Physics 124 – Common Hour Exam 2
Monday, April 4, 2016, 9:50 PM - 11:10 PM
ARC-103 (Aa-Jz), Hill 114 (Ka-Nz),
SEC 111 (Oa-Sh), PLH (Si-Zz)

Your name sticker ⇒
with exam code

SIGN HERE

1. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
2. In the section labeled NAME (Last, First, M.I.), enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit RUID Number.
4. Under CODE enter the exam code given above.
5. Enter 124 under COURSE. You do not need to write anything else on the answer sheet. You should continue to read the instructions.
6. During the exam, you are allowed one 8.5 x 11 inch sheet of paper handwritten, both sides.
7. The exam consists of 15 multiple-choice questions. For each multiple-choice question mark only one answer. There is no deduction of points for an incorrect answer; if you cannot work out the answer to a question, you should make an educated guess.
8. If you have questions or problems during the exam, you may raise your hand and a proctor will assist you. We will provide the value of physical constants that are needed. It is your responsibility to know the relevant equations.
10. You are not allowed to help any other student, ask for help from anyone but a proctor, change your seat without permission from a proctor, or use any electronic device other than a scientific calculator. Doing so will result in a zero score for the exam.
11. When you are done with the exam, hand in only this cover sheet and your answer sheet. Show your ID to a proctor.
12. Please sign above by the name sticker to indicate that you have read and understood these instructions.
Possibly useful constants:

\[ G = 6.67 \times 10^{-11} \text{ N\cdot m}^2/\text{kg}^2 \]
\[ g = 9.8 \text{ m/s}^2 \]
Radius of Earth =6.4 \times 10^6 \text{ m}, mass of Earth = 6.0 \times 10^{24} \text{ kg}

Speed of sound in air at 20°C \( v_{\text{sound}} = 344 \text{ m/s} \)
\[ \rho_{\text{water}} = 10^3 \text{ kg/m}^3, \ \text{1 atm} = 1.01 \times 10^5 \text{ Pa} \]

Moments of inertia for uniform density objects:
\[ I_{\text{disk}} = I_{\text{solid cylinder}} = \frac{1}{2} MR^2 \]
\[ I_{\text{thin walled hollow cylinder}} = I_{\text{ring}} = MR^2 \]
\[ I_{\text{solid sphere}} = \frac{2}{5} MR^2, \ I_{\text{thin walled hollow sphere}} = \frac{2}{3} MR^2 \]
\[ I_{\text{slender rod, axis through center}} = \frac{1}{12} ML^2 \]
\[ I_{\text{slender rod, axis through one end}} = \frac{1}{3} ML^2 \]

Circumference of a circle =2\pi r; area of a circle = \pi r^2

Surface area of a sphere = 4\pi r^2; Volume of a sphere = \frac{4}{3} \pi r^3

Surface area of a cylinder = 2\pi rh + 2\pi r^2; Volume of cylinder = \pi r^2h

\[
\begin{align*}
\sin(0^\circ) &= \cos(90^\circ) = 0 \\
\sin(90^\circ) &= \cos(0^\circ) = 1 \\
\sin(30^\circ) &= \cos(60^\circ) = 1/2 \\
\sin(60^\circ) &= \cos(30^\circ) = \sqrt{3}/2 \\
\sin(45^\circ) &= \cos(45^\circ) = \sqrt{2}/2
\end{align*}
\]

Some metric prefixes:
\[ f = \text{femto} = 10^{-15} \]
\[ p = \text{pico} = 10^{-12} \]
\[ n = \text{nano} = 10^{-9} \]
\[ \mu = \text{micro} = 10^{-6} \]
\[ m = \text{milli} = 10^{-3} \]
\[ k = \text{kilo} = 10^3 \]
\[ M = \text{mega} = 10^6 \]
\[ G = \text{giga} = 10^9 \]
1. A block with mass $m = 0.5 \text{ kg}$ attached to a spring with spring constant $k = 8.0 \text{ N/m}$ undergoes simple harmonic motion with amplitude $A = 0.1 \text{ m}$. What is the maximum speed $v$ of the mass?
   a) $v = 1.6 \text{ m/s}$
   b) $v = 0.2 \text{ m/s}$
   c) $v = 0.8 \text{ m/s}$
   d) $v = 0.04 \text{ m/s}$
   e) $v = 0.4 \text{ m/s}$

