<u>**Grade 11 Notes May 18-22, 2020**</u>

Hope you are well and enjoyed the long weekend. Hopefully, you are keeping up with all your school work. Remember that even though we are not together you still need to learn grade 11 material for grade 12 classes. I have been noticing a real decline in submitted assignments. This is disappointing on so many levels. You are smart students don't let circumstances get in the way of gaining the knowledge you need to acquire this year.

This week we are going to continue our investigation of sound energy looking at

1. Questions Involving the Speed of Sound.

2. Sound Intensity

Remember there is no assignment due this week. I will be sending out a new assignment Thursday this week. Maybe take this opportunity to complete any assignments you haven't completed so far. Questions email me.

Have a good week.

Miss Takken

Punk Math Teachers

1. Questions Involving the Speed of Sound

Recall: the speed of sound travels at constant velocity and is calculated by the formula $v_{sound} = 332 + 0.6T$ where T is temperature.

Example 1: Scarlett yells at a wall on a 20°C day. If the echo is returned after 0.3 s how far away is the wall from Scarlett?

Let us start with determining the speed of sound on this particular day.

$v_{sound} = 332 + 0.6\ T$

$v_{sound} = 332 + 0.6(20)$

$v_{sound} = 344$ m/s

Now sound travels at constant velocity so

$v = d/t$

$d = vt$

$d = 344 \times 0.3$

$d = 103.2$ m

However this is an echo, so there and back again. We need to divide the distance in half to determine how far away Scarlett is from the wall.

$d = 103.2/2 = 51.6$ m

Example: David is operating a radar machine on a submarine to determine the depth of the water. David sends a pulse at 1200 m/s towards the bottom and hears the ping 2.3 seconds later. How deep is the water?

Again, sound travels at constant velocity so

v = d/t

d = vt

d = 1200 x 2.3

d = 2760 m

But the ping is an echo so we need to divide the distance in half to determine the depth of the water.

d = 2760/2 = 1380 m.

Example: Quinn and Blair are playing around an old well on a beautiful 20°C day. Blair accidentally falls in. If the well is 40 m deep how long before Quinn hears the splash?

We are going to make some pretty big assumptions here. 1. Blair does not get stuck or bounce off or scraps the wall of the well. 2. The temperature is constant from the top of the well to the bottom. 3. Quinn is standing at the top of the well.

Since we need to determine the time for Blair to fall and the time for the sound to come back up we need to do two parts for this question.

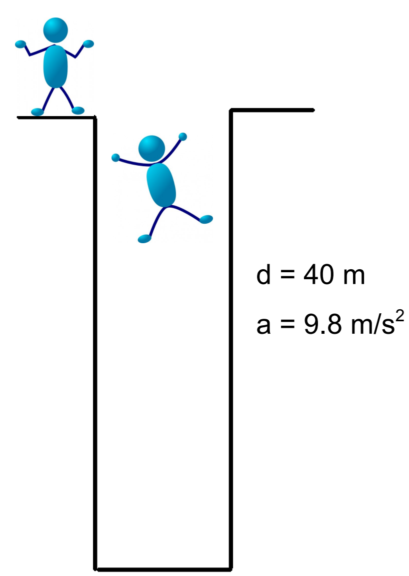
1. Time to fall to the bottom of the well.

