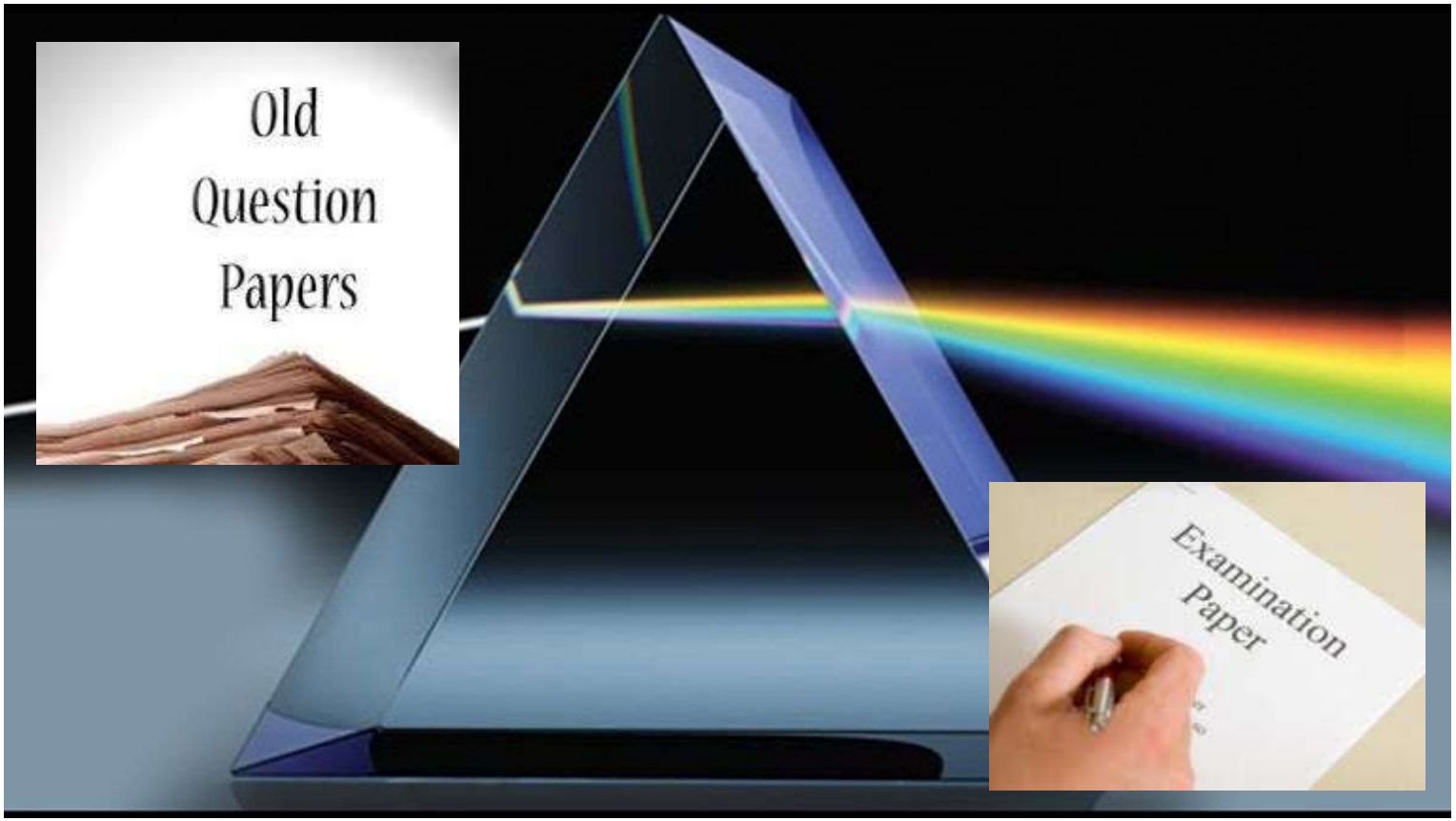
Old exam - Optical part



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Optics - Q1

- The critical angle for a certain liquid-air surface is 46.6°. What is the index of refraction of the liquid?

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Optics – Q2

- Suppose that you want to take a photograph of yourself as you look at your image in a mirror 3.0 m away. For what distance should the camera lens be focused?

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Optics – Q3

- How far from a concave mirror (radius 24.0 cm) must an object be placed if its image is to be at infinity?

