ENGINEERING PHYSICS

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ENGINEERING PHYSICS

Unit I : Review of concepts leading to Quantum Mechanics

- **Group velocity relations**

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Unit I : Review of concepts leading to Quantum Mechanics

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➢ *Suggested Reading*

1. *Concepts of Modern Physics, Arthur Beiser, Chapter 2*
2. *Learning Material prepared by the Department of Physics*

➢ *Reference Videos*

1. *Video lectures : MIT 8.04 Quantum Physics I*
2. *Institute of Sound and Vibrations Research, UK*

Group and Phase velocity relation

- *Group velocity*

$$v_g = \frac{d}{dk}(\omega) = \frac{d}{dk}(v_{ph}k)$$

$$= v_{ph} - k\frac{dv_{ph}}{dk} = v_{ph} - k\frac{dv_{ph}}{d\lambda}\frac{d\lambda}{dk}$$

$$= v_{ph} - \lambda\frac{dv_{ph}}{d\lambda}$$

- *Group velocity is dependent on the phase velocity and how the phase velocity changes with wavelength*

Group and Phase velocity relation

Group velocity = Phase velocity $v_g = v_{ph}$

$$-\lambda \frac{dv_{ph}}{d\lambda} = 0$$

- *Phase velocity does not change with wavelength*
- *The medium is non dispersive*
- *A dispersive medium is one in which*

Group velocity <> Phase velocity

- $v_g < v_{ph}$
- $v_g > v_{ph}$

Group and Phase velocity relation

- $v_g < v_{ph}$ - *group velocity is half the phase velocity*
- $v_g = {}^{v_{ph}}/_{2}$
- $\frac{dv_p}{v_{ph}} = \frac{1}{2}\frac{d\lambda}{\lambda}$ on integration yields
- $ln(v_{ph}) \propto ln\sqrt{\lambda}$ or $v_{ph} \propto \sqrt{\lambda}$
- This implies that the phase velocity is proportional to the square root of the wavelength

Group and Phase velocity relations

- $v_g > v_{ph}$ - *group velocity is twice the phase velocity*
- $v_g = 2v_{ph}$
- $\frac{dv_p}{v_{ph}} = -\frac{d\lambda}{\lambda}$ on integration yields
- $ln(v_{ph}) \propto ln\frac{1}{\lambda}$ or $v_{ph} \propto \lambda^{-1}$
- This implies that the phase velocity is inversely proportional to the wavelength

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Class #7 …….. Quiz….

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The concepts which true of matter waves ….

1. **Wave packets do not disperse in any medium**
2. **Group and phase velocities of a wave packet is dependent on the medium in which it propogates**
3. **In a non dispersive medium the group velocity is equal to the phase velocity**

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THANK YOU

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