MULTIPLE CHOICE

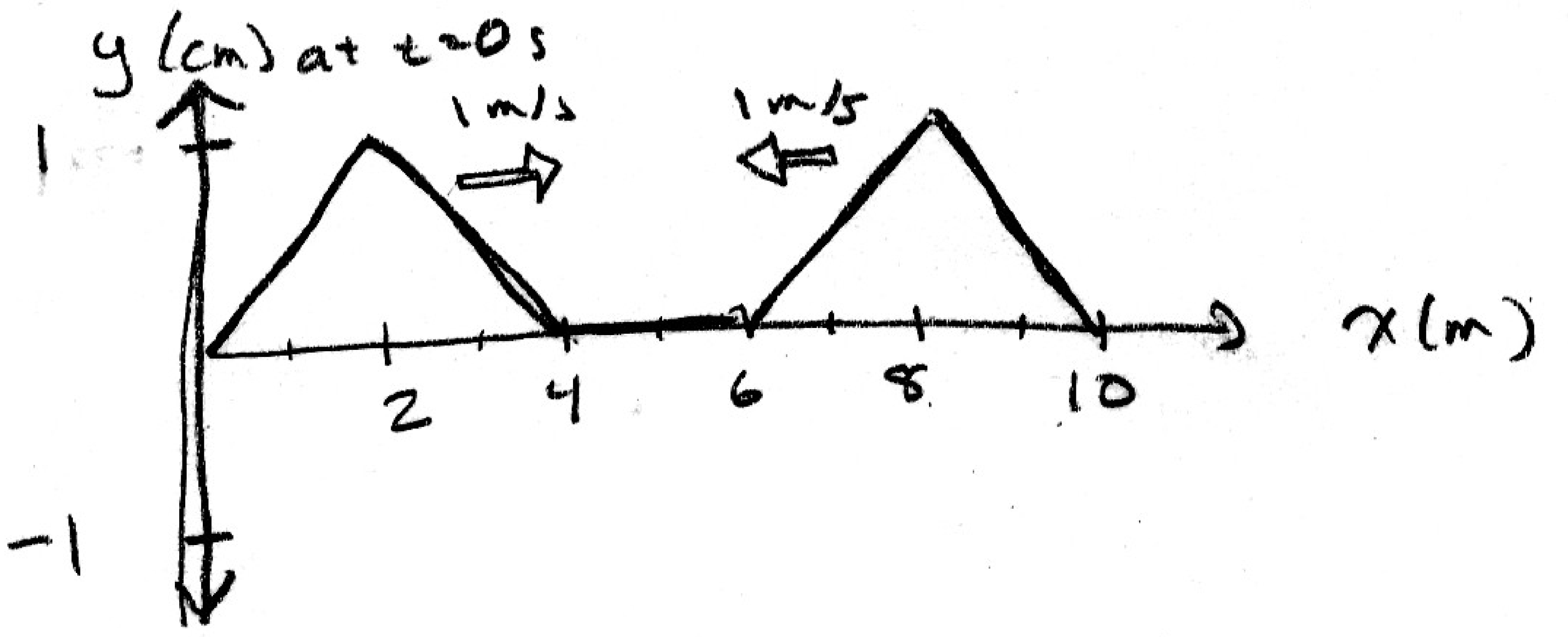
A. (b) Acceleration. For a spring, $|F| = kx$. At max displacement there is max force. $F = ma$, so there is also max acceleration.

