Benha University Faculty of Engineering – Shoubra Surveying Engineering Department Frist Year Surveying		Final Term Exam Physics Date: 22 / 1 / 2015 Duration : 3 hours

- Answer all the following question
- Illustrate your answers with sketches when necessary.
- No. of questions: 4 in two pages
- Total Mark: 90 Marks

Constants you may need: $e = 1.6 \times 10^{-19}$ C $m_e = 9.1 \times 10^{-31}$ kg

$h = 6.6 \times 10^{-34}$ J.s $c = 3 \times 10^{8}$ m/s

Question (1) (22 Marks)

(A) Choose the correct answers: **(10 Marks)**

1. The work function of Calcium is half that of the work function of Platinum. If the minimum photon energy required to emit photoelectrons from the surface of Calcium is E, then that for the surface of Platinum would be**:**

   Answer: (c) 2E

2. In a photoelectric effect, the energies of the emitted electrons vary with:

   Answer: (c) the frequency of the light.

3. In some crystal, the indices of refraction with respect to ordinary and extraordinary rays are found to be $\mu_o = 1.44$ and $\mu_e = 1.55$ respectively. This crystal is called:

   Answer: (b) Positive crystal

4. In a Young's double-slit experiment, light of wavelength 750 nm illuminates two narrow slits that are separated by 0.75 mm. The separation between adjacent bright fringes on a screen 7.5 m from the slits is:

   Answer: (b) 7.5 mm

5. In interference experiment, the center of a bright fringe occurs wherever waves from the slits differ in path by a multiple of:

   Answer: (b) λ

(B) In one typical double slit interference experiment; show that the spacing between the centers of two adjacent bright fringes is the same as the spacing between the centers of two adjacent dark fringes? **(6 Marks)**

Answer: see the text book pages 123, 124

(C) In Young's experiment, the two slits are placed 0.8 mm apart and the fringes are observed on a screen 90 cm away. It is found that with a certain monochromatic source of light, the third bright fringe is situated 8.2 mm from the central fringe.

1) Find the wavelength of the light?

2) Find the distance of the second dark fringe from the central maximum? **(6 Marks)**

Answer: $2d = 0.8$ mm $= 0.8 \times 10^{-1}$ cm

$D = 90$ cm

$X = 8.2$ mm $= 8.2 \times 10^{-1}$ cm

n = 3

(i) $X = n \frac{D\ \lambda}{2d}$

$$\lambda = \frac{2d\ X}{n\ D} = \frac{0.8x10^{-1} x\ 8.2x10^{-1}}{3\ x\ 90} = 2.4x10^{-4}\ \ cm$$

(ii) For dark fringes $X = (n\ -\ 1/2) \frac{D\ \lambda}{2d}$

n = 2

$$X = (2\ -\ 1/2) \frac{90\ x\ 2.4x10^{-4}}{0.8x10^{-1}} = 0.41\ \ cm$$

Question (2) **(22 Marks)**

(A) Compare using schematic diagrams the main characteristics of double refracting positive and negative crystals? **(6 Marks)**

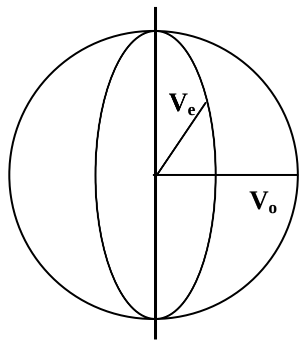
Answer:

Positive crystals:

Are crystals which characterized by:

1. The elliptical wavefront is entirely inside the spherical wavefront.
2. $V_o > V_e$ in all directions except at the optic axis.
3. $\mu_o < \mu_e$ in all directions except at the optic axis.

For example: quartz.



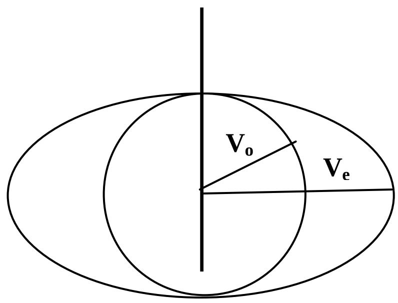
Optic axis

Negative crystals:

Are crystals which characterized by:

1. The spherical wavefront is entirely inside the elliptical wavefront.
2. $V_e > V_o$ in all directions except at the optic axis.
3. $\mu_e < \mu_o$ in all directions except at the optic axis.

