**1)** A candle is 40 cm to the left of a
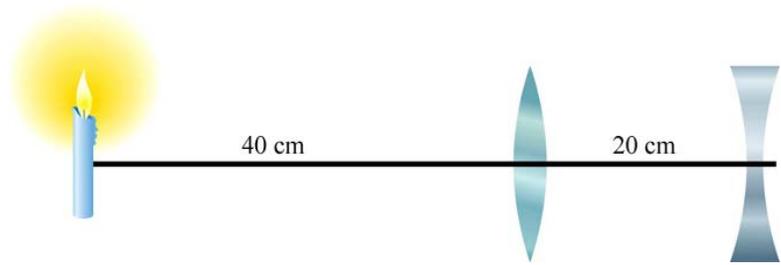convex lens, which in turn is 20 cm
to the left of a concave lens. The
*magnitude* of the focal length of both
lenses is 50 cm.



40 cm                    20 cm

**1a) (8 points)** If the candle is 10 cm
tall, how tall is the image of the candle created by both lenses?

**1b) (2 points)** Is the image inverted or right side up?

**2)** A ray of light is shining on the top center of a glass block. It can be at any angle $\theta$. The block has an index of refraction of $n = 1.6$, and is 2 cm wide and 1 cm high. In the following questions, you must support your answer with calculations and/or diagrams. Simple guesses or hunches will not be given credit.



**2a) (5 points)** Suppose the bottom surface of the block is coated with a black layer that absorbs all the light hitting it. Is it possible for any incoming light to escape through either side of the block?
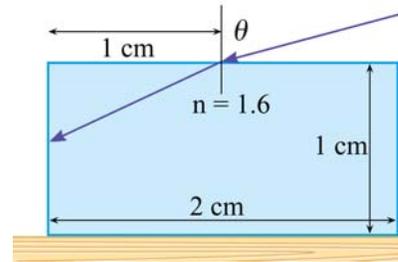
**2b) (5 points)** Suppose the bottom surface of the block is coated with a perfectly reflecting metallic film. Is it possible for any incoming light to escape through either side of the block?

**3) (10 points)** You are enjoying a roller coaster ride at the Iowa state fair when suddenly an insane stuntman who is playing a violin while he stands on the wings of a biplane roars past you. (That is, you are both going the same direction, with the stuntman in front.) You also notice that the 'A' string on his violin sounds a bit flat. You hear 400 Hz for the 'A' string, whereas a properly tuned violin must have the 'A' at 440 Hz. You remember reading someplace that stunt biplanes always fly at 179.78 miles per hour (= 80 m/s), so you decide to use that fact to calculate the speed of the roller coaster you are riding in. And – what is that speed? (Assume c = 343 m/s.)

**4)** A wave travelling down a wire is described by the graph at the right. The wire is under a tension of 2500 N, and has a linear density of 12 g/m.
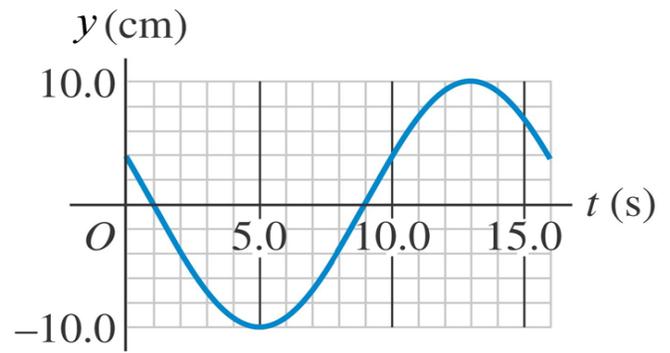
**4a) (2 points)** What is the period of this wave?



$y$ (cm)

10.0

$O$   5.0   10.0   15.0

$t$ (s)

−10.0

**4b) (2 points)** What is the velocity of this wave?

**4c) (3 points)** What is the wave number $k$ of this wave?

**4d) (3 points)** Where is the wave (what is the value of x) when t = 0?

**Multiple Choice / Short Answer**

_____ **5)** **(2 points)** The magnification of a simple refracting telescope is given by:
A) The object lens diameter divided by the eyepiece lens diameter
B) The eyepiece lens diameter divided by the object lens diameter
C) The object lens focal length divided by the eyepiece lens focal length
D) The eyepiece lens focal length divided by the object lens focal length
E) The object distance divided by the object lens image distance
F) The object lens image distance divided by the object distance

**6)** **(3 points)** If I am shouting with a power of 0.025 watts, and you are standing 4 m away, what decibel level are you experiencing?

_____ **7a)** **(2 points)** The longest pipes on a pipe organ are:
A) Open on both ends
B) Open on one end, closed on the other
C) Closed on both ends

**7b)** **(3 points)** Why? (Give a brief explanation for your answer to 7a)