Announcements

1. Thanks
2. Physics colloquium Thursday, Dec. 4th at 4 PM
   Professor Scott Wollenwebber, WFU School of Medicine --
   "Positron Emission Tomography: From Basic Physics to Functional Images"
3. Presentations –
4. Extra practice sessions?
5. Today –

   Comments on thermodynamics and HW 21

   Advice about preparing for final exam

   Some example problems

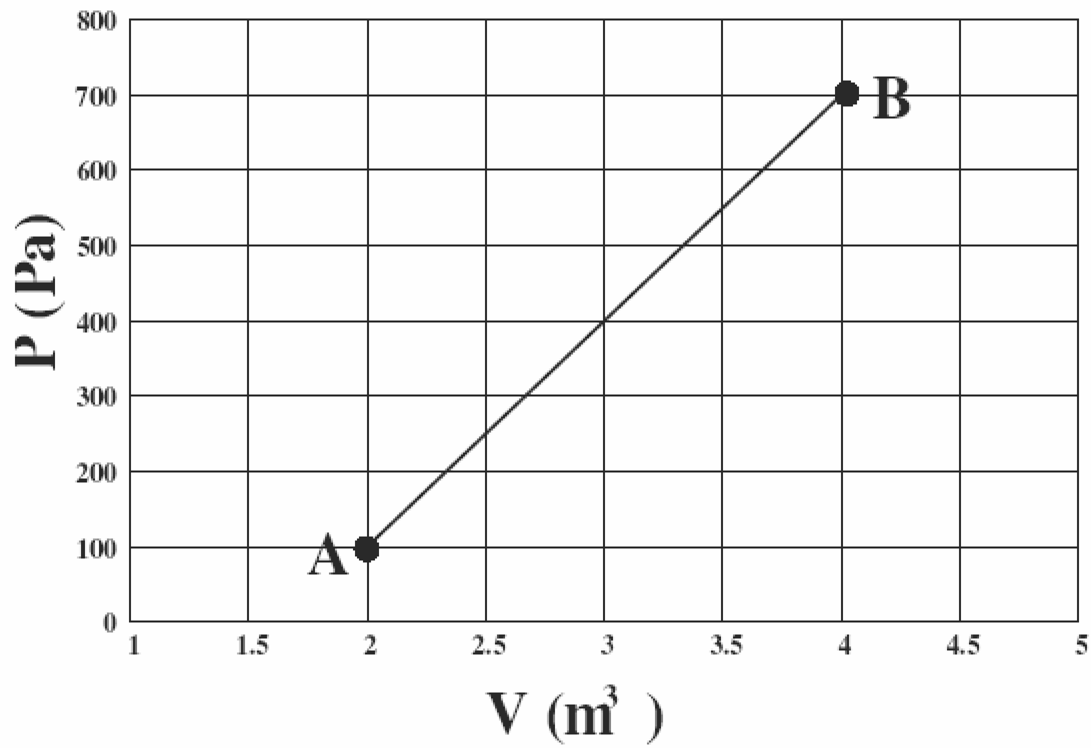
Basic equations of thermodynamics:

$$\text{First law:} \quad \Delta E_{\text{int}}^{A\to B} = Q_{A\to B} - W_{A\to B}$$

$$W_{A\to B} = \int_A^B P\,dV$$

$$\text{Entropy:} \quad S_{A\to B} = \int_A^B \frac{dQ}{T}$$

$$\text{Ideal gas:} \quad PV = nRT$$



5.

The figure above shows a P−V (Pressure−Volume) diagram for a process on a "system" consisting of 1 mole of an ideal gas whose heat capacity at constant volume is $C_V = 27.7$ J/(mole·K) ($\gamma = 1.3$).

3. HRW6 21.P.020. [73981] 1.08 mole of an ideal monatomic gas, at an initial pressure of 5.40 kPa and initial temperature of 601 K, expands from initial volume $V_i = 1\ \text{m}^3$ to final volume $V_f = 2\ \text{m}^3$. During the expansion, the pressure p and volume V of the gas are related by $p = 5.40 \exp[(V_i - V)/a]$, where p is in kilopascals, V_i and V are in cubic meters, and $a = 1.00\ \text{m}^3$.

