X3.8c 107

Physics 107 (Kaldon) **Name** _____

WMU - Winter 1999

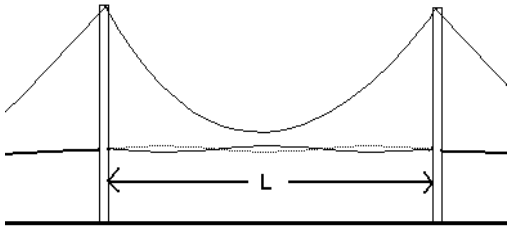
Exam 3 - 100,000 points Section: 8 (1:00 TuWThF) 9 (4:00 TuWThF)

3/28/1999•Rev.2

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Short Answers Should Be Short! – Feel Free to Ask Any Questions

Shake, Rattle and Roll… (50,000 points)

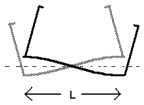
1.) On November 6, 1940, the brand new Tacoma Narrows Bridge underwent a catastrophic failure due to out of control resonance of the structure. The main span was 853.00 m (2800 feet) long between the towers at the time of the disaster, when the temperature was 9°C (48°F). (a) How long would the main span (made of steel girders) be if it had been a hot summer day, *T = 34°C (93°F)*? $\alpha_{steel} = 12 \times 10^{-6}\ °C^{-1}$



(b) If part of the 1200 tons of steel, much heat energy, that part from 9°C *The specific heat 445 J/kg·°C.* steel structure is about *m = 1,190,000 kg*, how *Q*, does it take to warm (48°F) to 34°C (93°F)? *capacity of steel is C_{steel} =*

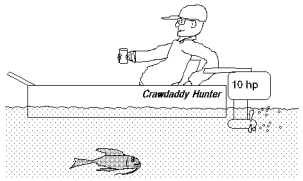
(c) Viewed from the side, at one point the standing wave on the main span, fixed at both ends by the tower, looked like this picture. Find the wavelength, λ, and describe what type of resonance (*fundamental, n^{th} overtone*).

(d) In mid-span (the middle of the bridge), there was a node ran down the painted line between the two lanes. Viewed *along* the bridge, the film clearly showed that the sides of the bridge went up and down, tilting the lamp posts back and forth, as shown in the sketch. The width of the bridge is 11.6 m (38.0 feet). Find the wavelength, λ, and describe what type of resonance (*fundamental, n^{th} overtone*).



(e) The rhythm of the waves are such that the lamp posts go up and down in a time of 1.00 second. What is the frequency, *f*, of this wave?

Fun With Evinrude (50,000 points)



2.) In the hot, humid backwaters of the Louisiana Bayou, a skiff is moving slowly along. One-third of the boat is submerged, which means that its mass-to-volume ratio is $\rho_{boat} = 333\ kg/m^3$. If the boat, passenger and current load has a mass of 84.0 kg, (a) what is the volume of the boat? $\rho_{water} = 1000.\ kg/m^3$

(b) This engine has $T_C = 10°C$ and $T_H = 773$ K. Find the 2nd Law Efficiency of this engine.

If the engine generates a useful power of 10.0 hp at full throttle, then there are 7460 J of useful work generated every second. If the Actual Efficiency is 27.4% (0.274), then find the (c) total energy input, Q_H, and…

(d) … waste heat rejected, Q_C, this engine accounts for each second?

(e) Water is pumped into the engine to cool it, with a water speed inside the engine of 1.00 m/s. The water then comes shooting out of the engine at 10.0 m/s. What gauge pressure was needed to get the water to come out like that? *Hint: Set up Bernoulli's Equation with $h_1 = h_2 = 0$, and figure out whether $P_1 > P_2$ or $P_1 < P_2$ first.*