# Midterm Exam #1 (Form B)

## Physics 1B Lecture 3

### Instructor: Hector Garcia Vasquez

**Tuesday, April 23rd, 2019**

**1:00 PM – 1:50 PM**

Last Name: [redacted]

First Name: [redacted]

University ID: [redacted]

**DO NOT TURN PAGE UNTIL INSTRUCTED**

You will have 50 minutes to complete this exam. One standard 3" x 5" index note card is permitted. Books and all other notes are not allowed. Scientific and graphing calculators are allowed. All other electronics are not allowed and must be put away. Both pen and pencil are allowed.

Please write your answer in the space below the problem. Scratch paper will be provided. **You must write legibly and demonstrate your reasoning to get full credit.** For clarity, please draw a box around your final answer.

| | |
|---|---|
| Q1 | 14 |
| Q2 | 5 |
| Q3 | 13 |
| Q4 | 19 |
| Q5 | 20 |
| **TOTAL** | 71 |

**Question 1**

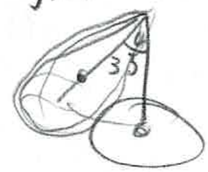
A 1.80 kg physical pendulum in simple harmonic motion is pivoted 200 cm from its center of mass with a moment of inertia 0.129 kg·m$^2$. At some point in time the pendulum is 3.50° from equilibrium, and 0.524 s later it is at -5.59° from equilibrium. from pivot not cm

(a) Find the amplitude of oscillations.

(b) Write a function for the angular position in time, Θ(t), that describes the motion between the given 0.524 s. Set Θ(0) equal to the first given angle, 3.50°.

a) A mass $= 1.8\,kg$ $r = .2\,m$ $I = 0.129\,kg/m^2$

$t = 0$ $\theta = 3.5$ $t = 0.524$ $\theta = -5.59$



$\theta = \Theta_{max} \cos(\omega t + \phi)$ +2

for SHM

$y(x,t) = A \sin(\frac{2\pi}{\lambda}(\cancel{x} - vt))$ - SHM not a wave

where $\frac{2\pi}{\lambda} x = \theta$

$\omega = \sqrt{\frac{mgL}{I}} = \sqrt{\frac{1.8(9.8)(\cancel{.2})}{0.129}}$ 2m

so $y(x,t) = A \sin(\theta - \omega t)$ X2

so

$A =$

+14

b) $\theta(t) = \Theta_{max} \cos(\omega t + \phi)$ +2

$\theta(t) = \Theta_{max}(\phi)$ ✓

$3.5 = \Theta_{max} \cos(\phi)$ A

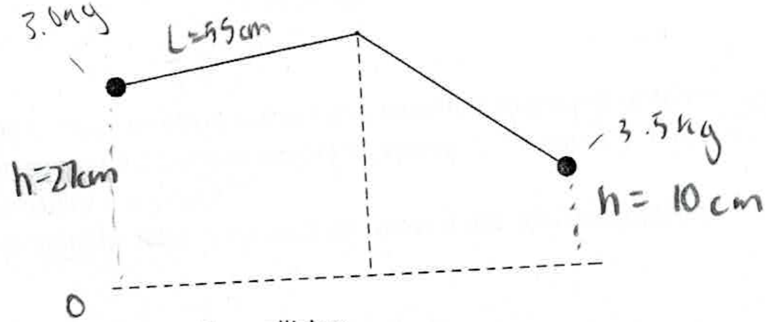
$\omega = \sqrt{\frac{1.8(9.8)(2)}{0.129}}$

$-5.59 = \Theta_{max} \cos(16.54(0.524) + \phi)$ ✓

$\theta(t) = \cancel{3.5} \cos(16.54 t + \phi)$

**Question 2**

The figure below shows two pendulums at t = 0. At t = 0, the ball on the right has a height of 10.0 cm and the ball on the left has a height of 27.0 cm. The balls are released from rest simultaneously. When they collide, they stick to each other. The strings are both 55.0 cm long. The ball on the right has mass 3.50 kg, and the ball on the left has mass 3.00 kg.




(a) Find the frequency of the motion after collision.
(b) Find the maximum angular displacement of the motion after collision.

a) $f = \frac{1}{2\pi}\sqrt{g/L} = \frac{1}{2\pi}\sqrt{\frac{9.8}{(.55)}} = \boxed{0.672\ Hz}$

$1/T$

$\omega = \sqrt{g/L} = 4.22$ +5

new mass $3.5 + 3 = 6.5\ kg$

b) for left

$y(x,t) = .27 \sin(4.22t + \phi)$ $\phi = 0$

for right

$y(x,t) = .10 \sin(4.22t + \phi)$

$y(x,t) = 0.27 \sin(4.22t)$

$y(x,t) = .10 \sin(4.22t)$

0

New Amplitude ?

$A\omega = V_{max}$

**Question 3**

A horizontal rope with some tension is given a pulse. The function that describes the motion of the pulse along the rope is given by:

$$y(x,t) = Ae^{-\frac{(cx-at)^2}{b}} \qquad ((cx-at)((cx-at)$$

(a) If constants a, b, and c are all positive, is this pulse travelling to the left or to the right? How can we change this function so that it describes a pulse travelling in the opposite direction?