B. (c) Remains the same. $T = 2\pi\sqrt{\frac{m}{k}}$ or $T = 2\pi\sqrt{\frac{L}{g}}$. Neither has to do with amplitude.

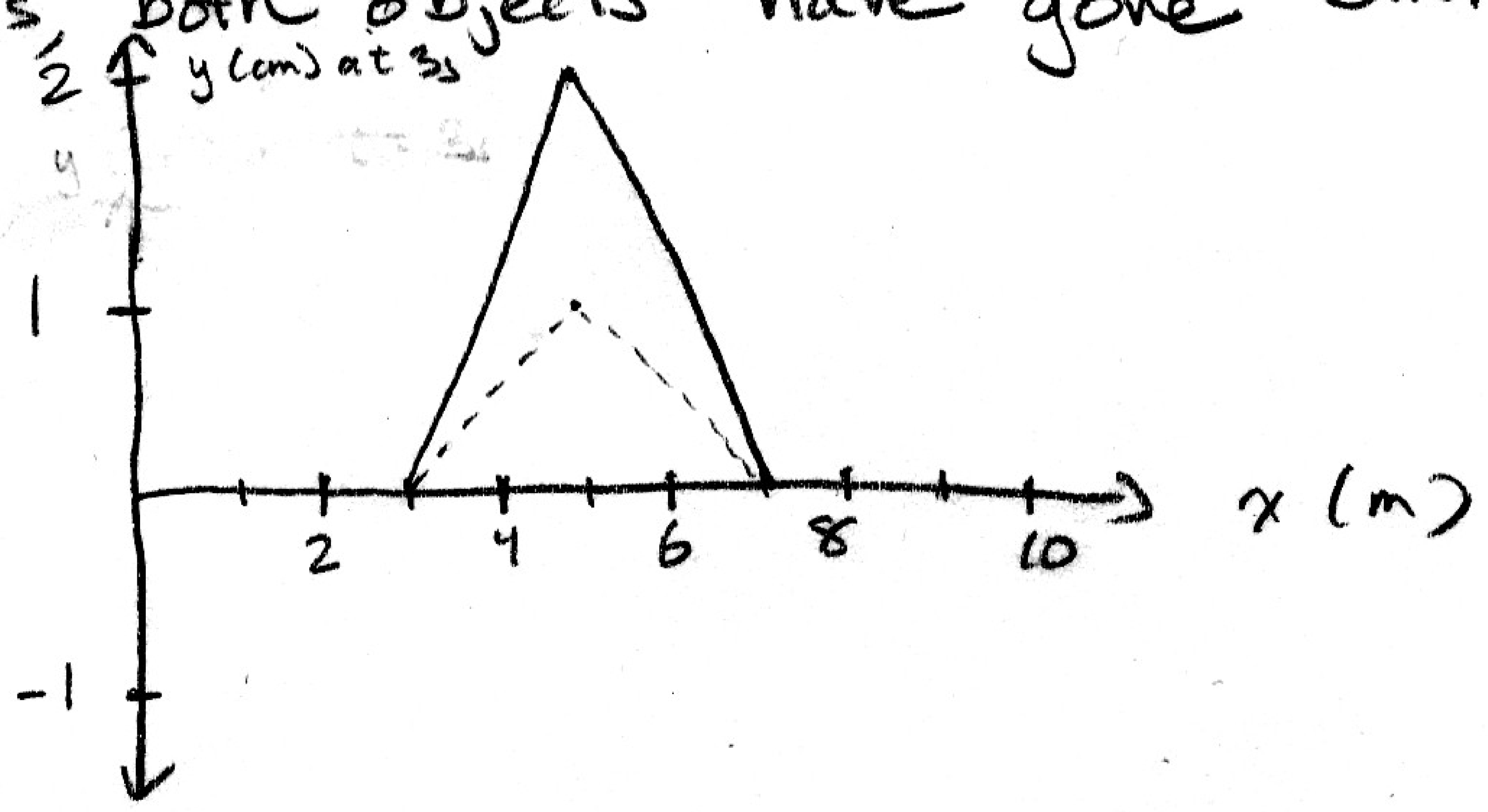
C. (c) When the temperature rises, objects expand. In this case, the pendulum expands, so it gets longer. $T = 2\pi\sqrt{\frac{L}{g}}$, so if L increases, T increases so the clock runs slower.

D. (c) The tension at any point in a rope is equal and opposite to the weight of the portion of rope below that point. As you go higher up the rope, there is "more rope" below, so the tension increases as you go up. Since $v = \sqrt{\frac{T}{\mu}}$, as tension increases, so does velocity.

E. Figure 16.1:



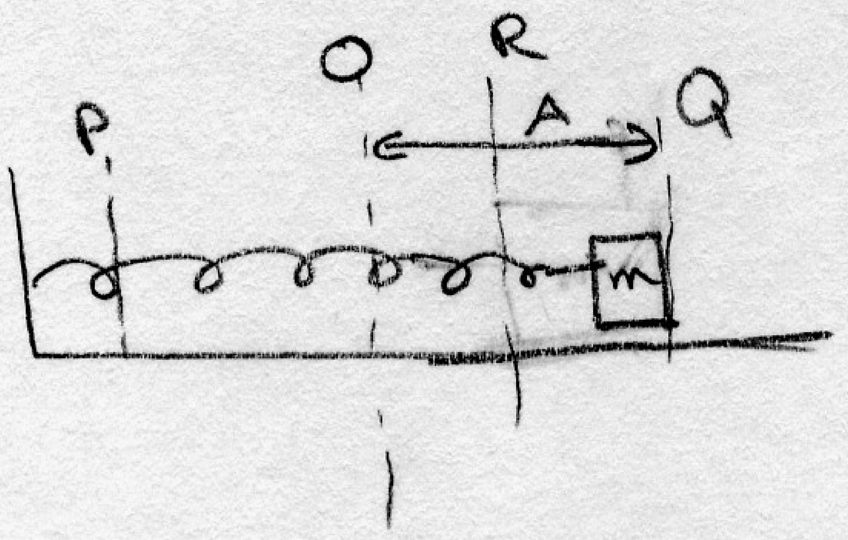
At t=3 s, both objects have gone 3m.



After 3 s, both triangle pulses have their peaks at 5 m. They stack right on top of each other. Remember: <u>total</u> area is constant.

