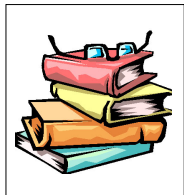


## Midterm 2 review



### Day 15:

Any final questions about nukes?  
Review

### Reminders:

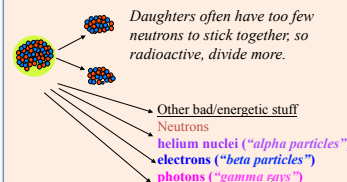
No HW this week!  
Today's lecture in full on website after class  
Extra HelpRoom review Wed 2-4p  
Thursday Exam here...

## An odd world...

You find yourself in some diabolical plot where you are given an alpha ( $\alpha$ ) source, beta ( $\beta$ ) source, and gamma ( $\gamma$ ) source. You must eat one, put one in your pocket and hold one in your hand. You ...

- $\alpha$  hand,  $\beta$  pocket,  $\gamma$  eat
- $\beta$  hand,  $\gamma$  pocket,  $\alpha$  eat
- $\gamma$  hand,  $\alpha$  pocket,  $\beta$  eat
- $\beta$  hand,  $\alpha$  pocket,  $\gamma$  eat
- $\alpha$  hand,  $\gamma$  pocket,  $\beta$  eat

### Radioactive materials and "radiation"



## Mid term on Thursday

- Balcony areas will be CLOSED on Thursday
- 30 multiple choice questions (30 pts)
- 1 Long Answer (out of 2!) (10pts)
- Total 40 points.
- There will be no early or late exams given and no make-up exams.
- Exam will be closed book.
- TWO 3 by 5 inch formula cards. You can WRITE anything on it BY HAND. Please write your student ID on your formula card.
- Calculator and pencil/eraser
  - Calculator cannot connect to outside world. No calculators on cell phones or laptops allowed.
  - No sharing of calculators.
  - A limited supply of spare calculators are available (no guarantees they work though!)
- Exam grades and solutions will be posted after the exam on D2L.

### 1010, Fall 2012, Fun-Sheet Exercise 2.

Each m/c question is worth 1 pt. YOU SHOULD ONLY PICK 1 of the 2 Long Answers for 10 pts: 30 pts M/C. 10pts Long Answer. Total points = 40.

Beware of grabbing at a numerical answer simply because you happen to see that number as you are calculating. We are sneaky and put in choices that are numbers you are likely to produce if you are not sure how to do the problem correctly. For many problems, it is good to make a simple sketch to picture the problem correctly.

For all of these problems, assume that air resistance is not important unless you are told otherwise.

Conversions & Constants you may or may not need:

$$1 \text{ pound} = 4.45 \text{ N} \quad 1 \text{ mph} = 0.447 \text{ m/s} \quad g = 9.8 \text{ m/s}^2 \text{ (but you can use } 10 \text{ m/s}^2 \text{)}$$

$$\text{density of water} = \rho_w = m/V = 1000 \text{ kg/m}^3$$

Formulas you may or may not need.

$$KE = \frac{1}{2} m v^2$$

$$GPE = m g h$$

$$W = F d$$

$$\text{Power} = E / t$$

$$PV = \frac{1}{2} m v^2 + mgh = E_{\text{total}}$$

$$P = \frac{1}{2} \rho v^2 + \rho g h = E_{\text{total}}/V = E_{\text{total}}/(\text{area} \times \text{time})$$

To ensure that you properly understand the question, we strongly recommend that you make a sketch of the situation described by the problem before giving an answer.

Yellah

Write the color on your M/C answer sheet. Return both the answer sheet and the exam.

## Midterm preparation

Prepare by:  
review the review notes for day 15!  
reviewing all the lecture notes (day 9-14), hw (4-6), and then book  
apply the principles we have learned -- practice (HW, clicker questions etc.)  
study with others  
come to the help room

There are sample problems for you to review in addition to today. See web.

