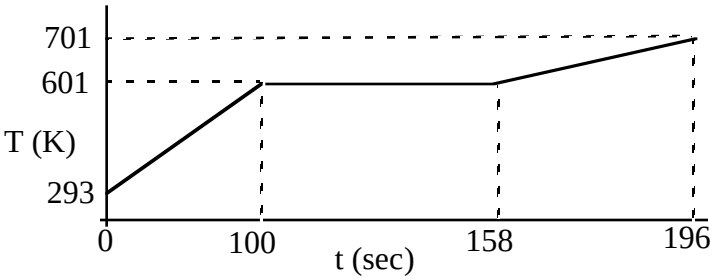
14. A 100 gram sample of lead is heated by a constant source of 40 watts of power. The lead is solid at room temperature and eventually melts, and the liquid lead warms up. From the graph determine the value of the specific heat of the **solid** lead and of the latent heat of fusion of lead.

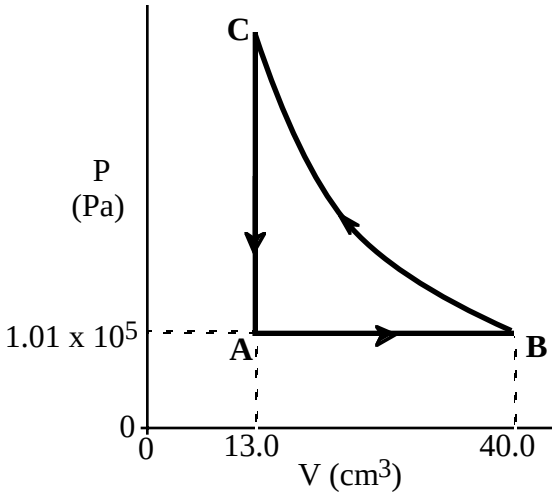


extra space

12. (a) Write an equation form of the First Law of Thermodynamics.

(b) State the First Law of Thermodynamics in words. Be very specific.

13. In the cyclic process shown on the P-V diagram to the right, process B --> C is adiabatic; $W_{B \text{ --> } C} = -15$ J; and the heat removed from the system during C --> A is 20 J.
(a) What is the value of the change in the internal energy over the complete cycle: A --> B --> C --> A?



(b) What is the value of the work done by the system during the C --> A process?

(c) What is the value of the work done by the system during the isobaric process?

(d) What is the value of the net work for the complete cycle?

(e) What is the value of the net heat for the complete cycle?

(f) Is this cycle a **refrigerator** or a **heat engine**? (Circle one.)

(g) Calculate the heat added during the A --> B process.

continues over

11. Two slits of width 0.050 mm and separation 0.300 mm have a **red** laser (wavelength = 633 nm) shining through them. (a) **Carefully** sketch a graph of intensity as a function of position for these slits.

(c) Label the center bright spot with a zero, it is the zeroth order maximum. *Now # rest.*

(d) What is the number of the first "missing maximum"? What other maxima will be missing?

(e) What is the path difference for the 4th maximum?

(f) What is the path difference for the minimum located between the 4th and 5th maxima?

(g) The pattern is observed on a screen 3.00 m away. Calculate the spacing between the bright fringes on the screen.

(h1) The slits are replaced by a grating with 5000 slits per cm. At what angle is the first order maximum located? How far is this from the center of the pattern?

(h2) How many orders could be observed for this grating with this wavelength? Explain your answer.

continues over

8. An electromagnetic wave travelling in a material is described by the following equation:

$$E(x,t) = 120 \text{ N/C } \sin[(4\pi \times 10^6 \text{ rad/m})x - (8\pi \times 10^{14} \text{ rad/s})t]$$

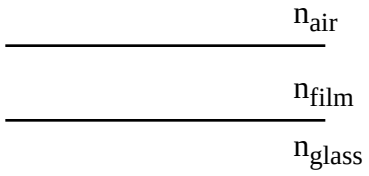
(a) Give the numerical value for the amplitude of the wave.

(b) Give the numerical value for the wavespeed.

(c) Calculate the index of refraction of the material.

(d) Is this visible light? **radio infrared yes ultraviolet x-ray other** (Circle one.)

