

TEST 3 (of 3)

Show all of your work. Students should make use of the conversion factor method throughout and express their answers in scientific notation.

1. Global Warming

- (a) What does the following graph show? How was the data for the last 200 years measured? How was the data for the last 1000 years measured? What is the nick-name that the media has given the graph?

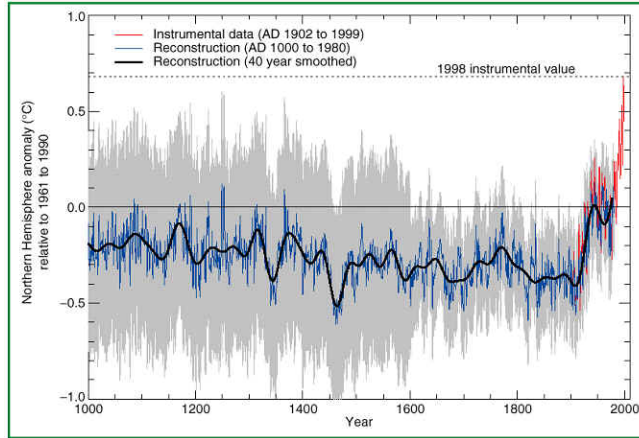
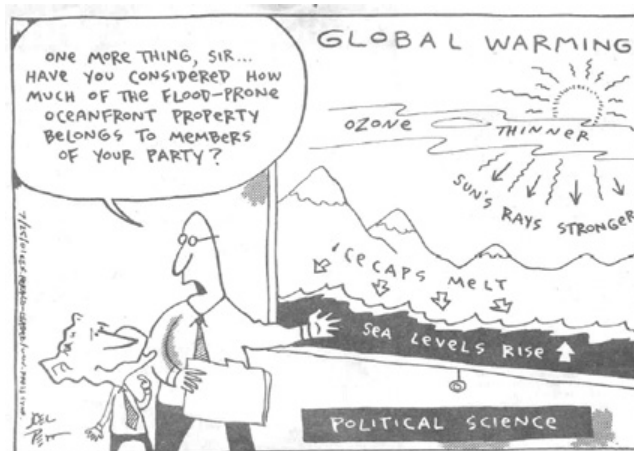


Figure 5: Millennial Northern Hemisphere (NH) temperature reconstruction (blue – tree rings, corals, ice cores, and historical records) and instrumental data (red) from AD 1000 to 1999. Smoother version of NH series (black), and two standard error limits (gray shaded) are shown. [Based on Figure 2.20]

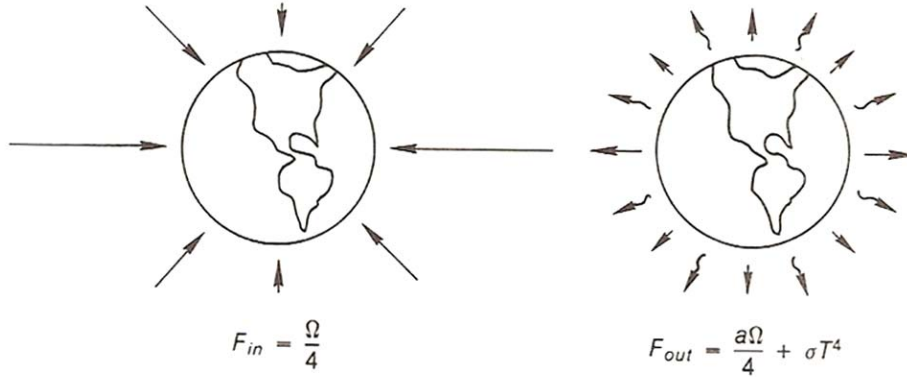
- (b) Explain what is meant by Global dimming. What pollutants are thought to be responsible for global dimming? What might be the effect of reducing this pollution?

- (c) What is wrong with this professors slide?



2. **Stefan-Boltzman Law**

- (a) Write down an expression relating F_{in} to F_{out} for a planet in radiative equilibrium.



