

12-10-13

# Radio activity part II: CH 34

## FUSION and FISSION

- H-Bombs
- "fusion" nuclear reactor: TRITIUM
- A-Bombs
- nuclear power reactors

(radioactive)

is a by-product

FISSION: uranium hit by a neutron produced in a previous nuclear reaction. IF uranium

becomes elongated enough

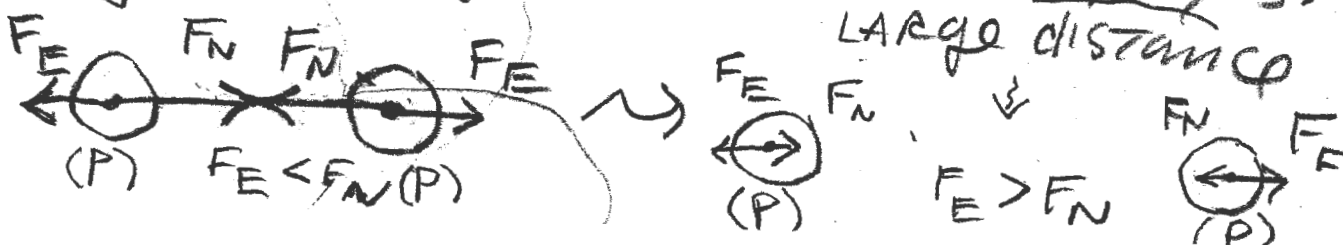
(after collision), electrical forces (strong at long distances)

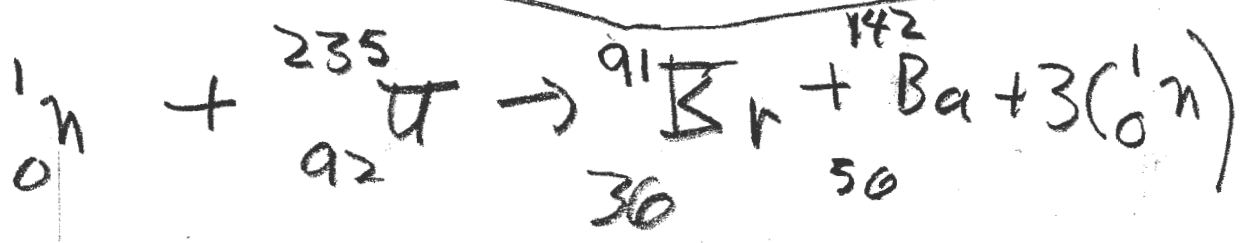
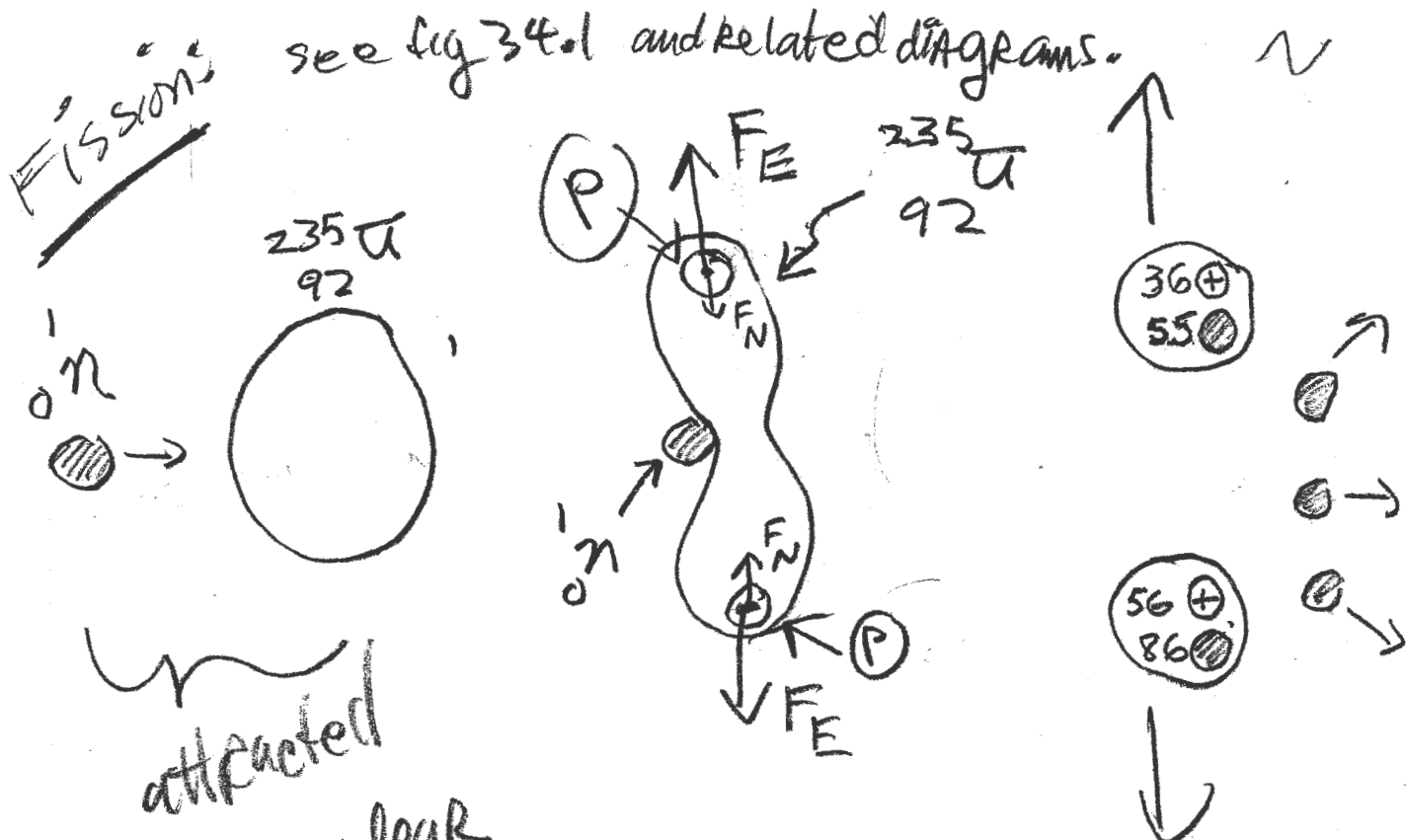
overwhelm attractive nuclear

