DOPPLER AND DECIBELS

-third marking period

DEFINITION

- Don’t try this at home

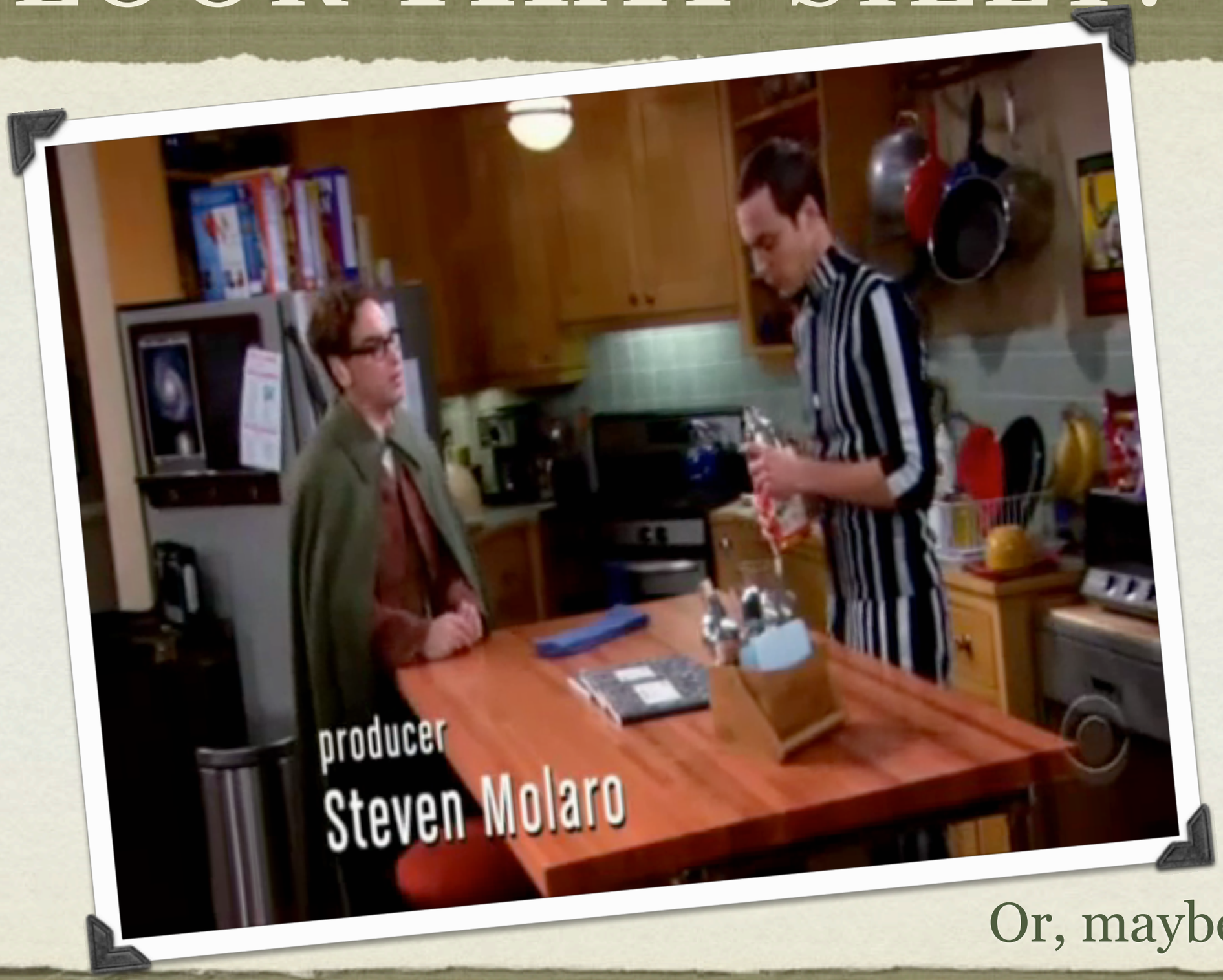
DOPPLER

- **An apparent change in frequency caused by the relative velocity of the source and observer of a wave.**

