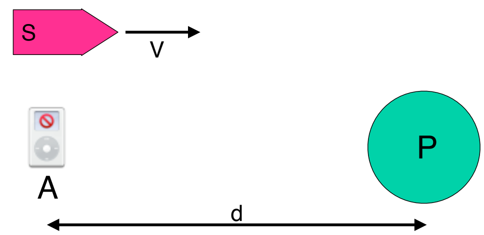
# Physics 262 Spring 2010 Exam #2

**Name:**________________________________________

**CLOSED BOOK, CALCULATORS ONLY**
**SHOW ALL WORK! Use extra blank sheets if necessary**

1 inch = 25.4 mm $\quad c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$

**1) (40 points)**




Consider astronauts (A) marooned in a rescue pod at a distance d from their home planet P. The rescue pod is in a stable, fixed position with respect to the home planet and so the pod and the planet may be considered part of the same inertial reference frame.

Spaceship S is traveling at velocity V on a line from the astronauts A toward the planet P. At time t=0, spaceship S passes astronauts A and the clocks for observers on S and the marooned astronauts are both synchronized at t=0.

**1) A (5)**

According to the astronauts A, at what time does spaceship S reach the home planet P?

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### 1) B (5)

According to observers on S, how fast is the home planet P approaching?

### 1) C (5)

According to observers on S, what is the distance to the home planet P at time t=0?

**1) D (5)**

According to an observer on spaceship S, what time is it when they pass the planet P?

**1) E (5)**

When spaceship S passes the home planet, it sends a light signal back to the marooned astronauts (no, it doesn't land on the planet). According to S, how much time does the signal take to reach A? What time does the signal arrive for A?

**1) F (15)**

Draw a Minkowski diagram for this situation, showing the world-lines of A, P, and S, and the signal sent back to A from S. Label as many points on the axes as you can. This might help answer some of the previous parts.

**2) (10 points)**

Two spaceships are approaching earth from opposite directions at V=0.7 c.

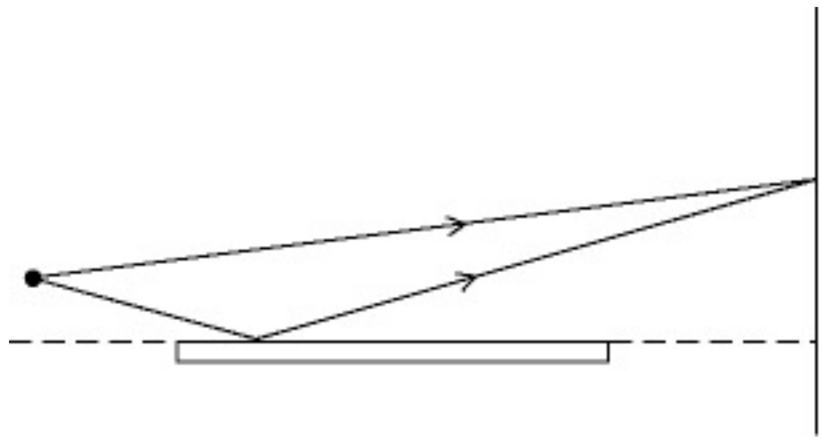
**2) A (5)**

From the earth's IRF, how fast are the two spaceships approaching each other?

**2) B (5)**

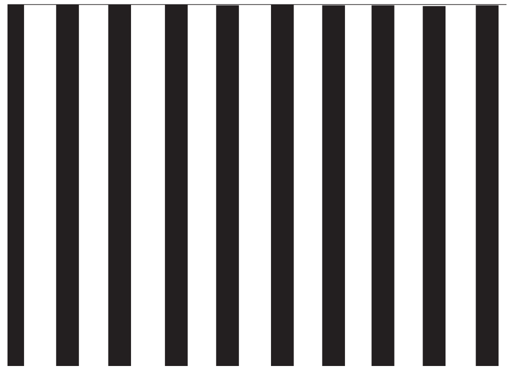
From one of the spaceships IRF, how fast is the other spaceship approaching?

**3) (20 points)**



Lloyd's Mirror is an apparatus that can be used to form interference fringes using a single source. Light from the source is reflected off a plane mirror and viewed on a screen. A reflected ray and a direct ray can interfere to form a fringe pattern on the screen. In the arrangement drawn here, the screen is 2.4 m from the source, and the separation between fringes on the screen is 1.3 mm. The light has wavelength 580 nm. How high above the reflecting plane is the source positioned?

**4) (30 points)**

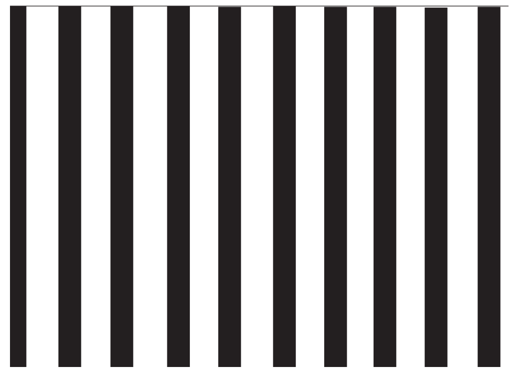


As described in an article by Steven J. Van Hook, "Inquiry with Laser Printer Diffraction Gratings," *The Physics Teacher,* September 2007, Volume 45, Issue 6, pp. 340-343, laser printers can be used to print diffraction gratings on transparency film. The highest resolution printers readily available can print about 300 lines per inch.

**4) A (15)**

If I were to use my laser pointer (l=670 nm) to illuminate such a grating, what would be the angular separation between the m=0 and m=±1 diffraction orders ("super maxima")?

**4) B (15)**



The beam diameter of my laser pointer is 1.5 mm. Suppose I wish to be able to measure the wavelength of my laser to an accuracy of ±1 nm. What diffraction order ("super maxima") must I use? How many diffraction orders are present for $\Theta_m \leq \pm (\pi/2)$?

Physics 262: Practice Exam 2
100 points

1. (30 points) Two spaceships approach earth from opposite directions at 0.8 c. They each are measured to be 100 m long in the earth's reference frame. How long are the ships in the one of the ship's reference frames?

2. (30 points) In a four slit interference setup, where each slit is a distance $d$ from it's neighbor, find the angle of the first minimum.

3. (20 points) Explain the 'Pole in Barn' paradox using a Minkowski diagram.

4. (10 points) If it desired to have a coating on glass that is anti-reflective at 500 nm, but not at 600 nm, should the thinnest film possible be used that produces destructive interference at 500 nm? Explain.

5. (5 points) When using x-ray diffraction to learn about a material's crystal structure, why are x-ray's used and not visible light?

6. (5 points) State the principle of relativity.