Partial exams: 6 Nov (Part 1A), 20 Nov (Part 1B), 4 Dec (Part 2), 11 Dec (Part 3)

Total time: 30 min

3 turns, about 12 students (will change every time)

No cell phones! Leave on my desk

No books, …

Only pen and calculator

If you don't have calculator ask me (not other students!)

Partial exam will contain 8 questions similar to the following

Why mica is used in structural pigment?

	yes	no
It's flat	x	
It's cheap	x	
It has low refractive index	x	
It's not colored	x	

Every correct sub-question gives 0.5 points. Wrong or no reply 0.0 points

Total for the questions is 8 x 4 x 0.5 = 16

Additionally 2 exercizes for 9.0 points each. Total 16 + 9 + 9 = 34
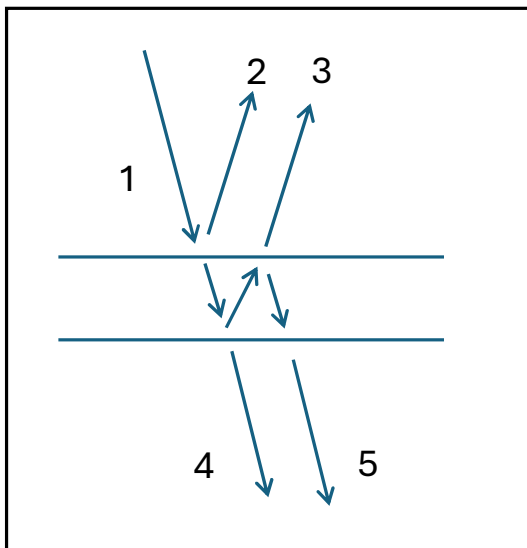
Exercise 1

A pigment is made by TiO_2 (refractive index n=2.7) and it is 150 nm thick.

1) Draw a scheme of the pigment and the interfering beams under white perpendicular illumination

2) Which wavelengths are reflected?

3) At which order?

4) Which wavelengths are transmitted?

5) What is the color of the pigment

2) 3) Reflected light

1)

$$2nd = (\frac{1}{2} + m)\lambda \qquad \lambda = (2 * 2.7 * 150 \ nm)/(\frac{1}{2} + m)$$

$$\lambda_1 = (2 * 2.7 * 150 \ nm)/(\frac{1}{2} + 1) \qquad \lambda_1 = 540 \ nm \qquad m=1$$

$$\lambda_2 = (2 * 2.7 * 150 \ nm)/(\frac{1}{2} + 2) \qquad \lambda_2 = 324 \ nm \ (UV) \qquad m=2$$

$$\lambda_3 = (2 * 2.7 * 150 \ nm)/(\frac{1}{2} + 3) \qquad \lambda_3 = 231 \ nm \ (UV) \qquad m=3$$

Only 540 nm is reflected in the vis, at order m=1

4) Transmitted light

$$2nd = m\lambda \qquad \lambda = (2 * 2.7 * 150\ nm)/\text{m}$$

$$\lambda_1 = (2 * 2.7 * 150\ nm)/(1) \qquad \lambda_1 = 810\ nm$$

$$\lambda_2 = (2 * 2.7 * 100\ nm)/(2) \qquad \lambda_2 = 405\ nm$$

$$\lambda_3 = (2 * 2.7 * 100\ nm)/(3) \qquad \lambda_3 = 270\ nm$$

Between 400 nm and 800 nm only 405 nm is transmitted, at order m=2

5) The color of the pigment is green

Exercise 2

A beam with wavelength is 480 nm is reflected at the air (n=1) to glass (n=1.5) interface. The angle between the beam and the interface is 40° with respect to the perpendicular.

1)What is the angle of the reflected beam with respect to the perpendicular?

2) If what is the difference in phase of the reflected beam with respect to the incoming?

3) what is the difference in phase of the refracted beam with respect to the incoming after travelling for 0 nm?

4)) what is the difference in phase of the refracted beam with respect to the incoming after travelling for 100 nm?

5) What is the relative intensity of the refracted beam?
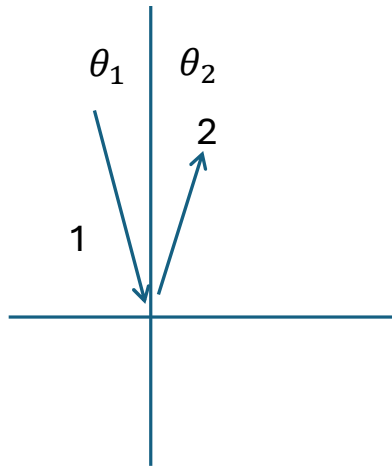
1) Angle is 40°. $\theta_1 = \theta_2$

2) $r = (n_0 - n_1)/(n_0 + n_1)$

   $r = (1 - 1.5)/(1 + 1.5)$

   $r = -0.2$

   $\Delta\phi = \lambda/2$ $\Delta\phi = 240\ nm$

3) $\Delta\phi = 0\ nm$

4) $\Delta\phi = nd$ $\Delta\phi = 1.5 * 100\ nm$ $\Delta\phi = 150\ nm$

5) Reflected intensity 4% $r^2 = (-0.2)^2$ $r^2 = 0.04$

   Transmitted intensity 96% $1 - r^2$