University Physics 2 – Spring 2012 – Test 1 – 01/27/12 SOLUTION KEY

Calculation Problems – Choose 4 out of 5 problems (25 points each)

1) A **4 kg** mass is connected to a horizontal spring (with spring constant **400 N/m**) on a frictionless surface. The mass is at the origin and given an initial velocity of **4 m/sec** in the +x direction. at t=0.

a) What is the complete v(t) equation for the motion of this mass?

b) What is the complete x(t) equation for the motion of this mass?

c) What is the kinetic energy when the mass is at ½ the amplitude of its motion?

d) When is the first time the acceleration is a maximum magnitude?

a) $v = 4\cos(\sqrt{\frac{400}{4}}t) = 4\cos(10t)$ b) $x = 0.4\sin(10t)$ c) $U_{sp} = \frac{1}{2}(400)(0.2)^2 = 8J$ $E = \frac{1}{2}(4)(4)^2 = 32J$ $KE = 24J$

d) acceleration = max when displacement = maximum = ¼ period .. thus if $T = \frac{2\pi}{10}$ $t = \frac{\pi}{20} = 0.157\,\text{sec}$

2) Traveling waves:

a) A traveling water wave is moving to the **right**, has an **amplitude of 0.5 m**, has a **period of 0.4 seconds**, and a **wavelength of 2 meters**. You can watch a tiny floating leaf bob up and down. What is the complete wave equation y(x,t)?

b) At x=0 m, what is the maximum vertical speed of a leaf?

c) at x=2 m, what is the maximum vertical speed of a leaf?

a) $k = \frac{2\pi}{\lambda} = \pi$ $\omega = \frac{2\pi}{T} = 5\pi$ to the right $y(x,t) = 0.5\sin(\pi x - 5\pi t)$

b) $v = A\omega = 2.5\pi$ c) same answer as b) .. maximum speed doesn't depend on location!

3) A source is moving **East** with a fixed speed and is emitting a frequency of **300 Hz**. The receiver is to the **West** of the source. Speed of sound in the room is **343 m/sec**.

a) When the receiver is at rest – it detects a frequency of **280 Hz** from the moving source. What is the speed of the source?

b) The receiver starts moving at **10 m/sec** to the **EAST**– there is a wall to the **West** of the receiver – and the sound from the moving source bounces off that west wall and arrives at the moving receiver – what frequency does the moving receiver detect from that bounced sound off the west wall?

a) $280 = 300\frac{343}{343+v}$ $343 + v = (1.07)(343)$ $v = 24.5 m/s$ b) $f' = \left[300\frac{343}{343+24.5}\right]\left\{\frac{343-10}{343}\right\} = 271.8Hz$

4) Sound intensity and Decibel scale questions:

a) Dr. Scott drinks a pop too quickly and emits a loud burp. An unfortunate student at a **distance of 1 meter** hears a sound level of **70 dB**. Another student heard the same burp at **40 dB**. Roughly how soft (opposite of loud) would the second student say the burp was compared to if they stood where the first student was? (such as half as loud, 1/3 as loud, etc.)

b) Exactly how far way (in meters) is the second student location?

c) If the second student stood so that they heard **57 dB** for the burp – what is the intensity (I) ratio between the first student and this new location?

a) 30dB = 3x 10dB .. every 10 dB is ½ as loud so half*half*half = 1/8 th as loud b) 30 dB translates to an intensity ratio of 1000 – distance ratio is the square root of the intensity - thus new distance = 31.62 meters. c) this is a 13 dB change .. so 10+3 .. this translates to x10x2 = 20 times the intensity

5) Waves in tubes:

a) An tube with **both ends open** is **2.5 meters** long. What are the lowest three resonant frequencies that can be excited in the tube if the **speed of sound is 331 m/sec** (so, in 0 degree air instead of room temperature)?

b) Two adjacent frequencies in a *completely different* tube are **90 Hz and 150 Hz** – is the tube both ends open, both ends closed, or one open/one closed – explain. And what is the length of this tube (if the speed of sound is the same).

a) L=2.4 m $f_{bothopen} = n\left(\frac{v}{2L}\right) = n\left(\frac{331}{2(2.5)}\right) = n(66.2) = 66.2, 132.4, 198.6Hz$

b) the difference between these = 60 Hz .. and neither is a multiple of 60 Hz – but both are odd multiples of 30 Hz - thus one open / one closed. 30=v/4L L=2.78m

Multiple Choice Answers: 1) C 2) C 3) C 4) B 5) C 6) B 7) D

MULTIPLE CHOICE QUESTIONS
(Choose 6 out of 7 - 3 points each {2 free points} – total of 20 points for this section)

1. A mass on a spring is oscillating on a horizontal frictionless surface. At a location of maximum displacement, which is also a maximum? 1) ___C___
A) speed. B) spring constant. C) acceleration. D) kinetic energy. E) momentum.

