Quiz 3 July 31, 2007
Chapters 16, 17, 18, 19, 20

Phys 631
Instructor R. A. Lindgren
9:00 am – 12:00 am

No Books or Notes allowed
Calculator without access to formulas allowed.
The quiz has two parts. The first 4 questions are problems with numerical answers. Please show your work on the exam.

The last 13 questions are multiple choice.
Please circle the best correct answer for each question. No partial credit on multiple-choice questions.

All questions and subparts are equally weighted.
There is a total of 33 points on Quiz 3.

Please sit in alternate seats.

Honor Pledge.
Please write on your exam
"I did not receive aid nor did I give aid" and sign it.

$$\sin\theta = \frac{opp}{hyp}$$

$$\cos\theta = \frac{adj}{hyp}$$

$$\tan\theta = \frac{opp}{adj}$$

$$G = 6.7 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$$

$$g = 9.8 \frac{m}{s}$$

$$v = v_o + at$$

$$v_{avg} = \frac{1}{2}(v_o + v)$$

$$x = v_{avg} t$$

$$x = v_o t + \frac{1}{2} a t^2$$

$$v^2 = v_o{}^2 + 2ax$$

$$a_c = \frac{v^2}{r}$$

$$D = \frac{1}{2} C \rho A v^2$$

$$F_{net} = ma$$

$$f_s(\max) = \mu_s N$$

$$f_k = \mu_k N$$

$$x - x_0 = (v_0 \cos\theta_0)t$$

$$y - y_0 = (v_0 \sin\theta_0)t - \tfrac{1}{2} g t^2$$

$$v_y = v_0 \sin\theta_0 - gt$$

$$v_y^2 = (v_0 \sin\theta_0)^2 - 2g(y - y_0)$$

$$v_x = v_0 \cos\theta_0$$

$$s = r\theta$$

$$v = \omega r$$

$$a_t = r\alpha$$

(for α =constant)

$$W = F \cdot x$$

$$F_s = -kx$$

$$Power = \frac{dW}{dt}$$

$$K = \frac{1}{2} m v^2$$

$$U = mgh$$

$$U_s = \frac{1}{2} k x^2$$

$$F = -\frac{dU}{dx}$$

$$p = mv$$

$$F = \frac{dp}{dt}$$

$\mathbf{V}_{\text{cm}}$ = Total momentum/Total mass

$$v_{1f} = \frac{(m_1 - m_2)}{(m_1 + m_2)} v_{1i}$$

$$v_{2f} = \frac{2m_1}{(m_1 + m_2)} v_{1i}$$

$$Rv_{rel} = Ma$$

$$v_f - v_i = v_{rel} \ln(\frac{M_i}{M_f})$$

$$J = F_{avg} \Delta t$$

$$\omega = \omega_o + \alpha t$$

$$\omega_{avg} = \frac{1}{2}(\omega_o + \omega)$$

$$\theta = \omega_{avg} t$$

$$\theta = \omega_o t + \frac{1}{2} \alpha t^2$$

$$\omega^2 = \omega_o{}^2 + 2\alpha\theta$$

$P = \tau\omega$

$I = \frac{1}{3}ML^2$

(Moment of inertia for a rod of length L rotating about one end)

$I = \frac{1}{2}MR^2$

(Moment of inertia for a thin disk of radius R rotating about CM)

$I = I_{cm} + Mr^2$ (parallel axis theorem)

$K = \frac{1}{2}I\omega^2$

$\tau = I\alpha$

$\tau = r \times F$

$\tau = dL/dt$

$L = r \times p$

$L = I\omega$

$a_{com} = \frac{-g\sin\theta}{(1 + I_{com}/MR^2)}$

$\frac{F}{A} = E\frac{\Delta L}{L}$

(E=Young's Modulus)

$\frac{F}{A} = G\frac{\Delta x}{L}$

(G=Shear Modulus)

$p = B\frac{\Delta V}{V}$ (B=Bulk Modulus)

$F_{buoy} = \rho Vg$

Apparent weight = weight - F_{buoy}

$A_1 v_1 = A_2 v_2$

$\rho Av = cons\tan t$

$\gamma = \frac{C_p}{C_v}$

$pV^\gamma = cons\tan t$

$C_p = C_v + R$

$C_V = \frac{3}{2}R$

(For a monatomic gas)

$F = \frac{GmM}{r^2}$

$U = \frac{-GmM}{r^2}$

$E = \frac{-GmM}{2r}$

$T^2 = \frac{4\pi^2}{GMr^3}$

$a = \frac{-GmM}{2E}$

(Semi-major axes of an elliptical orbit)

