Formula Sheet for LSU Physics 2112, EXAM 2, Spring 2019

Units:

$1\,\mathrm{m} = 39.4\,\mathrm{in} = 3.28\,\mathrm{ft}$ $\quad 1\,\mathrm{mi} = 5280\,\mathrm{ft}$ $\quad 1\,\mathrm{min} = 60\,\mathrm{s},\ \ 1\,\mathrm{day} = 24\,\mathrm{h}$ $\quad 1\,\mathrm{rev} = 360^\circ = 2\pi\,\mathrm{rad}$

$1\,\mathrm{atm} = 1.013{\times}10^5\,\mathrm{Pa} = 760\ \mathrm{torr} = 14.7\ \mathrm{psi}$ $\quad T = \left(\frac{1\,K}{1^\circ\mathrm{C}}\right) T_\mathrm{C} + 273.15\,\mathrm{K}$ $\quad T_\mathrm{F} = \left(\frac{9\,^\circ\mathrm{F}}{5^\circ\mathrm{C}}\right) T_\mathrm{C} + 32^\circ\mathrm{F}$

$1\ \mathrm{V} = \mathrm{J/C}$ $\quad 1\ \mathrm{eV}{=}1.602{\times}10^{-19}\ \mathrm{J}$

Constants:

$g = 9.8\,\mathrm{m/s^2}$	$m_e = 9.109 \times 10^{-31}\,\mathrm{kg}$	$m_p = 1.673 \times 10^{-27}\,\mathrm{kg}$
$c = 3 \times 10^8\ m/s$	$m_e c^2 = 511\,\mathrm{keV}$	$m_p c^2 = 938\,\mathrm{MeV}$
$e = 1.602{\times}10^{-19}\,\mathrm{C}$	$\epsilon_0 = 8.854 \times 10^{-12}\,\mathrm{C^2/(N\ m^2)}$	$hc = 1239.8\ \mathrm{eV{\cdot}nm}$
$k = 1.38 \times 10^{-23}\,\mathrm{J/K}$	$R = 8.31\,\mathrm{J/(mol{\cdot}K)}$	Avogadro's $\# = 6.02\ {\times}10^{23}\,\mathrm{particles/mol}$
$h = 6.626 \times 10^{-34}\ \mathrm{J{\cdot}s} = 4.136{\times}10^{-15}\ \mathrm{eV{\cdot}s}$		$\hbar = 1.054 \times 10^{-34}\ \mathrm{J{\cdot}s} = 6.582{\times}10^{-16}\ \mathrm{eV{\cdot}s}$

Simple Harmonic Motion (SHM): $\boldsymbol{T = \frac{1}{f} = \frac{2\pi}{\omega}}$

Linear:
$\boldsymbol{x(t) = x_m \cos(\omega t + \phi)}$
$\boldsymbol{v(t) = -x_m \omega \sin(\omega t + \phi)}$
$\boldsymbol{a(t) = -x_m \omega^2 \cos(\omega t + \phi) = -\omega^2 x(t)}$

Angular:
$\boldsymbol{\theta(t) = \theta_m \cos(\omega t + \phi)}$
$\boldsymbol{\Omega(t) = -\theta_m \omega \sin(\omega t + \phi)}$
$\boldsymbol{\alpha(t) = -\theta_m \omega^2 \cos(\omega t + \phi) = -\omega^2 \theta(t)}$

Linear Oscillator: Spring-Block: $\boldsymbol{\omega = \sqrt{\frac{k}{m}}}$ Horizontal Spring-Block: $\boldsymbol{E_{mec} = \frac{1}{2} k x_m^2}$

Hooke's Law: $F = -kx$

Pendulums: Torsion: $\boldsymbol{\omega = \sqrt{\frac{\kappa}{I}}}$ Simple: $\boldsymbol{\omega = \sqrt{\frac{g}{L}}}$ Physical: $\boldsymbol{\omega = \sqrt{\frac{mgh}{I}}}$

Torsion torque: $\boldsymbol{\tau = -\kappa\theta}$

Waves:

$\boldsymbol{y(x,t) = y_m \sin(kx \mp \omega t + \phi)}$ Angular Frequency: $\boldsymbol{\omega = \frac{2\pi}{T}}$ Wave Number: $\boldsymbol{k = \frac{2\pi}{\lambda}}$

Speed: $\boldsymbol{v = \frac{\omega}{k} = \lambda f}$ **Stretched String Speed:** $\boldsymbol{v = \sqrt{\frac{\tau}{\mu}}}$ Linear Density: $\boldsymbol{\mu = \frac{m}{L}}$

