}^2)(3.5 \text{ m}) = -25725 \text{ J}$$

We report this as –26 kJ.
(b) The net (total) work done on the girder is its change of kinetic energy.

$$\Delta K = \tfrac{1}{2}m(v_f^2 - v_i^2) = \tfrac{1}{2}(750 \text{ kg})((0.75 \text{ m/s})^2 - (0.25 \text{ m/s})^2) = 187.5 \text{ J}$$

The work done by tension is the total work minus the work done by gravity.

$$W_{\text{tension}} = W_{\text{total}} - W_{\text{grav}} = 187.5 \text{ J} - (-25725 \text{ J}) = 25900 \text{ J}$$

We report this as 26 kJ.
Assess: The magnitudes of the answers are the same because we rounded both to two significant figures.

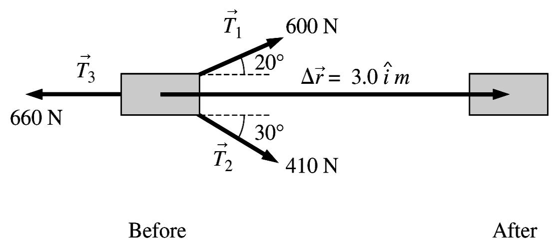
9.12. a) (3) (2) + (4) (-6) = -18 b) (3) (6) + (-2) (4) = 10

9.13.
a) The length of vector *A* is sqrt ($3^2 + 4^2$) = 5. Similarly, the length of *B* is 6.32. From the previous question, the dot product of *A* and *B* is -18. Using the definition of the dot product which says the dot product of two vectors is equal to the product of the magnitudes of the two vectors multiplied by the cosine of the angle between them (remember to join the tails of the two vectors!), we see that θ = $\cos^{-1}$ (-18) / (5 x 6.32) = 125^0.
b) The length of *A* is sqrt(13). The length of *B* is sqrt(52). So θ = $\cos^{-1}$ (10) / (13 x 2) = 67^0.

9.15
a) The dot product is (2) (4) cos 110^0 = -2.7
b) (5) (4) cos180^0 = -20
c) (4) (3) cos30^0 = 10

Some of the fonts in 9.19 below are weird. Hopefully they won't confuse you. Let me know if you have questions…

9.19. Model: Model the crate as a particle and use $W = \vec{F} \cdot \Delta\vec{r}$, where W is the work done by a force $\vec{F}$ on a particle and $\Delta\vec{r}$ is the particle's displacement.
Visualize:



Solve: For the tension $\vec{T}_1$:

$$W = \vec{T}_1 \cdot \Delta\vec{r} = (T_1)(\Delta r)\cos(20°) = (600\text{ N})(3.0\text{ m})(0.9397) = 1.7\text{ kJ}$$

For the tension $\vec{T}_2$:

$$W = \vec{T}_2 \cdot \Delta\vec{r} = (T_2)(\Delta r)\cos(30°) = (410\text{ N})(3.0\text{ m})(0.866) = 1.1\text{ kJ}$$

For the force $\vec{T}_3$:

$$W = \vec{T}_3 \cdot \Delta\vec{r} = (T_3)(\Delta r)\cos(180°) = (660\text{ N})(3.0\text{ m})(-1.0) = -2.0\text{ kJ}$$

Assess: Negative work done by the force of kinetic friction $\vec{T}_3$ means that 1.95 kJ of energy has been transferred *out* of the crate.

9.20. Model: Use the definition of work.
Visualize: Please refer to Figure EX9.20.
Solve: Work is defined as the area under the force-versus-position graph:

$$W = \int_{s_i}^{s_f} F_s ds = \text{area under the force curve}$$

$$\text{Interval } 0-1\text{ m: } W = (4\text{ N})(1\text{ m} - 0\text{ m}) = 4\text{ J}$$
$$\text{Interval } 1-2\text{ m: } W = (4\text{ N})(0.5\text{ m}) + (-4\text{ N})(0.5\text{ m}) = 0\text{ J}$$
$$\text{Interval } 2-3\text{ m: } W = \tfrac{1}{2}(-4.0\text{ N})(1\text{ m}) = -2\text{ J}$$

9.22. Model: Use the work–kinetic energy theorem.
Visualize: Please refer to Figure EX9.22.
Solve: The work–kinetic energy theorem is

$$\Delta K = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 = \int_{0\text{ m}}^{x_f} F_x\,dx = 10x - \tfrac{5}{2}x^2$$

$$v_f = \sqrt{\frac{20x - 5x^2}{2.0\text{ kg}} + 4.0\text{ m/s}}$$

$$\text{At } x = 2\text{ m: } \Rightarrow \quad v_f = 5\text{ m/s}$$
$$\text{At } x = 4\text{ m: } \Rightarrow \quad v_f = 4\text{ m/s}$$