

12-10-13

Radio activity part II: CH 34

Fusion and FISSION

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

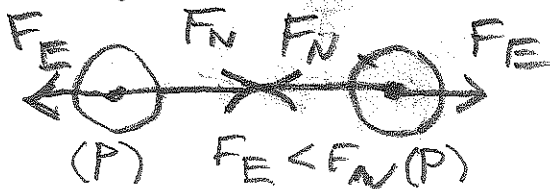
is a by-product

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)

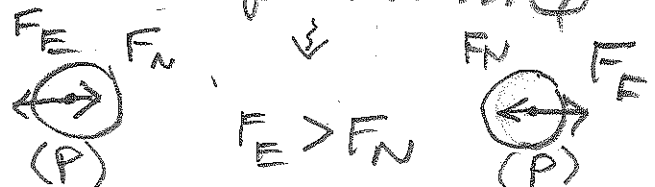
overwhelm attractive nuclear

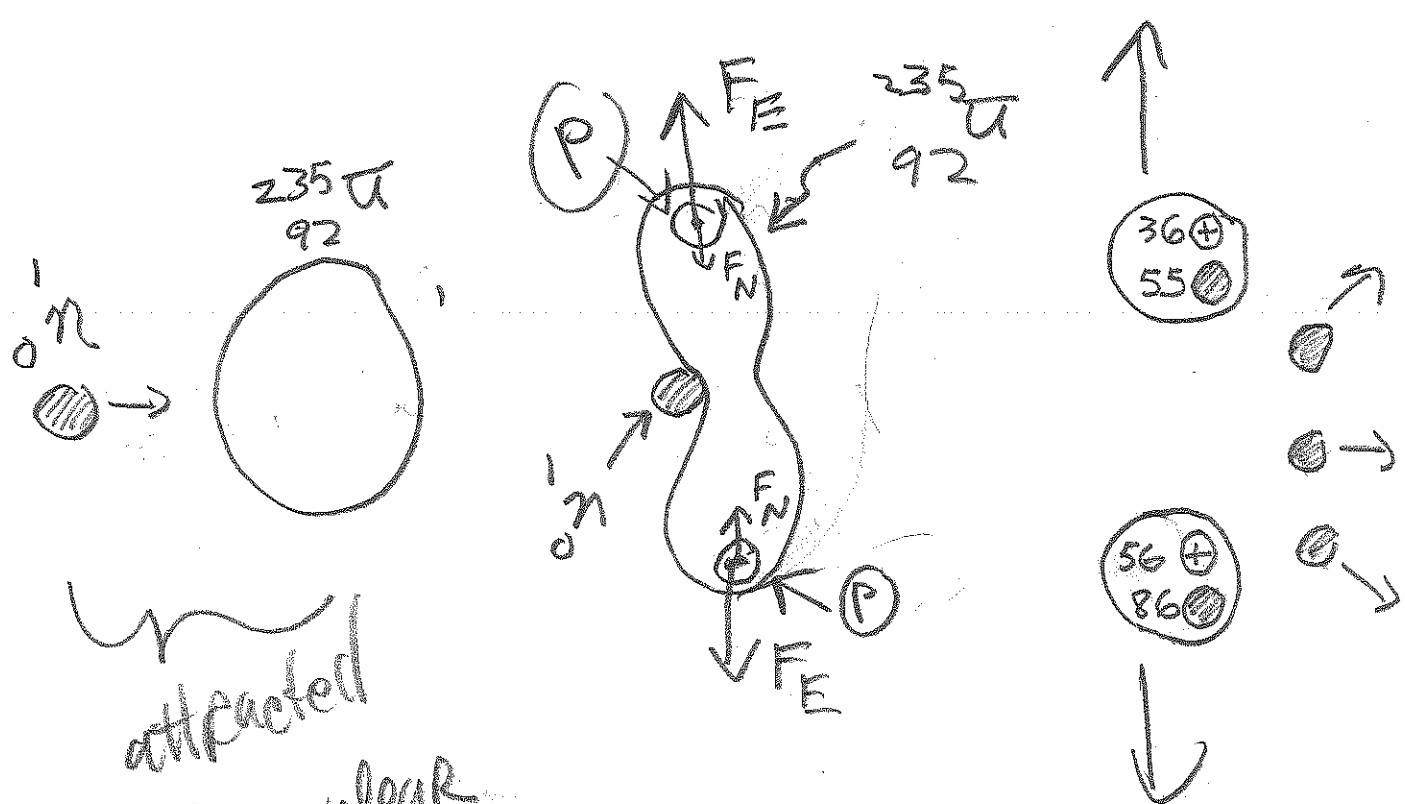
SHORT distance between protons:



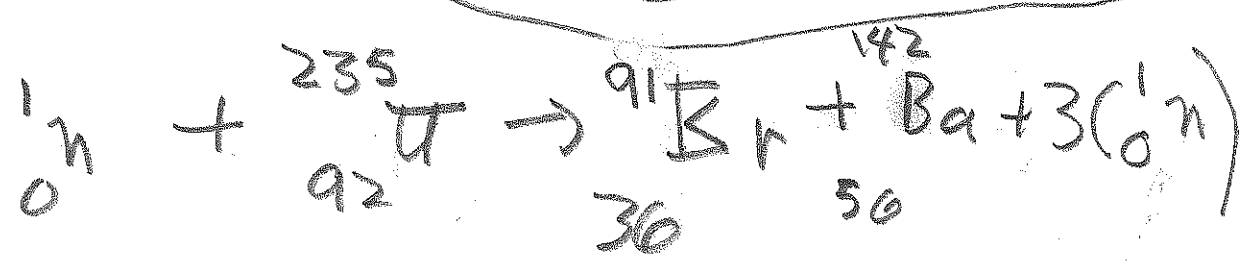
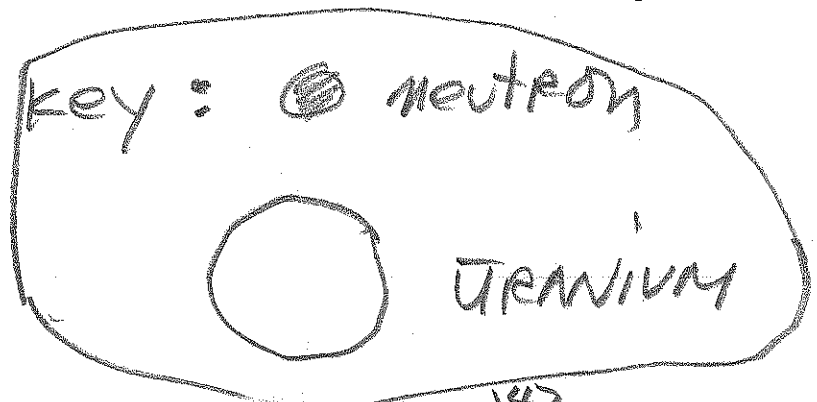
force \implies nucleus decays.

LARGE distance





attracted
via nuclear
force (F_N)



NOTE: (i) FINAL neutrons cause CHAIN REACTION

(ii) SUM OF FINAL PRODUCT MASSES

< MASS OF ORIGINAL U

ORIGINAL U MASS - FINAL PRODUCT MASS = ΔM
 $\Delta M c^2 = \text{ENERGY} = \text{KINETIC ENERGY OF } {}^1_0n$

Fission

final kinetic energy carried
by Kr, Ba and neutrons.

Energy used to

(A) power cities
with nuclear
power (controversial)

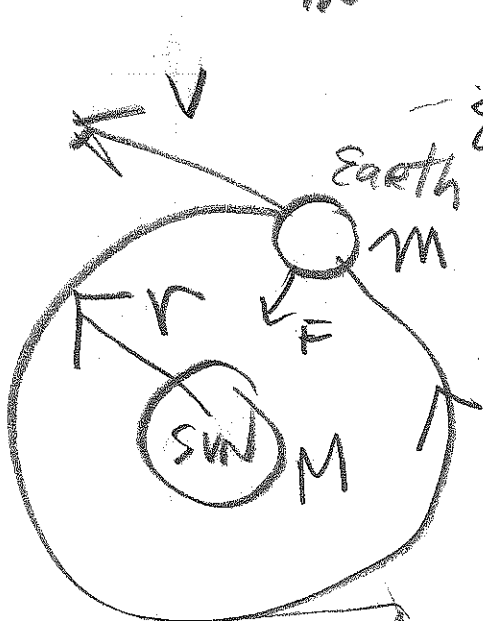
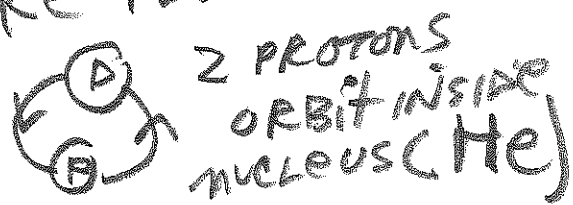
(B) destroy cities
with uncontrolled
power (Nagasaki)
(Nagasaki)