(a) What is the final pressure of the gas?

[.1] ______ kPa

(b) What is the final temperature of the gas?

[.1] ______ K

(c) How much work is done by the gas during the expansion?

[.1] ______ kJ

(d) What is the change in entropy of the gas during the expansion?

[.1] ______ J/K

(*Hint:* Use two simple reversible processes to find the entropy change.)

4. HRW6 21.P.023. [52279] A Carnot engine operates between 233°C and 133°C, absorbing 6.30×10^4 J per cycle at the higher temperature.

(a) What is the efficiency of the engine?

[.1] ______ %

(b) How much work per cycle is this engine capable of performing?

[.1] ______ J

6. HRW6 21.P.046. [52282] An inventor claims to have invented four engines, each of which operates between constant-temperature reservoirs at 400 and 300 K. Data on each engine, per cycle of operation, are:

engine A, $Q_H = 200$ J, $Q_L = -175$ J, and $W = 40$ J;
engine B, $Q_H = 500$ J, $Q_L = -200$ J, and $W = 400$ J;
engine C, $Q_H = 600$ J, $Q_L = -200$ J, and $W = 400$ J;
engine D, $Q_H = 100$ J, $Q_L = -90$ J, and $W = 10$ J.

Of the first and second laws of thermodynamics, which (if either) does each engine violate?

engine A
- both
- neither
- second law
- first law [.1]

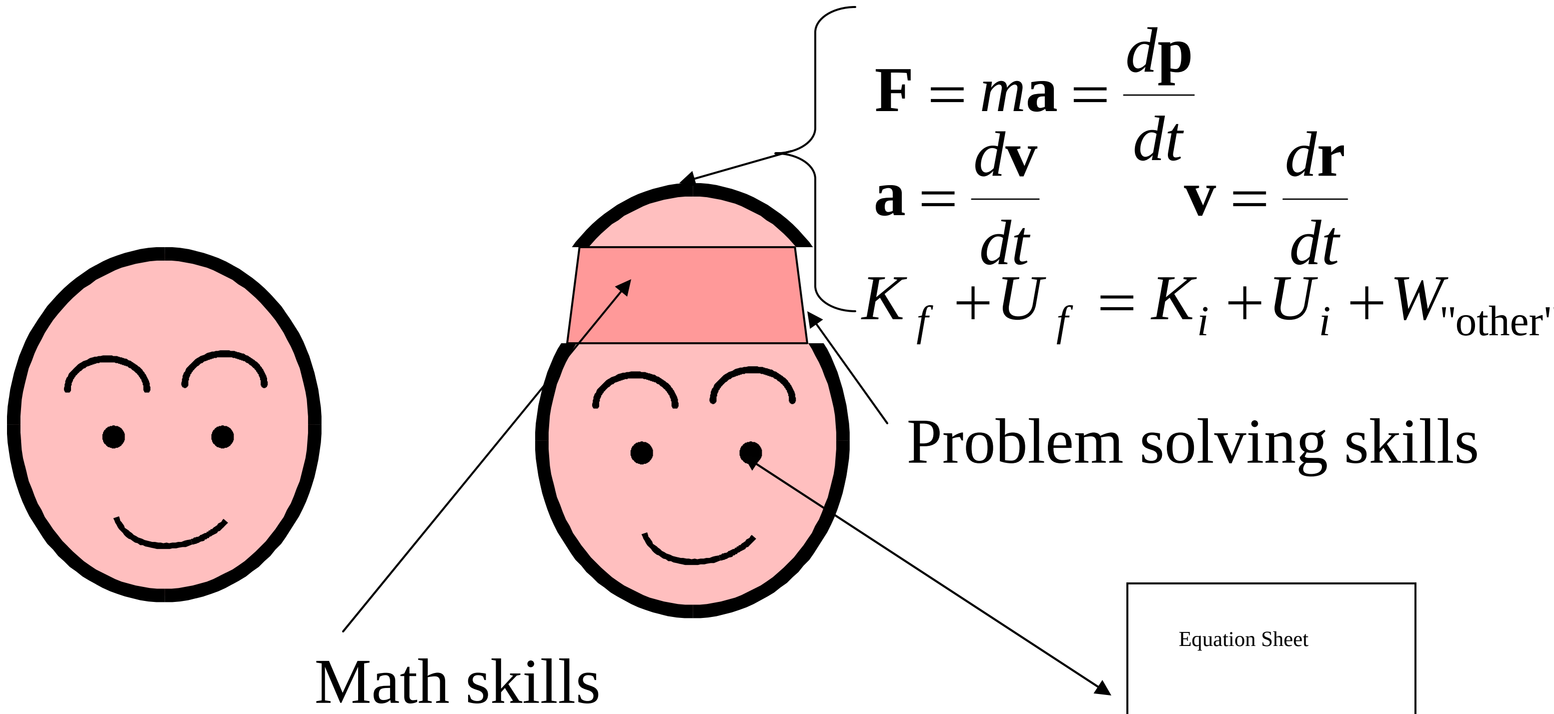
engine B
- second law
- both
- first law
- neither [.1]