THE DOPPLER EFFECT

- Make the sound of a race car speeding by…

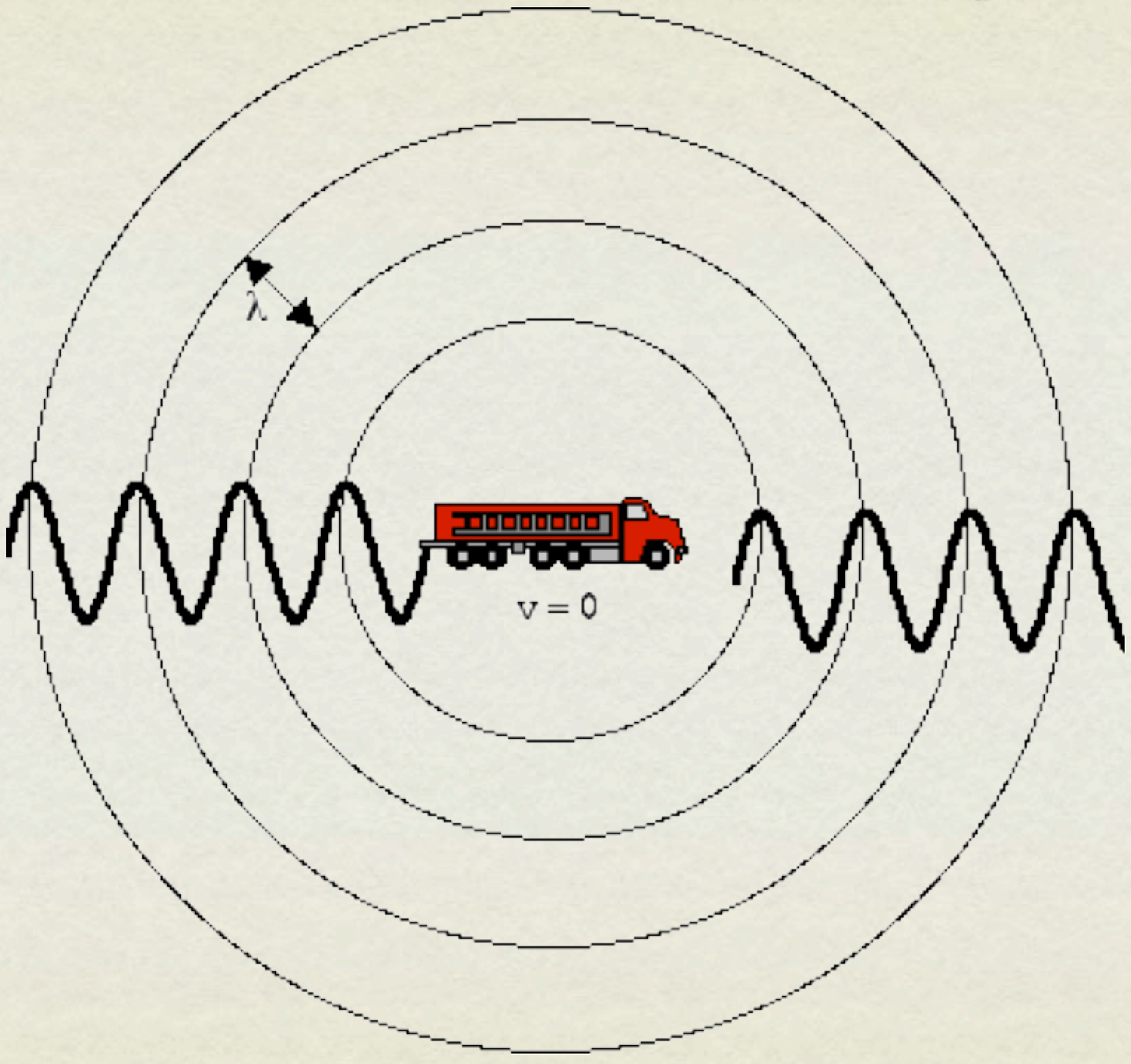
COME ON... YOU DON'T LOOK THAT SILLY!



