PHYS 116, W 2007
OE Vilches

Answers to 1st Exam

$X = 20 \cos(\pi t + 0.25\pi)$ , x in cm, t in seconds.

$\boxed{Q1}$ $\frac{2\pi}{T} = \pi \Rightarrow T = 2s$ (A)

$\boxed{Q2}$ At $t=0$ $x = 20\cos(0.25\pi) \approx +14$ cm

Moving to right, left, or stopped? Amplitude of motion is 20 cm, so mass is moving. As time increases above zero, angle goes towards $\frac{\pi}{2}$ (90°) where $\cos 90° = 0$. So mass is moving towards $x=0$ (to the left in picture). (D)

$\boxed{Q3}$ At $t = 1.25s$, $x = (20\text{ cm})\cos(\underbrace{1.5\pi}_{270°}) = 0$ (origin)

So mass has all kinetic energy (C)

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$\boxed{Q4}$ Same as Tycho problem, except with 4 springs instead of 2. Each $\frac{1}{4}$ segment stretches as if it had a $k_{\text{effective}} = 4k_{\text{whole spring}}$

Since there are four springs with $(4k)$ spring constant, total stretch is $\frac{1}{16}$ of original $\Rightarrow \frac{1}{16} \times 0.24\text{ m} = 0.015\text{ m}$ (E)

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$\boxed{Q5}$ For pendulum $T = 2\pi\sqrt{\frac{L}{g}}$ (independent of M

$T_{new} = T_{old}$ (A)

$\boxed{Q6}$ $f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$ $\frac{f_K}{f_E} = \sqrt{\frac{g_K}{g_E}} = \sqrt{\frac{2g_E}{g_E}} = \sqrt{2}$

so $f_K = f_E \times \sqrt{2}$ (C)

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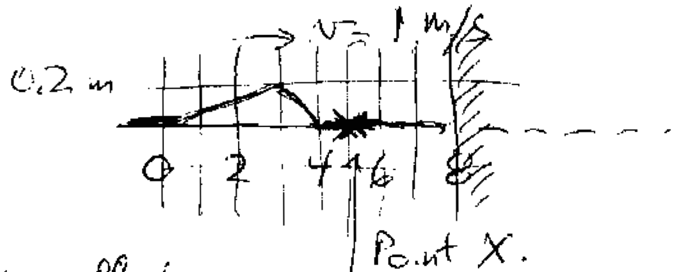
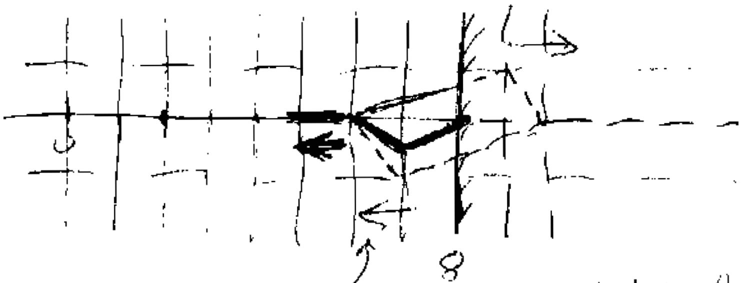



**Q7** Maximum speed will be when point X is going up $\Rightarrow$ $\Delta y = 0.2\text{ m}$, $\Delta t = 1\text{ s}$ (from $v = 1\text{ m/s}$)

$$v_y = \frac{\Delta y}{\Delta t} = \frac{0.2\text{ m}}{1\text{ s}} = 0.2\text{ m/s}$$

A

**Q8** for t = 6 seconds, tale of pulse will be at $x = 6$ m.




Sum of pulses going right and coming left leaving wall point fixed, in heavy lines

E

$$Y_a = 10\cos(3x - 4t) = 10\cos\left[3\left(x - \frac{4}{3}t\right)\right]$$
$$Y_b = 10\cos(5x + 4t) = 10\cos\left[5\left(x + \frac{4}{5}t\right)\right]$$
$$Y_c = 20\cos(10x + 60t) = 20\cos\left[10\left(x + \frac{60}{10}t\right)\right]$$
$$Y_d = 20\cos(4x - 20t) = 20\cos\left(4\left(x - \frac{20}{4}t\right)\right]$$

**Q9** To travel in the $+x$ direction the sign in the time term has to be <u>negative</u> - The time coefficient is the speed of the wave - $Y_a$ and $Y_d$ are waves travelling in positive x-direction [another way of looking at it is that as time advances, waves that were in the negative side of $x=0$ will appear at $x=0$]

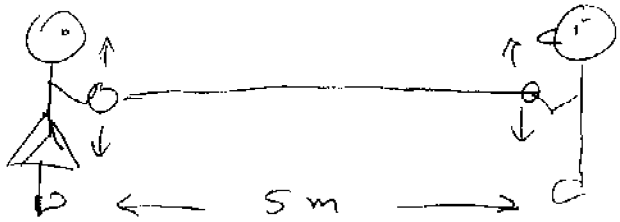
C

**Q10** $|v_{wave}| = \frac{60}{10} = 6\ \frac{m}{s}$

B

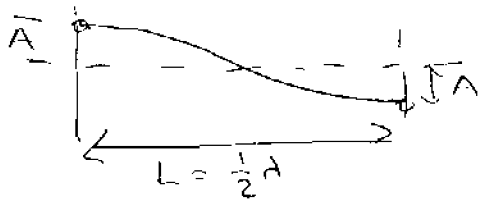
## Problem 1

$M = 0.5\,kg \quad T = 10\,N$



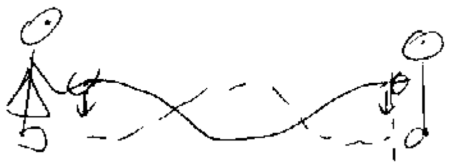

(a) $v = \sqrt{\frac{T}{M/L}} = \sqrt{\frac{10\,N}{0.5\,kg/5\,m}} = \sqrt{\frac{10\,N}{0.1\,\frac{kg}{m}}} = \sqrt{100\,\frac{m^2}{s^2}} = 10\,m/s.$

(b)



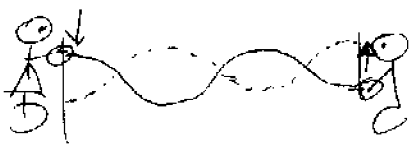

$f = \frac{v}{2L} = \frac{10\,m/s}{2 \times 5\,m} = \frac{10\,m/s}{10\,m} = 1\,Hz$

(c) 2nd harmonic (1st overtone)



moving in the same direction.

3rd harmonic (2nd overtone)



moving in opposite directions.

## Problem 2

(a) Wavelength is longer - Usually one works with frequencies

When approaching each other the frequency heard by cyclist is

$$f_{app} = f_0\left(\frac{1}{1 - \frac{v_P}{v_S}}\right)\left(1 + \frac{v_{cyc}}{v_S}\right) = \frac{v_S}{\lambda_{app}}$$

When moving away from each other

$$f_{away} = f_0\left(\frac{1}{1 + \frac{v_P}{v_S}}\right)\left(1 - \frac{v_{cyc}}{v_S}\right) < f_{approach}$$

(b) $I = \frac{400\,Watts}{4\pi R^2} = \frac{400\,W}{4\pi(20\,m)^2} = 7.96 \times 10^{-2}\,\frac{Watts}{m^2}$

(c) $db = 10 \log_{10} \frac{7.96 \times 10^{-2}\,W/m^2}{10^{-12}\,W/m^2} = \underline{109\,db}$