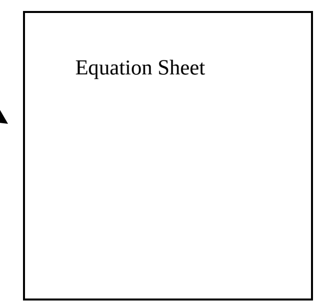
engine C
- neither
- second law
- first law
- both [.1]

engine D
- both
- first law
- second law
- neither [.1]

Advice on how to prepare for final exam

1. Reviewing physics material is a useful exercise --
    - Physics concepts often need time for your mind to "digest". Material that we covered in the beginning of the course should now make more sense.
    - You will be able to see more of the interconnections between many of the topics we covered.
2. Review lecture notes, re-read text, rework homework and online quiz problems, review previous exams.
3. Work lots of problems; make sure equation sheet has the right information.
4. Keep track of your questions and get them answered.





Advice:

1. Keep basic concepts and equations at the top of your head.
2. Practice problem solving and math skills
3. Develop an equation sheet that you can consult.

Problem solving steps

1. Visualize problem – labeling variables
2. Determine which basic physical principle(s) apply
3. Write down the appropriate equations using the variables defined in step 1.
4. Check whether you have the correct amount of information to solve the problem (same number of knowns and unknowns).
5. Solve the equations.
6. Check whether your answer makes sense (units, order of magnitude, etc.).

1. Suppose that you are traveling in your car on a straight and level road at an initial velocity of $v_i = 30$ m/s when you see a disturbance ahead of you. You immediately put your foot on the brake and come to a complete stop in 5 s. Assume that your braking deceleration is constant.

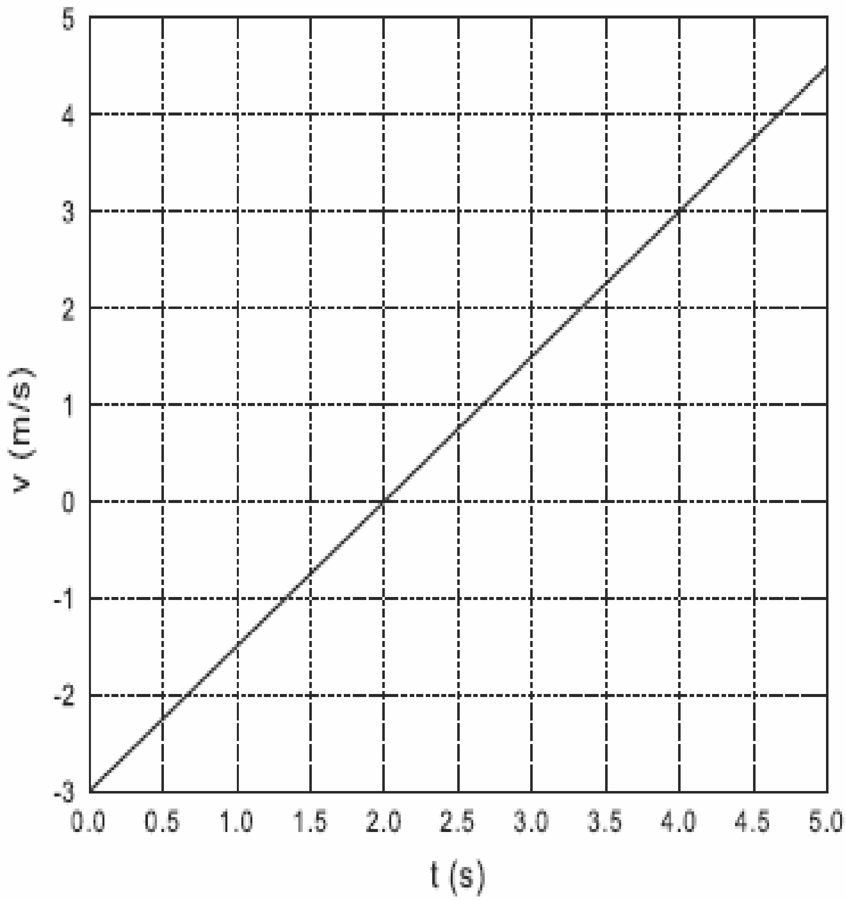
   (a) What deceleration did you achieve while braking?