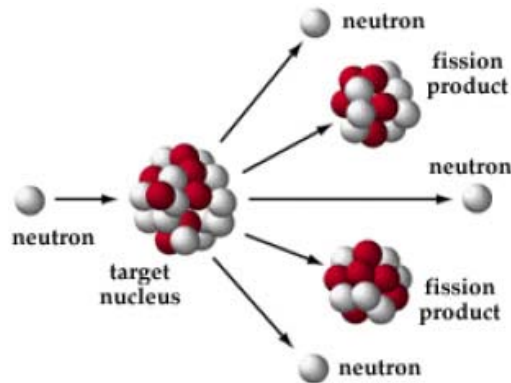
- (b) Solve this expression for T .

- (c) Substitute in variables and solve for T , why is this value not equal to the true temperature of the Earth?

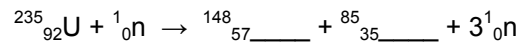
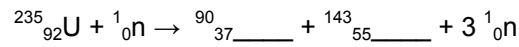
$$a = 0.3, \Omega = 1372 \text{ W m}^{-2}, \sigma = 5.7 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-1}$$

3. **Nuclear Accidents**

(a) Explain why energy is released from a nuclear fission reaction.



(b) Complete the following nuclear reactions for the fission of uranium-235.



(b) The following table shows the amount of radionuclides released from the Chernobyl accident. Explain why the activity of some of the isotopes has decreased to zero whilst others are still very high.

Nuclide	Activity 5/86	% of core inventory	Activity 5/96
Cs-137	1,000,000	13	795,200
Sr-90	220,000	4	172,900
Pu-239	700	3	700
I-131	7,300,000	20	0
Xe-133	45,000,000	100	0
Zr-95	3,800,000	3.2	0
Mo-99	3,000,000	2.3	0

4. **Radiation**

- (a) The rate of radioactive decay is proportional to amount remaining after time
- t
- .

$$N = N_0 e^{-\lambda t}$$

Where N = number nuclei at time t , N_0 = number of nuclei at start, λ = decay constant.

Derive the expression for half-life which occurs when $N = N_0/2$. [Must explain all steps]

[Answer: $\lambda = \ln 2 / t_{1/2}$]

- (b) Bananas are a good dietary source of potassium. However, 0.0117% of natural potassium is the radioactive isotope
- ^{40}K
- , which decays by beta particle emission with a half-life of
- 1.26×10^9
- years.

If large banana has a potassium content of about 600 mg and 0.0117% of this is potassium-40, then how much potassium-40 will a large banana contain?

- (c) The first order rate expression:

$$\frac{\Delta N}{N} = -\lambda t$$

Where $\lambda = \ln 2 / t_{1/2}$ can be used to find the activity ΔN of one mole ($N = 6 \times 10^{23}$ atoms) of ^{40}K per second.

- (ii) Find
- λ
- with units
- s^{-1}
- .

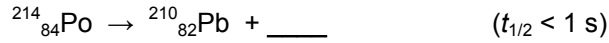
(ii) What is the activity (ΔN) of 1 mole of potassium-40? (Hint: use $t = 1$ s for disintegrations per second)

(iii) If 1 mole (40.0g) of ^{40}K has this activity, what activity 'x' does the potassium-40 in 1 banana have? Use the following ratio,

$$\frac{\text{No. atoms decaying per sec. in 1 mole}}{1 \text{ mole (40.0 g)}} = \frac{x \text{ (No. atoms decaying per second in banana)}}{\text{Mass of potassium-40 in banana}}$$

5. **Radon**

- (a) Complete the following radioactive decay reactions for radon and its progeny.



Which type of ionizing radiation is the most damaging when emitted from inhaled radionuclides? (give the chemical symbol in the form ${}^A_Z\text{X}$ where A = atomic mass, Z = atomic number.

- (b) Convert
- pCi L^{-1}
- to
- Bq m^{-3}
- using the following conversion factors:

$$1000 \text{ L} = \text{m}^3 \text{ and } 3.7 \times 10^{10} \text{ Bq} = 1 \text{ Ci}$$

- (c) Describe in detail the nuclear track etch detection method of radon measurement. Is this a direct or indirect measurement? According to the US EPA at what level (
- Bq m^{-3}
-) should Radon be remediated?

Bonus: Identify the subject area of each of the following 3 diagrams and describe what they show.