$\vec{r}_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i\vec{r}_i$

$p_1 + \frac{1}{2}\rho v^2 + \rho gh = cons\tan t$

$y_1(x,t) = y_m \sin(kx - \omega t)$

$\omega = \sqrt{k/m}$

$T = 2\pi\sqrt{\frac{I}{mgL}}$

$\Delta L = L\alpha\Delta T$

$Q = nC_v\Delta T$

$\Delta E_{\text{int}} = Q - W$

$P_{cond} = \frac{kA\Delta T}{L}$

$pV = nRT$

$R = kN_A$

$W = nRT\ln(\frac{V_f}{V_i})$

$E_{\text{int}} = \frac{fkt}{2}$

$v_{rms} = \sqrt{\frac{3RT}{M}}$

$v = \sqrt{\frac{T}{\mu}}$

$f' = f\frac{v \pm v_D}{v \pm v_S}$

$v = f\lambda$

(1) A wave on a string under tension T=4.1 N whose total mass is 4 gms and length is 3 m is described by

$y(x,t) = 15 \sin (kx - 4\pi t)$

where x and y are in centimeters and t is in seconds.

(a) What is the angular frequency of the transverse oscillations of a point on the string?

(b) What is the speed of the wave moving along the string and in what direction is it moving?

(c) What is the transverse speed for a point on the string at x= 6.0 cm when t is 0.25 s?

(d) What is the maximum transverse speed of any point on the string?

(e) What is the maximum transverse acceleration for any point on the string?

(2) An ideal monatomic gas initially at 300 K is compressed at a constant pressure of 25 N/m^2 from a volume of 3.0 m^3 to a volume of 1.8 m^3 . During the process the gas loses 75 J as heat.

(a) What is the work done during the process?

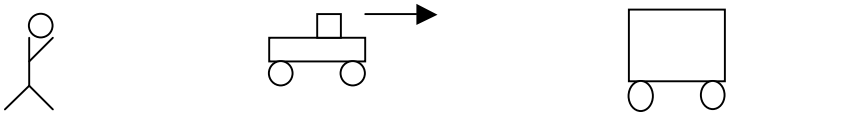
(b) What is the final temperature of the gas?

(c) Use the 1^{st} Law of thermodynamics to find the change in internal energy of the gas?

(d) How many moles of gas are there?

(e) Now solve this problem for the change in internal energy without knowing that the gas lost 75 J of heat.

(3) A police car with a siren emitting a sound of frequency 400 Hz travels away from you with a speed of 10 m/s towards a large parked trailer truck, whose surface is a good sound reflector. The speed of sound in air is 300 m/s.



you police car with siren parked trailer truck

(a) What is the frequency of the sound you hear coming directly from the siren?

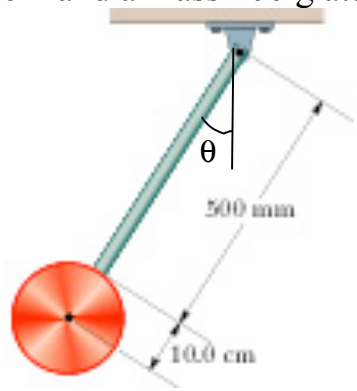
(b) What is the frequency of sound you hear reflecting back to you from the parked trailer truck?

(c) What is the beat frequency between the two sounds arriving at you?

(d) What is the wavelength of the sound wave when the police car stops with his siren still on?

(e) If the police car stops 0.52 m in front of the parked trailer truck, determine the difference in path length of the sound coming directly from the siren and that reflected off the trailer truck siding. Will you hear mostly constructive or mostly destructive interference? (Assume no change in phase of the sound wave when it reflects off the trucks siding)

(4) The physical pendulum in the figure consists of a uniform disk with radius 10.0 cm and a mass 400 g attached to a uniform rod with length 500 mm and mass 600 g.



(a) Find the moment of inertia of the pendulum by adding the moment of inertia of the rod and disk about the pivot point. Use the parallel axis theorem to find the moment of inertia of the disk about the pivot point.

(b) What is the distance between the pivot point and the center of mass of the pendulum?

(c) Using the moment of inertia from part a and the location of the center of mass from part b, calculate the period of the oscillation. (If you can not do parts a and b, assume reasonable values)

(d) How do you find the point along the shaft that is called the center of percussion? Where is it located?

(e) Write down an equation describing the angular dependence of the pendulum as a function of time. Assume the maximum angle is 0.2 radians. And the initial angular velocity is 0 rads/sec.

