Benha University Faculty of Engineering – Shoubra Surveying Engineering Department Frist Year Surveying		Final Term Exam Physics (Leftover) Date: 24 / 12 /2014 Duration : 3 hours

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

Question (1) **(25 degrees)**

(A) Choose the correct answers:

(i) The phase difference between the two waves that give rise to a dark spot in a Young's double-slit experiment is (where n = integer):

Answer: (b) $2n\pi + \pi$

(ii) In a Young's double-slit experiment, the slit separation is doubled. To maintain the same fringe spacing on the screen, the screen-to-slit distance D must be changed to:

Answer: (d) 2D

(iii) In a Young's double-slit experiment, light of wavelength 500 nm illuminates two narrow slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5 m from the slits is:

Answer: (a) 0.25 cm

(iv) Polarization experiments provide evidence that light is:

Answer: (b) a transverse wave

(v) Light from any ordinary source (such as a flame) is usually:

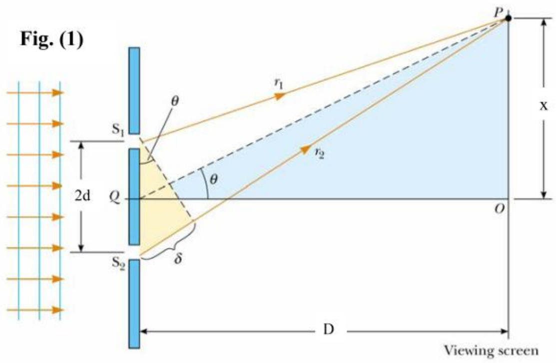
Answer: (c) unpolarized

(vi) In some crystal, the indices of refraction with respect to ordinary and extraordinary rays are found to be $\mu_o = 1.52$ and $\mu_e = 1.43$ respectively. This crystal is called:

Answer: (d) Negative crystal

(B) Using the theory of interference fringes to find the distance along the screen of the bright fringes and that of the dark fringes from the central fringe?

Fig. (1)



Answer: See text book pages 122-123

(C) As the sun rises over a water pond, an angle will be reached where its image seen on the water surface (μ_w = 1.33) will be completely linearly polarized in a plane parallel to the surface. Compute the appropriate incident angle. At what angle will the transmitted beam propagates through water?

Answer: $\mu_w = 1.33$ $\mu_{air} = 1$

$\tan \phi_p = \mu_w / \mu_{air}$

$\phi_p = \tan^{-1} (1.33/1) = 53.1^o$

Since, $\phi_p + r = 90^o$

Then, $r = 90 - \phi_p = 90 - 53.1$

$r = 36.9^o$

Question (2) **(22 degrees)**

(A) Differentiate clearly between:

(i) Constructive and destructive interference of light

Answer:

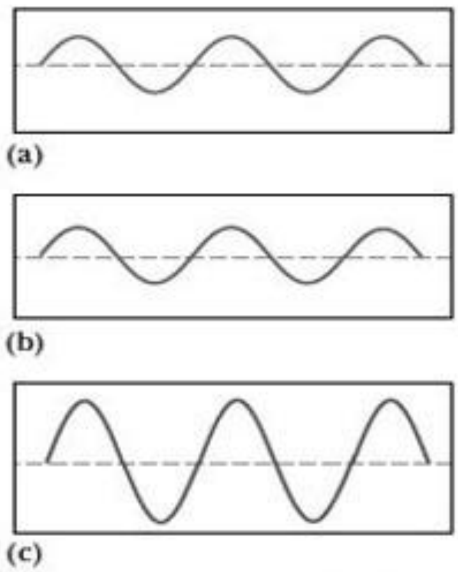


Figure 1 Constructive interference. If two waves having the same frequency and amplitude are in phase, as in (a) and (b), the resultant wave when they combine (c) has the same frequency as the individual waves, but twice their amplitude.

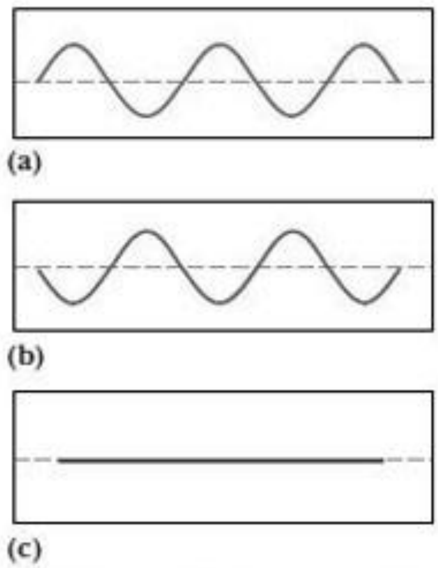


Figure 2 Destructive interference. When two waves with the same frequency and amplitude are 180° out of phase, as in (a) and (b), the result when they combine (c) is complete cancellation.

(ii) Stimulated and spontaneous emission of light

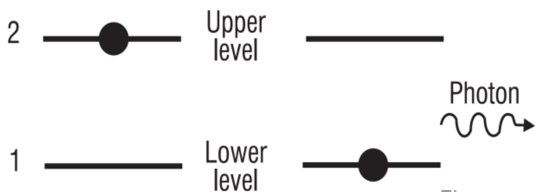
Answer:

Stimulated emission

The processes of stimulated emission can be described as:

- An excited atom has its electron in a higher energy state.
- An incident photon with energy ($h\nu = E_1 - E_o$) is interacted with the atom without absorption. So, the photon is transmitted out of the atom.
- This process causes an electron transition form the higher to a lower energy state and a photon is emitted with energy ($h\nu = E_1 - E_o$) equal to the value of energy difference between the higher and the lower energy states.

