

Practice Exam 3A

Physics 100, Spring 2007

Wednesday, April 20, 2007

Useful Equations and Numbers

Acceleration due to gravity...

on Earth = 10 m/s^2 on Mars = 3.7 m/s^2 on the Moon = 1.6 m/s^2 $(\text{wave speed}) = \text{wavelength} \times \text{frequency}$

$$\text{frequency} = \frac{1}{\text{period}}$$

 $(\text{deep water wave speed}) = 1.25 \times \sqrt{\text{wavelength}} = 5/4 \times \sqrt{\text{wavelength}}$ $(\text{shallow water wave speed}) = 3 \times \sqrt{\text{depth}}$ $(\text{force of gravity}) = (\text{mass}) \times (\text{acceleration due to gravity})$ $\text{speed of light} = 300,000,000 \text{ m/s} = 3 \times 10^8 \text{ m/s}$ $\text{speed of sound in air} = 340 \text{ m/s}$ $\text{distance to origin}_1 = \Delta \text{time} \times 5 \text{ miles/second}$ $\text{distance to origin}_2 = \Delta \text{time} \times \frac{1}{5} \text{ miles/second}$ $(\text{beat frequency}) = |f_1 - f_2|$ $20 \text{ m/s} = 45 \text{ mph}$ $1 \text{ mile/minute} = 60 \text{ mph}$ $1 \text{ pound of force} = 1 \text{ Newton}$ $1 \text{ km} = 0.6 \text{ miles}$ $1 \text{ furlong} = 201 \text{ meters}$ $1 \text{ hour} = 3,600 \text{ seconds}$ $1 \text{ minute} = 60 \text{ seconds}$ $1 \text{ g} = 10 \text{ m/s}^2$ $1 \text{ m/s} = 3.6 \text{ km/hour}$ $1 \text{ Newton} = 1 \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$ $1 \text{ m} = 3.2 \text{ feet}$ $1 \text{ Joule} = 10,000,000 \text{ ergs}$

**DO NOT OPEN EXAM UNTIL INSTRUCTED TO DO SO!
TURN OFF YOUR CELL PHONE!**

Name: _____ Student I.D.: _____

Relax! Be sure to write your name and SID on all of the pages. Show your work on all short answer questions! Look on page 1 for a list of handy equations and relations! Keep in mind that this is a long test, so if you're stuck on a problem, move on to the next one!

IF YOU HAVE QUESTIONS ON ANYTHING, RAISE YOUR HAND AND I WILL COME TO YOU!

Good luck!

Section 1. **True/False (1 pts. each)**

Warm up!

- _____ Raleigh seismic waves are purely transverse waves.
- _____ When sound waves refract in the atmosphere, they tend to bend towards warmer air, where the molecules move faster.
- _____ A tsunami with a period of one hour and a (fixed) wavelength of 500 km will travel a distance of 1,000 km in two hours.
- _____ A wave moving with a *speed* of 10 m/s and a *period* of 4 seconds has a wavelength of 40 m.
- _____ A water wave cannot have a wavelength greater than the depth of the ocean.
- _____ When an airplane flies faster than the speed of sound in air, the sonic energy gets compressed into a cone called the shock wave.
- _____ Infra-red radiation is a type of electromagnetic wave that has a higher frequency than visible light.
- _____ Only sound waves with different frequencies can interfere.
- _____ Sound waves consist of alternating regions of compression and rarefaction of the medium they're traveling in.
- _____ Sound waves are a *combination* of transverse and longitudinal waves.
- _____ P-Wave seismic waves are purely longitudinal.
- _____ Even though the water at the bottom of the ocean is colder than the water at the top of the ocean, the speed of sound in really deep, cold ocean water is higher than shallow, warm ocean water because it is under high pressure, compressing it.

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Section 2. Multiple Choice (4 pts. each)

Choose the single best answer unless instructed to do otherwise.

Hint: they're not all (C)!

1. If an ambulance begins accelerating away from you with its siren on, you will...
 - (a) hear the pitch of the siren decreasing due to the Doppler Effect.
 - (b) hear the pitch of the siren remaining the same since the ambulance is not moving at super-sonic speeds
 - (c) hear the pitch of the siren increasing due to the Doppler Effect.
 - (d) hear the pitch remain the same since you and the ambulance have a *negative* relative speed.
2. For a wave, the maximum displacement on either side of the equilibrium (midpoint) position is known as the...
 - (a) Period
 - (b) Amplitude
 - (c) Wavelength
 - (d) Domain
 - (e) Frequency
3. The distance between successive crests, troughs, or identical parts of a wave is known as the...
 - (a) Period
 - (b) Amplitude
 - (c) Domain
 - (d) Frequency
 - (e) Wavelength
4. The speed of a shallow water wave depends only on...
 - (a) the wavelength of the wave.
 - (b) the frequency of the wave.
 - (c) the depth of the water.
 - (d) the speed of sound in the water.
5. The second wave to arrive after an earthquake is...
 - (a) the Raleigh Wave.
 - (b) the Love Wave.
 - (c) the S-Wave.
 - (d) the P-Wave.
 - (e) *None of the above*

Section 3. **Short Answer Questions (8 pts. each)**

6. Shown below in Figure 1 is a cartoon representing the arrival of Raleigh seismic waves, whose crests are depicted as vertical black lines. The region of white background represents bedrock where Raleigh waves travel quickly. House B is built on bedrock. House A is built in the center of softer ground where the speed of the Raleigh waves is much slower. In the cartoon, the darker a region, the slower the wave.