Power: $\boldsymbol{P_{avg} = \frac{1}{2} \mu v \omega^2 y_m^2}$

Interference of Waves: $\boldsymbol{y'(x,t) = \left[2y_m \cos\frac{\phi}{2}\right] \sin\left(kx - \omega t + \frac{\phi}{2}\right)}$

Standing Waves: $\boldsymbol{y'(x,t) = [2y_m \sin(kx)]\ \cos(\omega t)}$ Resonance: $\boldsymbol{f_n = \frac{v}{\lambda_n} = n\frac{v}{2L}}$

Sound Waves:

$\boldsymbol{s(x,t) = s_m \cos(kx \mp \omega t)}$ $\quad \boldsymbol{\Delta p(x,t) = \Delta p_m \sin(kx \mp \omega t)}$ $\quad \boldsymbol{\Delta p_m = (v\rho\omega) s_m}$

Sound Speed: $\boldsymbol{v = \sqrt{\frac{B}{\rho}}}$ Angular Frequency: $\boldsymbol{\omega = \frac{2\pi}{T}}$ Wave Number: $\boldsymbol{k = \frac{2\pi}{\lambda}}$

Speed: $\boldsymbol{v = \frac{\omega}{k} = \lambda f}$ **Intensity:** $\boldsymbol{I = \frac{P}{A} = \frac{P_s}{4\pi r^2}}$ Intensity: $\boldsymbol{I = \frac{1}{2} \rho v \omega^2 s_m^2}$

Interference of Waves: $\boldsymbol{s'(x,t) = \left[2s_m \cos\frac{\phi}{2}\right] \cos\left(kx - \omega t + \frac{\phi}{2}\right)}$ $\quad \phi = 2\pi\frac{\Delta L}{\lambda}$ + "other shifts"

Resonant Frequencies in Pipes,

Both Ends Open: $\boldsymbol{f = \frac{v}{\lambda} = \frac{nv}{2L} \quad n = 1, 2, 3, ...}$

One End Open, One Closed: $\boldsymbol{f = \frac{v}{\lambda} = \frac{nv}{4L} \quad n = 1, 3, 5, ...}$

Sound Level: $\boldsymbol{\beta = (10\mathrm{dB}) \log \frac{I}{I_0}}$ $\quad \boldsymbol{I_0 = 10^{-12}\mathrm{W/m^2}}$

Beats:

$\boldsymbol{s(t) = s_m \cos\omega_1 t + s_m \cos\omega_2 t = 2s_m[\cos\omega' t]\cos\omega t}$ $\quad \boldsymbol{\omega' = \frac{1}{2}(\omega_1 - \omega_2)}$

Doppler Effect: Source Moving: $\boldsymbol{f' = f\frac{v}{v \mp v_{source}}}$ Detector Moving: $\boldsymbol{f' = f\frac{v \pm v_{det}}{v}}$

Combined: $\boldsymbol{f' = f\frac{v \pm v_{det}}{v \mp v_{source}}}$

PHYS2112: Test 2 INSTRUCTIONS Feb. 26, 2019

A. **Sit in the seat** indicated on the front screen (if someone is in your seat, please let us know). If you're left-handed, let us know and we'll try to reseat you.

B. **Fill out your SCANTRON** form as follows:

a) On SIDE ONE Top - PRINT you **name** at the top AND your **seat number**
(draw a line between answer bubbles #12 and #13 so that you've answered all)

b) On SIDE TWO:

I. **Print** your name (**LastName_FirstName**) in the *NAME* spaces

II. **Bubble in your name below** it (→ there's a space between last and first name)

III. **Bubble in your LSU ID** under *IDENTIFICATION NUMBER* (→ IMPORTANT!!)

C. When we pass out the **TEST at ~ 6 pm** , please:

a) **Print** your last name, then first name on your Test

b) Put your signature, LSU ID number

c) **Circle** your section instructor/time

D. Put EVERYTHING away (including ALL phones except pencil, calculator, and provided formula sheet & Scantron form.

E. There are **12** multiple choice questions and **2** free-response problems. There should be **6** total pages!

F. **For the free-response problems, show all relevant work in the space provided.** Without supporting work, even a correct answer will receive little or no credit. Partial credit will be awarded as warranted.

→ NOTE THAT PROBLEM #1 CONTINUES FROM PAGE 4 to PAGE 5

G. Be sure that your numerical answers appear with appropriate **SI units**. Points will be deducted for missing, incorrect, or "silly" units.

H. When you leave: turn in your Scantron (with 12 bubbles bubbled) ***and*** your test.