Constants

$R = 8.31$ J/(mol K) $\sigma = 5.67 \times 10^{-8}$ J/(s m^2 K^4) 1 kcal = 4186 J

Water: $L_f = 80$ cal/g $L_v = 540$ cal/g $G = 6.67 \times 10^{-11}$ Nm^2/kg^2

$M_E = 5.98 \times 10^{24}$ kg $R_E = 6.38 \times 10^3$ km $\rho_{ice} = 917$ kg/m^3

a. When 200 g of water at 15 °C is added to 300 g of soup at 98 °C to cool it, what will be the final temperature of the mixture? Take the specific heat of the soup to be 0.85 cal/g°C.

$200(T-15) = 300(98-T)(.85)$

$200T - 3000 = 24990 - 255T$

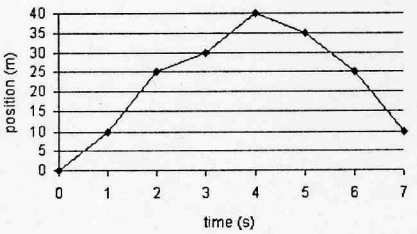
$455T = 27990$

$T = \boxed{61.5°C}$

b. Sound travels at a constant speed of 343 m/s. About how much time does it take for the sound of thunder to travel 1.609 km?

$t = \frac{x}{v} = \frac{1609}{343} = \boxed{4.7s}$

c. Consider the position vs time graph below. Between $t = 1$ and $t = 6$ find i) the average speed and ii) the average velocity.



i) $\frac{\text{dist}}{\text{time}} = \frac{45}{5} = \boxed{9 m/s}$

ii) $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{15}{5}$

$= \boxed{3 m/s}$

d. A person pulls a toboggan for a distance of 35 m along the snow with a rope directed at 60° above the snow. The tension in the rope is 100 N. How much work is done on the toboggan by the tension force?

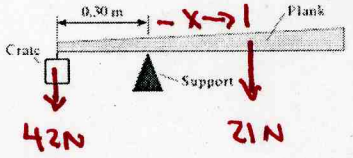
$W = (F\cos\theta)d$

$= (100\cos 60)\,35 = \boxed{1750 J}$

e. A 30.0 cm long piece of wire lengthens 1.62 mm when heated from 20 °C to 300 °C. What is the coefficient of linear thermal expansion for the material of the wire?

$\alpha = \frac{\Delta L}{L_0 \Delta T} = \frac{1.62 \times 10^{-3}}{.3(280)} = \boxed{1.9 \times 10^{-5} (°C)^{-1}}$

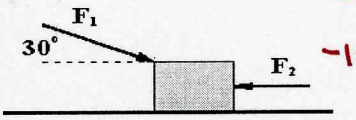
f. A 42-N crate is suspended from the left end of a nonuniform plank with weight 21 N. The system is balanced by a support that is 0.30 m from the crate. Where is the plank's center of gravity?



$.3(42) = 21x$

$x = \boxed{0.60 m}$

g. Two forces act on a 10.0 kg block as shown below. The magnitudes of the forces are $F_1 = 10.0$N and $F_2 = 16.7$N. What is the horizontal acceleration (magnitude and direction) of the block?



$-F_2 + F_1\cos 30 = ma$

$-16.7 + 10(.866) = ma$

$-8 = 10a$

$a = \boxed{-0.8 m/s^2}$

h. A spinning top decelerates at 3.0 rad/s^2 from an initial angular velocity of 20 rad/s. How many revolutions did the top make in during this time? (The top stops)

$\theta = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{-20^2}{2(-3)} = 67 rad = \boxed{10.6 rev}$

i. A stone of mass 100g is attached to a strong string and whirled in a vertical circle of radius 30 cm. At the exact top of the path the tension in the string is 3 times the stone's weight. What is the stone's speed at this point?

$T + W = m\frac{v^2}{r}$

$4mg = mv^2/r$

$v = \sqrt{4rg} = \boxed{3.4 m/s}$

j. A recording engineer works in a soundproofed room that is 40.0 dB quieter than outside. If the intensity in the room is 1.20×10^{-10} W/m^2, what is the intensity outside?

$\Delta\beta = 10\log(I_2/I_1)$

$4 = \log(I_2/I_1)$

$I_2/I_1 = 10^4 \Rightarrow I_2 = \boxed{1.2 \times 10^{-6} W/m^2}$

k. An organ pipe with both ends open has a length of 0.75 m. Assuming the speed of sound to be 343 m/s, what is the frequency of the third harmonic?

$f_3 = 3\frac{v}{2L} = \frac{3(343)}{2(.75)} = \boxed{686 Hz}$

l. From her bedroom window a girl drops a water-filled balloon 6.0 m to the ground. How long does it take to hit the ground?

$h = \frac{1}{2}gt^2$

$t = \sqrt{\frac{2h}{g}} = \boxed{1.1 s}$