PHYS260 Practice Exam Questions

Sample problems taken from last year's exam that you should understand in preparation for your exam on Monday. Please note, however, the format of your exam will be different from last year's. Instead of a combination of short and long questions, your exam will consist of four questions with multiple parts ranging in worth from 20 to 30 pts. There will be a total of 100 pt for the exam.

As last year, you will be given a table of constants similar to what you see here so your one-page sheet should focus on important equations, concepts and ideas, not constants you generally can look up in a table.

Again, the four questions on your exam will come from

- Harmonic motion
- Simple pendulum
- Fluids
- Thermodynamics processes & PV diagrams

Specific Heats		
Substance	c in J/gm K	Molar C J/mol K
Aluminum	0.900	24.3
Copper	0.386	24.5
Gold	0.126	25.6
Lead	0.128	26.4
Silver	0.233	24.9
Zinc	0.387	25.2
Mercury	0.140	28.3
Alcohol (ethyl)	2.4	111
Water	4.186	75.2
Ice (-10 C)	2.05	36.9

Gases at STP	Density (gm/cm^3)
Air	0.001293
Carbon dioxide	.001977
Carbon monoxide	0.00125
Hydrogen	0.00009
Helium	0.000178
Nitrogen	0.001251

Liquids	Density (gm/cm^3)
Water at 4^o C	1.0000
Water at 20^o C	0.998
Gasoline	0.70
Mercury	13.6
Milk	1.03

Solids	Density (gm/cm^3)
Magnesium	1.7
Aluminum	2.7
Copper	8.3-9.0
Gold	19.3
Iron	7.8
Lead	11.3
Platinum	21.4
Uranium	18.7
Osmium	22.5
Ice at 0 C	0.92

Substance (at 1 atm)	**Melting Point** T_m (K)	**Heat of Fusion** L_f (kJ/kg)	**Boiling Point** T_b (K)	**Heat to Vaporize** L_v (kJ/kg)
Hydrogen	13.8	58.6	20.3	452
Oxygen	54.4	13.8	90.2	213
Nitrogen	63.3	25.5	77.3	201
Ethyl Alcohol	156	104	351	858
Mercury	234	11.3	630	293
Water	273.15	334	373.15	2,256
Lead	600	24.7	2023	871
Aluminum	932	396	2740	10,465
Gold	1336	64.5	2933	1,578
Copper	1359	134	1460	5,065
Iron	1808	289	3023	6,363

$T_{melt} = T_{freeze}$ $T_{boil} = T_{condense}$

Section I: Each problem in this section is worth 10 pts.

I.1. Starting from the first law of thermodynamics show that if 1 mole of an ideal gas expands adiabatically from an initial temperature T_i to a final temperature T_f, the work done by the gas is

$$C_V(T_i - T_f),$$

where C_V is the molar heat capacity.

I.2. One mole of an ideal gas undergoes an isothermal expansion from V_i to V_f. Derive an expression for the heat flowing into the gas in terms of the temperature, and the initial and final volumes.

I.3. An object hangs from a spring balance and registers 30 N in air, 20 N when immersed in water and 24 N when immersed in an unknown liquid. What is the density of the unknown liquid?

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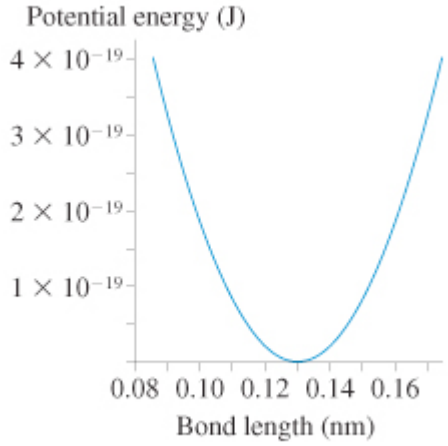
I.4. The sewer outlets of a house constructed on a slope are 8.2 m below street level. The the city sewer is only 2.1 m below street level. What is the minimum pressure differential that must be created by the sewage pump to transfer waste of an average density of 900 kg/m^3?

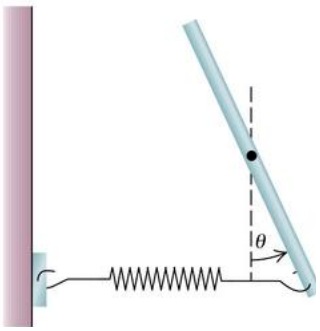
I.7. A molecular bond can be modeled as a spring between two atoms that vibrate with simple harmonic motion. The figure shows a simple harmonic oscillator approximation for the potential energy of an HCl molecule. Because the chlorine atom is much more massive than the hydrogen atom, it is reasonable to assume that the hydrogen atom (m = 1.67 × 10^{-27} kg) vibrates back and forth while the chlorine atom remains at rest.

What is the frequency? Be sure to indicate the values from the graph you are using.



Section II

II.1. A slender, uniform metal rod of mass M and length l is pivoted without friction about an axis through its midpoint and perpendicular to the rod. A horizontal spring, assumed to be massless and with force constant k, is attached to the lower end of the rod, with the other end of the spring attached to a rigid support. Assume that θ is small enough that the spring remains effectively.



(a) Find the torque due to gravity alone. (5pts)

(b) Find the torque, τ, due to the spring. (5pts)

(c) What is the angular frequency, ω, of oscillations of the rod? (5pts) You might find it helpful to remember that the moment of inertia for a rod pivoting about the center is $ml^2/12$.