2. A mass on a spring has a period **T** and the maximum distance from the equilibrium position occurs at a time $\mathbf{t_1}$. Some time passes (Δt) and the mass is now moving with a maximum velocity. The duration of time Δt is : 2) __C___
A) the period T. B) ½ the period T. C) ¼ the period T.
D) twice the period T. E) maximum speed occurs at time $\mathbf{t_1}$

3. A body of mass **m** moves in simple harmonic motion with a frequency of **2 Hz** and a maximum velocity of **6π m/sec**. Which of the following equations could correctly represents this motion?
A) $x = 1.5\cos(2\pi t)$ B) $x = 2\cos(\pi t)$ C) $x = 1.5\cos(4\pi t)$ 3) ___C__
D) $x = 3\pi \sin(1.5\pi t)$ E) $x = 3\pi\cos(4\pi t)$

4. A mass undergoing horizontal simple harmonic motion and has a maximum acceleration of $10 m/sec^2$. When the mass is located at ¼ of the amplitude A, what is the acceleration of the mass?
A) $10\ m/s^2$ B) $2.50\ m/s^2$ C) $5.00\ m/s^2$ D) $0.25\ m/s^2$ E) $40\ m/s^2$ 4) __B___

5. A mass on a spring oscillates with an amplitude of A. What is the position of the mass when the kinetic energy is exactly ½ of the total mechanical energy of the system? 5) ___C__
A) A B) A/2 C) $A/\sqrt{2}$ D) A/4 E) Not enough information provided to answer.

6. There is a sound source of power P. Two people are standing motionless listening to the sound. Person A is **2 times** further away than Person B. Person A will hear a sound that is _____ dB lower and is _____ times the intensity (I). 6) __B___
A) 6 ; 1/16 B) 6 ; 1/4 C) 16 ; 1/16 D) 4 ; 1/4 E) 2 ; 1/2

7. An oscillator tuned to a frequency of 30 Hz is dropped from a tall building. How does the frequency picked up by a stationary observer at the top of the building change with time? 7) __D___
A) The frequency will be lower than 30 Hz but does not change with time.
B) The frequency will be higher than 30 Hz but does not change with time.
C) The frequency will be higher than 30 Hz and decreases further with time.
D) The frequency will be lower than 30 Hz and decreases further with time.
E) The frequency stays at 30 Hz.

University Physics 2 – Spring 2012 – Test 1 – 01/27/12 Name _____

Chose 4 out of 5 calculation problems – 25 pts each = 100 points Multiple choice = 20 points (2 free pts!)

Honor Code Pledge: "I have neither given nor received unauthorized aid in completing this work, nor have I presented someone else's work as my own." _____

Calculation Problems – Choose 4 out of 5 problems (25 points each)

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MULTIPLE CHOICE QUESTIONS (7 questions – Choose 6 - 3 points each – total of 20 points for this section – two free points) – Circle the best answer!

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A) speed. B) spring constant. C) acceleration. D) kinetic energy. E) momentum.

2. A mass on a spring has a period **T** and the maximum distance from the equilibrium position occurs at a time $\mathbf{t_1}$. Some time passes (Δt) and the mass is now moving with a maximum velocity. The duration of time Δt is :
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4. A mass undergoing horizontal simple harmonic motion and has a maximum acceleration of **10 m/sec^2**. When the mass is located at ¼ of the amplitude A, what is the acceleration of the mass?
A) 10 m/s^2 B) 2.50 m/s^2 C) 5.00 m/s^2 D) 0.25 m/s^2 E) 40 m/s^2

5. A mass on a spring oscillates with an amplitude of A. What is the position of the mass when the kinetic energy is exactly ½ of the total mechanical energy of the system?

A) A B) A/2 C) $A/\sqrt{2}$ D) A/4

E) Not enough information provided to answer.

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E) The frequency stays at 30 Hz.

Choose 6/7 of the Multiple Choice questions and 4/5 of the Calculation questions!