Electromagnetic Waves Practice Problems

Multiple Choice

1 Which of the following theories can explain the bending of waves behind obstacles into “shadow region”?

- A Particle theory of light
- B Wave theory of light
- C Kinetic theory
- D Special theory of relativity
- E Classical mechanics

2 The wave theory of light is associated with:

A Isaac Newton
B Albert Einstein
C Max Plank
D Christian Huygens
E Robert Milliken

3 A beam of light has a wavelength of 600 nm in air. What is the frequency of light? ($c = 3x10^8$ m/s)

A $5.0x10^{14}$ Hz
B $2.0x10^{14}$ Hz
C $3.0x10^{14}$ Hz
D $6.0x10^{14}$ Hz
E $2.0x10^{14}$ Hz

4 A light beam changes its direction when it strikes a boundary between air and water. Which of the following is responsible for this phenomenon?

A Diffraction
B Interference
C Reflection
D Refraction
E Polarization

5 **A light beam traveling in air with a wavelength of 600 nm falls on a glass block. What is the wavelength of the light beam in glass? (n = 1.5)**

- **A** 500 nm
- **B** 400 nm
- **C** 600 nm
- **D** 300 nm
- **E** 900 nm

6 **A light beam traveling in air with a wavelength of 600 nm falls on a glass block. What is the speed of the light beam in glass? (c = $3x10^8$ m/s, n = 1.5)**

- **A** $3.0x10^8$ m/s
- **B** $2.0x10_8$ m/s
- **C** $1.5x10^8$ m/s
- **D** $1.0x10^8$ m/s
- **E** $0.5x10^8$ m/s

7 **A light beam traveling in air with a wavelength of 600 nm falls on a glass block. What is the frequency of the light beam in glass? (c = $3x10^8$ m/s, n = 1.5)**

- **A** $5.0x10^{14}$ Hz
- **B** $2.5x10^{14}$ Hz
- **C** $3.0x10^{14}$ Hz
- **D** $6.0x10^{14}$ Hz
- **E** $2.0x10^{14}$ Hz

8 Which of the following is the correct order of electro-magnetic radiation with an increasing frequency?

A Radio Waves, Visible Light, IR Radiation, UV Radiation, X-Rays, γ –Rays

B γ –Rays, Visible Light, IR Radiation, UV Radiation, X-Rays, Radio Waves

C Radio Waves, UV Radiation, Visible Light, IR Radiation, X-Rays, γ –Rays

D Radio Waves, Visible Light, X-Rays, IR Radiation, UV Radiation, γ –Rays

E Radio Waves, IR Radiation, Visible Light, UV Radiation, X-Rays, γ –Rays

9 A light beam spreads when it travels through a narrow slit. Which of the following can explain this phenomenon?

A Polarization

B Reflection

C Dispersion

D Diffraction

E Refraction

10 In Young's double-slit experiment a series of bright and dark lines was observed. Which of the following principles is responsible for this phenomenon?

A Polarization

B Reflection

C Dispersion

D Interference

E Refraction

11 Which of the following electro-magnetic waves can be diffracted by a building?

A Radio waves
B Infrared waves
C Ultraviolet waves
D Visible light
E γ-Waves

12 A blue beam of light falls on two narrow slits producing an interference pattern on a screen. If instead blue light a red beam of light was used in the same experiment, which new changes to the interference pattern we can observe?

A Interference fringes move close to the central maximum
B Interference fringes move away from the central maximum
C No change in interference
D Bright fringes are replaced with dark fringes
E The number of fringes increases

13 In a Young's double-slit experiment interference pattern is observed on a screen. The apparatus is then submerged into water. What is the new change in the interference pattern?

A Interference fringes move close to the central maximum
B Interference fringes move away from the central maximum
C No change in interference
D Bright fringes are replaced with dark fringes
E The number of fringes increases

14 Two coherent light waves approaching a certain point on a screen produce a constructive interference. The optical extra distance traveled by one of the waves is:

A $\lambda/2$
B $\lambda/3$
C $3\lambda/2$
D λ
E $5\lambda/2$

15 In a Young's double-slit experiment the distance between the slits increases. What happens to the separation between the fringes?

A Increases
B Decreases
C Stays the same
D Increases for the bright fringes and decreases for the dark fringes
E Increases for the dark fringes and decreases for the bright fringes

16 In a double-slit experiment a distance between the slits is doubled. What happens to the separation between the two adjacent maxima?

A Doubles
B Quadruples
C Is cut to a half
D Is cut to a quarter
E Stays the same

17 In a single-slit experiment as a result of interference of a laser beam a student observes a set of red and dark concentric circles. When he increases the slit separation what happens to the interference pattern?

A The separation between the circles increases
B The separation between the circles decreases
C No change in interference pattern
D The separation between the circles increases and then decreases
E The separation between the circles decreases and then increases

18 A light beam falls on a thin film and partially reflects from the film and partially transmits through the film. What is the phase difference between the reflected and transmitted waves?