FISSION REACTORS see pg 34.9

FUSION

(A) BACKGROUND:

nucleons are like planets
in orbit:



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

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

combine:

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

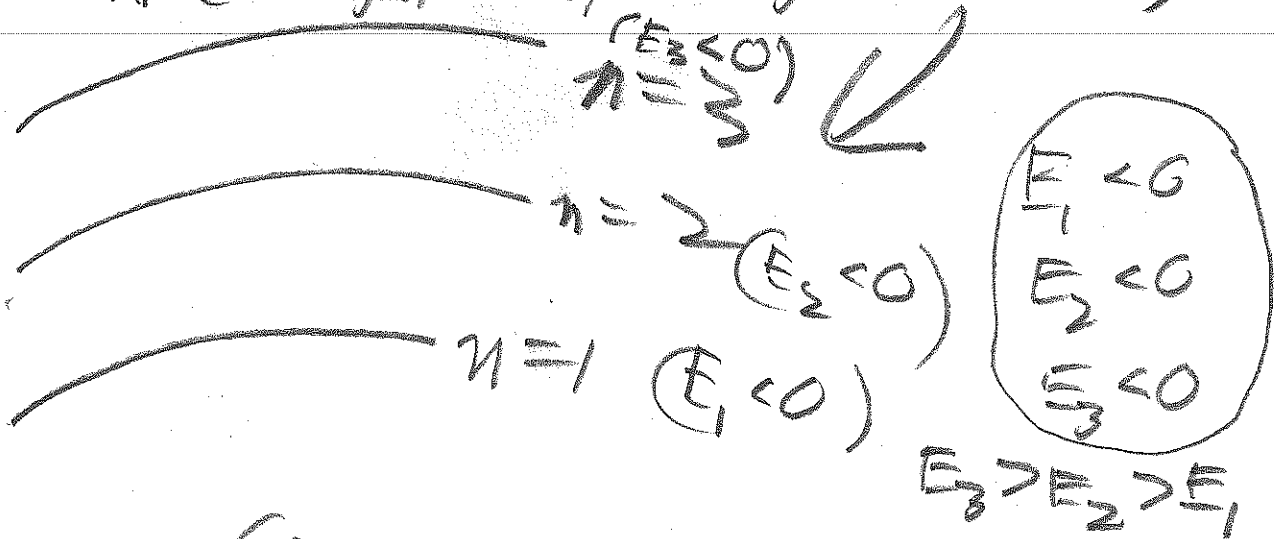
= KE + PE (BOUND STATE)

* Beyond PII
scope: go onto
internet.

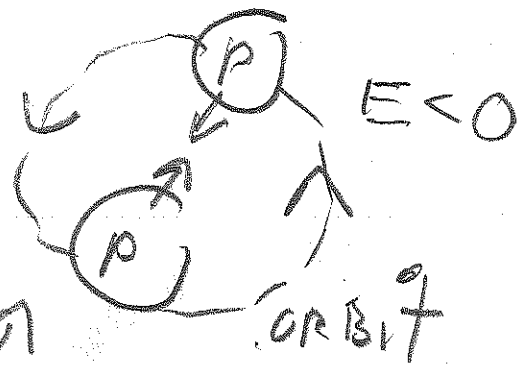
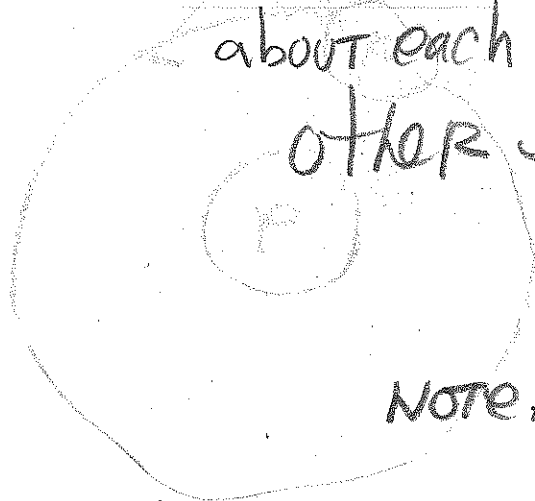
BOUND STATE: ENERGY < 0