Or, maybe you would

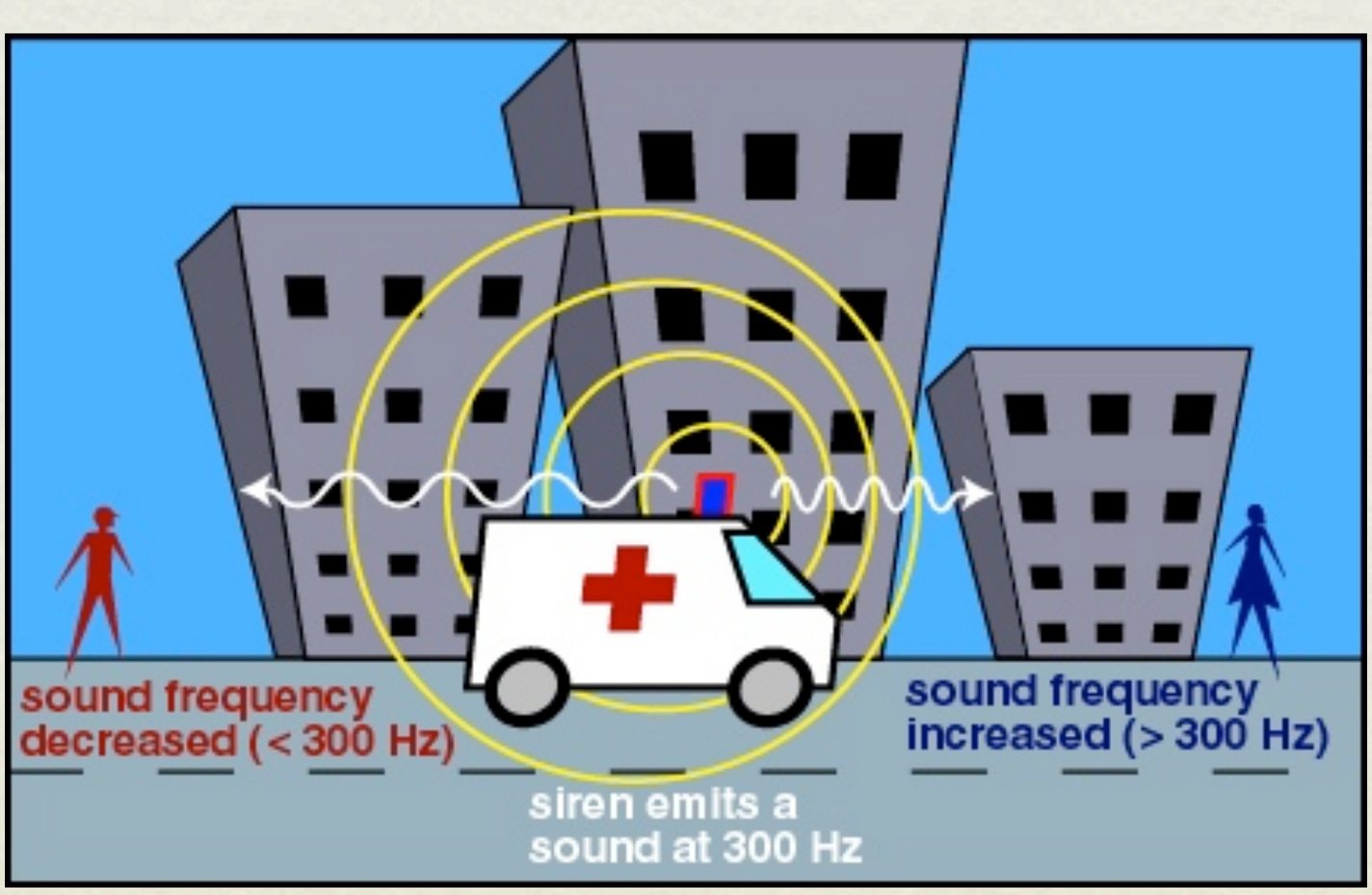
A STATIONARY SOURCE

- **The wave fronts of the sound go out in all directions at equal velocities.**



A MOVING SOURCE

- In front the compressed wavelength has a higher frequency
- The rarified waves have a lower frequency



SCARY EQUATION

- f frequency
- v velocity
- o observed
- s source

$$f_o = f_s\left(\frac{v \pm v_o}{v \pm v_s}\right)$$

SIMPLE MOVING SOURCE

$$f_o = f_s\left(\frac{v \pm v_o}{v \pm v_s}\right)$$

- A train approaches a student traveling at 40 m/s. The horn on the train has a frequency of 400Hz. What frequency does the student hear?

$$f_o = 400\left(\frac{341 \pm 0}{341 - 40}\right)$$

- A train approaches a student traveling at 40 m/s. The horn on the train has a frequency of 400Hz. What frequency does the student hear?