A λ
B 2λ
C $\lambda/3$
D $\lambda/4$
E $\lambda/2$

19 A light beam traveling in water enters air. What is the phase difference between the incident and transmitted waves?

A 0
B 2λ
C $\lambda/3$
D $\lambda/4$
E $\lambda/2$

20 A light beam of coherent waves with a wavelength of 600 nm falls perpendicularly on a diffraction grating. The separation between two adjacent slits is 1.8 μm. What is the maximum number of spectral orders can be observed on a screen?

A 1

B 2

C 3

D 4

E 5

21 Sun rays fall on a glass prism. Which of the following rays will be refracted the least?

A Blue

B Violet

C Green

D Yellow

E Red

22 Unpolarized light passes through two Polaroids; the axis of one is vertical and that of the other is 60˚ to the vertical. If the intensity of the incident light is I_0, what is the intensity of the transmitted light?

A I_0

B I_0 /4

C $I_0/3$

D $I_0/2$

E $I_0/8$

Free Response

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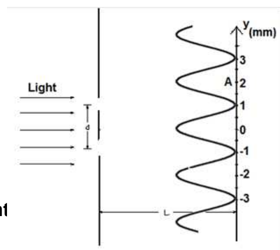
1. Coherent monochromatic light falls normally on two slits separated by a distance d = 2.2 mm. The interference pattern is observed on a screen L = 4 m from the slits.

a. What is the result of the interference at point A?

b. What is the wavelength of the incident light?

c. Determine the angular width between two second order maxima.

d. If one of the slits is covered with a glass block and two waves emerge from the slits 180˚ out of phase. Describe the interference pattern on the screen.



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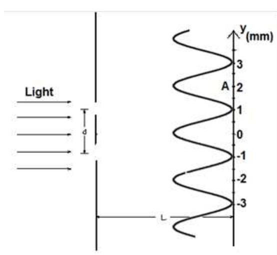

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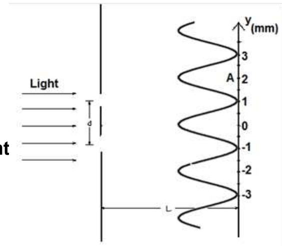
1. Coherent monochromatic light falls normally on two slits separated by a distance d = 2.2 mm. The interference pattern is observed on a screen L = 4 m from the slits.

b. What is the wavelength of the incident light?



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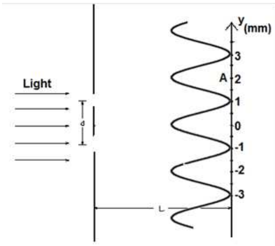

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1. Coherent monochromatic light falls normally on two slits separated by a distance d = 2.2 mm. The interference pattern is observed on a screen L = 4 m from the slits.

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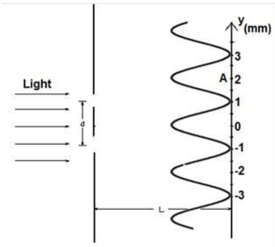


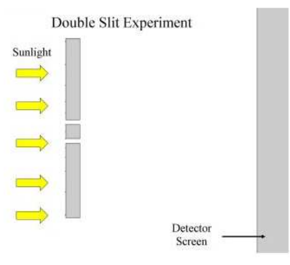
2. In a double-slit experiment sun rays are incident on two narrow slits 2.4 mm apart. Colored fringes are observed on a detector screen 2 m away from the slits. (λ_{violet} = 400 nm, λ_{red} = 700 nm)

a. Determine the path difference between two blue waves arriving to the first order maximum.

b. Determine the path difference between two red waves arriving to the first order maximum.

c. Determine the width of the second order maximum.

d. The entire apparatus is submerged into water with the index of refraction 1.3. Determine the width of the second maximum.



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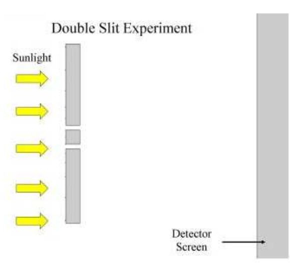

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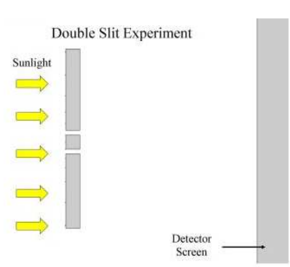

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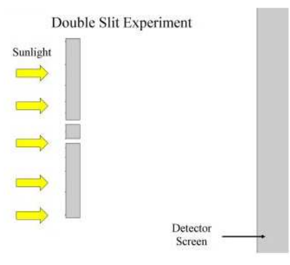

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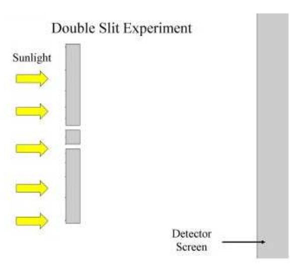
d. The entire apparatus is submerged into water with the index of refraction 1.3. Determine the width of the second maximum.



3. Light with two wavelengths λ_{blue} = 450 nm and λ_{red} = 700 nm is incident on a 6000 lines/cm diffraction grating. Colored interference pattern is observed on a screen 2.5 m away.

