**NOTE PHYSICS 4 - THEORY**

**(Midterm)**

1. **Vibration. Resonance**
2. **In simple harmonic oscillation:**

+ The restoring force:

+ Displacement of simple harmonic motion:

with:

(k: string constant (N/m); m: mass of the object(kg))

+ The period: ;

+ Frequency:

1. **The physical pendulum:**

+ Angular displacement:

with: (I: inertia moment; d: the distance from the rotating point)

+ The period:

+ In the simple pendulum:

1. **Force Oscillation and Resonance:**

+ In damped oscillation, the displacement is:

with: (b: damping coefficient (kg/s))

+ In force oscillation:

with: ;

if

1. **Mechanical Wave**
2. **The wave function:**

with: ()

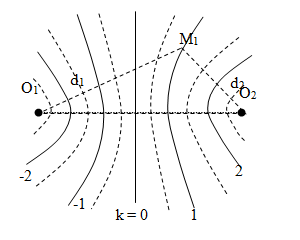
and: (K: the wave number)

1. **The speed of waves on strings:**

with: T: tension of the string (N)

µ: mass per unit length (kg/m)

1. **Superposition and Interference:**

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The general function of interference;

For the phase difference:

For the path difference:

**In case two waves are in the same phase**

**In case two waves are out of phase**

1. **Standing wave**

The position of the nodes: (n = 1,2,3,…)

The position of the antinodes: (n= 1,2,3,..)

**In a string fixed at both ends:**

* The wavelength: (n = 1,2,3,…)
* The frequency: (n = 1,2,3,…)

⇨ The fundamental frequency: and

**In a pipe opened at both ends:**

* The wavelength: (n = 1,2,3,…)
* The frequency: (n = 1,2,3,…)

⇨ The fundamental frequency: and

**In a pipe closed at one end:**

* The wavelength: (n = 1,3,5,…)
* The frequency: (n = 1,3,5,…)

⇨ The fundamental frequency: and

(n is odd number)

1. **Sound wave:**

+ Normal human can hear from 20Hz to 20000Hz

+ The intensity of sound wave: The rate at which the energy flows through a unit area

with: P is the power

+ The intensity of sound level:

I0: threshold of hearing (

1. **Doppler effect:**

the speed of sound

: the speed of the observer

: the speed of the source

⇨ The motion is toward ⇨ Higher frequency

⇨ The motion is away ⇨ Lower frequency

**3) Wave Optics:**

**a) The nature of light:** The photon energy:

**b) Interference of light wave:**

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The path difference:

* Bright fringe:

Angular position:

* Dark fringe:

Angular position:

The intensity:

**c) Interference in a thin film**

+ Change of phase due to reflection

* ⇨ 1800 phase change
* ⇨ no phase change

+ The wavelength of light in a medium

+ The interference in a thin film

* **Constructive interference:**
  + (m = 1,2,3,..)
* **Destructive interference:** (m = 1,2,3,…)

(t: the thickness of the film; n: refraction index of the film)

**d) Light diffraction:**

+ The general condition for destructive interference

(m = 1,2,3,…)

(a: the width of the split)

+ Position of dark fringe

+ The intensity at each point on the screen

* If ⇨ all the light concentrate at the geometrical focus
* If a < ⇨ The central maximum spread over 1800 ⇨ Cannot see the fringe

**e) Diffraction grating:** consider a large number of splits, all with the same width a and spaced equal distances d between centers

The condition for maximum intensity:

(m =1,2,3,…)

(d: grating spacing)

For grating spacing d: d =

**f) Diffraction of X-rays by crystal**

The Bragg equation (for the path difference)

(: the incident angle; d: the distance between adjacent planes)

**g) Polarization:**

The intensity of the light transmitted through the analyzed:

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For the unpolarized light passing through a polarizer:

I =

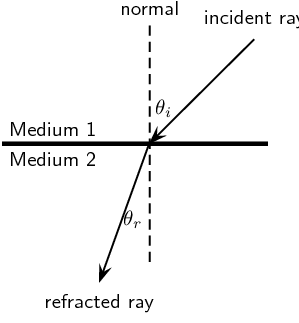
**4) Geometric Optics**

**a) Refraction and Reflection**

**+ Index of refraction:**

( the speed of light in a medium)

**+ The law of reflection**: The angle of reflection is equal to the angle of the incident light

**+ Snell’s Law of Refraction:**

**+ The critical angle for total internal reflection:**

(if

**b) Thin lenses:**

**+ The focal length f (the lens maker’s equation):**

* If ⇨ converging lens
* If ⇨ diverging lens

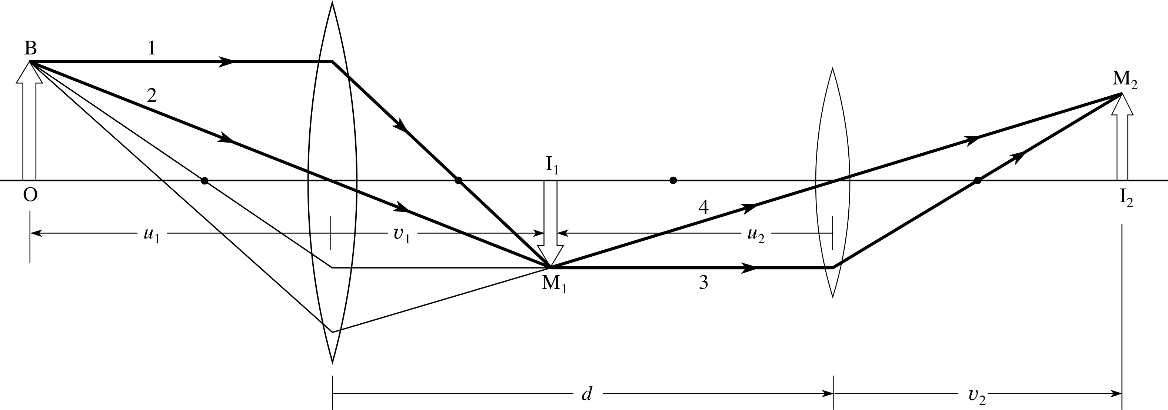
**+ Thin-lens equation:**

* If: ⇨ Real object; ⇨ Virtual object
* If: ⇨ Real image; ⇨ Virtual image

**+ Magnification:**

* If ⇨ The image is the same direction as the object (erect image)
* If ⇨ The image is opposite direction to the object (inverted image)

**+ For the two lenses system:**



* Thin-lens equation for lens 1:
* The distance between lens 1 and lens 2:
* Thin-lens equation for lens 2:
* Total magnification:

**c) Prism (optional)**

For minimum deflection:

**d) Mirrors (optional)**