SHORT distance between protons:

force  $\Rightarrow$  nucleus deforms.

LARGE distance





NOTE: (i) FINAL neutrons cause CHAIN REACTION  
 (ii) SUM OF FINAL PRODUCT MASSES

< MASS OF ORIGINAL U

ORIGINAL U MASS - FINAL PRODUCT MASS =  $\Delta M$

ch 35, Einstein:  $\Delta M c^2 = \text{ENERGY} = \text{KINETIC ENERGY OF } {}^1_0n$

# Fission

final kinetic energy carried  
by Kr, Ba and neutrons.

Energy used to

- (A) power cities  
with nuclear  
power (controversial)
- (B) destroy cities  
with uncontrolled  
power (Hiroshima)  
(Nagasaki)


FISSION REACTORS see fig 34.9

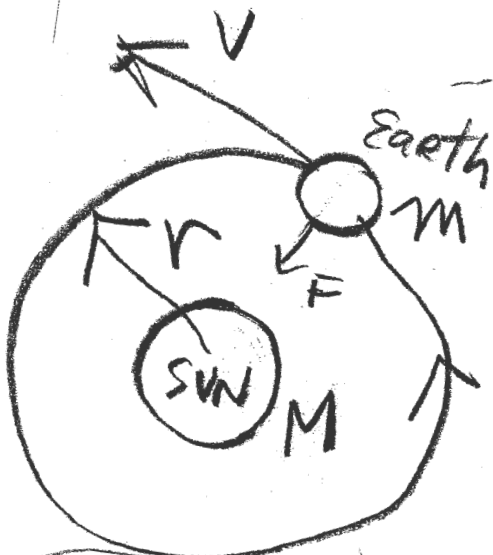
4

FUSION

(A) Background: ALSO APPLIES TO FISSION. see pp 606-9

NUCLEONS ARE LIKE PLANETS

IN ORBIT:  2 PROTONS ORBIT INSIDE NUCLEUS (He)