- Prepare by applying the principles we have learned – practice.
- You CANNOT memorize answers to specific questions.
- Make a formula card now with the important equations.
- Go over homeworks, class clicker questions, questions in the book (see 1010 website).
  - Not sure how to get the answer – take it to the help room.

## Midterm 2 summary

- Conservation of energy

$$W_{\text{ext}} - |W_{\text{friction}}| = \Delta PE + \Delta KE$$

- Work done by a force =  $F \times d_{//}$
- Looked at work done by external forces and by friction
- GPE =  $mgh$ , KE =  $\frac{1}{2} m v^2$ , PPE =  $PV$ , SPE =  $\frac{1}{2} k x^2$ , Thermal energy = constant  $\times T$
- Ramps, roller coasters, balls.....
- Power = energy/s

- Bernoulli's equation

$$E_{\text{tpv}} = P + \frac{1}{2} \rho v^2 + \rho g h$$

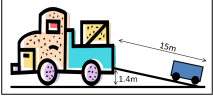
- Conservation of energy for an incompressible fluid

- Nuclear Energy

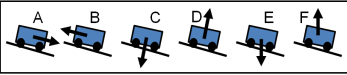
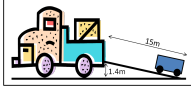
- potential energy wells of nucleus
- Alpha decay
- Fission & Fusion
- Radioactivity

### Conservation of energy

I'm moving boxes into the back of a truck that sits 1.4m above the ground. I use a 15m long ramp and a small cart to help me. When loaded, the cart has a mass of 20 kg. Friction is negligible.



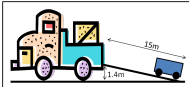
What is the direction of the net force on the cart, when it is on the ramp and nobody is pushing it?

Cart mass = 20kg

If the cart has a mass of 20kg, how much PE does it gain when you push it up the ramp?

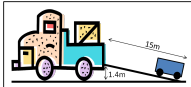
- 274.4 J
- 196 J
- 28 J
- 345.8 J
- 108.6 J



Cart mass = 20kg

What is the force required to push the cart up the ramp at a steady speed?

- 196 N
- 18.3 N
- 0 N
- 13.1 N
- Something else

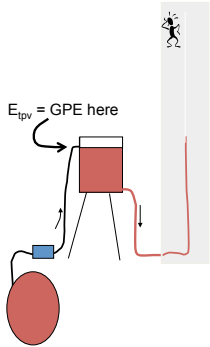


Cart mass = 20kg

What length of ramp would I need if I could only push at a maximum force of 12 N?

- 16.3 m
- 18.3 m
- 22.9 m
- 28.2 m
- Can't tell without more information

### Water distribution in skyscrapers



$E_{\text{pump}} = \text{GPE here}$

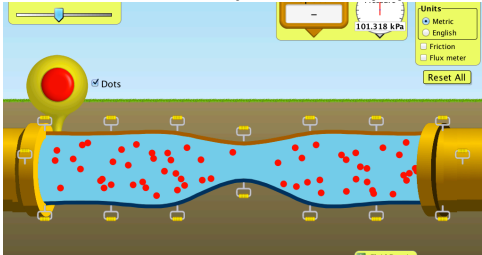
The skyscraper water problem:

- Less pressure on the higher floors,
- Water won't make it to the top floor....

How can you solve this problem?

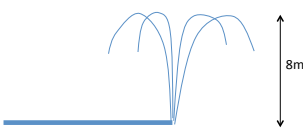
- Put very high pressure pump at bottom (give water enough PPE at bottom)
- Use a series of pumps up the building
- Pump water to a tank on the roof, then you will always have pressure on the floors below.