(b) What is the wave speed of the pulse?

(c) If we make the tension in the rope twice as large, what is the new wave speed?

a) $y(x,t) = Ae^{-((cx}$ left X

X change all valus to negative.

b) $v = \sqrt{\frac{F_T}{\mu}}$ $v = \lambda f$ if $k = c$ ✓ $\omega = a$ ✓

$k = \frac{2\pi}{\lambda}$

+6 $c = \frac{2\pi}{\lambda}$ $f =$

$\lambda = \frac{2\pi}{c}$

d. $v_0 = \sqrt{\frac{F_T}{\mu}}$ $\sqrt{\frac{2F_T}{\mu}}$ it would be

$\sqrt{2}$ more of $v_0$

$\sqrt{2}v_0$ +1

13

## Question 4

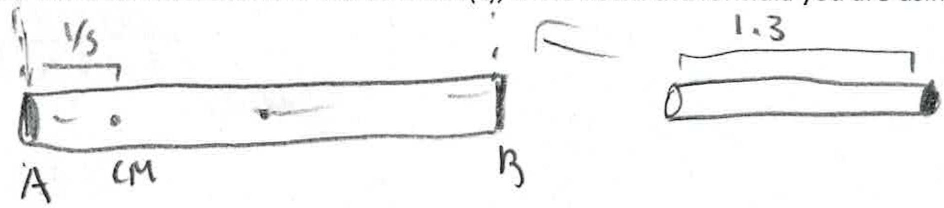
A 1700 N irregular beam is hanging horizontally by its ends from the ceiling by two vertical wires (A and B), each 1.30 m long and weighing 0.149 N. The center of gravity of this beam is one-fifth of the way along the beam from the end where wire A is attached.

1, 3, 5

A 1.30 m long pipe is closed at one and open at the other. A standing air wave in the pipe is in its second overtone. The pipe is held near the hanging wires, causing the strings to vibrate with large amplitude. The speed of sound in air is 344 m/s. $v = 344$ $n = 5$

(a) What is the wave speed for each wire?

(b) What mode $n$ is produced in each string? Round to the nearest whole number. Note: if you've chosen an indexing scheme that is different from the textbook(s), write down the formula you are using.




so info

$W_{Beam} = 1700\,N$ $\quad L_{wire} = 1.3\,m$ $\quad W_{wire} = 0.149\,N$

$L_{pipe} = 1.30\,m$ $\quad v = 344$ $\quad n = 5$

+4

Beam

so $\lambda_5 = \frac{4}{5}(1.3) = 1.04$ $\quad f_5 = \frac{5(344)}{4(1.3)} = \underline{330.8\ Hz}$

a) $F_{TA} = 4/5\,(1700)$ $\quad F_{TB} = 1700 - F_{TA}$

$= 1380$ $\quad = \cancel{1}360$

$\mu = \frac{mass}{L} = \frac{0.149/9.8}{(1.3)} = 0.0117$

$v = \sqrt{\frac{F_{TA}}{\mu}}$

$v_A = \sqrt{\frac{F_{TA}}{\mu}} = \sqrt{\frac{340}{0.017}}$ $\quad v_B = \sqrt{\frac{1360}{\mu}} =$

$v_A = 170.5\,m/s$ $\quad$ +9 $\quad v_B = 341.\,m/s$

b) n?

using before v & the frequency transfered from the f beam

$f_n = n\frac{v}{2L}$ $\quad f_n = 330.8$

for A $\quad$ for B

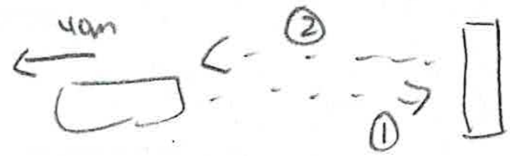
$330.8 = n\frac{(170.5)}{2(1.3)} = \quad n \approx 5$ $\quad$ +6 $\quad 330.8 = n\frac{(341)}{2(1.3)}$ $\quad n \approx 2.5 \approx 3$

**Question 5**

source

A police car's siren emits a sinusoidal wave with frequency 400 Hz. The speed of sound is 344 m/s. The police car is moving away from a warehouse at 40 m/s. What frequency does the driver hear reflected from the warehouse?

$f = 400$ $v = 344$




$$f_o = f_s \frac{(v \pm v_o)}{(v \mp v_s)}$$ 
-observer
- source

① observer = warehouse source = car $f_s = 400$ $v = 344$ $V_s = 40$

$$f_o = 400 \frac{(v)}{(v + v_s)} = \frac{400(344)}{344 + 40} = 358.\bar{3} \text{ Hz}$$

② Observer = car source = warehouse $f_s =$

$V_o = 40$ $v = 344$

$$f_o = 358.\bar{3} \frac{V - V_o}{V} = \frac{358.3(344 - 40)}{344}$$

$$f_o = 316.7$$

So the driver hears a frequency of 316.7 Hz

+20