ENERGY = KE + PE

$= \frac{1}{2}mv^2 + \left(-\frac{GMm}{r}\right)^*$

ALSO:  $F = \frac{mv^2}{r} = \frac{GMm}{r^2}$

↑ centripetal force

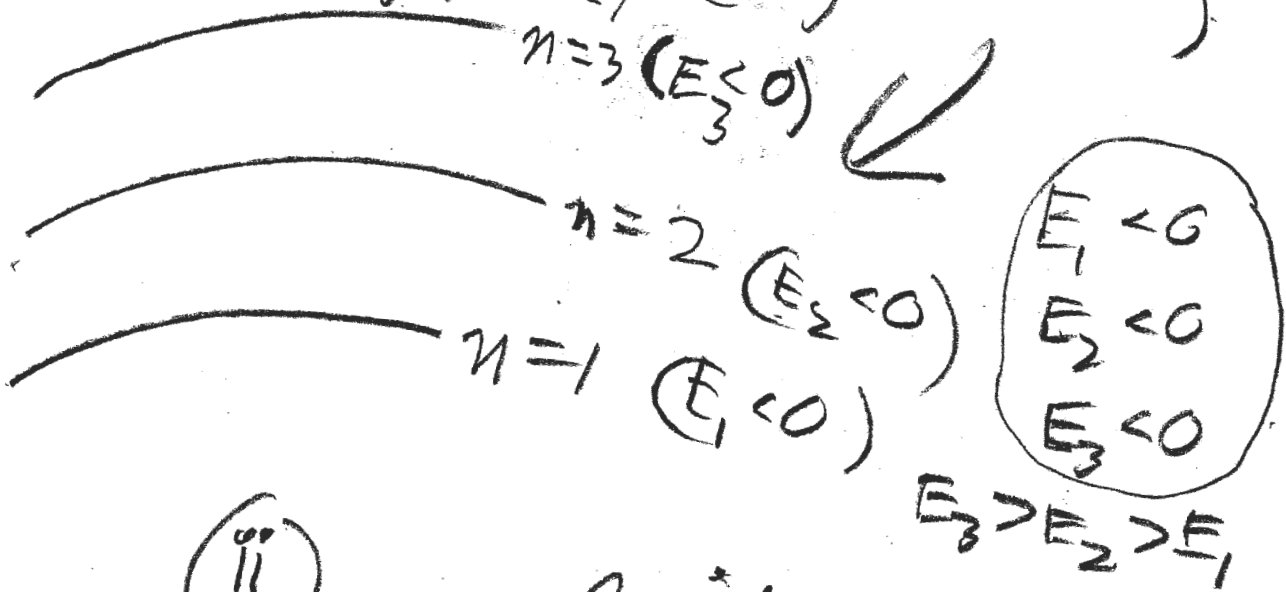
TOTAL ENERGY =  $-\frac{GMm}{2r} < 0$

= KE + PE

BOUND STATE: ENERGY < 0 (BOUND STATE)

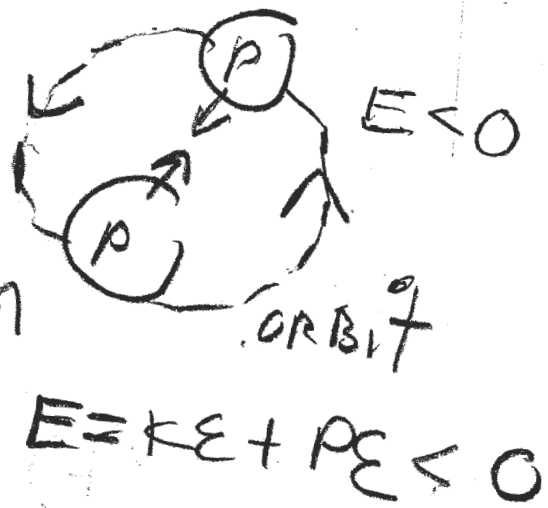
\* Beyond P11 scope: go onto internet.

$E < 0$  (BOUND STATES)  
 TRUE  $\textcircled{i}$  FOR ATOMS (HYDROGEN LEVELS  
 ARE NEGATIVE  $e$ ) (fig 32.10)