9 . A glass plate is coated with a thin film of MgF_2 ($n = 1.380$) of thickness L, and it is designed to <u>maximize</u> the transmission of green light of wavelength $\lambda = 546$ nm which is normally incident on the plate. $n_{glass} = 1.500$



(a) **Sketch** (in the space to the right) the paths of the two transmitted rays that must combine if the transmitted light is to be very bright, and **show** on your sketch the phase change due to reflection for **each** ray.

(b) What is the phase difference due to the reflections?

(c) What must the total **<u>phase</u>** difference between these two rays be if they are to give maximum transmission?

(d) Calculate the minimum non-zero thickness of the film that will work.

10. A Pyrex glass beaker which can contain exactly 250 cm^3 at 273 K is warmed to 373 K. Does the volume of liquid that the beaker can hold

increase decrease remain the same ? (Circle one.)

What is the change in the capacity, ΔV, of the beaker? The coefficient of linear expansion for Pyrex glass is 3.2×10^{-6} /C˚.

continues over

6. A standing wave on a string is described by the following equation:

$y(x,t) = (7.00 \text{ mm}) \sin[(4\pi \text{ rad/m})x] \cos[(880\pi \text{ rad/sec})t]$

(a) Find the two smallest x values at which nodes are located.

(b) Calculate the wavelength of this wave.

(c) Calculate the maximum speed of a particle on the string at x = 0.200 m.

7. An organ pipe, open at the **right** end, has length L = 2.30 m.
(a) Draw a sketch on the first axis below showinga graph of the **displacement** vs. position for the fundamental frequency, then draw one showing the second allowed wave, and repeat showing the third allowed wave.

first _____ second _____

third _____

(b) On your second diagram, indicate the positions of the nodes by labeling them with the letter N and the positions of the antinodes using the letter A.

(c) What is the speed of the fundamental wave?

(d) What is the wavelength of the fundamental wave?

(e) What is the frequency of the fundamental wave?

(f) There is a piano in the room with the organ, and some of its strings begin to vibrate because of the organ note. What frequency will the piano string that vibrates due to the fundamental have?

continues over

(b) If the ramp were frictionless, would the speed be

larger than **smaller than** **equal to** your answer in (a). (Circle one.)

(c) If the ball rolled **and** slipped, would the speed be

larger than **smaller than** **equal to** your answer in (a). (Circle one.)

4. When a 500 gram mass is hung on the end of a vertical spring, the spring stretches 25.0 cm to a new equilibrium position. The mass is now pulled down an additional 8.00 cm and released.
(a) What are the values of the angular frequency of the oscillation and the amplitude x_m of the oscillation.

(b) Calculate the speed of the mass when it is 4.00 cm from the new equilibrium posiiton.

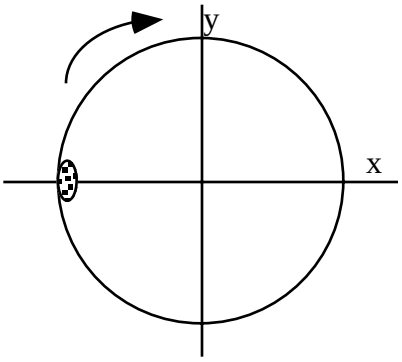
(c) What must be true if this motion is to be simple harmonic motion?

5. A police car (with siren frequency 500 Hz) is traveling east at 25.0 m/s in the left lane of a highway and chasing a speeding red Corvette traveling east at 15.0 m/s also in the left lane.
(a) Sketch the police car and the Corvette and indicate their velocities on the diagram.

(b) Write an equation (with all numbers substituted) for the frequency that the Corvette driver hears.

continues over

1. The overhead view in the figure shows a ladybug on the edge of a disk turning clockwise (like a merry-go-round). The angular speed of the disk is decreasing. At the instant shown in the diagram,



(a) what is the direction of the radial acceleration of the ladybug? (Circle one.)

+x -x +y -y +z -z

(b) what is the direction of the tangential acceleration of the ladybug? (Circle one.)

