Review — Sept. 19, 2008

Physics 1320 | Music & Physics | Prof. Tunks & Olness

Understand units. Recall the 3 fundamental units, and be able to reduce terms to basic units. Example: which of the following do not have units of acceleration.
Use the basic formula: d= s t, or equivalently: x= v t. Example, sound travels x distance in t seconds. Find v.
Perform problems from lab. Example: Which of the following do not have 4 significant figures. Example: Galileo measures a wave covers a round trip of 20 miles in 30 seconds, and 40 miles in 50 seconds. Find the reaction time of his assistant, and the true speed of the wave.
Examine a graph of a wave and determine amplitude, phase, period, frequency, etc.
Given K and M, compute the f for a mass on a spring.
Given g and L, , compute the f for a mass on a string.
Two tones sound together. Compute the average frequency, and the beat frequency.
A speaker outputs 100 W/m^2 at a distance of 1m. Compute the intensity at a distance of 10m.
For both and open and closed organ pipe, sketch the first 5 resonances. Find the frequency and wavelength in terms of the length of the pipe, and the speed of sound.
Understand the dB scale, and be able to add SIL. Understand and know how to use the inverse square law
Know about wave properties: Reflection, Refraction, Interference, Diffraction, Doppler effect.

VARIOUS TERMS:
Length, time, mass, speed, velocity, area, acceleration, volume,
force, work, pressure, power,vector, momentum, equilibrium,

vibration - oscillation, periodic motion, period, T, cycle, frequency, f, Hz, simple harmonic motion, SHM, amplitude, displacement, restoring force, momentum, phase, sine curve, pure tone, sinusoid, fundamental frequency, mass - stiffness, natural frequencies, damping, driving force, f=1/T, T=1/f, envelope, wave history, time domain/frequency domain graphs,

medium, propagation, compression, expansion (rarefaction), density, elasticity, longitudinal wave, transverse wave, tension, displacement-time, pressure-time curves, pressure/displacement phase relationship (90 degrees), wavelength, speed of sound, reflection, refraction, diffraction, phase, constructive interference, destructive interference, beats (fb=f1-f2), Doppler effect, efficiency, intensity, inverse square law,

standing wave, node, antinode, vibratory modes, harmonics, partials, overtones, open tube function (open pipe), stopped (closed) tube function (stopped pipe), conical pipe function, resonance, sympathetic vibration, Helmholtz resonator, linear and logarithmic scales,

intensity (I) in Watts per squared meter, intensity level (IL) in dB (10 log I1/I2), intensity ratio, sound pressure level , threshold of audibility, Fletcher-Munson curves, equal loudness contours, loudness level (LL) in phons, threshold of feeling (pain), loudness (L) in sones, sound level meter, dB(A), OSHA standard ,

Exam #2 Study Sheet　　　　Oct. 17, 2006

Physics 1320　　Music & Physics　　Prof. Tunks & Olness

IMPORTANT: Review Term Sheets:

Harmonic series

Musical Ratios/Intervals: 5th, 4th, Major/Minor 3rd, 2nd

Middle C=C_4, and US conventions

Inverse square law

Chorus effect

Formant region.

Subjectives tones: Difference tones.

Loudness difference Limen:

Frequency difference Limen:

Pitch vs. loudness

implied fundamental

phon: Loudness level

sone: Loudness

sound intensity level: dB

intensity level: W/m^2

Masking

Critical Band:

Scales: {P,J,M,E}

time-domain/frequency-domain graphs

human ear

Pythagorean / Just (de Caus) /Meantone (¼ comma)/Equal Temperament

Fletcher-Munson contours of equal loudness

$x = v\,t$

$F = ma$ *Newton's 2nd Law*

$P = F/A$

$W = F\,x$

$F = -k\,x$ *Hooke's Law*

$W = \frac{1}{2} k x^2$ (for spring)

$$f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$$

$x(t) = A\ \mathrm{Sin}(2\pi f t + \phi)$

$$v = c = f\lambda$$

$c = 332\ (m/s) \pm 0.6\ (m/s/°C)$

$c = 1087\ (ft/s) \pm 1.1\ (ft/s/°F)$

$f_{AVERAGE} = (f_1 + f_2)/2$

$f_{BEATS} = f_1 - f_2$

$I = P/A = P/(4\pi r^2)$ *(P=Power)*

T=KV/(Sa)

where K=0.049 (British)

or K=0.16 (Metric)

