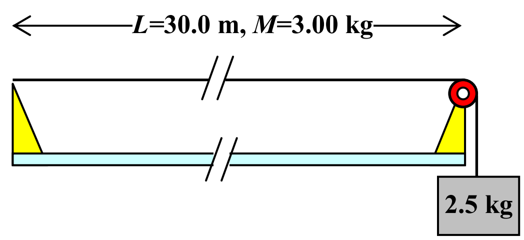
PHY131 Final Exam Review

Water ($\rho_W = 1.00\times10^3$ kg/m^3) flows through a pipe from the basement to upstairs, a height difference of 15.0 m. Upstairs, the pipe has a radius of 1.00 cm, while in the basement the radius is 2.00 cm. There are no other pipes with flow, and you should take water as incompressible and flowing without friction. Upstairs, the absolute water pressure is 2.00 atm and the flow rate is 0.400 L/s. Calculate the absolute water pressure in the basement. Note: for simplicity use $g = 10$ m/s^2. 1 L = 10^{-3} m^3 (~1 qt).

A wide cylindrical drum of 1.00 m^2 cross section is filled with water to a height of 1.00 m. A hole of 1.00 cm^2 cross section is drilled in the side near the bottom. Calculate the time necessary to drain the vat completely. Note: For simplicity use $g = 10$ m/s^2, $\rho_{\text{water}} = 1000$ kg/m^3, 1 cm = 10^{-2} m.

A block of mass $m = 3.00$ kg is attached to a long vertical spring with spring constant $k = 48.0$ N/m. At time $t=0$ the block is 0.75 m below the equilibrium position and moving downwards with speed 4.0 m/s. Calculate the equation of motion of the block; i.e. calculate the values of the amplitude A, the angular frequency ω, and the phase angle φ in the expression for the vertical coordinate $y = A\cos(\omega t + \varphi)$.

A rope of mass 3.00 kg is stretched between two support posts that are 30.0 m apart. The rope goes over a little pulley at the second support post, where a weight of 25.0 kg is hung onto the rope. Note: use $g = 10$ m/s^2



a. Calculate the time it takes for a pulse on the string to travel the distance between the supports.
b. Calculate the lowest frequency of standing waves on the rope.
c. Calculate the wavelength of the disturbances traveling outwards from the oscillating rope in the surrounding air.

An Aluminum water heater has a power consumption of 400 W. The mass of the water heater alone is 0.333 kg. Specific heats: $c_{\text{Water}} = 4186$ J/kg/K; $c_{\text{Al}} = 900$ J/kg/K. Heat of vaporization: $L_{\text{v,Water}} = 22.6\times10^5$ J/kg.

1. Calculate the time it takes to bring 1.00 L of water from tap temperature (10.0 °C) to a boil. Assume no electrical energy is lost to the environment.
2. Calculate the additional time it would take to convert all the water to steam.

A thermodynamic process takes 4.01 mol of an ideal monatomic gas from initial state a ($p_a = 1.00\times10^5$ Pa, $T_a = 300$ K) via the intermediate state b ($T_b = 1800$ K), to final state c ($p_c = p_a$, $V_b = V_c = 3.00\times V_a$).

The process $a \rightarrow b$ is a **straight** path (i.e. a line) in the pV-diagram, see the Figure. The gas constant $R = 8.31$ J/K/mol.

1. Complete the Table below:

	p (Pa)	***V*** (m^3)	***T*** (K)
a	1.00×10^5 Pa		300 K
b		$3V_a =$	1800 K
c	1.00×10^5 Pa	$3V_a =$	

2. Calculate the change in internal energy ΔU, the heat added to the gas Q, and the work done by the gas W in each of the processes, see the Table below:

process	$\boldsymbol{\Delta U}$ (J)	$\boldsymbol{Q}$ (J)	$\boldsymbol{W}$ (J)
$\boldsymbol{a \rightarrow b}$			
$\boldsymbol{b \rightarrow c}$			
$\boldsymbol{c \rightarrow a}$			
$\boldsymbol{a \rightarrow b \rightarrow c \rightarrow a}$			

3. Calculate the efficiency of the cycle.