$\textcircled{ii}$

nuclei:  
 PROTONS ORBIT  
 about each  
 other  $\rightarrow$



NOTE ALSO:  $PE < 0$

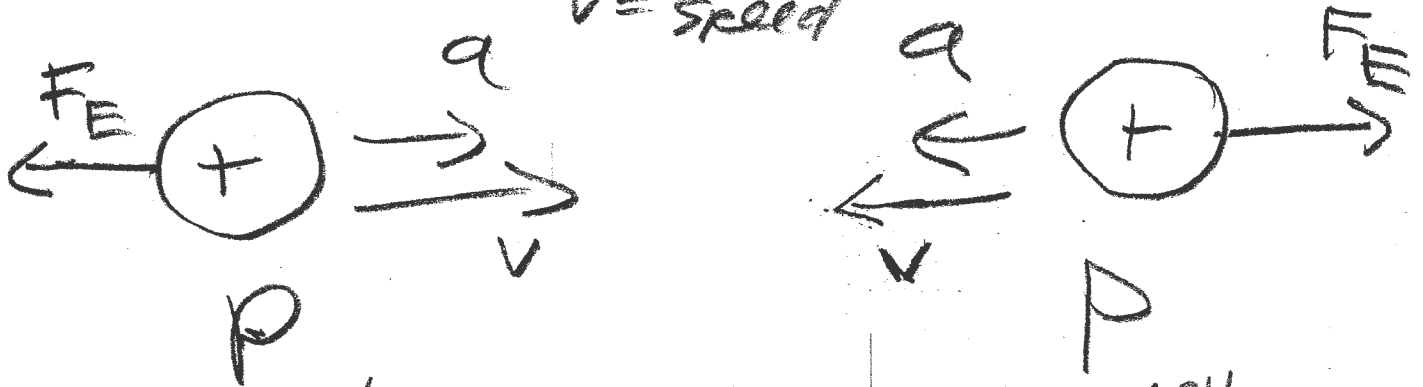
FIG 34.19  $\rightarrow$  NOTE:  $2m_p >$  MASS OF NUCLEUS  
 ALSO FIG 34.20  $\left| \frac{2m_p c^2 - \text{NUCLEUS MASS} \cdot c^2}{2} \right| = |E|$

# Fusion (pages 610-612) 6

accelerate 2 PROTONS

TOWARD EACH OTHER: (p611)

$a = \text{acceleration}$   
 $v = \text{speed}$



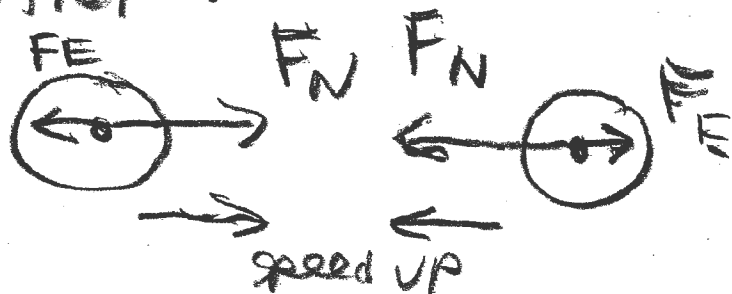
AT FAR DISTANCES, P's SLOW DOWN as they approach, due to ELECTRIC REPULSION.

Force  $F_E$

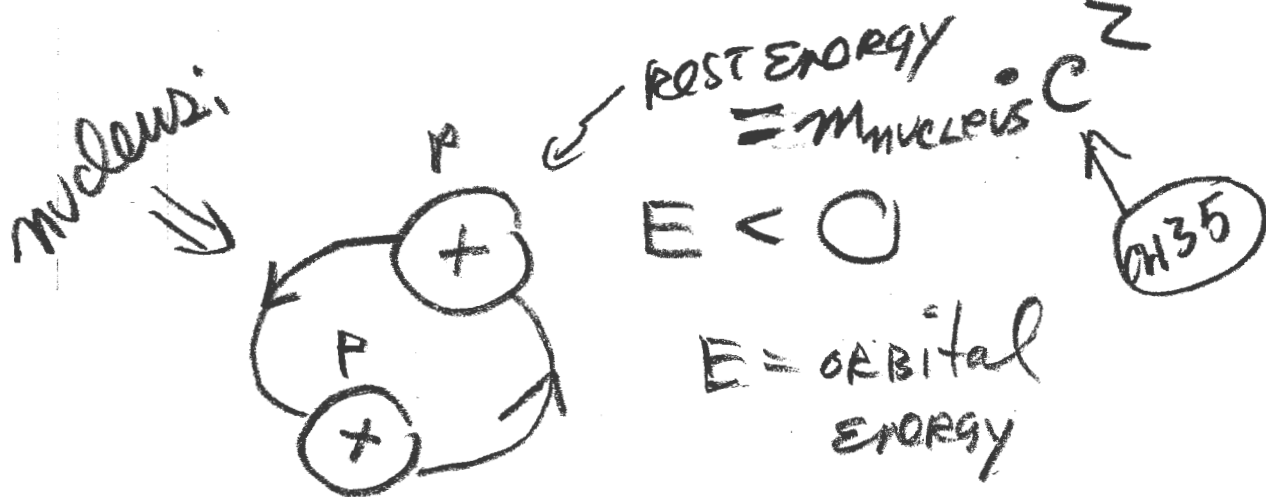
When P's get close,  $F_N > F_E$

and P's speed up toward

each other:



$P$ 's approach each other  
and "lock" into orbit,



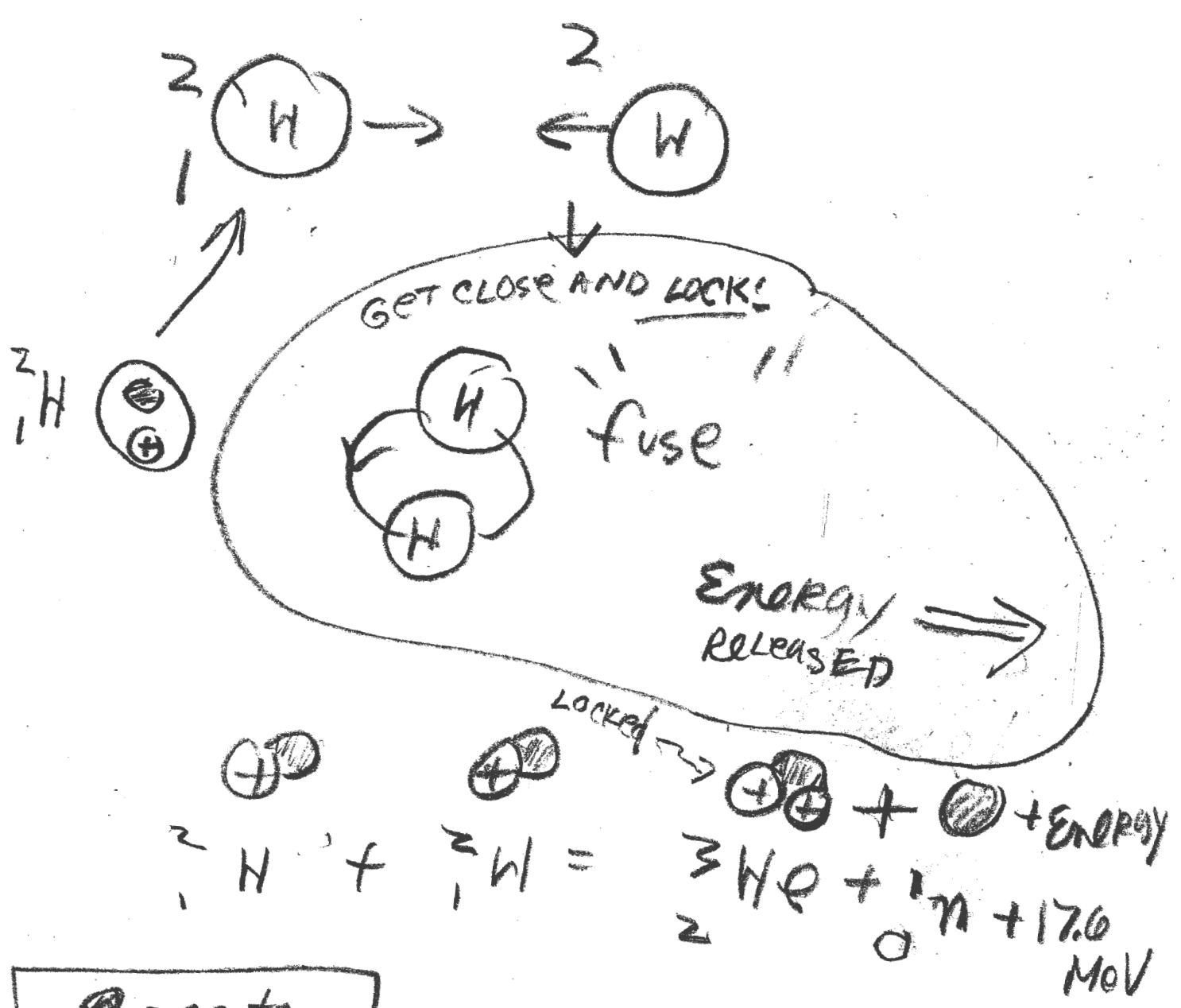
$$m_{\text{nucleus}} < 2m_p$$

$$2m_p c^2 - m_{\text{nucleus}} c^2 = |E|$$

TOTAL ENERGY of nucleus:

$$2m_p c^2 - |E| = m_{\text{nucleus}} \cdot c^2$$

see figs. 34.18, 34.19, 34.20,  
34.21.