$SIL = 10\ \mathrm{Log}(I/I_0)$

$I = I_0 \times 10^{L/10}$ $I_0 = 10^{-12}\ W/m^2$

Conversions:

$1\ \lambda = 360° = 2\pi$ radians

1 Hz = 1 cycles/sec = 2π rad/s = 360°/s

PHYSICAL CONSTANTS

$\rho = 1.21\ kg/m^3$ (density of air)

$\rho = 10^3\ kg/m^3$ (density of water)

BASIC FORMULAS

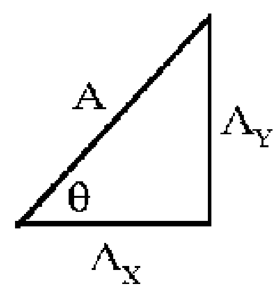
Sphere: $A = 4\pi r^2$, $V = \pi r^3$

Cylinder: $A = 2\pi r L$, $V = \pi r^2 L$

$A_X = A\cos(\theta)$;

$A_Y = A\sin(\theta)$;

$\tan(\theta) = A_Y / A_X$;



CAUTION:

- pressure is "P", density is rho "ρ" ... and sometimes power is "P"
- acceleration is "a", Area is "A"
- force is "F", frequency is "f", ... and Fahrenheit is "F"

	+0 dB	+1 dB	+ 2 dB	+ 3 dB	+ 4 dB	+ 5 dB	+ 6 dB	+ 7 dB	+ 8 dB	+ 9 dB	+ 10 dB		
120 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-0}$	W/m^2
110 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-1}$	W/m^2
100 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-2}$	W/m^2
90 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-3}$	W/m^2
80 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-4}$	W/m^2
70 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-5}$	W/m^2
60 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-6}$	W/m^2
50 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-7}$	W/m^2
40 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-8}$	W/m^2
30 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-9}$	W/m^2
20 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-10}$	W/m^2
10 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-11}$	W/m^2
0 dB	1.0	1.3	1.6	2.0	2.5	3.2	4.0	5.0	6.3	7.9	10.0	$\times 10^{-12}$	W/m^2

Level Difference	Intensity Ratio
SIL_1-SIL_2=	I_1 / I_2
0 dB	1.0
1 dB	1.3
2 dB	1.6
3 dB	2.0
4 dB	2.5
5 dB	3.2
6 dB	4.0
7 dB	5.0
8 dB	6.3
9 dB	7.9
10 dB	10.0
20 dB	10^2
30 dB	10^3
40 dB	10^4
50 dB	10^5
60 dB	10^6
70 dB	10^7
80 dB	10^8
90 dB	10^9
100 dB	10^{10}
$(10 \times n)$ dB	10^n

Sound Level dBA	Max 24hr Exposure Occupational	Max 24hr Exposure Non-occupational
80		4 hr
85		2 hr
90	8 hr	1 hr
95	4 hr	30 min
100	2 hr	15 min
105	1 hr	8 min
110	30 min	4 min
115	15 min	2 min
120	0 min	0 min

	Pythagorean	Just	Mean Tone*	Equal
C	0	0	0	0
C#	114	92	76	100
D	204	204	193	200
Eb	294	316	310	300
E	408	386	386	400
F	498	498	503	500
F#	612	590	579	600
G	702	702	696.5	700
G#	816	816	772	800
A	906	884	890	900
Bb	996	996	1007	1000
B	1110	1088	1083	1100
C	1200	1200	1200	1200