For example: Calcite



Optic axis

(B) Derive an expression for elliptically polarized light emerged when a plane-polarized light incident on a quarter-wave plate? **(6 Marks)**

Answer: see the text book pages 105, 106

(C) What is the angle between the principal planes of a polarizer and analyzer if the intensity of natural light after passing through the polarizer and analyzer is reduced to one fourth of its original value? **(5 Marks)**

Answer: $I_2 = \frac{1}{4} I_o$

We have: $I_1 = \frac{1}{2} I_o$

And, $I_2 = I_1 \cos^2 \theta$

$= \frac{1}{2} I_o \cos^2 \theta$

then, $\frac{1}{4} I_o = \frac{1}{2} I_o \cos^2 \theta$

$\frac{1}{4} = \frac{1}{2} \cos^2 \theta$

$\theta = 45^o$

(D) If the indices of refraction of calcite for ordinary and extraordinary rays are given as: $\mu_o = 1.65$ and $\mu_e = 1.49$. Calculate the thickness of a half-wave plate made of calcite for the yellow light radiation from sodium vapor lamp with wavelength of 589 nm? **(5 Marks)**

Answer: $\mu_o = 1.65$, $\mu_e = 1.49$, $\lambda = 589 \times 10^{-9}$ m

$t (\mu_o - \mu_e) = \frac{1}{2} \lambda$

$589 \times 10^{-9} = 2 \times t \times (1.65 - 1.49)$

$t = 1.84 \times 10^{-6}$ m $= 1.84 \times 10^{-3}$ mm

Question (3) (23 Marks)

(A) Define the following: **(6 Marks)**

Answer:

1) Work function of a metal surface: is the minimum energy of the incident radiation that can make photoelectric emission.

2) Saturation current: is the maximum value of photo-current after which the current can not increased by increasing the potential difference

3) Stopping potential: is the value of negative potential at which the photo-current is zero

(B) Discuss the phenomenon of photoelectric emission? Explain the effect of variation of the frequency (ν) and the intensity (I) of the incident light on the velocity of the emitted electrons? **(6 Marks)**

Answer: see the text book pages 143, 144

(C) The work of emission of an electron in a certain metal is found to be 2.1 eV. The metal is fully illuminated by radiation energy of 6.6 eV. What will be the stopping potential for this emission? **(5 Marks)**

Answer: $h\nu = h\nu_0 + eV_o$

$6.6 \times 1.6 \times 10^{-19} = 2.1 \times 1.6 \times 10^{-19} + 1.6 \times 10^{-19} V_o$

$V_o = 4.5$ V

(D) The threshold frequency for photoelectric emission in Copper is 1.1×10^{15} Hz. When light of frequency 1.6×10^{15} Hz is directed on a Copper surface, find 1) the work function of emission? 2) the maximum velocity of the photoelectrons emitted? **(6 Marks)**

Answer: $\nu_0 = 1.1 \times 10^{15}$ Hz

$\nu = 1.6 \times 10^{15}$ Hz

1) $w = h\nu_0$

$= 6.6 \times 10^{-34} \times 1.1 \times 10^{15} = 7.2 \times 10^{-19}$ J

2) $h\nu = h\nu_0 + ½ mv^2$

$6.6 \times 10^{-34} \times 1.6 \times 10^{15} = 6.6 \times 10^{-34} \times 1.1 \times 10^{15} + ½\, 9.1 \times 10^{-31} v^2$

$v = 8.5 \times 10^5$ m/s

Question (4) (23 Marks)

(A) Give an expression for the general equation of a thin lens whose radii of curvature r_1, r_2 and refractive index n when the lens is placed in air? Show the magnification of the image produced? **(6 Marks)**

Answer: see the text book pages 27, 28

(B) Use the wave theory to discuss the refraction of a plane wave at a plane surface? **(6 Marks)**

Answer: see the text book pages 11

(C) A convex refracting surface of radius of curvature 20 cm separates two media of refractive indices of 1.33 and 1.5. An object is kept in the first medium at a distance of 240 cm from the refracting surface. Calculate the position of the image and magnification? **(6 Marks)**

Answer: see solved example in the text book pages 19

(D) A lens made of glass whose index of refraction is 1.6 has a focal length of +20 cm in air. Find its focal length when it is fully immersed in water whose focal length is 1.33? **(5 Marks)**

Answer: $f_a = 20$ cm

$1/f_a = (n - 1)(1/R_1 - 1/R_2) = 0.6\ (1/R_1 - 1/R_2)$

$1/f_w = (n/n_w - 1)(1/R_1 - 1/R_2) = 0.45\ (1/R_1 - 1/R_2)$

$f_w/f_a = 0.6/0.45$

$f_w = 60$ cm

GOOD LUCK

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