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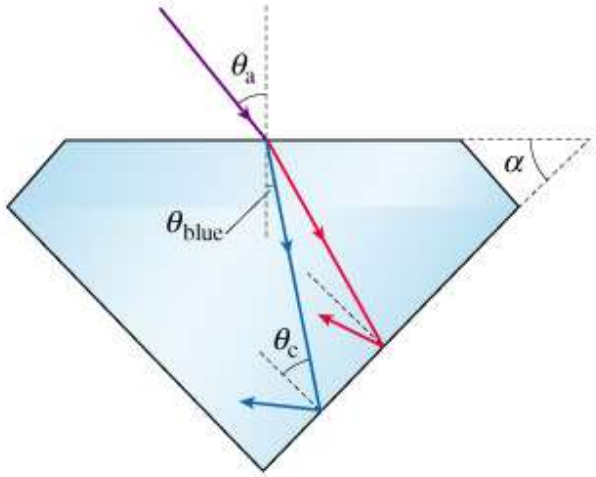
Optics – 4

- A convex lens has a focal length f. An object is placed between f and 2f on the axis. The image formed is located:
  - at 2f.
  - between f and 2f.
  - at f.
  - between the lens and f.
  - at a distance greater than 2f from the lens.

Optics – 5

- A beam of white light is incident on the surface of a diamond at an angle θ_a (Figure 1). Since the index of refraction depends on the light's wavelength, the different colors that comprise white light will spread out as they pass through the diamond.
- For example, the indices of refraction in diamond are n_red=2.41 for red light and are n_blue=2.45 for blue light. Thus, blue light and red light are refracted at different angles inside the diamond, as shown in the picture. The surrounding air has n_air=1,00. Note that the angles in the figure are not to scale.



I. Now consider θ_c, the angle at which the blue refracted ray hits the bottom surface of the diamond.
If θ_c is larger than the critical angle θ_{crit}, the light will not be refracted out into the air, but instead, it will be totally internally reflected back into the diamond. **Find θ_{crit} for the blue light**

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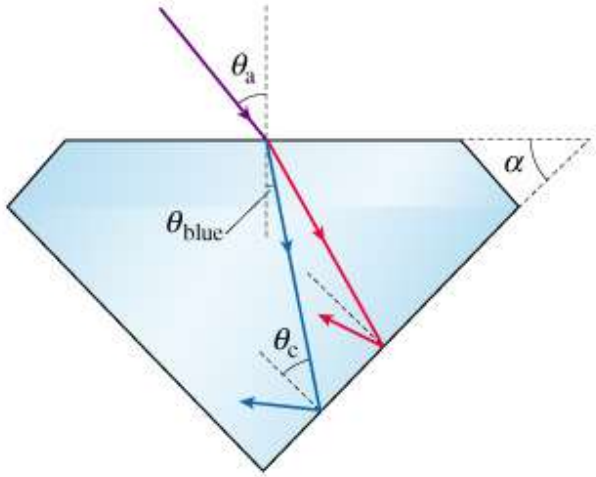
Optics – 6

- A beam of white light is incident on the surface of a diamond at an angle θ_a (Figure 1). Since the index of refraction depends on the light's wavelength, the different colors that comprise white light will spread out as they pass through the diamond.
- For example, the indices of refraction in diamond are n_red=2.41 for red light and are n_blue=2.45 for blue light. Thus, blue light and red light are refracted at different angles inside the diamond, as shown in the picture. The surrounding air has n_air=1,00. Note that the angles in the figure are not to scale.



A diamond is cut such that the angle between its top surface and its bottom surface is α=45.

Find the minimum value of the incident angle θ_a such that the blue light is totally internally reflected off the bottom surface.

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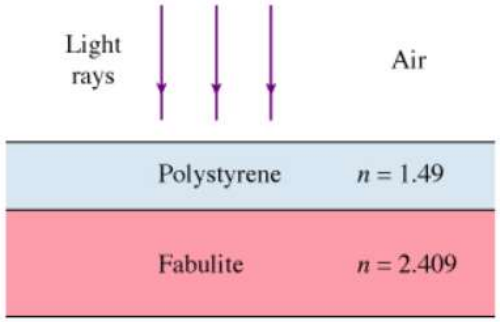
Optics – 7

- A thin film of polystyrene is used as an antireflective coating for fabulite (known as the substrate). The index of refraction of the polystyrene is 1.49, and the index of refraction of the fabulite is 2.409.
- What is the minimum thickness of film required? Assume that the wavelength of the light in air is 520 nm.



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Optics – 8

- For diffraction by a single slit, what is the effect of increasing the slit width?

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Optics – 9

- A physics professor wants to perform a lecture demonstration of Young's double-slit experiment for her class using the 633-nm light from a He-Ne laser. Because the lecture hall is very large, the interference pattern will be projected on a wall that is 7.0 m from the slits. For easy viewing by all students in the class, the professor wants the distance between the m=0 and m=1 maxima to be 25 cm.

  – Make a sketch of the experimental set-up described above. Clearly indicate all distances and angles involved.
  – What slit separation d is required in order to produce the desired interference pattern?

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Optics – 10

- Unpolarized light passes through six successive Polaroid sheets each of whose axis makes a 44° angle with the previous one. What is the intensity of the transmitted beam?

Optics - 11

- An astronomical telescope produces an inverted image. One way to make a telescope that produces an upright image is to insert a third lens between the objective and the eyepiece. To have the same magnification, the non-inverting telescope will be longer, Suppose lenses of foacl length 10 cm, 210 cm and 1,5 cm are available.