PRACTICE PROBLEMS IN RADIOACTIVITY
FOR GENERAL SCIENCE 181

1. A Radiological Health Technician at TVA is asked to see if the lead shielding around a γ ray source in a hot room is sufficient to protect workers outside the room from exposure to Gamma radiation. If the safe exposure limit is 200 γ rays per second, is a lead shield 5.6-mm thick sufficient to protect the workers? The attenuation coefficient is 2.3 mm and the intensity of the gamma ray source in the hot room is 5.67×10^9 γ rays per second.

Solution:

(1) $I = I_o e^{[-X / Xo]}$

(2) $X / Xo = 5.6mm/2.3mm = 2.43$

(3) $e^{[-2.43]} = 0.0876$

(4) $I = (5.67 \times 10^9\ \gamma/s)\ 0.0876 = 496,787,211\ \gamma/s$

(5) **The answer is no.**

2. How thick will the shield have to be, to reduce the exposure to 200 γ/s?

(1) $I = Io\ e^{[-X / Xo]}$

(2) Divide both side of the equation by I_o .

$$I / I_o = e^{[-X / Xo]}$$

3. Take the Natural Log of both side of the equation:

$$\ln(I / I_o) = \ln(e^{[-X / Xo]})$$

$$\ln(I / I_o) = -X / Xo$$

4. $\ln(200\gamma/s / 5.67 \times 10^9\ \gamma/s) = -X/2.3\ mm$

5. $-17.16 = -X/2.3\ mm$

6. $X = (17.16)(2.3mm) = 39.46$ **mm**
(aprox. 1.5 inches)

2. An Inspector from the Tennessee Division of Radiological Health is inspecting the x-ray machine in a dentists office to make sure that patients and office workers are not exposed to too high a dose of radiation when x-rays of a patient's teeth are taken. The intensity and energy of the x-rays is determined by the voltage used on the x-ray machine.

The inspector records a x-ray intensity in the patient chair at 500 Severits (Do not worry about the units) for each patient.
How thick would the lead apron the x-ray technician wears have to be to keep her exposure to 5 Severits per patient? The absorption coefficient of lead is 2.3mm

(1) $$I = Io\ e^{[-X / Xo]}$$

(2) Divide both side of the equation by I_o .

$$I / I_o = e^{[-X / Xo]}$$

4. Take the Natural Log of both side of the equation:

$$\ln(I / I_o) = \ln(e^{[-X / Xo]})$$

$$\ln(I / I_o) = -X / Xo$$

4. $$\ln(5 \text{ Severits} / 500 \text{ Severits}) = -X/2.3 \text{ mm}$$

5. $$-4.6 = -X/2.3 \text{ mm}$$

7.

$$X = (4.6)(2.3\text{mm}) = 10.6 \text{ mm}$$

(aprox. 0.4 inch)

3. A piece of lead 50.0 mm thick (X_o = 2.3 mm) can reduce the intensity of the exposure to a gamma ray source from 9.87 X 10^{12} γ/s to approximately 3,500γ/s. How thick would a piece of aluminum have to be to reduce the gamma ray intensity level to same amount? (X_o for aluminum is 50.0mm)

(1)

$$I = Io\, e^{[-X / Xo]}$$

(2) Divide both side of the equation by I_o .

$$I / I_o = e^{[-X / Xo]}$$

5. Take the Natural Log of both side of the equation:

$$\ln(I / I_o) = \ln(e^{[-X / Xo]})$$

$$\ln(I / I_o) = -X / Xo$$

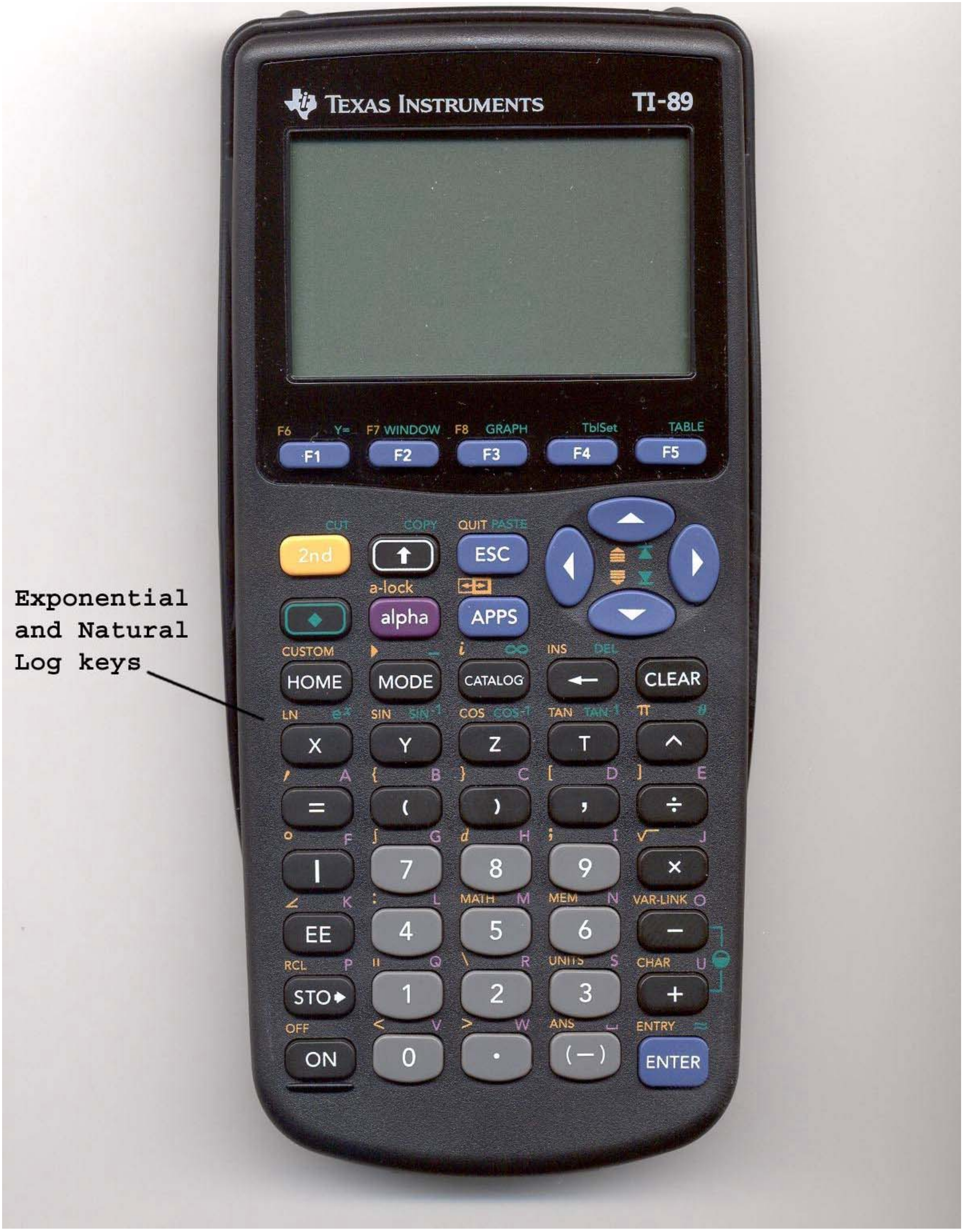
Answer:

X is approx. = 1088.0 mm

4. How thick would solid cement block material have to be to reduce the exposure to 3500γ/s if X_o for cinder blocks is 120.0 mm ?

Answer:

X is approx. = 2600 mm (102 inches, 8.5 feet)



Exponential and Natural Log keys