### What about speed in a pipe?



$P + \frac{1}{2} \rho v^2 + \rho gh = E_{\text{total}}/V$       ( $E_{\text{total}}$  per unit volume)

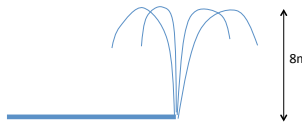
<http://phet.colorado.edu/en/simulation/fluid-pressure-and-flow>



I'm designing a fountain for a city park. I want the water in the fountain to squirt 8m vertically in the air. What pressure will I need in the large pipe just before the nozzle? (Assume that friction can be ignored)


a. 8000 Pa  
 b. 80 Pa  
 c. 80,000 Pa  
 d. 12 000 Pa  
 e. More information required

$E_{\text{tot}} = P + \frac{1}{2} \rho v^2 + \rho gh$



What is the speed of the water immediately after the nozzle?

a. ~15.3 m/s  
 b. ~12.5 m/s  
 c. ~8.7 m/s  
 d. ~4.3 m/s  
 e. Water does not come out



If the fountain squirts  $2\text{m}^3$  of water in the air every second, what is the power produced by the pump that is supplying the pressurized water to the nozzle?

a. 78400 W  
 b. 2 W  
 c. 1000 W  
 d. 237,806 W  
 e. 156,800 W

### Recipe- how to make an atom:

Ingredients: 1 teaspoon protons  
 1 teaspoon neutrons  
 1 cup of electrons

- Proton (positive charge)
- Neutron (no charge)
- Electron (negative charge)

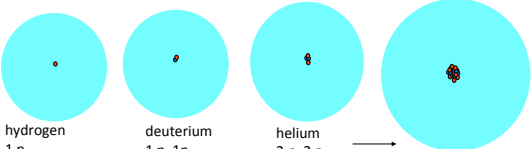
- Mix protons and neutrons thoroughly.
- Bake at 100 million degrees until sticks together to form solid dense nucleus (about .0000001 s).
- Frost with lightly with fluffy layer of negative electrons.
- Chill before serving!

atom size:  
 Radius of nucleus is 10,000 times smaller than nucleus-electron distance

### Each element has different number of protons.

Atom ingredients:

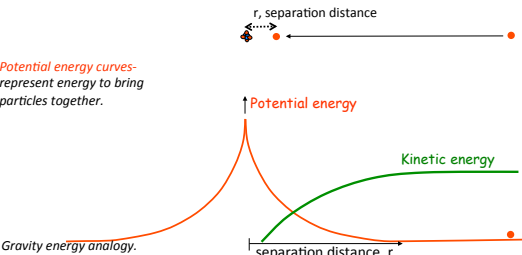
- Proton (positive charge) - charge =  $1.6 \times 10^{-19}$  Coulombs  
 mass =  $1.66 \times 10^{-27}$  kg.
- Neutron (no charge) - no charge  
 mass =  $1.66 \times 10^{-27}$  kg.
- Electron (negative charge) - charge =  $-1.6 \times 10^{-19}$  Coulombs  
 mass =  $9.10 \times 10^{-31}$  kg