   (b) How far did you travel while braking?

   (c) Estimate the coefficient of friction for this process.

   (d) Discuss how the friction occurs.

2.



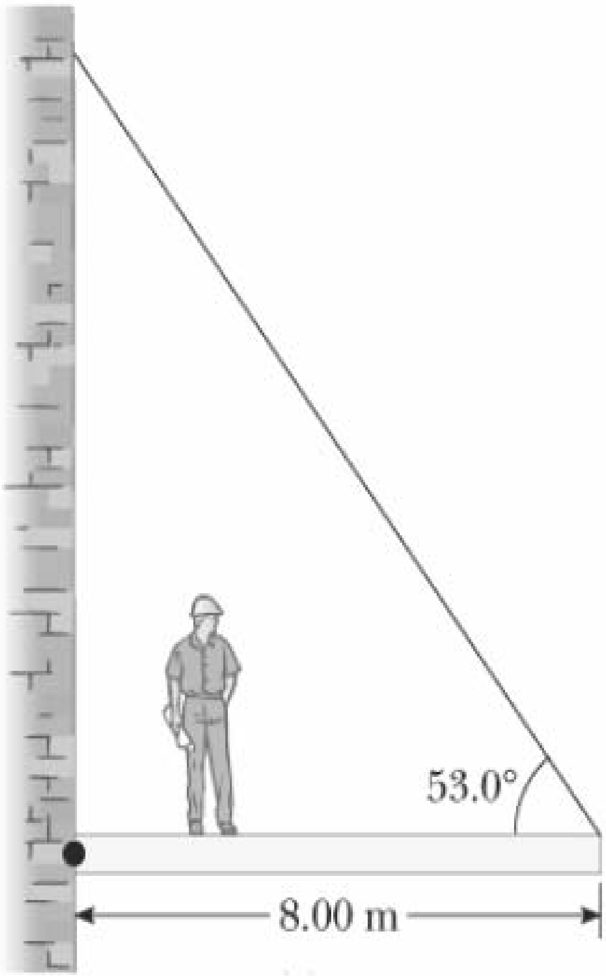
The figure on the left shows a graph of the horizontal velocity of an object as a function time.

(a) What is the instantaneous velocity of the object at $t = 2$ s?

