Physics 101: The Science of Sound
MiniTest 1a, 9/28/07

Name ____________________________

For questions with numerical answers, draw a box around your final answer. Except as noted, correct answers get full credit. Incorrect answers get partial credit based on the work shown. If any problem relies on a previous answer, scoring on that problem will be based on YOUR previous answer, whether or not it is correct.

NOTE: There were three versions of the MiniTest, versiona a, b, and c. Each had the same problems, but the numbers were different. These solutions are for version a, and also show the numerical correct answers for versions b and c when they are different.

Scoring: Raw Total: _____/100 pts Adjusted Score: ______%

Potentially useful equations

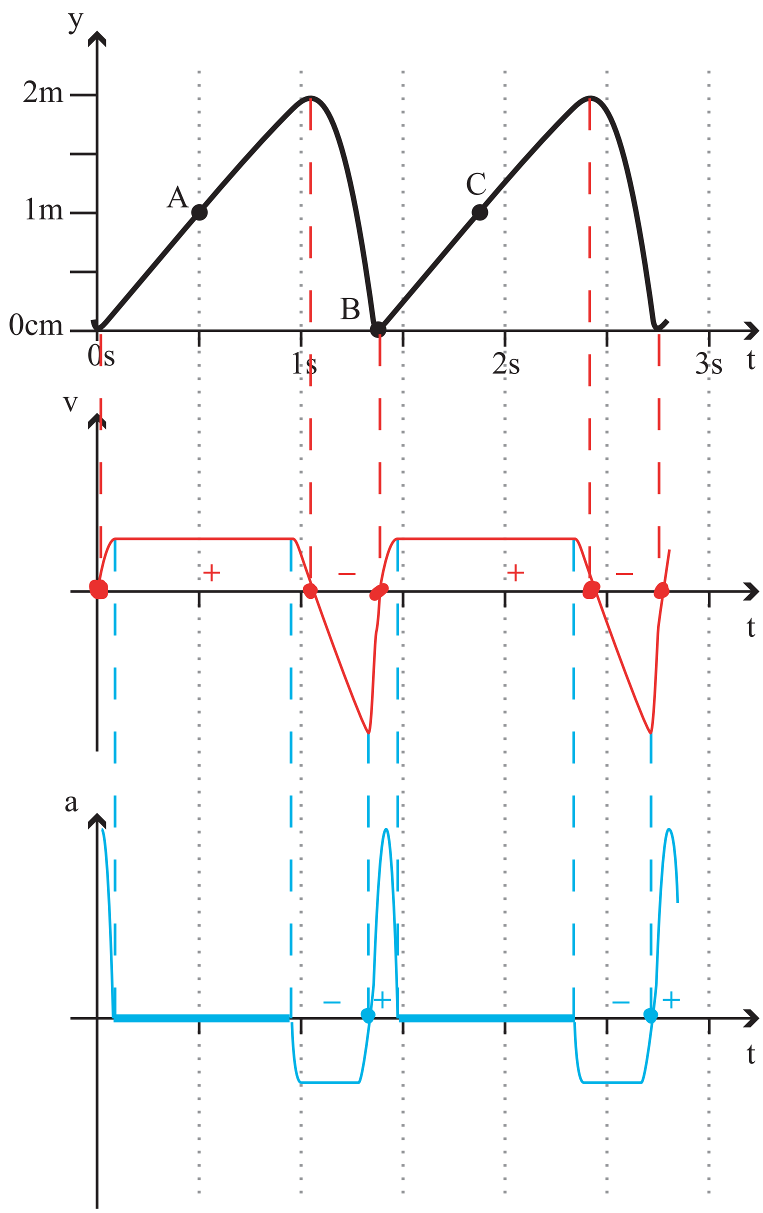
$g = 9.80 \text{ m/s}^2$

$\pi = 3.1415$

$$f = \frac{N}{\Delta t}$$

$$F = -k\,\Delta x$$

1) [20 pts] This graph shows the vertical position versus time of a pile driver hammer. Between t=0s and t=1s, the hammer is lifted up. Then the hammer is released and is allowed to fall freely, so that it hits a post and drives the post into the ground.
Sketch the velocity and acceleration versus time. Make sure I can tell how things line up in time.