(5) If the power output of a sound source emitting spherical waves is 100 W, the sound intensity 5.0 m from the source is:

(_) 100 W/m^2
(_) 4.0 W/m^2
(_) 20 W/m^2
(_) 1.6 W/m^2
(_) 0.32 W/m^2

(6) A piano wire has length L and mass M. If its fundamental frequency is f, its tension is:

(_) 2Lf/m
(_) 4f $2L^3/M$
(_) $4LMf^2$
(_) $2Mf^2/L$
(_) 4MLf

(7) The coefficient of expansion of a certain steel is 0.000012 per C°. The coefficient of volume expansion, in $(C°)^{-1}$, is:

(_) 0.000036
(_) 0.000012
(_) (0.000024)
(_) depends on the shape of the volume to which it will be applied

(8) Fifty grams of ice at 0°C is placed in a thermos bottle containing one hundred grams of water at 6°C. How many grams of ice will melt? The heat of fusion of water is 333 kJ/kg and the specific heat is 4190 J/kg K.

(_) 2.0 g
(_) 8.3 g
(_) 7.5 g
(_) 50 g
(_) 17 g

(9) A slab of material has area A, thickness L, and thermal conductivity k. One of its surfaces (P) is maintained at temperature T1 and the other surface (Q) is maintained at a lower temperature T2. The rate of heat flow from P to Q is:

(_) LA(T1 - T2) / k
(_) $kA(T1 - T2) / L^2$
(_) k(T1 - T2) / (LA)
(_) kA(T1 - T2) / L
(_) kL(T1 - T2) / A

(10) During a reversible adiabatic expansion of an ideal gas, which of the following is NOT true?

(_) $pV^{\gamma} = \text{constant}$
(_) $pV = nRT$
(_) $W = - pdV$
(_) $TV^{\gamma-1} = \text{constant}$
(_) $pV = \text{constant}$

(11) An ideal gas of N diatomic molecules has temperature T. If the number of molecules is doubled without changing the temperature, the internal energy increases by:

(_) 3/2NkT
(_) 3NkT
(_) 0
(_) 5/2NkT
(_) 1/2NkT

(12) The force exerted on the walls of a vessel by a contained gas is due to:
(_) repulsive force between gas molecules
(_) slight loss in average speed of a gas molecule after collision with wall
(_) elastic collisions between gas molecules
(_) inelastic collisions between gas molecules
(_) change in momentum of a gas molecule due to collision with wall

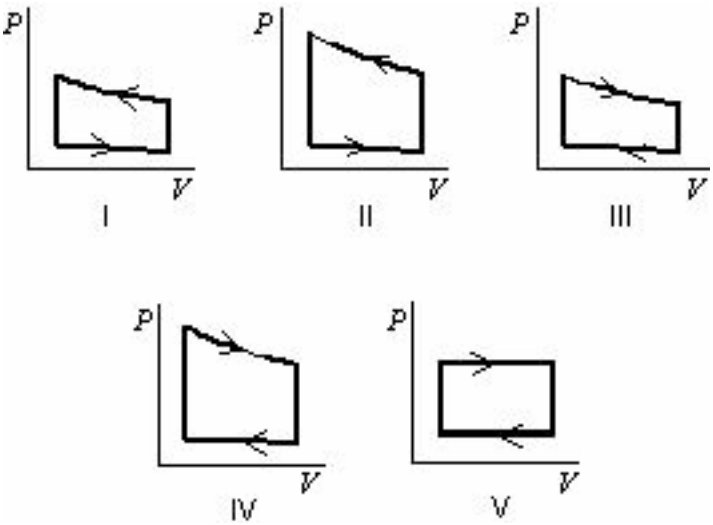
(13) Which of the following is NOT a state variable?

(_) internal energy
(_) temperature
(_) pressure
(_) work

(14) If the speed of sound is 340 m/s, the two lowest frequencies of an 0.5 m organ pipe, closed at one end, are approximately:

(_) 170 and 510 Hz
(_) 170 and 340 Hz
(_) 57 and 170 Hz
(_) 340 and 680 Hz
(_) 340 and 1020 Hz

(15) Pressure vs. volume graphs for a certain gas undergoing five different cyclic processes are shown below. During which cycle does the gas do the greatest positive work?



(_) I
(_) II
(_) IV
(_) III
(_) V

(16) The "Principle of Equipartition of Energy" states that the internal energy of a gas is shared equally:

(_) among the relevant degrees of freedom
(_) between temperature and pressure
(_) between translational and vibrational kinetic energy
(_) between kinetic and potential energy
(_) among the molecules

(17) Two identical but separate strings, with the same tension, carry sinusoidal waves with the same amplitude. Wave A has a frequency that is twice that of wave B and transmits energy at a rate that is _____ that of wave B.

(_) four times
(_) half
(_) one-fourth
(_) eight times
(_) twice