2. An object undergoes simple harmonic motion of amplitude $A$, centered at $x=0$, along the $x$ axis. At which of the following positions $x$ can the acceleration $a$ be greater than 0 but the velocity $v$ be less than 0?
   a) $x = -A$
   b) $x = -A/2$
   c) $x = 0$
   d) $x = A/2$
   e) $x = A$

3. Two loudspeakers, $A$ and $B$, are driven by the same amplifier and emit sinusoidal waves in phase. The frequency of the waves emitted by each speaker is 172 Hz. You are a distance $d_A = 8.00 \text{ m}$ from $A$. What is the closest distance $d_B$ you can be to amplifier $B$ and be at a point of DESTRUCTIVE interference? Assume speed of sound is $v = 344 \text{ m/s}$.
   a) $d_B = 8.0 \text{ m}$
   b) $d_B = 1.0 \text{ m}$
   c) $d_B = 4.0 \text{ m}$
   d) $d_B = 2.0 \text{ m}$
   e) $d_B = 0.5 \text{ m}$

4. A cubical box, 0.05 m on each side, is immersed in a fluid. The gauge pressure at the top surface of the box is 600 Pa and the gauge pressure on the bottom surface is 1220 Pa. What is the density $\rho$ of the fluid?
   a) $\rho = 1260 \text{ kg/m}^3$
   b) $\rho = 1200 \text{ kg/m}^3$
   c) $\rho = 12.6 \text{ kg/m}^3$
   d) $\rho = 1490 \text{ kg/m}^3$
   e) $\rho = 14.9 \text{ kg/m}^3$
5. A simple pendulum has horizontal displacement as a function of time given by the following equation in SI units:

\[ x(t) = 0.07 \cos\left(\frac{t}{0.4} - 2.4\right) \]

Find the length \( L \) of the pendulum. Assume that \( g = 9.8 \text{ m/s}^2 \).

a) \( L = 0.39 \text{ m} \)

b) \( L = 0.78 \text{ m} \)

c) \( L = 1.18 \text{ m} \)

d) \( L = 1.57 \text{ m} \)

e) \( L = 1.88 \text{ m} \)

6. A number of strings of different densities are under tension. For each string you measure the mass per unit length \( \mu \) and the speed \( v \) of transverse waves on the string.

- String A has \( \mu_A = 0.0200 \text{ kg/m}, v_A = 40.0 \text{ m/s} \).
- String B has \( \mu_B = 0.0400 \text{ kg/m}, v_B = 40.0 \text{ m/s} \).
- String C has \( \mu_C = 0.0400 \text{ kg/m}, v_C = 80.0 \text{ m/s} \).
- String D has \( \mu_D = 0.0200 \text{ kg/m}, v_D = 80.0 \text{ m/s} \).

Rank the strings in the order of the tension, \( T \), they are under.

a) \( T_A > T_B > T_C > T_D \)

b) \( T_C > T_D > T_A = T_B \)

c) \( T_C > T_D > T_B > T_A \)

d) \( T_C = T_D > T_A = T_B \)

e) \( T_D > T_C > T_A > T_B \)

7. Two swift canaries fly towards each other, each moving at a speed \( v_C \) of 5 percent \( v_{\text{sound}} \) relative to the ground. Each canary warbles a note of frequency \( f_C \). What frequency \( f_L \) will each canary measure for the note from the other one?

a) \( f_L = f_C \)

b) \( f_L = 0.90 f_C \)

c) \( f_L = 0.95 f_C \)

d) \( f_L = 1.11 f_C \)

e) \( f_L = 1.05 f_C \)
8. A shower head has 20 circular openings, each with a radius of 1.0 mm. The shower head is connected to a pipe with radius 1.0 cm. If the speed of the water in the pipe is $v_1$, what is the water speed $v_2$ as it exits the shower-head openings?

   a) $v_2 = v_1$
   b) $v_2 = 20v_1$
   c) $v_2 = 100v_1$
   d) $v_2 = 2v_1$
   e) $v_2 = 5v_1$

9. A 3.0 m long string with mass density $\mu = 1.0 \times 10^{-2}$ kg/m is under a tension of $F=100$ N. Both ends of the string are fixed in place. A resonance is set up on the string with five antinodes. What is the resonance frequency $f$?

   a) $f = 83$ Hz
   b) $f = 120$ Hz
   c) Not enough information is given to determine the fundamental resonance frequency.
   d) $f = 164$ Hz
   e) $f = 42$ Hz

10. An oscillator creates periodic waves on a string. Which of the following statements is TRUE?

   a) If the period of the oscillator doubles, the wavelength is halved but the wave speed is unchanged.
   b) If the amplitude of the oscillator doubles, the wavelength doubles but the wave speed is unchanged.
   c) If the period of the oscillator doubles, the wavelength is unchanged but the wave speed doubles.
   d) If the period of the oscillator doubles, the wavelength doubles but the wave speed is unchanged.
   e) If the amplitude of the oscillator doubles, the wavelength doubles and the wave speed is reduced by one-half.

