

# Physics 1214 - General Physics II

Midterm - 2013.05.08

Name: \_\_\_\_\_

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Instructions: Please show all work on each problem, and give full explanations where needed. No points will be awarded for a correct answer, points are awarded on the work shown for each problem. When you are finished, please attach your cheat sheet to this exam. Good luck!

problem	points	score
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
8	10	
9	10	
10	5	
Total	95	

1. A <sup>®</sup>My Little Pony<sup>©</sup> double-slit interference experiment is performed, with a light being passed through a narrow slit, then through a double slit and onto a screen. The distance between the slits is  $d = 0.2$  mm, with a screen 5 meters beyond the slits. My Little Ponies are squeezed so that they emit light of varying colors: violet at 400 nm, blue at 475 nm, green at 510 nm, yellow at 570 nm, orange at 590 nm and red at 650 nm, are each independently run through the experiment. The heights of the first few bands for each wavelength of light are recorded. In what order (from shortest height to tallest height) are the colors arranged on the back screen?

2. A My Little Pony is located 10 cm from a concave mirror along the optical axis. The image of the pony is inverted and found to be at the same location as the pony itself. What is the radius of curvature for the mirror?

3. Using your answer to Problem 2, how far from the mirror must the pony be for the image to be at infinity?

4. A spaceship carrying your favorite My Little Pony is moving away from Mars with speed  $0.9c$ , and launches a shuttle in the same direction as its motion with a constant speed of  $0.7c$  relative to the spaceship. What is the shuttle's speed relative to Mars?

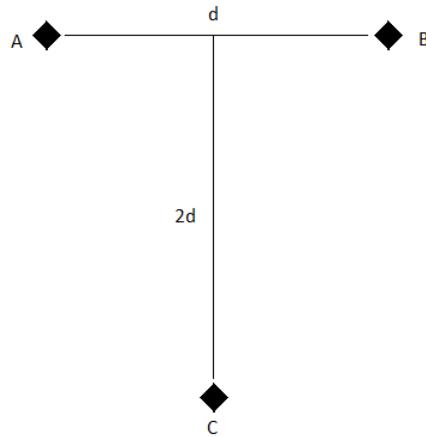
5. The spaceship from Problem 4 sends a pulse of light out in all directions for a  $3.00 \mu\text{s}$  burst. How long does the pulse of light last as perceived by someone on Mars? How long does the pulse of light last for someone on the shuttle that was launched in problem 3?

6. After a grueling semester of physics, you relax with a friendly My Little Pony by the pool. A huge gust of wind blows your pony into the deep end of the pool, where it sinks the bottom and patiently waits for you to go grab it. From your vantage point, it appears that the pony is 7.5 feet under water. How deep, in actuality, is the spot in the pool from which the My Little Pony needs to be rescued?

7. A certain My Little Pony's eyes has a sensitivity to a very specific color of light. To avoid this wavelength of light from entering the retina, a special pair of sunglasses was manufactured. The special coating on the glasses has an index of refraction equal to  $n = 1.18$  and a thickness of 275.5 nm. The glass itself has an index of refraction equal to  $n = 1.52$ . What color of visible light (approximately) is the My Little Pony sensitive to? Give at least one other wavelength of light that the glasses completely reflect. You may wish to look back at problem 1 for color-wavelength relationships.

8. With a little help from a rainbow, your My Little Pony manages to gallop at a speed of  $0.98c$ . At rest, your pony is 5 inches long and 6 inches tall. As the pony races by, you measure its height and length again. How long and how tall is your pony while it is racing by at  $0.98c$ ?

9. Two speakers,  $A$  and  $B$  are separated by a distance  $d$  horizontally. A third speaker,  $C$ , is a distance  $2d$  south from the midpoint between the speakers  $A$  and  $B$ . Assuming all speakers are in phase, locate the point on the line connecting speaker  $C$  to the line between  $A$  and  $B$  for which constructive interference occurs for all three speakers. Hint: Your answer will be a rational multiple of  $d$ , and this spot will also allow you to hear what your My Little Pony is whispering about you from the other room (see next problem).



Speaker setup for Problem 9.

10. Your My Little Pony has grown tired of you as a friend and decides to bake you four cookies with a little something extra in them. Each cookie has a particular source of radiation baked into it — alpha, beta, gamma and neutron. You do not wish to offend your pony and wish to eat just one cookie in its presence. Which do you eat, and why?