$d = v_1t+1/2at^2$ where d = 40 m, v_1 = 0 m/s, a = 9.8 m/s^2

$40 = 0 + 1/2(9.8)t^2$

$t = \sqrt{(40/4.9)}$

t = 2.86 s



2. Time for sound to come back up.

$v_{sound} = 332 + 0.6T$

$v_{sound} = 332 + 0.6(20)$

v_{sound} = 344 m/s

v = d/t

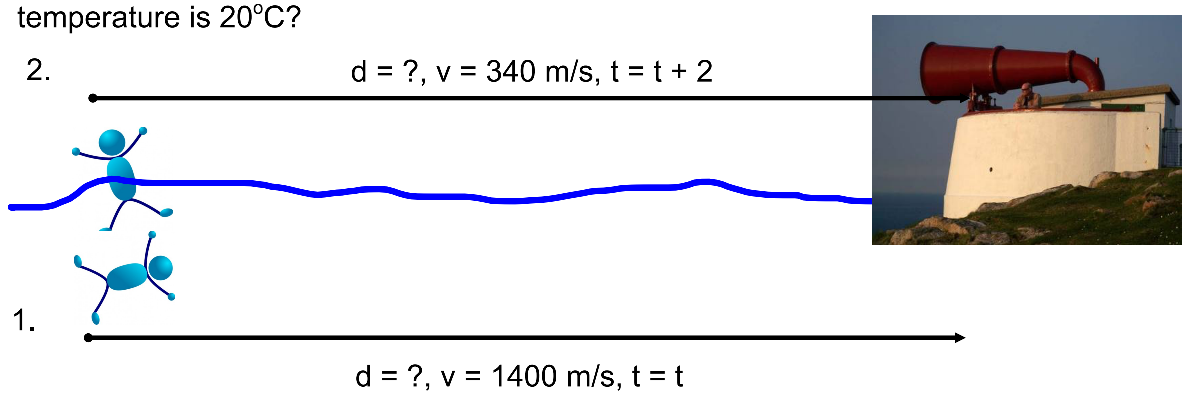
t =d/v

t = 40/344

t = 0.12 s

3. Total time is t = 2.86 + 0.12 = 2.98 s before Quinn hears the splash.

Example: Aidan is underwater when he hears a foghorn. The speed of sound in water is 1400 m/s. Aidan pops his head above the water and 2 seconds later he hears the sound again. (Yes it is possible to hear a sound two times if you are quick enough and it is travelling through two different mediums). How far away is Aidan from the foghorn if the temperature is $20^{o}C$?



In part 1 of the picture Aidan is below the water. It takes t seconds for the sound to reach Aidan through the water. It travels at constant velocity.

d = vt

d = 1400t

In part 2 of the picture Aidan is below the water. It takes t + 2 seconds for the sound to reach Aidan through the air. It travels at constant velocity

d = vt

d = 344(t+2)

The distances from part 1 and 2 are the same so we can equate the two scenarios.

d = d

1400t = 344(t+2)

1400t = 344t + 688

1400t - 344t = 688

1056t = 688

t = 0.65 s.

Use this t value to find d

d = 1400t

d = 1400(0.65)

d = 912 m. The foghorn is 912 m from Aidan.