Spontaneous emission



The processes of spontaneous emission can be described as:

- An excited atom has its electron in a higher energy state.
- Due to the life time of excitation, the atom undergoes an electron transition into a lower energy state.
- A photon is emitted from this process with energy ($h\nu = E_1 - E_o$) equal to the value of energy difference between the higher and the lower energy states of the atom.

(iii) Isotropic and anisotropic media

Answer:

Isotropic medium:

It is the medium in which the velocity of light waves is the same in all directions.

The wavefront produced in such medium always spherical.

For example: glass

Anisotropic medium:

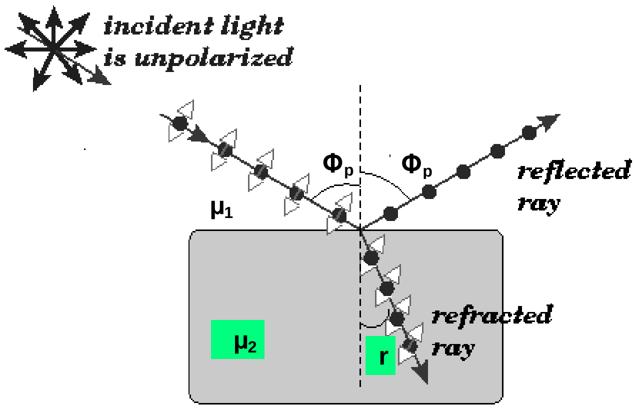
Is the medium in which the velocity of light waves is not the same in all directions.

this medium has a property of double refraction in which two wavefronts are produced, one of them is spherical and the other is elliptical.

For example: many crystalline substances

like calcite, quartz.

(B) State Brewster's law and derive the relation between the refraction angle and the angle of polarization?



Answer:

Brewster's law states that:

$\tan \phi_p = \mu_2 / \mu_1$

ϕ_p : is the angle of incidence at which the reflected ray will be completely polarized

μ_1 and μ_2 : is the refractive indices of the incidence and transmitted media

From Snell's law: $\sin \phi_p / \sin r = \mu_2 / \mu_1$ ...... (1)

From Brewster's law: $\tan \phi_p = \mu_2 / \mu_1$

So, $\sin \phi_p / \cos \phi_p = \mu_2 / \mu_1$ ...... (2)

From (1) and (2)

$\sin \phi_p / \sin r = \sin \phi_p / \cos \phi_p$

$\sin r = \cos \phi_p$

$\sin r = \sin (90^o - \phi_p)$

So, $r = 90^o - \phi_p$

Then, $\phi_p + r = 90^o$

(C) Interference fringes are produced by a Fresnel's biprism in the focal plane of a reading microscope which is 100 cm from the slit. A lens interposed between the biprism and the microscope and gives two images of the slits in two positions. If the images of the slits are 5.5 mm in one position and 2.5 mm in the other position, and the wavelength of the light used is 580 nm, find the distance between the consecutive interference bands?

Answer: $D = 100 \times 10^{-2}$ m , $\lambda = 580 \times 10^{-9}$ m

$P_1 = 5.5 \times 10^{-3}$ m , $P_2 = 2.5 \times 10^{-3}$ m

Since, $w = \lambda D / \sqrt{(P_1 P_2)}$

$w = 580 \times 10^{-9} \times 100 \times 10^{-2} / \sqrt{(5.5 \times 10^{-3} \times 2.5 \times 10^{-3})}$

$w = 1.56 \times 10^{-4}$ m

Question (3) **(22 degrees)**

(A) Write the Einstein's relations for stimulated absorption, stimulated emission and spontaneous emission of light?

Answer: -

$$B_{10} = B_{01}$$

$$\frac{A_{10}}{B_{10}} = \frac{8\ \pi\ h\ \nu^3}{c^3}$$

Which are Einstein's relations

(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?

Answer: See text book pages 143-144

(C) For certain metal, the photoelectric effect begins at 275 nm. Find:

(i) The work function of the metal?

(ii) The maximum velocity of the electrons ejected from the metal for incident light with wavelength of 200 nm?

($h = 6.6 \times 10^{-34}$ J.s , $c = 3 \times 10^{8}$ m/s , $m = 9.1 \times 10^{-31}$ Kg)

Answer: $\lambda_o = 275 \times 10^{-9}$ m

(i) $W = hc / \lambda_o$

$= 6.6 \times 10^{-34} \times 3 \times 10^{8} / 275 \times 10^{-9} = 7.2 \times 10^{-19}$ J

(ii) $hc / \lambda = hc / \lambda_o + ½\ mv^2$

$6.6 \times 10^{-34} \times 3 \times 10^{8} / 200 \times 10^{-9} = 6.6 \times 10^{-34} \times 3 \times 10^{8} / 275 \times 10^{-9} + ½\ 9.1 \times 10^{-31}\ v^2$

Then, $v = 7.7 \times 10^{5}$ m/s

Question (4) **(21 degrees)**

(A) Give a detailed description of the construction, working and magnification of the astronomical telescope? Your answer should be supported by geometric diagrams?

Answer: See text book pages 57-58

(B) The focal length of the objective lens in a typical compound microscope is 1 cm and that of the eye-piece is 5 cm. Find the position at which the object must be placed if the observer sees a distinct image at 25 cm with the distance between the objective and eye-piece lenses is 20 cm (explain with the aid of a diagram)

Answer: Solved example page 56

(C) An object 6 cm high is located 30 cm in front of a convex mirror of radius of curvature 40 cm. determine the position and the height of its image?

Answer: Solved example page 19

GOOD LUCK !!!!!

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