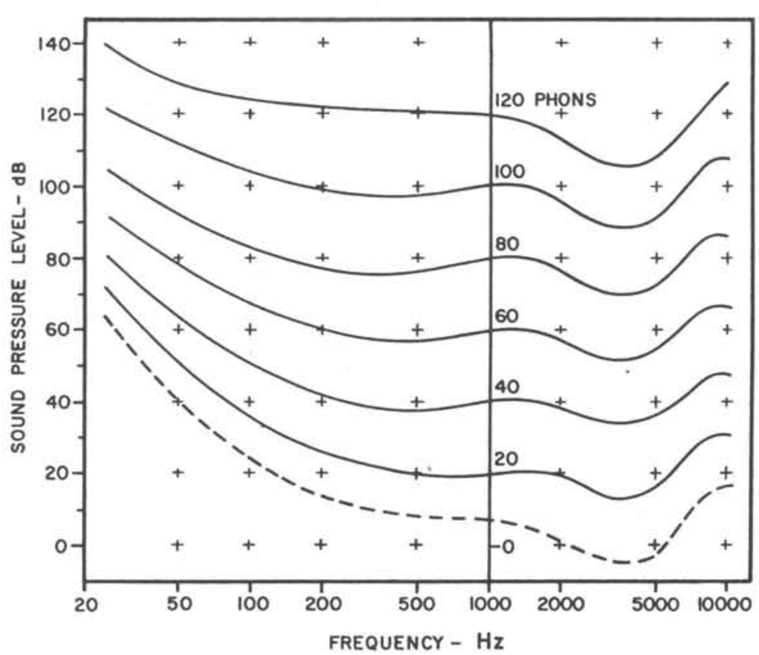


Fig. 3. Sensitivity of the ear as a function of frequency; equal loudness curves relating loudness level in phons to sound pressure level in decibels.

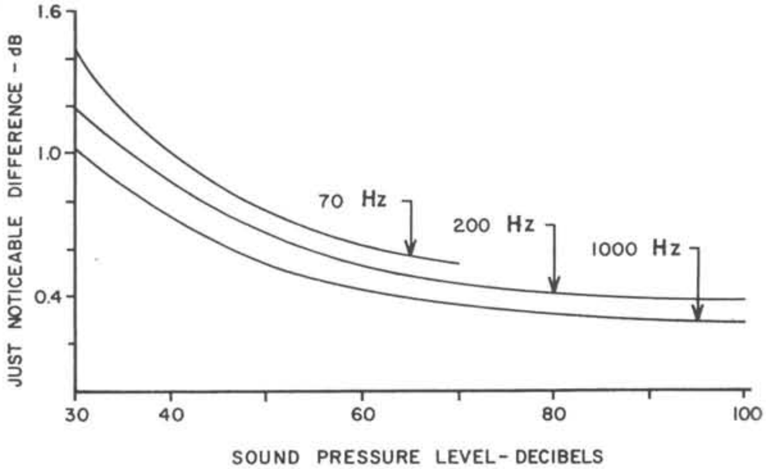
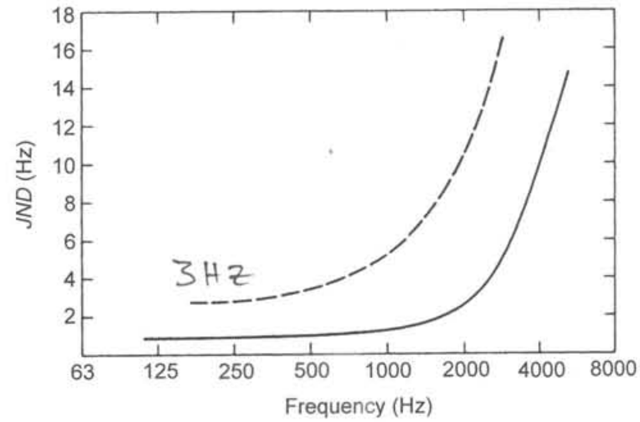


FIG. 2. Just noticeable difference in sound pressure level for three frequencies.



