

# Major Concepts in Physics

## Lecture 25.

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<http://physics/courses/PHY102.08Spring>

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# Announcements

- Final Thursday 1 May 5-7:00 pm in Stolkin. Comprehensive. Same style, format to mid terms.
- People needing extra time – room reserved at end
- I will not be here – one of the TAs will proctor

# Recap last lecture

- All inertial frames equivalent for discovering/using laws of physics
  - Consequence – speed of light is SAME measured from any inertial frame
- For this to be true – rate of passage of time must depend on inertial frame
- All inertial observers agree on the distance squared in **spacetime** between 2 events

$$(\Delta x)^2 - c^2 (\Delta t)^2 = \Delta s^2$$

# Time dilation

- Consider frame moving at speed  $v$  relative to us and 2 events which occur at same place in that frame -  $\Delta X=0$
- From our frame  $\Delta x=v\Delta t$
- $\text{Distance}^2 = -c^2 (\Delta T)^2 = (\Delta x)^2 - c^2 (\Delta t)^2 =$   
 $v^2 (\Delta t)^2 - c^2 (\Delta t)^2$
- Thus  $(\Delta T)^2 = (\Delta t)^2 (1 - v^2/c^2)$

Time dilation - time interval less in moving frame

# Momentum, energy

- Relativistic momentum:

$$p = \gamma m_0 v$$

$$\gamma = 1 / (1 - v^2/c^2)^{1/2}$$

$m_0$  rest mass

- Energy  $E = \gamma m_0 c^2$
- Object has energy even in frame where its at rest. Mass  $\gamma m_0$  is equivalent to energy. Can be interconverted.

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# Example problems

- An astronaut wears a new Rolex watch on a journey at a speed of  $2.0 \times 10^8$  m/s with respect to Earth. According to mission control in Houston the trip takes 12 hr. How long is the trip measured on the Rolex ?

## Another ....

- A spaceship travels at a constant velocity of  $0.9999c$  from Earth to a point 710 light years away as measured in Earth's rest frame. A passenger is 20 yr old when he starts out. How old is he when he arrives as measured by the ship's clock?

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# Momentum etc

- A proton moves at  $0.9c$ . What is its momentum according to
- a) relativity
- b) Newtonian physics

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# Energy

- The solar energy arriving at the Earth's surface has intensity  $1.4\text{kW/m}^2$ . The Earth is at a distance of  $1.5 \times 10^{11}$  m from the Sun. How much mass does the Sun lose each day?  
?

# One more

- A neutron (mass=1.00866u) decays into a proton (mass=1.00728u), an electron (mass=0.00055u) and an antineutrino(mass=0). What is the sum of the kinetic energies of the particles produced if the neutron is at rest ? ( $1\text{u}=931.5\text{ MeV}/c^2$ )

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# What to do ...

- Look at lectures, particularly review lectures 7,13,21
- Look over previous midterms and practice exams/solutions
- Look over your homeworks/quizzes.

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# Quick Summary I

- Waves. Basic definitions. How to read off wavelength, frequency, speed and direction from wave function
- Interference and diffraction. Double slit interference problems. Single slit diffraction problems
- Standing waves. Sound in pipes
- EM waves. Basic ideas.

# II

- Thermal radiation. Stefan and Wien's law.
- Color mixing: basic ideas. Filters. Polarization. Brewster's angle.
- Ray approximation. When is it valid ?
- Laws of reflection and refraction. Total internal reflection
- Mirrors and lenses. Simple ray diagrams. Lens/Mirror equation.
- Virtual images. Magnification.

# III

- Definitions of temperature, heat, work, internal energy. Molecular interpretation.
- Ideal gases
- 1<sup>st</sup> and 2<sup>nd</sup> law of thermodynamics. Entropy.
- Photoelectric effect. Wave nature of matter. Diffraction of electrons.
- Bohr model of H atom. Discrete energies. Uncertainty principle
- Pauli principle.

# IV

- Basic ideas of nuclear physics.  $Z$ ,  $A=N+Z$
- Fission/fusion. Binding energy.
- Radioactive decay. Alpha, beta, gamma
- Principle of relativity. Distance in spacetime. Time dilation problems.
- Relativistic momentum and energy. Simple problems

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That's all Folks !

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Good luck with Final ....