(A) On figure 1, qualitatively draw what will happen to the waves as they travel from right to left. Use as your starting point the arrows already drawn on the leftmost crest and continue them towards the left up to at least House A (they may not hit House A, but you don't have to draw the lines past House A).

(B) How will the shaking of the ground round House A will compare to that around House B?

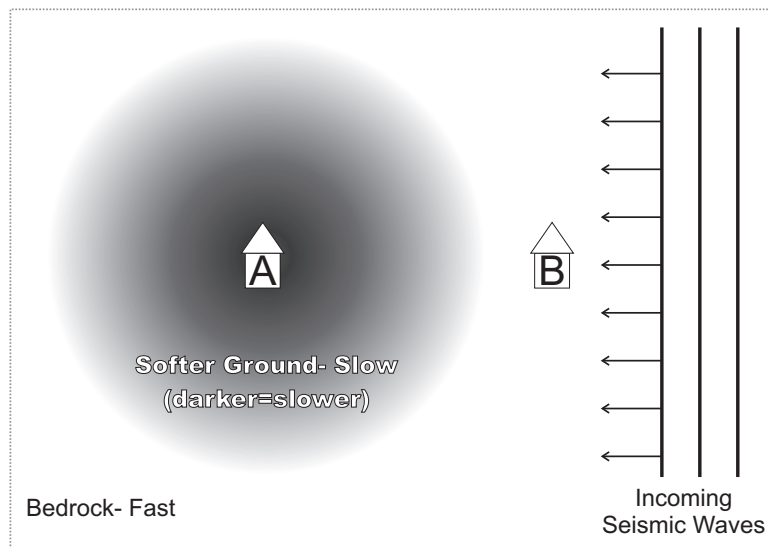


Figure 1: Raleigh seismic waves approach from the right in bedrock (white). House B rests in bedrock, while House A is sitting in softer ground where Raleigh waves travel more slowly. The darker, the slower. See Question 6

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7. The Sun is a very large thermonuclear explosion. Explain why we do not hear the sound coming from the Sun, even though we can see it.
8. A piano tuner has three tuning forks: one with a natural frequency of 440 Hz, one with a natural frequency of 442 Hz, and one with a natural frequency of 443 Hz. Using only two tuning forks at a time,
- (A) what is the highest beat frequency he could produce?
 - (B) what is the lowest beat frequency he could produce?
 - (C) what is the shortest beat period he could produce?

9. Shown below in Figure 2 is a depiction of the Earth and its atmosphere. Near the ground in Layer 1, the heat from absorbed sunlight warms the atmosphere. Above that, in Layer 2, the atmosphere is cold. Above that in Layer 3, we do not know what the relative temperature is. We do know that sound generated in Layer 2 can easily travel around the Earth so that a superhero flying in Layer 2 above the South Pole can hear an explosion that happened in Layer 2 above the North Pole.
- (A) From this information, what can you say about the temperature of the atmosphere in Layer 3? **Explain your answer for full credit.**

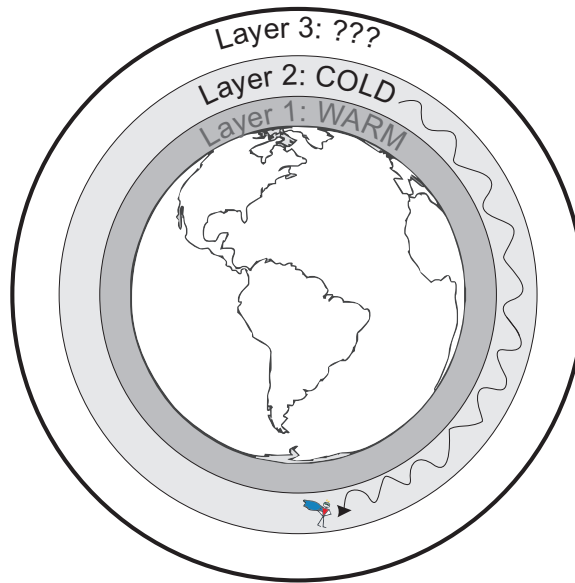


Figure 2: A cartoon of the Earth's atmosphere. The region near the ground is warm (Layer 1). Further up, it is cold (Layer 2). Above that, we don't know (Layer 3). However, sound generated in the cold layer above the North Pole easily makes it to a superhero in that same layer above the South Pole. See Question 9

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10. (A) A water wave with a wavelength of 3 m is traveling in water 6 m deep. What is its speed?
- (B) A radio wave has a wavelength of 3 m traveling in the vacuum of space. What is its frequency?
- (C) You see a bolt of lightning flash and first hear the thunder 10 seconds later. How far away did the lightning strike?
- (D) You feel a small jolt in the ground and 3 seconds later you feel another jolt. A short time after that, your house really starts shaking. How far away did the earthquake happen?
- (E) When struck, a tuning fork produces 300 Hz sound. How effective is this tuning fork at absorbing 250 Hz sound?

THIS IS THE LAST PAGE OF PRACTICE EXAM 3A. CONGRATULATIONS!