2a) [5 pts] What is the *average velocity* of the hammer while traveling between points A and C?

$v = \frac{\Delta x}{\Delta t}$ $\Delta x = 0$

$\boxed{\text{So } v = 0 \frac{m}{s}}$

2b) [5 pts] What is the *average speed* of the hammer while traveling between points A and C?

$s = \frac{d}{\Delta t}$

d = one full cycle
= 2m up and 2m down
= 4m

$\Delta t = 1.9s - 0.5s = 1.4s$

$\boxed{s = \frac{4m}{1.4s} = 2.86 \frac{m}{s}}$

b: 5.71 m/s
c: 1.43 m/s

2c) [5 pts] What is the *average velocity* of the hammer while traveling between points A and B?

$v = \frac{\Delta x}{\Delta t}$

$\Delta x = 0m - 1m = -1m$
$\Delta t = 1.4s - 0.5s = 0.9s$

$\boxed{v = \frac{-1m}{0.9s} = -1.11 \frac{m}{s}}$

b: −2.22 m/s
c: −0.555 m/s

3) [15 pts] A guitar string is tuned to a frequency of 480Hz. How many cycles of motion will it make during 5s?

$f = \frac{N}{\Delta t}$ So $N = f\,\Delta t = (480Hz)(5.0s) = \boxed{2400 \text{ cycles}}$

b: 1800 cycles
c: 2050 cycles

4) [15 pts] You want to design a spring powered pop-gun: a compressed spring will, when released, shoot a 5 gram "bullet" out of the 15 cm long barrel. In order to get the bullet up to a reasonable speed, you figure you need an acceleration 100 times larger than free-fall acceleration. What force will that require? (Circle one)

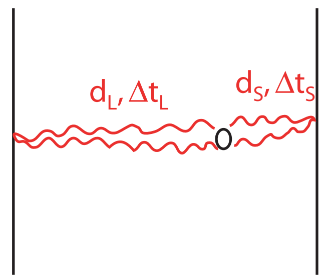
(A) 4.90 N	(B) 32.67 N/m	(C) 0.333 g/m	(D) 0.500 N
(E) 4900 N	(F) 32667 N/m	(G) 0.750 N•m	(H) 500.0 N

The acceleration that we want is 100 g = 100 (9.8m/s) = 980 m/s

For that, we need a big enough force to push the mass: F = ma = (0.005kg)(980 m/s) = **4.9 N (choice A)**

(The length of the gun barrel is just extra information.)

5) [20 pts] If you clap while in a large tunnel, you hear several echos. Let's focus on the echos reflecting off of two opposite walls. Suppose you hear that the echo off the farther wall and the echo off the nearer wall return to you 38ms apart. You can see that you are 2m from the nearer wall. How far are you from the farther wall?



I'll use d as the full path length, which is twice the distance to a wall.

$$\Delta t_S = \frac{d_S}{s} = \frac{2\,(2\text{m})}{(340\text{ m/s})} = 0.011765\text{ s}$$

$$\Delta t_L = \Delta t_S + 38\text{ms} = 0.011765\text{s} + 0.038\text{s} = 0.049765\text{s}$$

$$d_L = s\,\Delta t_L = (340\text{m/s})\,(0.049765\text{s}) = 16.92\text{ m}$$

The distance to the far wall is half that, or **8.46m.**

Note: This solution does not show extremely careful problem setup. But there will be partial credit for that (defining variables, identifying equations, etc.

b: 11.52 m
c: 9.48 m

6) [15 pts] Describe the two basic ways that we have to quantify Force, including the names of the men who pioneered these two viewpoints in the early 17th century. Two or three sentences should be sufficient.

Newton quantified force by relating it to the acceleration that it can produce (when applied to an object with a particular mass). This is reflected in Newton's 2nd law, F=ma.

Hooke quantified force by relating it to the deformation that it can produce (when applied to an object with a particular spring constant). Usually this is thought of a stretching a spring. This is reflected in Hooke's Law, $F=-k\,\Delta x$.