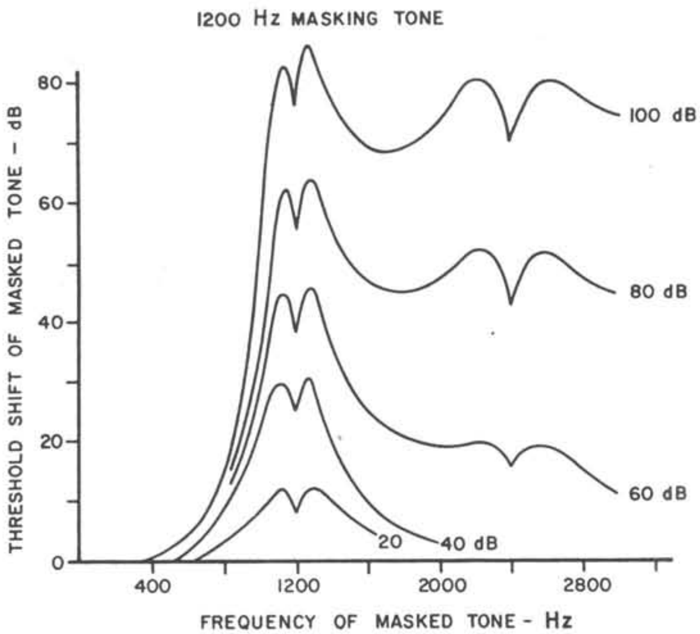


FIG. 5. Masking curves for a masking tone of 1200 hertz.

Sound Level (dBA)	Maximum 24-Hour Exposure: Occupational	Nonoccupational
80		4 hr
85		2 hr
90	8 hr	1 hr
95	4 hr	30 min
100	2 hr	15 min
105	1 hr	8 min
110	30 min	4 min
115	15 min	2 min
120	0 min	0 min

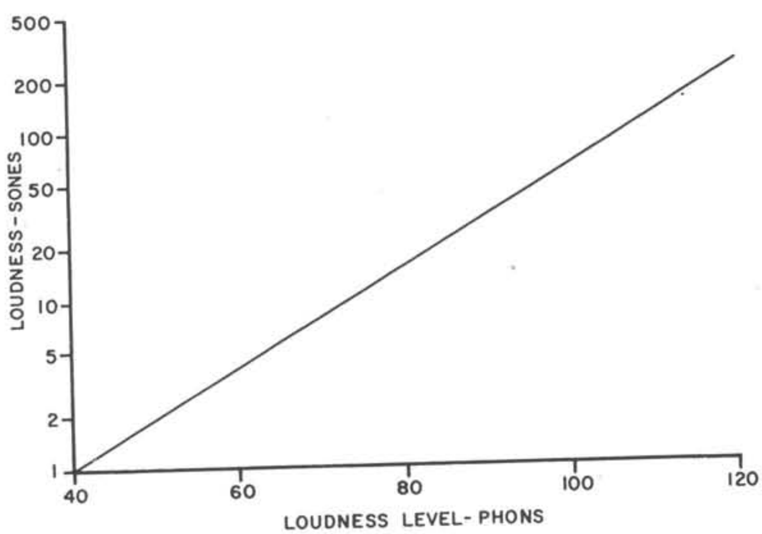


FIG. 4. Relation between loudness in sones and loudness level in phons.