453 Hz

SIMPLE MOVING OBSERVER

$$f_o = f_s\left(\frac{v \pm v_o}{v \pm v_s}\right)$$

- The train now stands still. Homer S. runs away from it at 60 m/s. The horn on the train has a frequency of 800Hz. What frequency does Homer hear?

$$f_o = 800\left(\frac{341 - 60}{341 \pm 0}\right)$$

- The train now stands still. Homer S. runs away from it at 60 m/s. The horn on the train has a frequency of 800Hz. What frequency does Homer hear?

659 Hz

DOPPLER SOURCE AND OBSERVER

$$f_o = f_s\left(\frac{v \pm v_o}{v \pm v_s}\right)$$

- The train now faces Homer S. moving at 20 m/s. Homer can run at an amazing 30 m/s. The horn on this train has a frequency of 500 Hz. What frequency does Homer hear?

$$f_o = 500\left(\frac{341 + 30}{341 - 20}\right)$$

- The train now faces Homer S. moving at 20 m/s. Homer can run at an amazing 30 m/s. The horn on this train has a frequency of 500 Hz. What frequency does Homer hear?

578 Hz

DECIBEL LEVELS

- dB - units of relative intensity
- W/m^2 - units of intensity
- other things where relative numbers are used?

THRESHOLD OF HEARING

- **Hummingbird from 10m away**
- **$1x10^{-12}$ W/m²**
- **0 dB**

SAMPLE DECIBEL LEVELS

Source	Intensity Level	Intensity
Threshold of Hearing (TOH)	0 dB	$1x10^{-12}$ W/m^2
Rustling Leaves	10 dB	$1x10^{-11}$ W/m^2
Whisper	20 dB	$1x10^{-10}$ W/m^2
Normal Conversation	60 dB	$1x10^{-6}$ W/m^2
Busy Street Traffic	70 dB	$1x10^{-5}$ W/m^2
Vacuum Cleaner	80 dB	$1x10^{-4}$ W/m^2
Large Orchestra	98 dB	$6.3x10^{-3}$ W/m^2
European iPod at Maximum Level	100 dB	$1x10^{-2}$ W/m^2
Front Rows of Rock Concert	110 dB	$1x10^{-1}$ W/m^2
Threshold of Pain	130 dB	$1x10^{1}$ W/m^2
Military Jet Takeoff	140 dB	$1x10^{2}$ W/m^2
Instant Perforation of Eardrum	160 dB	$1x10^{4}$ W/m^2

HOW MUCH LOUDER?

- What is “Louder”?
- 30 dB is 10 times above 20 dB
- 40 dB is 10 times above 30 dB
- How much “louder” is 40 dB than 20 dB?
- 100 (not 20)

HOW MUCH LOUDER?

- How much “louder” is a vacuum cleaner than a whisper?
- 80dB to 20dB
- 60dB difference
- 6 Bels
- 10^6 or a million times more intense sound

HOW MUCH LOUDER?

- How much “louder” is a large orchestra than normal conversation?
- 98 dB to 60 dB
- 38 dB difference
- 3.8 Bels
- $10^{3.8}$ or 6,310 times more intense

BACKWARDS

- What is 1000 times louder than a 65dB sound?
- Not too hard... 10^3
- 3 Bels
- 30 dB
- 65 + 30dB = 95 dB

BACKWARDS

- What is 30 times softer than a 80 dB sound?
- Use that log button
- $\log_{10}30 = 1.48$
- 1.48 Bels
- 14.8 dB
- 80dB - 14.8 = 65.2 dB

ACTUAL INTENSITY

- What is the actual intensity of a 104 dB sound?
- missing number?
- nope- remember the hummingbird!
- 10.4 Bels = $10^{10.4}$ times
- $(1 \times 10^{-12}) \times (1 \times 10^{10.4}) = 0.025\ W/m^2$

HOMEWORK

- Honors Problem set for sound waves
- Chapter 16 p504+
- dB levels 63, 65, 66, 67, 70, 71, 72, 102
- Doppler 76, 77, 78, 80, 84

GET IT?