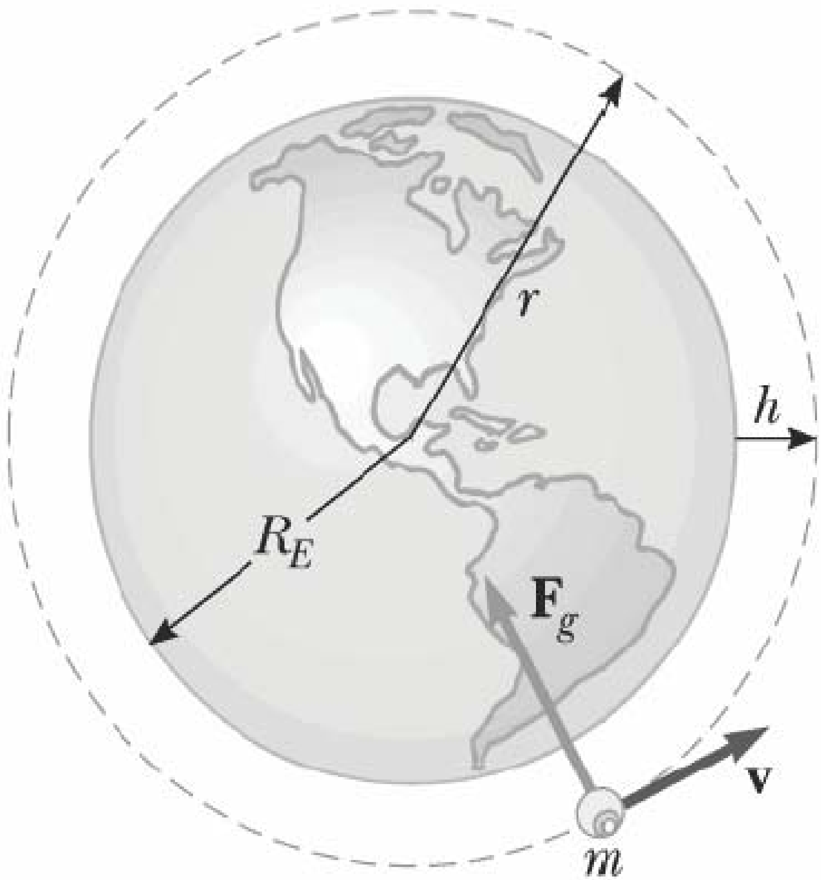
(b) What is the instantaneous acceleration of the object at $t = 2$ s?

(c) What is the displacement of the object measured at $t = 2$ s relative to its initial displacement at $t = 0$ s?

8.



The figure on the left shows a uniform horizontal beam with a length of 8 m and a weight of 300 N, attached to the wall with a hinge. The far end of the beam is supported by a cable that makes an angle of 53^o with the horizontal. A 700 N man is standing 3 m from the wall. Find the tension in the cable.

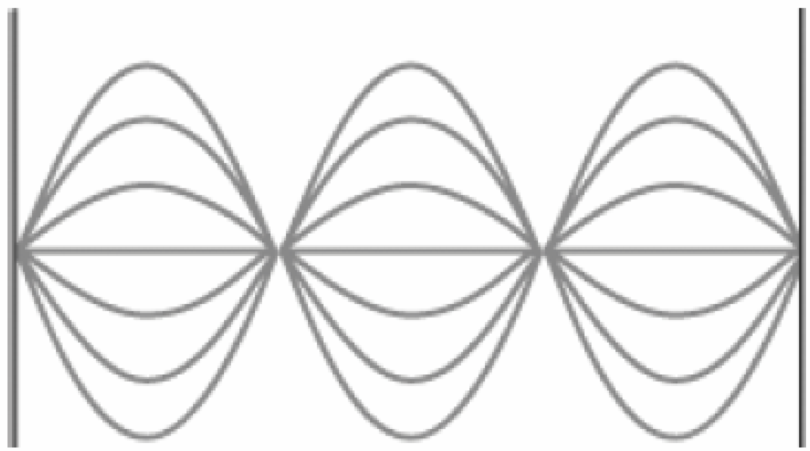
9. 

The figure on the left shows a satellite having a mass $m = 54321$ kg in a circular orbit at a height $h = 220000$ m above Earth's surface.

(a) What is the gravitational force which the Earth exerts on the satellite?

(b) What is the centripetal acceleration of the satellite.

(c) How long does it take the satellite to make one complete orbit about the Earth?

13. 

