UGrad

Hi = 95

Low = 39

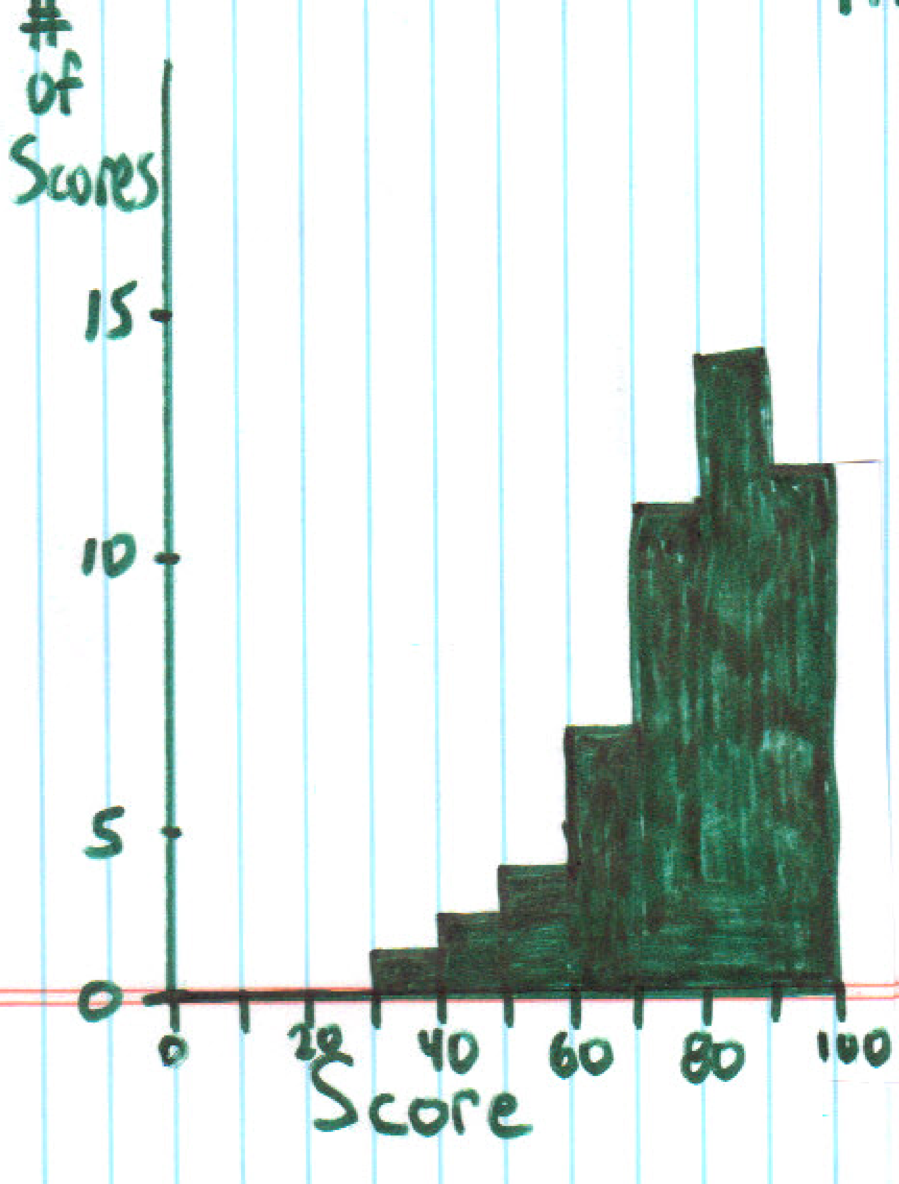
Ave = 76.6

Grad

Hi = 97

Low = 52

Ave = 85.6



Midterm Exam #1

① ⓐ This is a production and decay problem.

$$N(t) = \frac{R}{\lambda}\left(1 - e^{-\lambda t}\right)$$

$$\lambda_{^{18}F} = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{110 \text{ min}} = 0.378/\text{hr}$$

$t = 12$ hours $\quad \therefore e^{-\lambda t} = 0.01$

$\therefore$ Can neglect this term (if you want)