hydrogen 1 p  
 deuterium 1 p, 1n  
 helium 2 p, 2 n  
 Uranium 238 92 p, 146 n

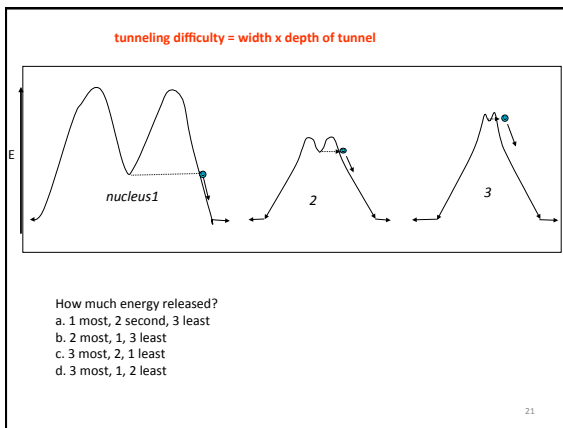
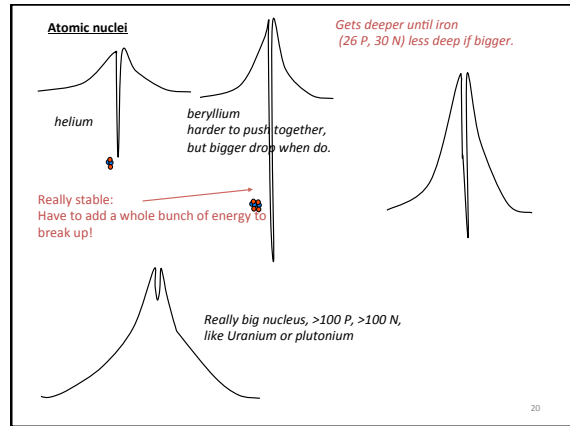
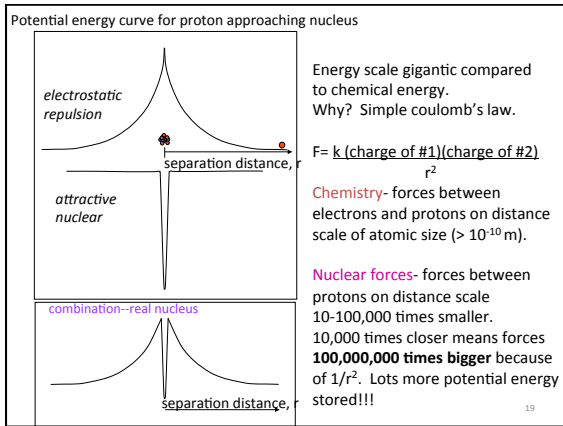
What if threw proton so starts out going towards nitrogen nucleus with a lot of speed (lots of kinetic energy)?

Starts with lots of kinetic energy →  
 Repelling force from nucleus slows down proton →  
 Proton's kinetic energy converted into electrostatic potential energy, as it gets closer to nucleus



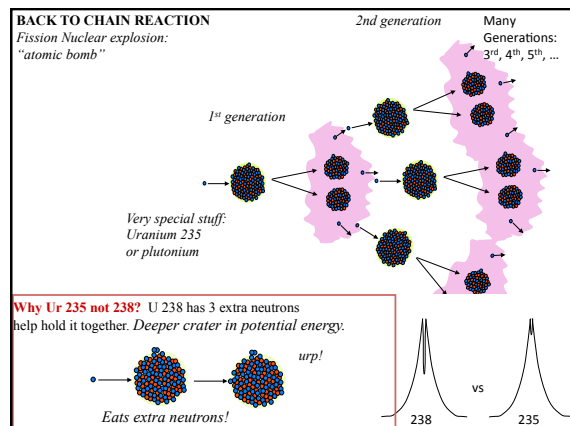
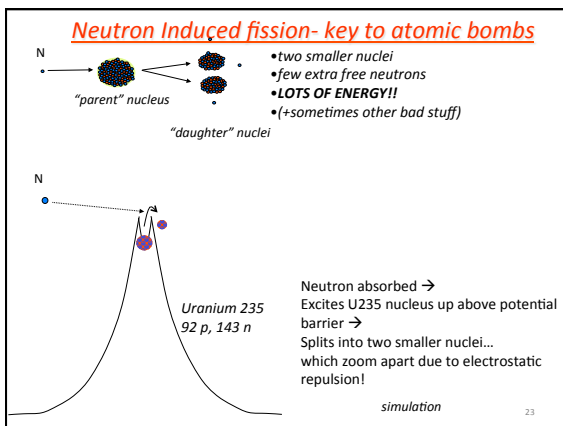
Potential energy curves- represent energy to bring particles together.

Gravity energy analogy.  
 if at center, want to roll down hill/fly apart ... lots of electrostatic potential energy



Another Sim  
(because this is hard to do at home)

<http://phet.colorado.edu/en/simulation/nuclear-fission>



U235 and U238 atoms are placed into a container, which are likely to result in a chain reaction (resulting in explosion) when a free neutron triggers fission of one of the U235:

a. #2 only  
 b. #1, #2, and #5  
 c. #2 and #4  
 d. #2, #3, and #4  
 e. #2, #4, and #5.

