Review Key

June-03-16 10:55 AM

Special Relativity Review

1. **Define:** Inertial Frame

A reference frame moving at a constant velocity

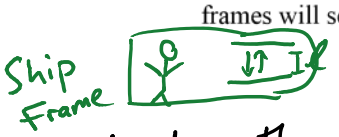
2. State the two postulates of special relativity

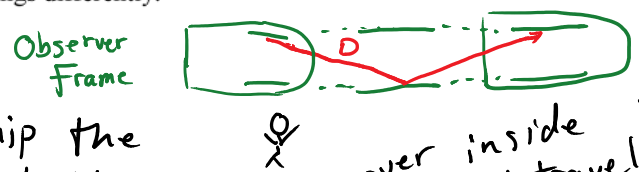
- The laws of Physics are valid in all inertial reference frames.
- The speed of light is the same in all reference frames

3. Michelson and Morley revolutionized physics in 1887 when they published their findings for their experiment. What assumptions can we draw based on their findings?

- The speed of light is a constant, regardless of reference frame
- There is no fixed or preferred reference frame.

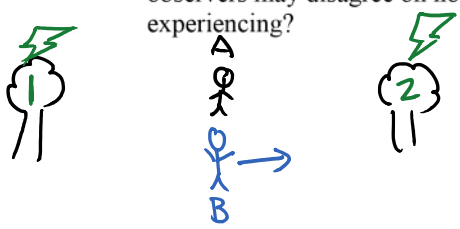
4. Use the concept for a light-clock to describe how two observers in different inertial frames will see things differently.





Outside the ship the observer sees light travel farther than the observer inside the ship. since light travels at "c" in all frames, time is dilated inside the ship.

5. Two observers are in the middle between two trees, one observer is at rest, the other is moving towards one of the trees. Both trees are struck by lightning. Describe how the observers may disagree on how events occurred. What is the name of the concept they are experiencing?



Observer A may observe the lightning bolt strike both trees simultaneously. Observer B may observe tree 2 is struck before tree 1.

They are experiencing relative simultaneity

Nuclear Physics Review

1. **Define**
   a. Nucleon
   Individual parts of the nucleus, protons and neutrons
   b. Binding Energy
   - The energy a nucleus uses to hold together.
   - The energy required to separate the nucleons in the nucleus.
   c. Fission
   Splitting of a heavy atom into lighter products.
   d. Fusion
   The combining of two lighter nuclei into a heavier product.

2. Isotopes are different atoms of a single element that have different masses. In terms of sub-atomic particles (protons, electrons and neutrons) what do the isotopes have in common? What do the isotopes not have in common?

   protons } same
   electrons }

   neutrons → different

3. Determine the mass defect and binding energy of the following isotopes.

Isotope	# of protons	# of neutrons	Mass Defect amu	Binding Energy MeV
$^{2}_{1}H$	1	1	0.00184	1.714 MeV
$^{3}_{1}H$	1	2	0.008557	7.971 MeV
$^{4}_{2}He$	2	2	0.029279	27.273 MeV
$^{7}_{3}Li$	3	4	0.040484	37.701 MeV
$^{90}_{36}Kr$	36	54	0.81033	754.81 MeV
$^{143}_{56}Ba$	56	87	1.240685	1155.69 MeV
$^{235}_{92}U$	92	143	1.864558	1736.82 MeV

4. What is a helpful gauge to finding the relative stability of a nucleus? Use this to for three of the above isotopes. Which is the most stable?

Binding Energy per nucleon

$^{143}Ba = 8.082\ MeV/nuc$

$^{4}He = 6.818\ MeV/nuc$

$^{235}U = 7.391\ MeV/nuc$

$^{2}H = 0.857\ MeV/nuc$

$^{7}Li = 5.386\ MeV/nuc$

$^{3}H = 2.659\ MeV/nuc$

$^{90}Kr = 8.387\ MeV/nuc$ ← most stable

5. Complete the following nuclear equations. State if the reaction is an alpha decay, beta decay, gamma decay, fission or fusion.

a) $^{214}_{84}Po \rightarrow {}^{210}_{82}Pb + {}^{4}_{2}He$ Alpha Decay

b) $^{4}_{2}He + {}^{3}_{2}He \rightarrow {}^{7}_{4}Be$ Fusion

c) $^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{143}_{56}Ba + {}^{90}_{36}Kr + 3\ {}^{1}_{0}n$ Fission

d) $^{131}_{53}I \rightarrow {}^{0}_{-1}e + {}^{131}_{54}Xe$ Beta Decay

6. Find the energy released in the following nuclear reactions.

a. $^{1}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He$

$4.023874 = 4.002603 + \Delta m$

$\Delta m = 0.021271\ u \times 931.49\ MeV/u$

$\Delta E = 19.814\ MeV$

b. ${}_1^2H + {}_1^2H \rightarrow {}_2^4He$

$4.028202 = 4.002603 + \Delta m$

$\Delta E = 23.845\,MeV$

c. ${}_1^3H + {}_2^4He \rightarrow {}_3^7Li$

$7.018652 = 7.016004 + \Delta m$

$\Delta E = 2.4666\,MeV$

d. ${}_0^1n + {}_{92}^{235}U \rightarrow {}_{56}^{143}Ba + {}_{36}^{90}Kr + 3{}_0^1n$

$236.052594 = 235.866137 + \Delta m$

$\Delta E = 173.68\,MeV$

Data Table:

Particle	Mass (amu)
${}_1^1p$	1.007276
${}_0^1n$	1.008665
${}_1^1H$	1.007825
${}_1^2H$	2.014101
${}_1^3H$	3.016049
${}_2^4He$	4.002603
${}_3^7Li$	7.016004
${}_{36}^{90}Kr$	89.919516
${}_{56}^{143}Ba$	142.920626
${}_{92}^{235}U$	235.043929

Conversions:

1amu = 1.6605×10^{-27}kg

1amu = 931.49MeV

1MeV = 1.60×10^{-13} J