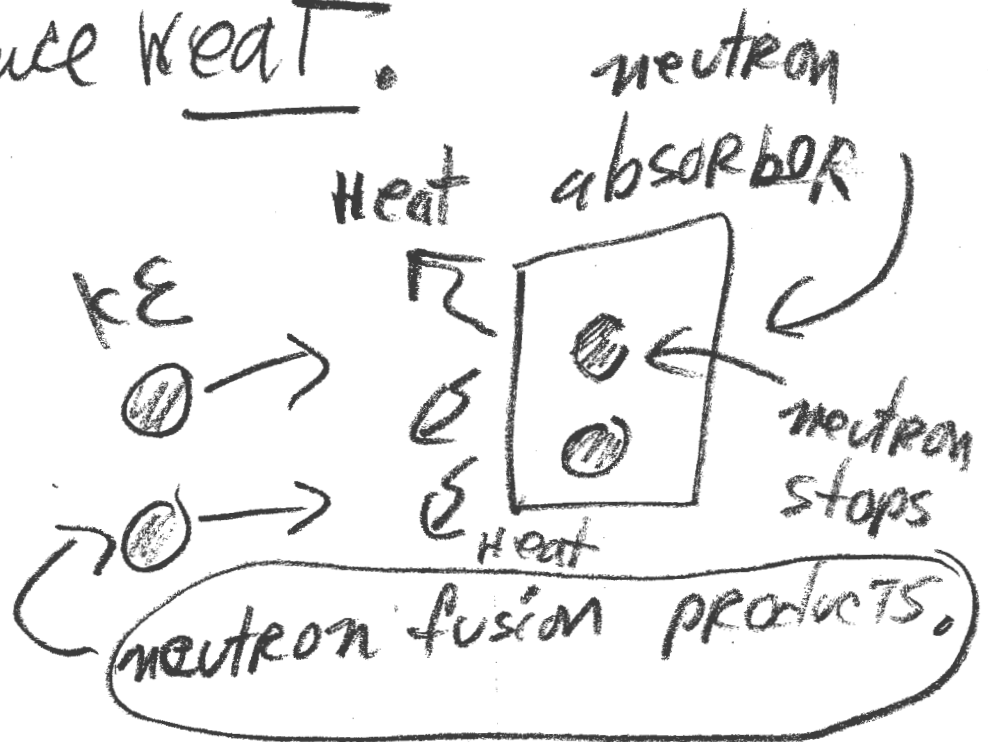
⊙ = neutron  
⊕ = proton

1 MeV =  $1 \times 10^6$  electron volts  
Million VOLTS

17.6 MeV  $\approx$  kinetic energy of neutrons and  ${}^3_2\text{He}$ , stopped and captured to



produce heat.



Heat = fusion final  
Energy used  
in nuclear  
power or  
nuclear war.

"cooling"  
lab  
notes  
(5)

12-11-13 - P11  
"cooling" lab

-kt (10)

$$T - T_{\text{room}} = T_0 e^{-kt}$$

$\Rightarrow \boxed{0}$  as  $t \rightarrow \infty$   
↑  
LARGE

next topic:

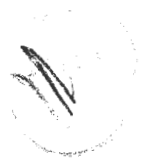
LINKS for Quiz 10 = FINAL QUIZ

Lecture  
notes {

- 12-03-13
- 12-05-13
- 12-11-13

+ [Masteringphysics.com](http://Masteringphysics.com)  
CH 30, 31, 32, 33,  
34.

# Last Quiz



HW NOT POSTED.  
NUKES

CH 34

33

32

31

30

29

28

26

⋮

QUIZ 10 = POSTED.

SCANTON.

+ CH 28, 26, 25, 24

↑  
Light

↑  
Light

↑

↑

QUIZ 9

MAGNETISM

FARADAY'S LAW

HW  
POSTED

PH

12-11-13

12 12

home grade remedies

$$\left( \quad \right) (20) + \left( \quad \right) (20) + \left( \quad \right) (60) = 1$$

decimal fraction: HW

decimal fraction: Lab

decimal fraction: Quizzes 1 to 9

$$\frac{19}{20}$$

$$\frac{12}{20}$$

$$\frac{45}{60}$$

$$(0.95)(20) + (0.60)(20) + (0.75)(60) = X$$

A (HW)

D- (Labs)

C (Quizzes)

$$19 + 12 + 45 = 76$$

$$\rightarrow \boxed{76\%} = \text{Solid C}$$