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2) a) C Should be units of $\frac{n}{cm^2 s}$ so that when it is devided by E the units end up being $\frac{n}{cm^2\text{-}MeV\text{-}s}$

b) $\text{neutrons} = \iiint_{vol} d^3r \int_0^{\infty} \frac{\phi(\vec{r}, E)}{\sqrt{2E}}\, dE$

$$\text{neutrons} = \int_{-\frac{w}{2}}^{\frac{w}{2}} dx \int_{-\frac{w}{2}}^{\frac{w}{2}} dy \int_{-\frac{w}{2}}^{\frac{w}{2}} dz \int_{1\times10^{-6}}^{0.01} dE\, \frac{C}{E}\left(\frac{2E}{m_n}\right)^{-1/2} \cos\left(\frac{\pi x}{w}\right)\cos\left(\frac{\pi y}{w}\right)\cos\left(\frac{\pi z}{w}\right)$$

$$\text{neutrons} = \sin\left[\frac{\pi x}{w}\right]_{-\frac{w}{2}}^{\frac{w}{2}} \sin\left[\frac{\pi y}{w}\right]_{-\frac{w}{2}}^{\frac{w}{2}} \sin\left[\frac{\pi z}{w}\right]_{-\frac{w}{2}}^{\frac{w}{2}} \int_{1\times10^{-6}}^{0.01} C\left(\frac{2}{m_n}\right)^{-1/2} E^{-3/2}\, dE$$

$$\text{neutrons} = 3\left[\sin\left(\frac{\pi}{2}\right) - \sin\left(\frac{-\pi}{2}\right)\right] C\left(\frac{2}{m_n}\right)^{-1/2}\left(\frac{-1}{2}\sqrt{E}\,\Big|_{1\times10^{-6}}^{0.01}\right) =$$

$$\text{neutrons} = 6\left(\frac{-C}{2}\right)\left[\frac{2}{m_n}\right]^{-1/2}\left[\sqrt{0.01} - \sqrt{1\times10^{-6}}\right]$$

$$\text{neutrons} = \left(\frac{-C}{3}\right)\left(\frac{2}{m_n}\right)^{-1/2}(0.18)$$

$$\text{neutrons} = \frac{-C}{0.033\sqrt{\frac{2}{m_n}}}$$

2) c) $\phi(x,y,z) = \int_{1\times10^{-6}}^{0.01} \phi(x,y,z,E)\,dE$

$$\phi(x,y,z) = \int_{1\times10^{-6}}^{0.01} \frac{C}{E}\left(\cos\frac{\pi x}{w}\right)\cos\left(\frac{\pi y}{w}\right)\cos\left(\frac{\pi z}{w}\right)dE$$

$$\phi(x,y,z) = C\left(\ln 0.01 - \ln 1\times10^{-6}\right)\left(\cos\frac{\pi x}{w}\right)\left(\cos\frac{\pi y}{w}\right)\left(\cos\frac{\pi z}{w}\right)$$

$$\phi(x,y,z) = 9.21C\left(\cos\frac{\pi x}{w}\right)\left(\cos\frac{\pi y}{w}\right)\left(\cos\frac{\pi z}{w}\right)$$

2) d) $\int_{-\frac{w}{2}}^{w/2} dx \int_{-\frac{w}{2}}^{\frac{w}{2}} dy\ J\left(x,y,\frac{w}{2},E\right)\vec{e}_z$

$$\int_{-\frac{w}{2}}^{w/2} dx \int_{-\frac{w}{2}}^{w/2} dy\ \frac{C}{E}\cos\left(\frac{\pi z}{w}\right)$$

$$\frac{C}{E}\cos\left(\frac{\pi}{2}\right) = 0$$

2) e) $\int_{1\times10^{-6}}^{1\times10^{-5}} dE \int_{-\frac{w}{2}}^{\frac{w}{2}} dx \int_{-\frac{w}{2}}^{w/2} dy\ J\left(x,y,\frac{w}{2},E\right)\vec{e}_z$

$$\int_{1\times10^{-6}}^{1\times10^{-5}} \frac{C}{E}\,dE \int_{-\frac{w}{2}}^{\frac{w}{2}} dx \int_{-\frac{w}{2}}^{\frac{w}{2}} dy\ \cos\left(\frac{\pi}{2}\right)$$

$$\left(C\ \ln E\Big|_{1\times10^{-6}}^{1\times10^{-5}}\right)(0) = 0$$

2) A) $PR = \int_{\text{react core}} PRD$

$$PRD = \nu(E)\, \Sigma_f(\vec{r}, E)\, \phi(\vec{r}, E)$$

$$\nu(E) = 2.5$$

$$\Sigma_f(\vec{r}, E) = 0.5 \ [cm^{-1}]$$

$$\phi(\vec{r}, E) = \frac{C}{E} \cos\left(\frac{\pi x}{w}\right) \cos\left(\frac{\pi y}{w}\right) \cos\left(\frac{\pi z}{w}\right)$$