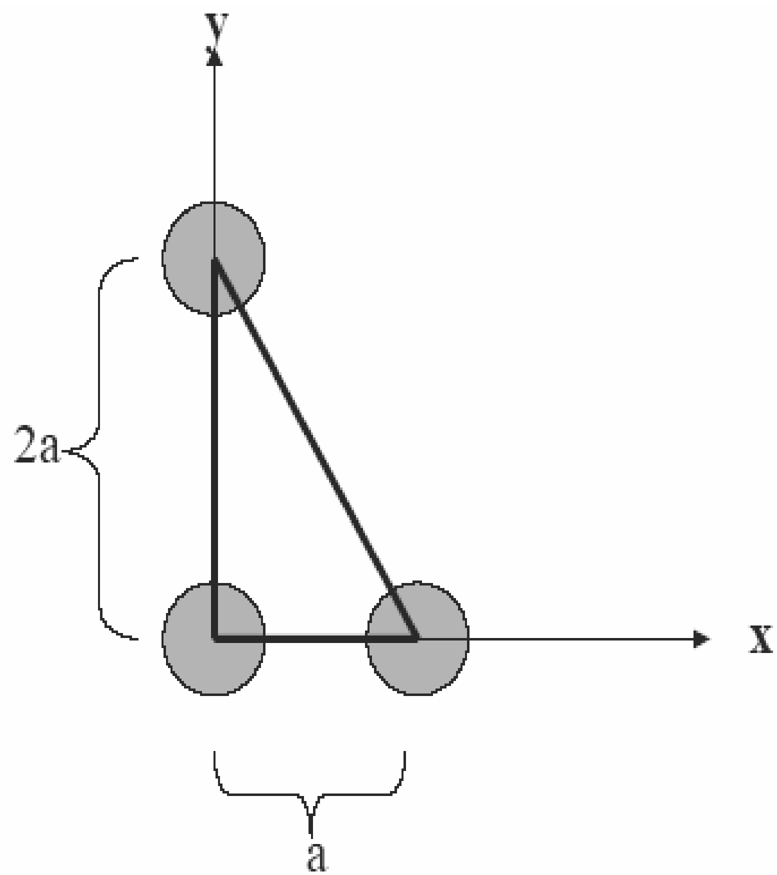
The figure on the left shows a graph of a transverse periodic standing wave on a string having a length $L = 0.754$ m. The velocity of the wave on the string $v_{\text{string}} = 1200$ m/s.

(a) What is the wavelength λ of this standing wave?

(b) What is the frequency f of the this standing wave?

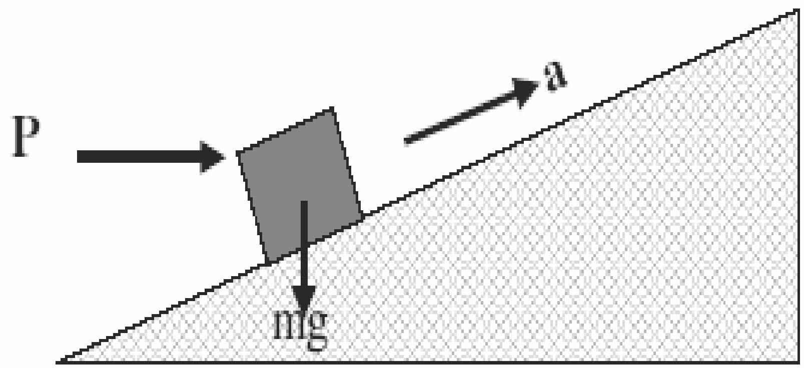
(c) If this string vibration were coupled to the air, what would be the wavelength of the resultant sound wave?

14. In class we had a demo with two identical tuning forks, both with resonance frequencies of $f = 440$ cycles/s, each mounted on an open wooden box. One of the tuning forks was struck with a mallet and its sound was heard. The struck tuning fork was then stopped from vibrating. The unstruck tuning fork continued to sound. Explain how this demo relates to the notion of resonance.



5. The above figure shows 3 objects, each with mass $m = 3$ kg held in a massless frame where the length a is given by $a = 0.03m$. Find the location of the center of mass of this system. Discuss how you can use the center of mass to predict the motion of this system in at least one situation.

7. The figure above shows a before and after picture of a collision process, where $m_1 = 2$ kg and $m_2 = 1$ kg. The magnitudes of the velocities before the collision are measured to be $v_{1i} = 5m/s$ and $v_{2i} = 10m/s$, while the magnitudes of the velocities after the collision are measured to be $v_{1f} = 8.619m/s$ and $v_{2f} = 2.619m/s$. Using this data, determine whether momentum was conserved during this collision. Discuss the implications of your results.

4. 

Suppose you are pushing a box of weight $mg = 200$ N with a horizontal force **P** up an incline at a constant acceleration of $a = 0.3$ m/s^2. Assume that the coefficient of kinetic friction between the box and the surface of incline is $\mu_k = 0.4$ and that the angle of the incline is $\theta = 15^o$. What is the magnitude of **P**?