$\therefore A(12 \text{ hours}) = N\lambda \approx R = 5\times10^{10}/\text{sec} = \underline{1.35 \text{ Ci}}$

ⓑ After beam is turned off, there is just exponential decay

$$A(24 \text{ hrs}) = (1.35 \text{ Ci})\, e^{-(24)(0.378)}$$

$$= \underline{1.55\times10^{-4} \text{ Ci}}$$

(2)

$${}^{256}_{100}Fm_{156} \xrightarrow{SF} {}^{128}_{50}Sn_{78} + {}^{128}_{50}Sn_{78}$$

protons and # neutrons does not change as a result of fission

$\therefore$ Energy release $= \Delta BE = 2\,BE({}^{128}Sn) - BE({}^{256}Fm)$

$$BE({}^{128}Sn) = a_v(128) - a_s(128)^{2/3} - a_c(50)(49)(128)^{-1/3} - a_{sym}\frac{(128-100)^2}{128} + a_p(128)^{-3/4}$$

$$BE({}^{256}Fm) = a_v(256) - a_s(256)^{2/3} - a_c(100)(99)(256)^{-1/3} - a_{sym}\frac{(256-200)^2}{256} + a_p(256)^{-3/4}$$

Note: when we calculate ΔBE, the volume and symmetry terms cancel out

$\therefore$ Energy release $= a_s\left[(256)^{2/3} - 2(128)^{2/3}\right]$

$$+ a_c\left[(100)(99)(256)^{-1/3} - 2(50)(49)(128)^{-1/3}\right]$$

$$- a_p\left[(256)^{-3/4} - 2(128)^{-3/4}\right]$$

$$= \underline{\underline{247.7\ \text{MeV}}}$$

3

(a) $\vec{\frac{1}{2}} + \vec{1}$ can product angular momenta $1/2$ or $3/2$

$\vec{1/2} + \vec{\frac{5}{2}}$ can produce angular momenta 2 or 3

$\vec{\frac{3}{2}} + \vec{\frac{5}{2}}$ can produce angular momenta $4, 3, 2, 1$

$\therefore$ $\boxed{\text{Final Answer} = 1, 2, 3, 4}$

(b) $2j+1 = 10 \longrightarrow \therefore \boxed{j = 9/2}$

$\vec{J} = \vec{l} + \vec{1/2} \quad \therefore\ l = 4$ or 5

but $\pi = (-1)^l = + \quad \therefore \boxed{l = 4}$

(c) ${}^{239}_{94}Pu_{145} + {}^{1}_{0}n_{1} \longrightarrow {}^{140}_{54}Xe_{86} + {}^{98}_{\cancel{40}}\underline{Zr_{58}} + 2n$

Conserve proton # and neutron #

#protons : $94 - 54 = 40 \Longrightarrow Zr$

#neutrons : $145 + 1 - 86 - 2 = 58 \Longrightarrow {}^{98}Zr$

4

a $$\int_{-\infty}^{\infty} \psi^* \psi \, dx = 1$$ <u>Normalization Condition</u>

$$\Rightarrow \int_{-b}^{3b} A^2 \, dx = 1 \Rightarrow A^2 x \Big|_{-b}^{3b} = 1$$

$$\therefore 4b A^2 = 1 \Rightarrow \boxed{A = \frac{1}{2\sqrt{b}}}$$

b $$P = \int_0^b \frac{1}{4b} \, dx = \frac{x}{4b}\Big|_0^b = \boxed{\frac{1}{4}}$$

c $$\langle x \rangle = \int_{-\infty}^{\infty} \psi^* x \psi \, dx = \int_{-b}^{3b} \frac{x}{4b} \, dx = \frac{x^2}{8b}\Big|_{-b}^{3b}$$

$$= \frac{8b^2}{8b} = \boxed{b}$$

$$\langle x^2 \rangle = \int_{-\infty}^{\infty} \psi^* x^2 \psi \, dx = \int_{-b}^{3b} \frac{x^2}{4b} \, dx = \frac{x^3}{12b}\Big|_{-b}^{3b}$$

$$= \frac{28b^3}{12b} = \boxed{\frac{7}{3} b^2}$$