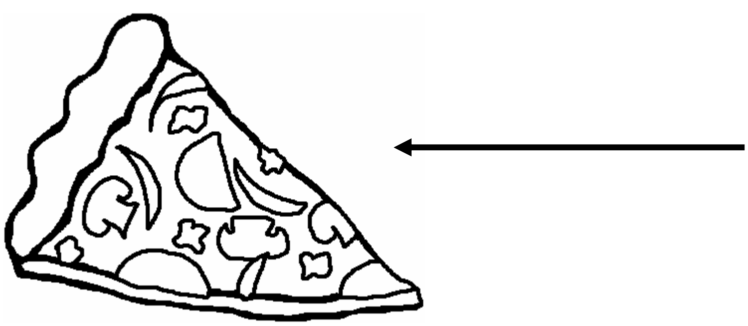
SPS Lunchbox Seminar

"Crystal Growth, Neutron Scattering and Spin Correlations: A Tale of two Complex Oxides "

Martin Greven, Stanford University

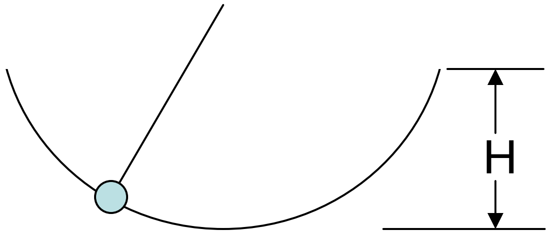


only $1 a slice!

Monday, October 29th, 12:30 pm

SPS Lounge (B135)

A pendulum of mass 20 kg and length 10 m is going 10 m/s at its lowest point. How high does it swing? Ignore dissipation



A. 5.1 m
B. 7.6 m
C. 2.5 m
D. 10.2 m
E. Not enough information to tell

Exam solutions are posted on the class website:
http://faculty.washington.edu/storm/121C/

Graded exams that were not yet picked up will be returned at the end of class.

The bubble sheets were mis-graded. (Question 3) This has been fixed, and new scores posted.

If you (still) feel a grading error has been made on your exam, you may submit a request (to Helen Gribble in PAB C136) for regrading. (Form on class website.) If you plan this, do not write anything more on your exam. If you request regrading, your entire exam will be regraded.
DEADLINE: Next Wed

HW #5 is due next Wed by midnight.
It is relatively short.

Office hours Wednesday: 4:00 – 5:30pm…

Exam grades posted on Tycho.

Sections 7.4 and 7.5 Energy in Modern Physics

Relativity Mass and energy can be interchanged. Find

$\Delta E = \Delta m\, c^2$

c is the speed of light, 3×10^8 m/s

set E = 0 when m = 0 and get the famous

$E = m\, c^2$ ("rest energy." Add *K* to it)

Nuclear physics (and atomic too) masses are very small, so it is convenient to talk about $m\, c^2$ in energy units, and the energy is "electron-volt" (explain.) $1 \text{ eV} = 1.6 \times 10^{-19}$ J.

The tiny energy unit is handy for atoms which are tiny too.

In **nuclei**, it takes **MeV** to break a nucleus into parts, and the proton and neutron have masses about 1000 MeV.

Can measure masses of nuclei accurately and thereby see how much energy comes from assembly (fusion) or destruction (fission) of nuclei. **Examples:**

$2\,p + 2\,n \rightarrow {}^{4}He$. Get 28 MeV

${}^{235}U + n \rightarrow {}^{92}Kr + {}^{142}Ba + 2n$ Get 179 MeV

why get energy from building ${}^{4}He$ but also from breaking ${}^{236}U$?

Atoms: H = p + e Get 13.6 eV (not MeV).
Molecules: 2H + O -> H_2O Get a couple eV.

Kinetic energy in relativity

$$K = \frac{1-\sqrt{1-v^2/c^2}}{\sqrt{1-v^2/c^2}} mc^2$$

which looks complicated and nothing like *mv*^{2}/2

But, $\sqrt{1-\varepsilon^2} = 1-\varepsilon^2/2 + O(\varepsilon^4)$ **(small** ε**) and**

$$\frac{1}{\sqrt{1-\varepsilon^2}} = 1+\varepsilon^2/2 + O(\varepsilon^4)$$

which gives

$$K = [\frac{v^2}{2c^2} + O(\frac{v^4}{c^4})]mc^2 \doteq \frac{v^2 m}{2} \text{ if } \frac{v^2}{c^2} \ll 1$$

so Newton is right
in the limit that v^2 is small compared to c^2.
or equivalently ½ mv^2 << mc^2 i.e. K << rest mass.

The space shuttle, at, 7.6 km/s, is only 2.5 x10^{-5}c

Speed limit: ***v*** **<** ***c*** **unless** ***m*****=0, then** ***v*****=*****c***

clicker

The difference between mc^2 for a neutron and a proton is 1.29 MeV.

The neutron is unstable and decays into a proton, an electron (for which mc^2 is 0.51 MeV), and a neutrino (which has mass less than 2 meV.)

How much kinetic energy do the decay products share?

A. 1.29 MeV
B. 0.78 MeV
C. Less than 0.78 MeV
D. None
E. It depends on which way the proton and electron go

Energy in Quantum Mechanics

If a system involves a particle "bound" in a potential, the system can only have certain energies. (quantization of energy).

Examples of bound systems:

You are bound to the earth, and so is the moon

The earth-moon is bound to the sun

An electron is bound to a proton to make H

2 neutrons and 2 protons are bound together to make a ^{4}He nucleus.

The differences between allowed energies are given in terms of *hf*
***h* is "Planck's constant" 6.6 x 10^{-34} J-s.**
***f* is the frequency associated with the bound state. For tiny things *f* can be relatively large. Also, *h* is about 4 x 10^{-15} eV-s**

In the H atom, the energy difference between the lowest and next allowed states for the electron is 10 eV.

When you get up from your seat, the energy it takes, mgΔh, where Δh is how far you move your CM, is about 2 x 10^{22} eV.