2. Sound Intensity

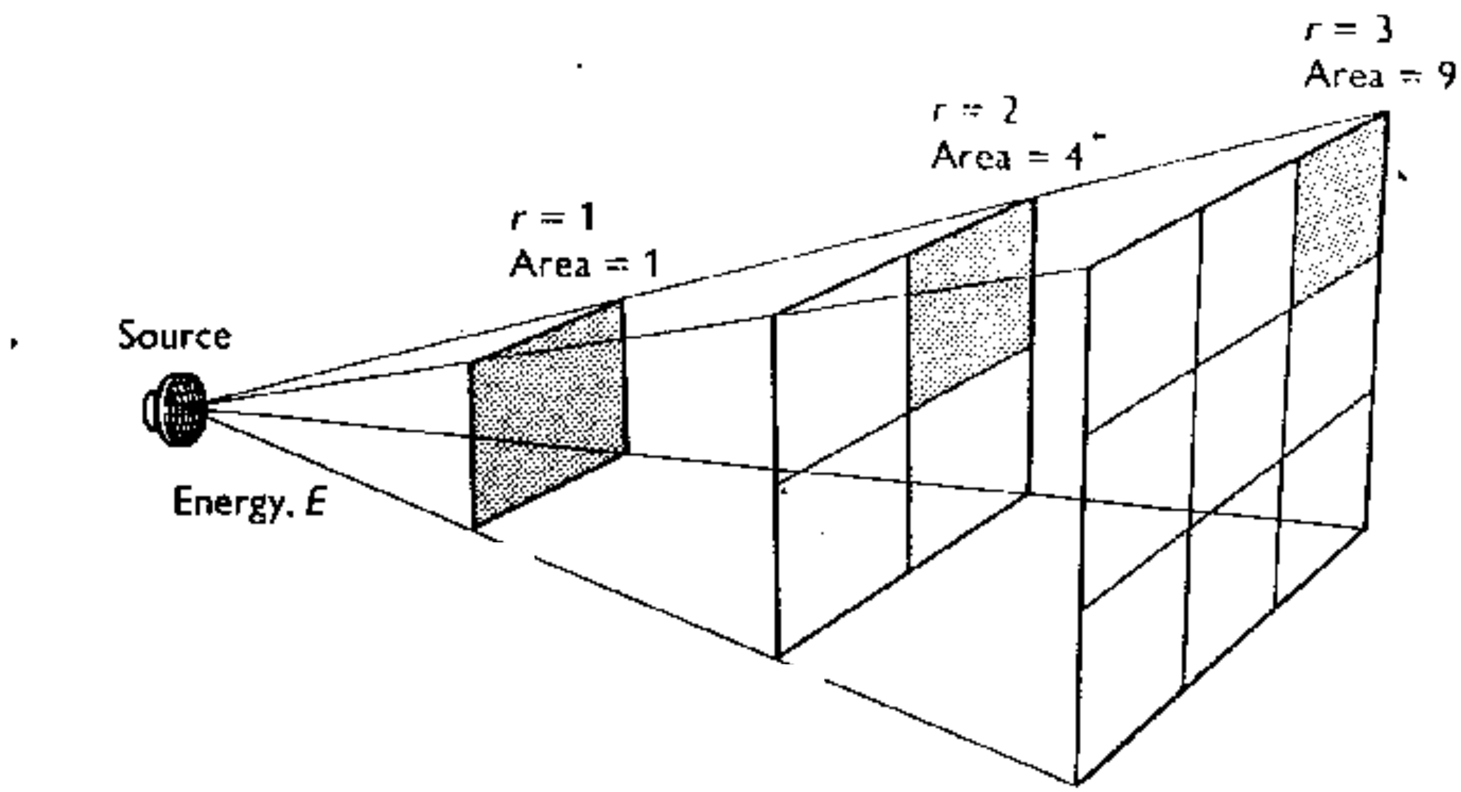
Definition ~ the intensity of a sound refers to its loudness. It is a measure of the power of the sound per unit area.

Recall: Power is the rate at which energy is transferred or transformed.

The formula for intensity is

$$I = \frac{P}{A}$$

Where I = intensity (W/m^2), P = power (W) and A = area (m^2).



When a sound is emitted it spreads out in an area of $4\pi r^2$. If we intersect that sound at distance of r_1 and at a distance of r_2. How do the relative intensities compare?

The Inverse Square Law

$I_1 \alpha 1/ 4\pi r_1^2$

$\therefore I_1 = k / 4\pi r_1^2$

$4\pi I_1 r_1^2 = k$

$I_2 \alpha 1/4\pi r_2^2$

$\therefore I_2 = k/4\pi r_2^2$

$4\pi I_2 r_2^2 = k$

$$k = k$$

$$\cancel{4\pi} I_1 r_1^2 = \cancel{4\pi} I_2 r_2^2$$

$$I_1 r_1^2 = I_2 r_2^2$$

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$$

Example: A helicopter hovers overhead causing sound waves to emanate uniformly. If one listener is 700 m away and another listener is 1000 m away, by how much has the intensity level of sound decreased when it reaches listener two?

$r_1 = 700$ m $r_2 = 1000$ m. How is I_2 related to I_1?

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$$

$$\frac{I_1}{I_2} = \frac{1000^2}{700^2}$$

$\frac{I_1}{I_2} = 2.04$ Cross multiply so that I_2 is in relation to I_1.

$I_2 = I_1/2.04$

$I_2 = 0.49 I_1$ Therefore I_2 is 0.49x the intensity of I_1.

Now you try pg. 475 # 37, 38, 40, 41, 50, 51,