$$PR = \int_{-\frac{w}{2}}^{\frac{w}{2}} dx \int_{-\frac{w}{2}}^{\frac{w}{2}} dy \int_{-\frac{w}{2}}^{\frac{w}{2}} dz\, (2.5)(0.5)\left(\frac{C}{E}\right)$$
$$\cos\left(\frac{\pi x}{w}\right) \cos\left(\frac{\pi y}{w}\right) \cos\left(\frac{\pi z}{w}\right) \int_{1\times10^{-6}}^{0.01} dE$$

$$PR = \sin\left[\frac{\pi x}{w}\right]_{-\frac{w}{2}}^{\frac{w}{2}} \sin\left[\frac{\pi y}{w}\right]_{-\frac{w}{2}}^{\frac{w}{2}} \sin\left[\frac{\pi z}{w}\right]_{-\frac{w}{2}}^{\frac{w}{2}} 1.25C \ln[E]_{1\times10^{-6}}^{0.01}$$

$$PR = \left[\sin\left(\frac{\pi}{2}\right) - \sin\left(-\frac{\pi}{2}\right)\right]\left[\sin\left(\frac{\pi}{2}\right) - \sin\left(-\frac{\pi}{2}\right)\right]\left[\sin\left(\frac{\pi}{2}\right) - \sin\left(-\frac{\pi}{2}\right)\right] 1.25C \ln(0.01) - \ln[1\times10^{-6}]$$

$$PR = [1-(-1)]\,[1-(-1)]\,[1-(-1)]\ 1.25C\,[-4.61 - (-13.82)]$$

$$RR = 92.1C \ [n/s]$$

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2) i) To compute the production rate of neutrons with energies from 1ev - 25ev use the same equation as part (h) but change the bounds of the integral over energy giving:

$$PR = 7.5C \; \ln[E]_{1\times10^{-6}}^{2.5e^{-5}} = 7.5C\left(\ln[2.5\times10^{-5}] - \ln[1\times10^{-6}]\right) =$$

$$PR = 24.1C \; [n/s]$$

2) j)

Donald Doyle UIN: [redacted]

3) a) E_0 has units of MeV so that the fraction $\frac{E}{E_0}$ is demensionless

A has units of $MeV^{3/2}$ so that when multiplied by $\sqrt{E}$ the resulting units are MeV

b) $neutrons = \iiint_{vol} d^3r \int_0^{\infty} \frac{\phi(\vec{r},E)}{\sqrt{2E}} = \frac{1}{\frac{m_n}{}}$

$neutrons = \int_{-\frac{w}{2}}^{\frac{w}{2}} dx \int_{-\frac{w}{2}}^{\frac{w}{2}} dy \int_{-\frac{w}{2}}^{\frac{w}{2}} dz \cos\left(\frac{\pi x}{w}\right) \cos\left(\frac{\pi y}{w}\right) \cos\left(\frac{\pi z}{w}\right) \left[\int_{1\times10^{-6}}^{0.01} \frac{c}{E} \sqrt{\frac{2E}{m_n}} dE + \int_0^{1\times10^{-6}} \right.$

$\frac{A \cancel{\sqrt{E}} e^{-\frac{E}{E_0}}}{\sqrt{\frac{2}{m_n}} \cancel{\sqrt{E}}} dE$

$neutrons = 6 \left[C \frac{1}{\sqrt{\frac{2}{m_n}}} \int_{1\times10^{-6}}^{0.01} E^{-3/2} dE + \int_0^{1\times10^{-6}} \frac{A}{\sqrt{\frac{2}{m_n}}} e^{-E/E_0} dE \right.$

$neutrons = \frac{6CA}{\sqrt{\frac{2}{m_n}}} \left(\frac{-1}{2}\sqrt{E} \Big|_{1\times10^{-6}}^{0.01} + -E_0 e^{-E/E_0} \Big|_0^{1\times10^{-6}} \right)$

$neutrons = \frac{6CA}{\sqrt{\frac{2}{m_n}}} \left(\frac{-1}{2} \left(\sqrt{0.01} - \sqrt{1\times10^{-6}} \right) - \left[E_0 e^{1\times10^{-6}/E_0} \right) - E_0 e^0 \right]$

$neutrons = \frac{6CA}{\sqrt{\frac{2}{m_n}}} \left[-0.0495 - E_0 e^{\frac{1\times10^6}{E_0}} + E_0 \right]$

$neutrons = \frac{6CA}{\sqrt{\frac{2}{m_n}}} \left(E_0 - 0.0495 - E_0 e^{1\times10^6/E_0} \right)$