+x -x +y -y +z -z

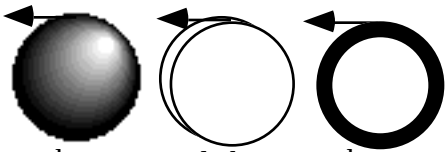
2. During Physics 311, we wrote Newton's Second Law as:

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \text{ which led to } \textit{Impulse} = \int \vec{F} dt = \Delta \vec{p}.$$

(a) Write the rotational equivalent of the Newton's Second Law equation above. Say, in words, what each symbol means.

(b) Write the rotational equivalent of the impulse equation above.

(c) A disk, a hoop, and a solid sphere all have the same mass and radius, and all are at rest to begin with. There is a string wrapped around each, and they are spun (like tops) about axes through their centers by equal constant forces which act on the strings for 0.2 sec.



(i) Rank the three objects [disk, hoop, sphere] in order from the one with the largest angular **momentum** to the one with the smallest angular momentum. If any are equal, say so explicitly.

Largest _____ _____ _____ Smallest

(ii) Rank the three objects [disk, hoop, sphere] in order from the one with the largest angular **speed** to the one with the smallest angular speed. If any are equal, say so explicitly.

Largest _____ _____ _____ Smallest

3. (a) Calculate the speed of a solid wooden ball when it reaches the bottom of a ramp. The ball rolls without slipping down the ramp which is 1.20 m long and 0.650 m high. $I_{ball} = {}^{2}/_{5}\, MR^2$.

continues over

SPSP 312 Name _____
19 Nov 2002 Lecture 1

Final Exam

Remember:
Show all your work for full credit. **Ask** if anything seems unclear.

Formulae and Constants:

ang mom $L = I\omega = r \times p$ torque $= r \times F$ $I = \Sigma\, mr^2$

$x = A \cos(\omega t + \phi)$ $\omega = 2\pi f = 2\pi / T$ $g = 9.8\ m/s^2$

$PE_{spring} = (1/2)\, k\, x^2$ $\rho_{water} = 10^3\ kg/m^3$

$\omega_{spring} = (k/m)^{1/2}$ $v_{sound} = 343\ m/s$

$\omega_{pend} = (g/L)^{1/2}$ $c = 3 \times 10^8\ m/s$

$\omega_{physp} = (mgL/I)^{1/2}$ $P_{atm} = 1.01 \times 10^5\ N/m^2$

$R = 8.31\ J/mole \cdot K$

$y(x,t) = A \sin[k(x - vt)]$
$= A \sin(kx - \omega t)$
$= A \sin[(2\pi / \lambda)\, x - (2\pi / T)\, t]$

c_{water} = 4190 J/kg•C° = 1 cal/g•C°
c_{ice} = 2220 J/kg•C° = 0.530 cal/g•C°
L_{water} = 333 kJ/kg = 80 cal/g (fusion)
L_{water} = 2.260 MJ/kg = 540 cal/g (vaprztn)

$P = (1/2)\, \mu\, \omega^2\, A^2\, v$ $T_C = T - 273\ K$ 1 cal = 4.19 J

ideal gas: $C_v = 3/2\ R$ $C_P = 5/2\ R$

$y(x,t) = 2A \sin(kx) \cos(\omega t)$

$v_{fluid} = (B_s / \rho)^{1/2}$ $v = \lambda f = \omega / k$

$v_{string} = (F / \mu)^{1/2}$

$\beta_1 - \beta_0 = 10 \log(I_1 / I_0)$ $f' = f\,(v \pm v_D)/(v \pm v_S)$

$n = c/v$ $\lambda_n = \lambda / n$

$d \sin\theta_m = m\lambda$ $(m = 0, 1, 2, ...)$
$a \sin\theta_m = m\lambda$ $(m = 1, 2, ...)$

$\Delta L = \alpha\, L_0 \Delta T$ $Q / \Delta t = kA\, \Delta T / L$

$Q = mL + mc\Delta T$ $W = \int_{V_i}^{V_f} P\, dV$

$dS = dQ / T$ efficiency $= W_{net} / Q_{in}$ ideal eff $= 1 - T_c / T_h$

Page

1.	/30
2.	/40
3.	/40
4.	/40
5.	/35
6.	/40
7.	/10
web PS 10.	/15?
	/250