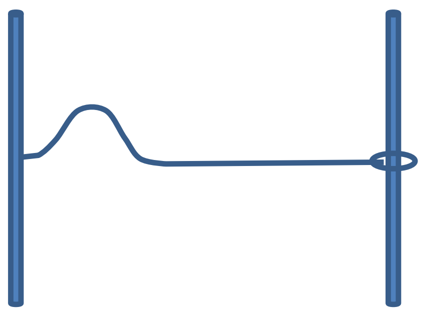
Name: ______________________________ DISC: ____________ Score: _____ / 20

Instructions:
- Do your own work.
- Answer the questions below in the space provided.
- Make sure you show all your work and any equations that you use.
- Please place a box around your answers.
- Remember to give the correct units with all numerical answers

Q1	Q2	Q3	Q4
10	10	5	5

1. A pulse travels down a string fixed at one end and free at the other as shown in the diagram (the ring on the end of the string allows the string end to be free).



LENGTH OF STRING	M (STRING)	v_{pulse}
$0.25\ m$	$0.1\ kg$	$0.75\ m/s$

Table 1: Properties of the System

a. The reflected pulse will be

Selection (2 pts):

i. Inverted.
ii. Upright. (circled)

b. Given the parameters in the table above, what is the tension T in the string (remember $v = \sqrt{\frac{T}{M/L}}$)?

Tension (2 pts):

Using $v = \sqrt{\frac{T}{M/L}}$ we can solve for T: $T = v^2\left(\frac{M}{L}\right) = (0.75\frac{m}{s})^2\frac{0.1kg}{0.25\ m} = 0.225\ kg\ m/s^2$

c. If you double the string tension what is the speed of the pulse?

New speed (3 pts):

Again using $v = \sqrt{\frac{T}{\frac{M}{L}}}$ we can directly solve for v: $v = \sqrt{\frac{T}{\frac{M}{L}}} = \sqrt{\frac{2\,T}{\frac{M}{L}}} = \sqrt{2}\sqrt{\frac{T}{\frac{M}{L}}} = \sqrt{2}v$

$$v = 1.414 \times 0.75\frac{m}{s} = 1.061\ m/s$$

Meeting of Pulses (3 pts):

d. At the same time the original pulse is reflected the string is plucked again. This produces a second pulse of the same amplitude. What will happen when the pulses meet?

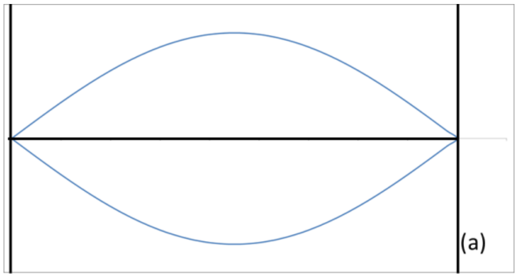
Because the string is not fixed at the end, as illustrated by the wring on the right-hand end of the string, the reflected pulse will be upright. When the second upright pulse and the reflected pulse meet, they will constructively interfere with each other. This will result in a pulse which is twice the amplitude of either pulse separately.

This question went generally well.

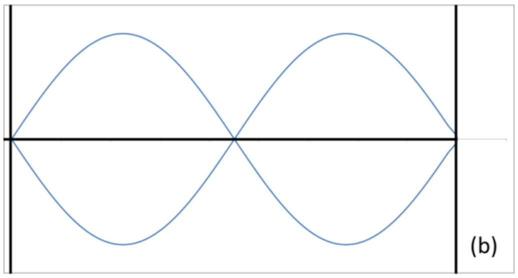
The biggest errors I saw were:

1) **Arithmetic errors (-1 pt ea.)**
2) **Getting the reflection wrong (-2 pts)**
3) **Getting the reflection right, but getting the interference wrong (-3 pts)**

2. Consider the standing waves on a string as shown:



Mass of String	$0.35\ kg$
Length of String	$50\ cm$
Tension of String	$100\ N$
Speed of Wave	$v = f\lambda$



First Harmonic (2 pts):

a. Which image (a) or (b) describes the fundamental harmonic. Explain your reasoning.

Image (a) describes the fundamental harmonic. The fundamental harmonic ($n = 1$) has no nodes between the fixed points, image (b) has one node between the fixed points, so it must be $n = 2$.

b. What is the wavelength of each wave?

Wavelength (3 pts):

Figure (a)	Figure (b)
$\lambda = \frac{2L}{n} = 100\ cm$	$\lambda = \frac{2L}{n} = \frac{(2)(50\ cm)}{2} = 50\ cm$

Interference (2 pts):

c. Using the parameters in the table above, find the speed of a wave on this string.

$$v = \sqrt{\frac{T}{M/L}} = \sqrt{\frac{100\ N}{(0.35\ kg)/(0.50\ m)}} = 11.95\ m/s$$

d. What are the frequencies of the waves?

Frequencies (3 pts):

Figure (a)	Figure (b)
$f = \frac{v}{\lambda} = \frac{\left(23.9\frac{m}{s}\right)}{(1\ m)} = 11.95\ s^{-1}$	$f = \frac{v}{\lambda} = \frac{\left(23.9\frac{m}{s}\right)}{(0.5\ m)} = 23.9\ s^{-1}$

This problem also went generally well—students either knew the definitions or they didn't. Most common errors:

1) **Incorrect knowledge of the fundamental harmonic.**
2) **Incorrect n (n=2) for the first harmonic (-1 pt)**
3) **Arithmetic errors (- 1 pt each)**