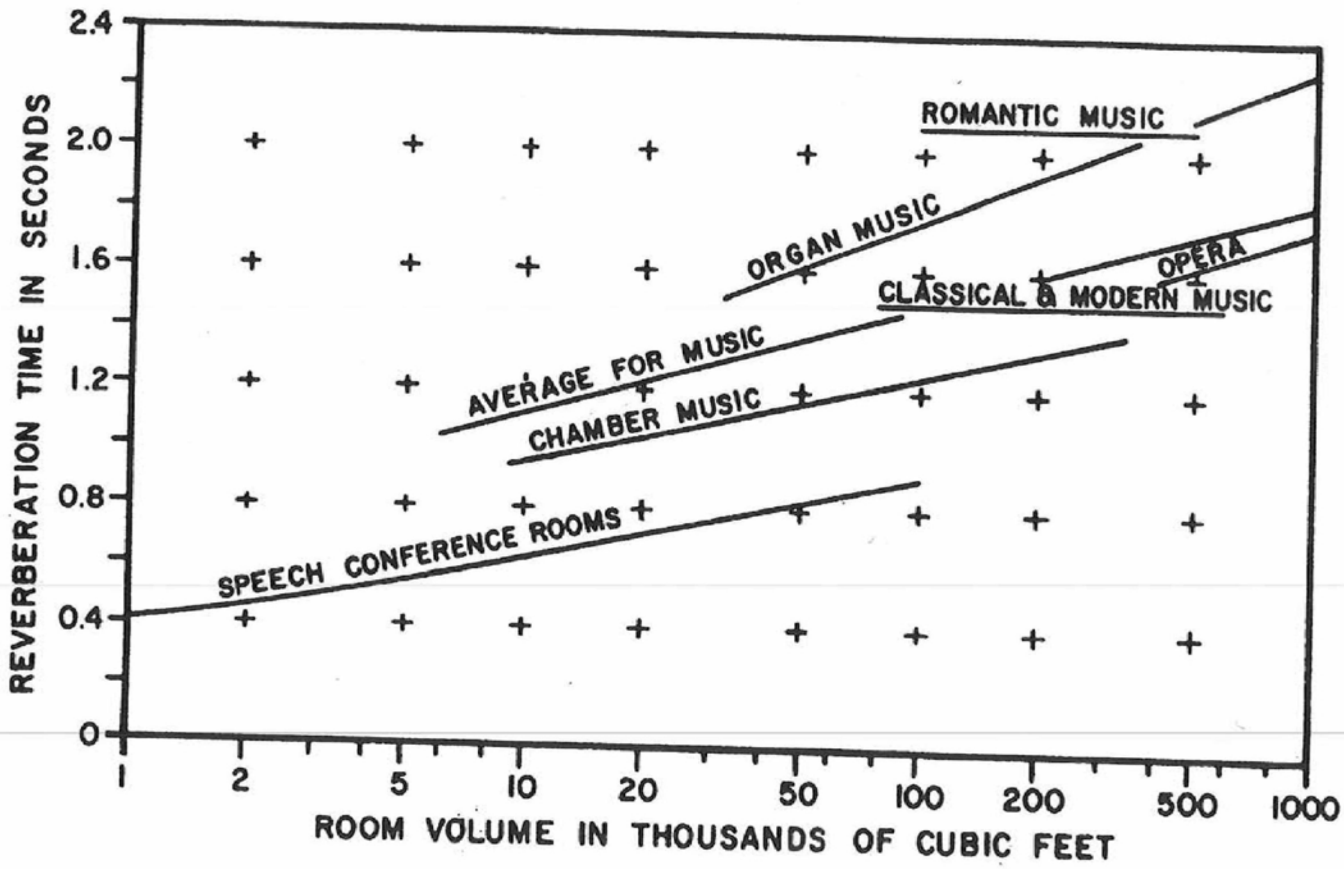


FIG. 5. Optimum reverberation time for auditoriums of various sizes and functions at a frequency of 500 hertz.

	FREQUENCY—HERTZ					
	125	250	500	1000	2000	4000
Marble or glazed tile	.01	.01	.01	.01	.02	.02
Concrete, unpainted	.01	.01	.01	.02	.02	.03
Asphalt tile on concrete	.02	.03	.03	.03	.03	.02
Heavy carpets on concrete	.02	.06	.14	.37	.60	.65
Heavy carpets on felt	.08	.27	.39	.34	.48	.63
Plate glass	.18	.06	.04	.03	.02	.02
Plaster on lath on studs	.30	.15	.10	.05	.04	.05
Acoustical plaster, 1″	.25	.45	.78	.92	.89	.87
Plywood on studs, ¼″	.60	.30	.10	.09	.09	.09
Perforated cane fiber tile, cemented to concrete, ½″ thick	.14	.20	.76	.79	.58	.37
Perforated cane fiber tile, cemented to concrete, 1″ thick	.22	.47	.70	.77	.70	.48
Perforated cane fiber tile, 1″ thick, in metal frame supports	.48	.67	.61	.68	.75	.50