

Multiple choice: Each question is worth 5 points.

1. Thin film interference is caused due to a single source of light

A. changing its wavelength after a reflection.	B. increasing its speed after a reflection.	C. being totally internally reflected by the film.	<input checked="" type="radio"/> D. reflecting from two surfaces (top and bottom) of the film.
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2. An unknown film floating on water ($n=1.33$) appears dark at its edges where the film's thickness is approaching zero. As you know, this is due to thin film interference, but the thickness of the film is almost zero; so there must be a single phase shift in one of the two reflections. You conclude that the index of refraction of the unknown film must be

<input checked="" type="radio"/> A. greater than 1.33	B. less than 1.33	C. equal to 1.33	D. None of these can be predicted for sure.
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3. You are playing in the lab with your laser and your diffraction grating. If you change your red (650 nm) laser to a green (500 nm) laser, what happens to the spacing of the maxima projected from the diffraction grating?

A. The spacing remains the same.	<input checked="" type="radio"/> B. The spacing gets smaller.	C. The spacing gets bigger.	D. None of these can be predicted for sure.
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4. Someone diagnoses you as being "near sighted," which means that the lens of your eye is bending light too much for objects that are far away. What kind of lens would correct this?

A. A converging lens.	<input checked="" type="radio"/> B. A diverging lens.	C. A Fresnel lens.	D. A planar lens.
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5. You're admiring Adam's favorite green shirt as he stands here in the classroom under the white lights. This green color you see is due to

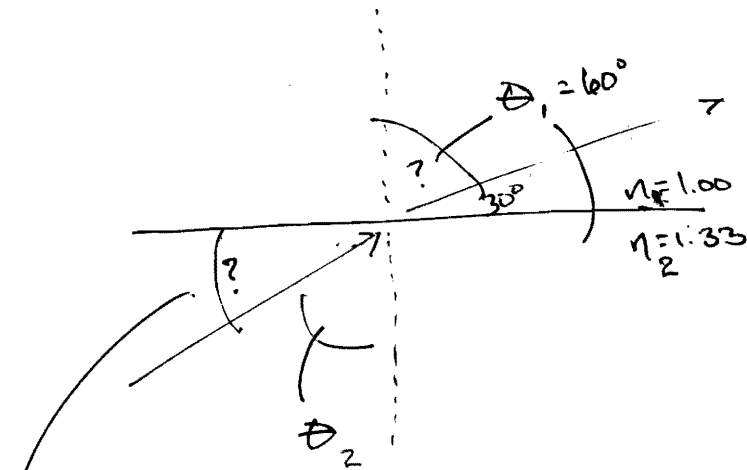
<input checked="" type="radio"/> A. the shirt's ability to reflect green wavelengths, and the fact that white light is composed of all of the visible spectrum's wavelengths.	B. the shirt's ability to absorb green wavelengths, and the fact that white light is composed of all of the visible spectrum's wavelengths.	C. the shirt's ability to reflect green wavelengths, and the fact that white light is composed of none of the visible spectrum's wavelengths.	D. the shirt's ability to absorb green wavelengths, and the fact that white light is composed of none of the visible spectrum's wavelengths.
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6. For some ridiculous reason, you wake up one day and decide that you want to become an astronomer. You drive to the nearest store and buy yourself the best telescope you can afford; but you feel a little sad because you bought one that has a 4-inch aperture (diameter of the opening and mirror collecting the light), rather than the more expensive 6-inch aperture telescope. Which of these features is most affected by your telescope's inferior diameter?

A. Its ability to help you write poetry.	B. Its ability to magnify an image.	C. Its ability to distinguish color within an image.	<input checked="" type="radio"/> D. Its ability to distinguish details of an image.
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A. The many paths of light

1. [15 points] You dive underneath some water ($n=1.33$) and shine your laser pointer so that it emerges from the pool (in air) at an angle of 30.0° above the surface (horizontal) of the water. At what angle is the laser pointed below the horizontal surface of the water?



$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\sin \theta_2 = \frac{n_1}{n_2} \sin \theta_1$$

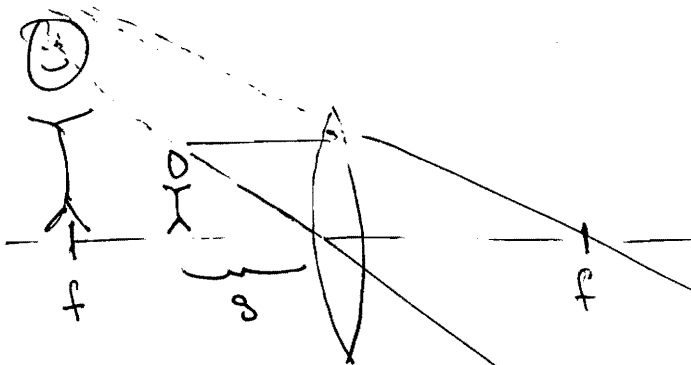
$$\sin \theta_2 = \frac{1.00}{1.33} \sin 60^\circ$$

$$\theta_2 = 40.6^\circ$$

→ what the question asks for: $90^\circ - \theta_2 = \boxed{49.4^\circ}$

2. [20 points] Adam is standing to the left of a converging lens whose focal length is $+60.0$ cm. He would like you to see an upright image of him that is twice as tall as his actual height. (Note: this will be a virtual image.)