11. The lowest-pitch tone to resonate in a pipe of length $L$ that is closed at one end and open at the other end is 200 Hz. Which of the following frequencies $f$ will NOT resonate in the same pipe?

   a) $f = 1400$ Hz
   b) $f = 1800$ Hz
   c) All of the frequencies will resonate.
   d) $f = 400$ Hz
   e) $f = 1000$ Hz
12. The siphon shown is used to transfer gasoline from a higher level to a lower level. If the fluid is drawn up and is continuous through the tube, determine the velocity $v$ of flow of gasoline at the outlet of the siphon, if the vertical distance from the liquid surface to the outlet is 1.0 m. If needed, use $g = 9.8 \text{ m/s}^2$.

a) $v = 1.1 \text{ m/s}$
b) $v = 2.2 \text{ m/s}$
c) $v = 4.4 \text{ m/s}$
d) $v = 9.8 \text{ m/s}$
e) $v = 6.5 \text{ m/s}$
13. The figures show four identical masses attached to springs and hung vertically. The masses are pulled down various distances and then released. The spring constant $k$ and the distance $d$ that the mass is pulled down are given for each case in the figures. Rank these situations on the basis of the maximum kinetic energy $K$ of the identical masses, from greatest to least.

- **A**
  - $d = 60$ cm
  - $k = 240$ N/m

- **B**
  - $d = 90$ cm
  - $k = 180$ N/m

- **C**
  - $d = 50$ cm
  - $k = 150$ N/m

- **D**
  - $d = 90$ cm
  - $k = 150$ N/m

**a)** $K_A > K_B > K_D > K_C$

**b)** $K_A = K_B > K_C > K_D$

**c)** $K_B > K_D > K_A > K_C$

**d)** The ranking cannot be determined with the information that is provided.

**e)** $K_B > K_A > K_D = K_C$
14. An all female guitar quintet is getting ready to go on stage. The lead guitarist, Karen, who is always in tune, plucks her low E string and the other 4 members, sequentially, do the same. Each member records the initial beat frequency $f$ between her low E string and Karen’s low E string. These are the initial beat frequencies for each guitarist:

- $f_{\text{beat,Evita}} = 5 \text{ Hz}$
- $f_{\text{beat,Freja}} = 3 \text{ Hz}$
- $f_{\text{beat,Diane}} = 0 \text{ Hz}$
- $f_{\text{beat,Carol}} = 1 \text{ Hz}$

Rank each member on the basis of the frequency of her low E string.

a) The correct ranking cannot be determined because need more information than just the initial beat frequency.

b) $f_{\text{Evita}} > f_{\text{Freja}} > f_{\text{Carol}} > f_{\text{Diane}}$

c) $f_{\text{Carol}} > f_{\text{Diane}} > f_{\text{Evita}} > f_{\text{Freja}}$

d) $f_{\text{Diane}} > f_{\text{Carol}} > f_{\text{Evita}} > f_{\text{Freja}}$

e) $f_{\text{Freja}} > f_{\text{Evita}} > f_{\text{Diane}} > f_{\text{Carol}}$

15. A flask of water rests on a scale that reads 100 N. One at a time, each of four small blocks of unknown material are held completely submerged in the water by a rigid rod of negligible mass and volume. The mass and volume of each block is given in the table.

<table>
<thead>
<tr>
<th></th>
<th>Mass (g)</th>
<th>Volume (cm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block A</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Block B</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Block C</td>
<td>200</td>
<td>50</td>
</tr>
<tr>
<td>Block D</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

The blocks do not touch any part of the flask. Rank these blocks on the basis of the scale reading when the blocks are completely submerged.

a) $D > A = B > C$

b) $B > D > A = C$

c) $A = B > C > D$

d) $A > B > C > D$

e) $C > A = B > D$