Problem 1

Things we know: 7.50 N applied, spring stretches 3.00 cm



$m = .500$ kg

O is unstretched position

Q is 5.00 cm from O

A = amplitude = 5.00 cm

released from rest at $t=0$

oscillates b/t P and Q

A. Take the 1st fact:

$$F = k\Delta x$$

$$k = \frac{F}{\Delta x} = \frac{(7.50\ N)}{(3.00\ cm)} = \boxed{250\ N/m}$$

B. $$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{(250\ N/m)}{(.500\ kg)}} = \boxed{22.4\ rad/s}$$

$$T = 2\pi\sqrt{\frac{m}{k}} = \frac{2\pi}{\omega} = \frac{2\pi}{(22.4\ rad/s)} = \boxed{0.281\ s}$$

C. Total energy is made of kinetic and potential energy. When $x=A$, all the energy is potential.

$$E_{tot} = P.E.(x=A) = \frac{1}{2}kA^2 = \frac{1}{2}(250\ N/m)(5.00\ cm)^2 = \boxed{0.313\ J}$$

Total energy is constant (because of conservation of energy).

D. Amplitude of motion is $\boxed{5.00\ cm}$ the farthest that the mass will get from the unstretched position.

E. $$V_{max} = \omega A = (22.4\ rad/s)(5.00\ cm) = \boxed{1.12\ m/s}$$

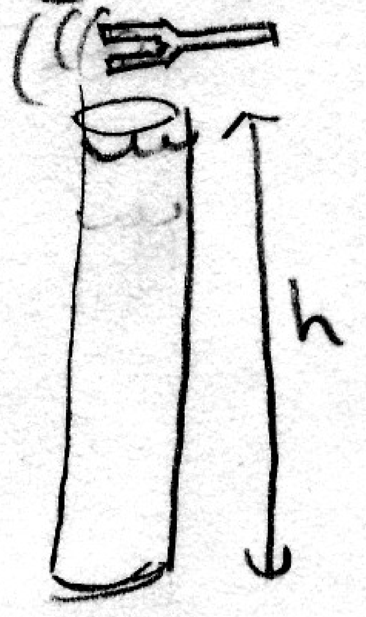
This occurs when $\Delta x = 0$, when the block passes through equilibrium and is going right.

$$a_{max} = \omega^2 A = (22.4\ rad/s)^2(5.00\ cm) = \boxed{25.0\ m/s^2}$$

This occurs when $x = -A$, when the block is at rest and about to move right.

Problem 2

Things we know:



h = height of tube = 1.0 m

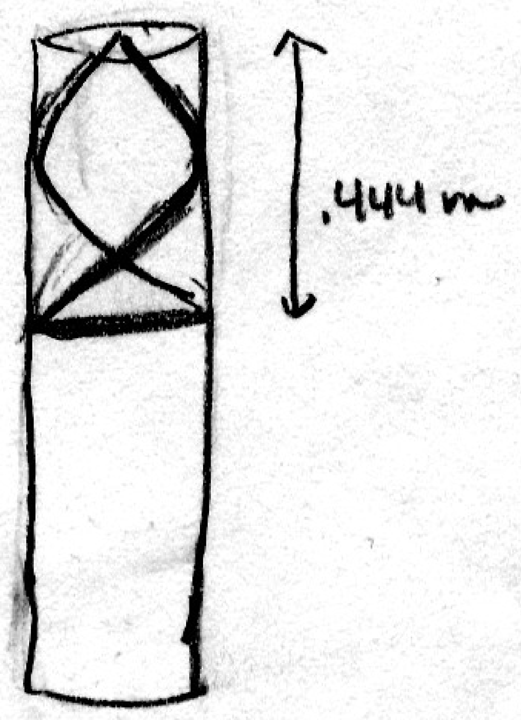
T = temperature = 20° C

f = freq. of tuning fork = 580 Hz

Water slowly drained from bottom.

a. Number of modes increases with length (ie., as water is drained and more of the tube is just air).

b. $m = 3$ for the 2nd harmonic. This is an open-closed tube.



$$\lambda = \frac{4L_3}{3}$$

$$L_3 = \frac{3}{4}\lambda = \frac{3}{4}\left(\frac{V_{sound}}{f}\right) = \frac{3}{4}\frac{(343\ m/s)}{(580\ Hz)} = 0.444\ m$$

c. $m = 1$ for 1st harmonic.

$$L_1 = \frac{1}{4}\lambda = \frac{1}{4}\frac{(343\ m/s)}{(580\ Hz)} = \boxed{0.148\ m}$$

$$L_2 = \boxed{0.444\ m}$$

Problem 3

Things we know: Source (your friend) is moving toward observer (you).

$f_o = 400\text{ Hz}$ = orig. frequency

$v_s = 25.0\text{ m/s}$ = friend's speed

$v = 340\text{ m/s}$ = speed of sound

a. $$f_+ = \frac{f_o}{1 - v_s/v} = \frac{(400\text{ Hz})}{1 - (25.0\text{ m/s})/(340\text{ m/s})} = \boxed{432\text{ Hz}}$$

Because the source is approaching, the wave crests are getting "bunched up" and hit you more frequently. Hence, the frequency (the pitch) increases.

b. Now, source (you) is moving away from observer.

$f_o = 400\text{ Hz}$

$v_s = 10\text{ m/s}$

$v = 340\text{ m/s}$

$$f_- = \frac{f_o}{1 + v_s/v} = \frac{(400\text{ Hz})}{1 + (10.0\text{ m/s})/(340\text{ m/s})} = \boxed{389\text{ Hz}}$$