$E < 0$ (BOUND STATES)

TRUE FOR ATOMS (HYDROGEN LEVELS ARE NEGATIVE) (FIG 32.10)



nuclei:
 protons orbit
 about each
 other



$E = KE + PE < 0$

NOTE ALSO: $PE < 0$

FIG 34.18 → NOTE: $2m_p >$ MASS OF NUCLEUS

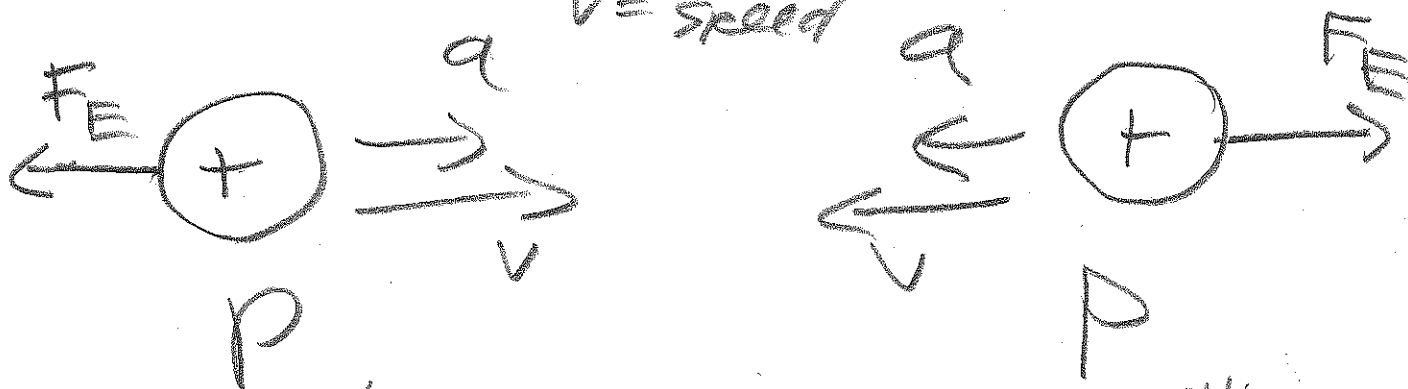
$$\left| 2m_p c^2 - \text{NUCLEUS MASS} \cdot c^2 \right| = |E|$$

Fusion (pages 610-612)

accelerate 2 PROTONS
TOWARD EACH OTHER

$a = \text{acceleration}$

$v = \text{speed}$



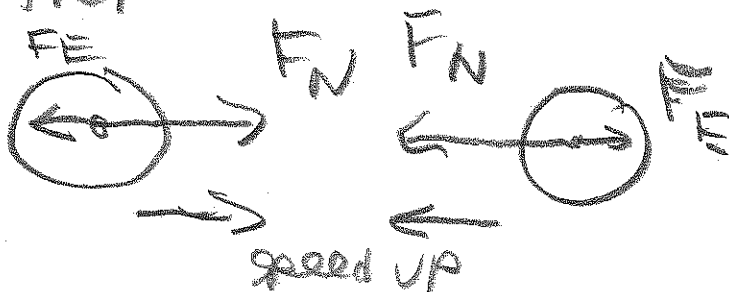
P's SLOW DOWN as they APPROACH,
DUE TO ELECTRIC REPULSION.