Lots of uranium in the ground... why not just blow up?

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### Fusion bomb or "hydrogen bomb"

Basic process like in sun. Stick small nuclei together.

Deuterium on Deuterium      Deuterium on Tritium

Which will release more energy during fusion?  
 a. Deuterium combining with deuterium  
 b. Deuterium combining with tritium

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### Fusion bomb or "hydrogen bomb"

Basic process like in sun. Stick small nuclei together.

Stick hydrogen isotopes together to make helium.

activation energy of 100 million degrees

push together energy required

energy released if push over the hump

helium

Simple if can push hard enough- just use sun or fission bomb. More energy per atom than fission. Can use LOTS of hydrogen.

**⇒ End up with GIGANTIC bombs**  
 1000 times bigger than first fission bombs

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### Fusion bomb (simple picture)

chemical explosive

hydrogen isotopes tritium, deuterium

Plutonium "trigger"

chemical explosive

Shaped plutonium and assembled bombs at Rocky Flats.

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In atomic bomb, roughly 20% of Pl or Ur decays by induced fission  
 This means that after explosion there are

a. about 20% fewer atomic nuclei than before with correspondingly fewer total neutrons and protons,  
 b. 20% fewer at. nucl. but about same total neut. and protons.  
 c. about same total neutrons and protons and more atomic nuclei,  
 d. almost no atomic nuclei left, just whole bunch of isolated Neut.s and prot.s.,  
 e. almost nothing of Ur or Pl left, all went into energy.

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Why are Nukes so destructive?

**Radioactive materials and "radiation"**

Daughters often have too few neutrons to stick together, so radioactive, divide more.

Other bad/energetic stuff that comes out.

- Neutrons
- electrons ("beta particles")
- photons ("gamma rays")
- helium nuclei ("alpha particles")

**Why radiation bad?**

Jocell

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**Alpha particles: helium nuclei**

- most of radiation is this type
- common is Radon (comes from natural decay process of  $U^{238}$ ), only really bad because Radon is a gas .. Gets into lungs, if decays there bad for cell.

In air: Travels ~2 cm ionizing air molecules and slowing down ... eventually turns into He atom with electrons

If decays in lung, hits cell and busts up DNA and other molecules:

Usually doesn't get far -- because it hits things

**Beta particles:** energetic electrons ... behavior similar to alpha particles, but smaller and higher energy

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**Sources of Gamma Radiation**

Neutron

"parent" nucleus

"daughter" nuclei

- two smaller nuclei
- few extra free neutrons
- LOTS OF ENERGY!!**
- (+sometimes other bad stuff)

"daughter" nuclei - come out in *excited* nuclear energy state ... Give off gamma rays as drop to lower energy.

Jumps down in energy ... Gives off gamma ray ... **VERY HIGH ENERGY PHOTON**

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**gamma rays: high-energy photons**

- So high energy can pass through things (walls, your body) without being absorbed, but if absorbed really bad!

In air: Can travel long distances until absorbed

In body, if absorbed by DNA or other molecule in cell ... damages cell... can lead to cancer.

Most likely

If pass through without interacting with anything in cell then no damage.

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Also break DNA → cancer

But also can cure cancer- Concentrate radiation on cancer cells to kill them.

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**An odd world...**

You find yourself in some diabolical plot where you are given an alpha ( $\alpha$ ) source, beta ( $\beta$ ) source, and gamma ( $\gamma$ ) source. You must eat one, put one in your pocket and hold one in your hand. You ...

- $\alpha$  hand,  $\beta$  pocket,  $\gamma$  eat
- $\beta$  hand,  $\gamma$  pocket,  $\alpha$  eat
- $\gamma$  hand,  $\alpha$  pocket,  $\beta$  eat
- $\beta$  hand,  $\alpha$  pocket,  $\gamma$  eat
- $\alpha$  hand,  $\gamma$  pocket,  $\beta$  eat

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