- a. How far from the lens should Adam stand, and
b. how far from the lens will you perceive his image?



$$m = 2 = \frac{-s'}{s} \rightarrow s' = -2s$$

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'} = \frac{1}{s} - \frac{1}{2s} = \frac{1}{2s}$$

$$\frac{1}{f} = \frac{1}{2s} \rightarrow f = 2s$$

$$s = \frac{f}{2} = \frac{60\text{cm}}{2}$$

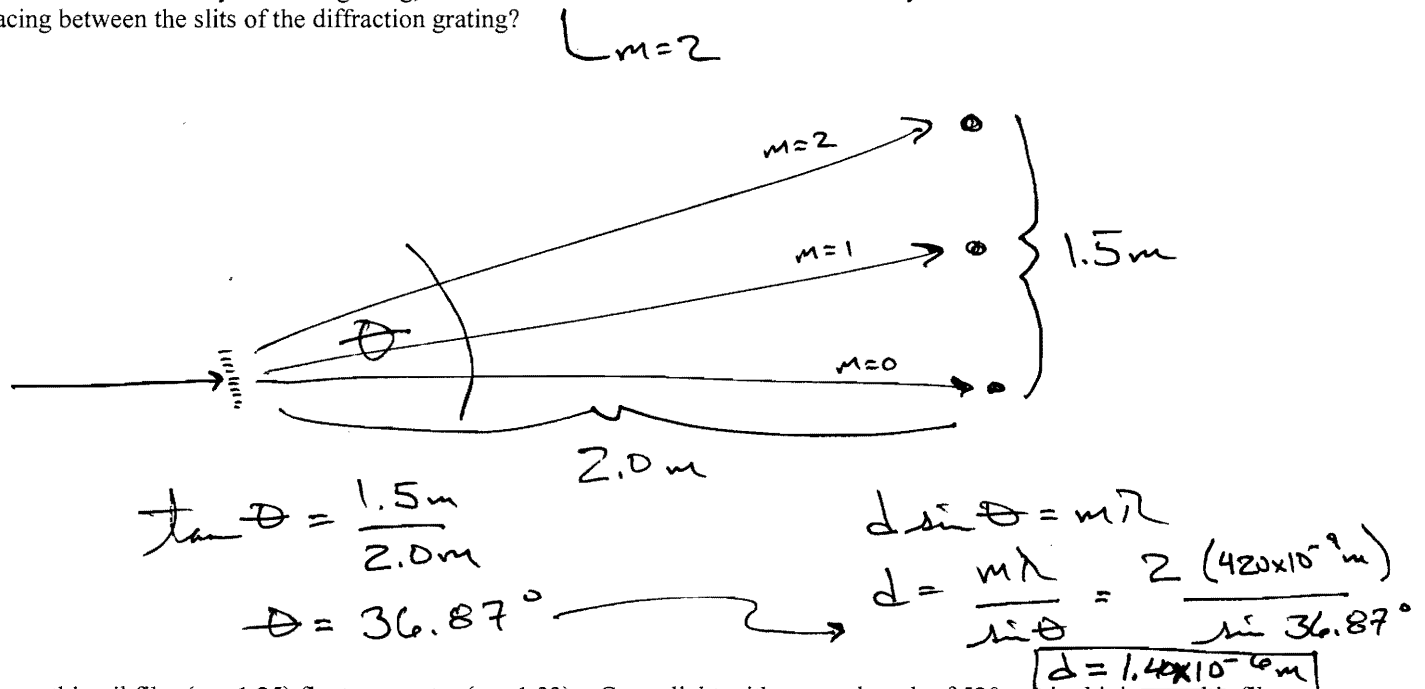
(a) ADAM STANDS HERE → $s = \boxed{30.0\text{cm}}$

$$s' = -2s = -2(30.0\text{cm})$$

(b) ADAM'S VIRTUAL IMAGE = $\boxed{-60.0\text{cm}}$

B. The wave nature of light

1. [15 points] ~~When~~ Blue light with a wavelength of 420 nm illuminates a diffraction grating. The diffraction pattern shines on a wall that is 2.00 m away from the grating, with the *second-order* maximum 1.50 m away from the central maximum. What is the spacing between the slits of the diffraction grating?



2. A very thin oil film ($n = 1.25$) floats on water ($n = 1.33$). Green light with a wavelength of 520 nm is shining on this film.

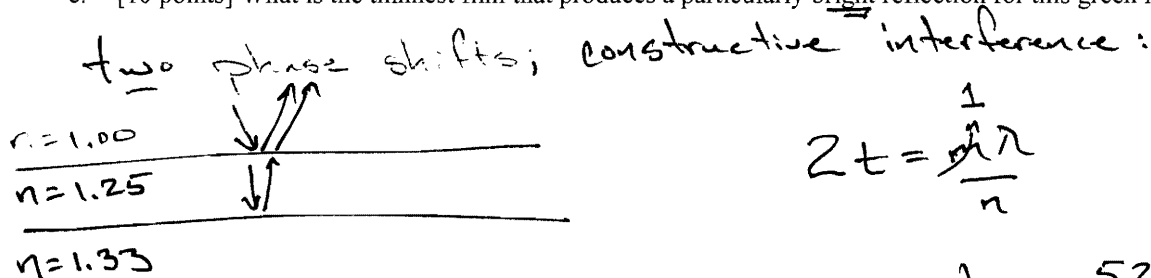
a. [5 points] What is the speed of light through the oil?

$$v_n = \frac{c}{n} = \frac{3 \times 10^8 \frac{\text{m}}{\text{s}}}{1.25} = \boxed{2.40 \times 10^8 \frac{\text{m}}{\text{s}}}$$

b. [5 points] What is the wavelength of the green light when it is in the oil?

$$\lambda_n = \frac{\lambda}{n} = \frac{520 \text{ nm}}{1.25} = \boxed{416 \text{ nm}}$$

c. [10 points] What is the thinnest film that produces a particularly bright reflection for this green light?



$$t = \frac{\lambda}{2n} = \frac{520 \text{ nm}}{2(1.25)} = \boxed{208 \text{ nm}}$$