Force F_E

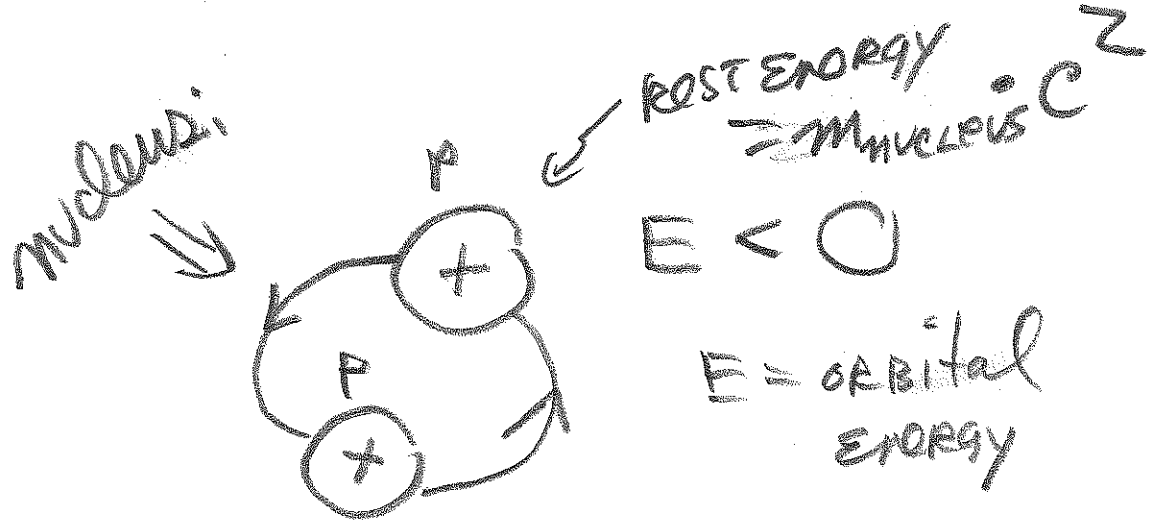
WHEN P'S GET CLOSE, $F_N > F_E$

and P'S speed up TOWARD

EACH OTHER:



$P's$ approach each other
and "LOCK" INTO ORBIT,



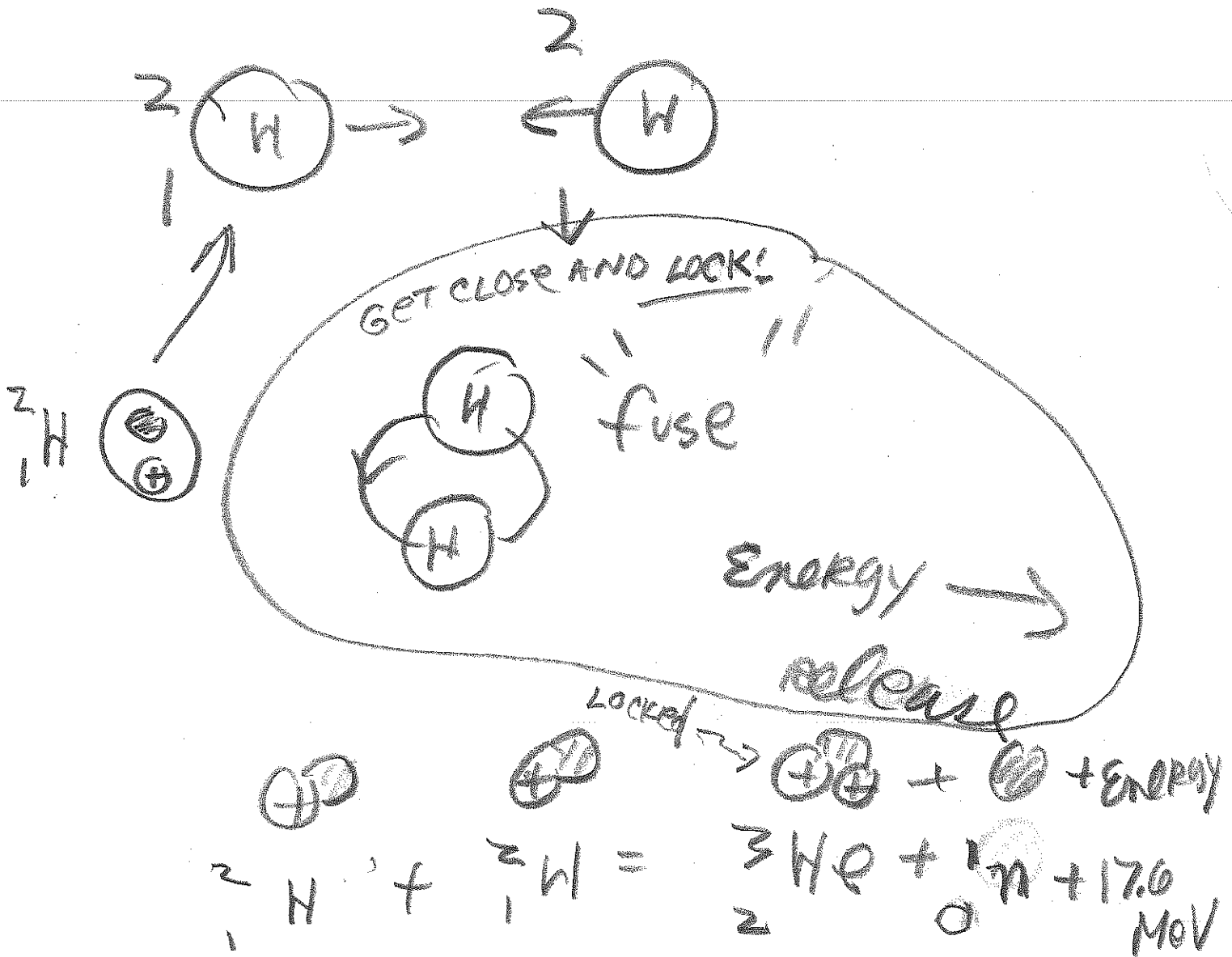
$$m_{\text{NUCLEUS}} < 2m_p$$

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

TOTAL ENERGY of nucleus:

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

see fig 34.18

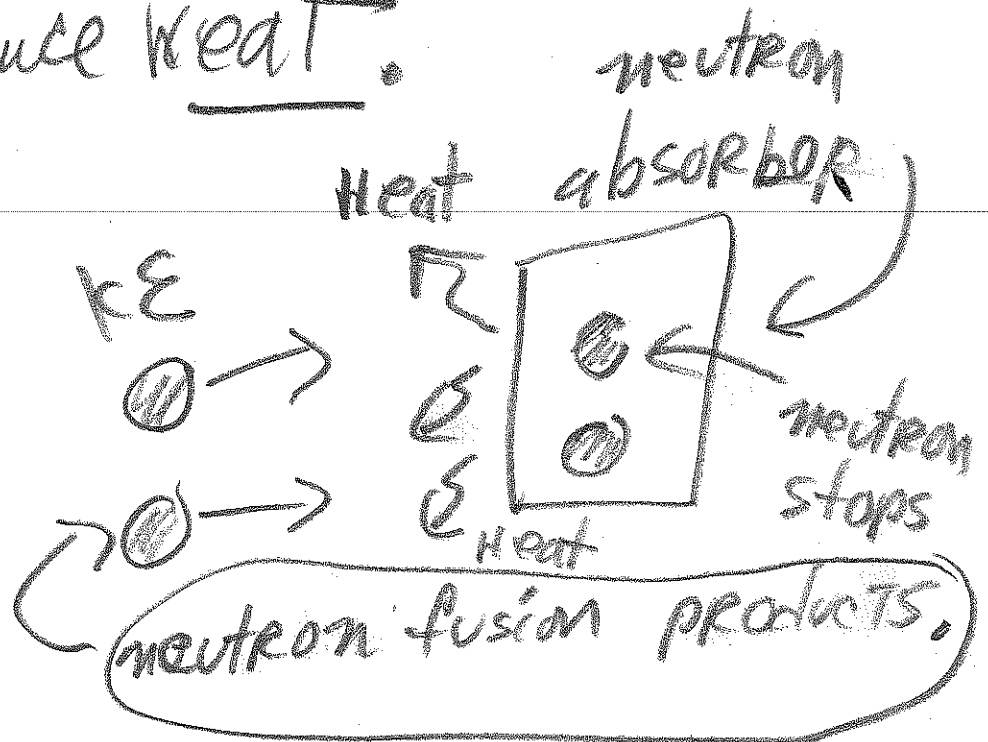


⊙ = neutron
 ⊕ = proton

$1 \text{ MeV} = 1 \times 10^6$ electron
 volts
 Million

$17.6 \text{ MeV} \approx$ 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.