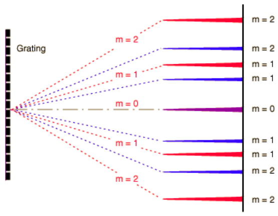
a. What is the angular width between two blue first order spectrum lines?

b. What is the angular width between two blue first order spectrum lines?

c. What is the distance between two red and blue spectrum lines in the second order?

d. How many spectrum orders of blue light can be seen on the screen?

e. How many spectrum orders of red light can be seen on the screen?



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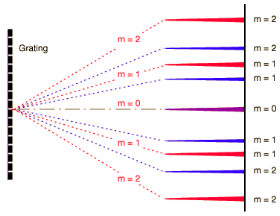

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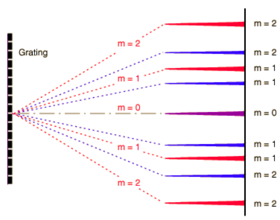

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3. Light with two wavelengths λ_{blue} = 450 nm and λ_{red} = 700 nm is incident on a 6000 lines/cm diffraction grating. Colored interference pattern is observed on a screen 2.5 m away.

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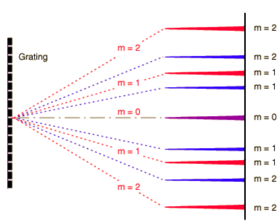

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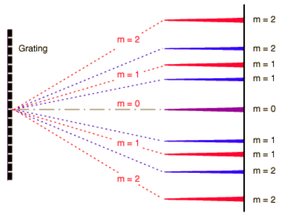
3. Light with two wavelengths λ_{blue} = 450 nm and λ_{red} = 700 nm is incident on a 6000 lines/cm diffraction grating. Colored interference pattern is observed on a screen 2.5 m away.

d. How many spectrum orders of blue light can be seen on the screen?



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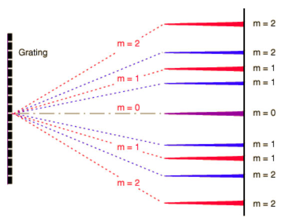
3. Light with two wavelengths λ_{blue} = 450 nm and λ_{red} = 700 nm is incident on a 6000 lines/cm diffraction grating. Colored interference pattern is observed on a screen 2.5 m away.

e. How many spectrum orders of red light can be seen on the screen?



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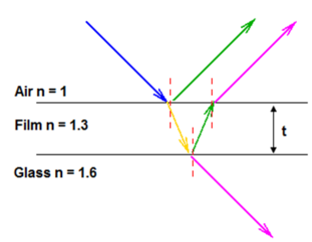
4. A glass block n = 1.6 is covered by a thin film n = 1.3. A monochromatic light beam λ= 600 nm initially traveling in air is incident on the film. (Assuming the angel of incidence in small)

a. What is the frequency of the incident light?

b. What is the frequency of the incident light?

c. What must be the minimum thickness of the film in order to minimize the intensity of the reflected light?

d. What must be the minimum nonzero thickness of the film except in order to maximize the intensity of the reflected light?



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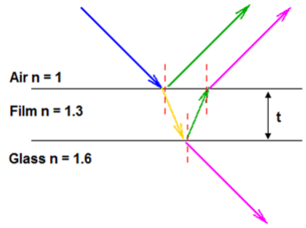

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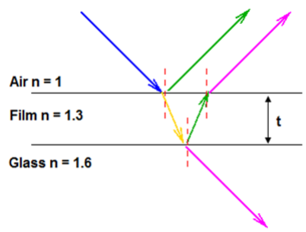

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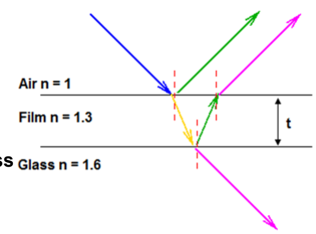

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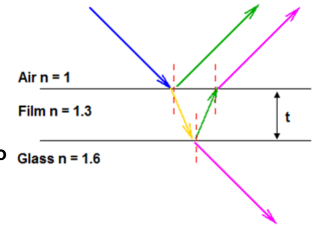

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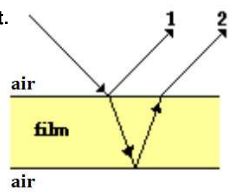
5. A soap bubble is illuminated with 480 nm light. The index of refraction of the bubble is 1.3.

a. Calculate the frequency of the incident light?

b. Calculate the wavelength of light in the film.

c. Calculate the minimum thickness of the film required to minimize the intensity of the reflected light.

d. Calculate the minimum nonzero thickness of the film required to maximize the intensity of the reflected light.



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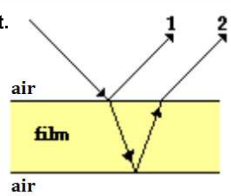

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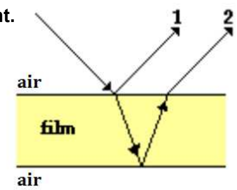

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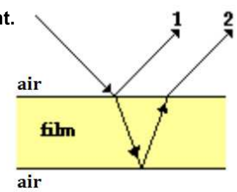

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