Quiz 2

Enter your student number!

Circle final answers. All answers and calculations must be on question sheet.

You have until 4:45 pm. I'll review the answers at that time.

The answer to part B depends on the answer to part A. If you can't do part A, assume the answer is 680 GtC.

The answer to part C depends on the answer to part B. If you can't do part B, assume the answer is 4 GtC/y.

Quiz 2 Solutions

A. What was the preindustrial stock of CO_2 in the atmosphere, in GtC?

$$\left[\frac{278 \cdot 10^{-6}\ \text{mole}_{CO_2}}{\text{mole}_{air}}\right]\left[1.8 \cdot 10^{20}\ \text{mole}_{air}\right]\left[\frac{12\ g_C}{\text{mole}_{CO_2}}\right]\left[\frac{Gt}{10^{15}\ g}\right]$$

$$= 600.5 \approx 600\ \text{GtC}$$

Quiz 2 Solutions

B. If humans stabilize CO_2 concentrations at twice the preindustrial value, and the added CO_2 has an average residence time of 170 years, what is the steady-state flow of anthropogenic CO_2 into the atmosphere, in GtC/y?

If the CO_2 concentration doubles, the stock of anthropogenic carbon would be 600 GtC. If the residence time of this carbon is 170 y, the equilibrium anthropogenic flow is:

$$F_A = \frac{S_A}{\tau_A} = \frac{600\ \text{GtC}}{170\ \text{y}} = 3.53 \approx 3.5\frac{\text{GtC}}{\text{y}}$$

Quiz 2 Solutions

C. The current rate of anthropogenic emission is 26 Gt/y of CO_2. If parties to the UNFCCC today agreed to stabilize global emissions by 2050 at the level calculated in part B, at what average rate would emissions have to decline?

$$F_0 = \left[\frac{26\ \text{Gt}_{CO_2}}{\text{y}}\right]\left[\frac{12\ \text{GtC}}{44\ \text{Gt}_{CO_2}}\right] = 7.09\ \frac{\text{GtC}}{\text{y}}$$

$$F_1 = 3.53\ \frac{\text{GtC}}{\text{y}}$$

$$r = \frac{\log_e\left(\frac{3.53}{7.09}\right)}{44} = -0.01585 \approx -1.6\frac{\%}{\text{y}}$$

$$i = \left(\frac{3.53}{7.09}\right)^{\frac{1}{44}} - 1 = -1.6\frac{\%}{\text{y}}$$

Quiz 2 Solutions

D. If the radiative forcing due to non-CO_2 GHGs is stabilized at 1.0 W/m^2, what is the total radiative forcing and the corresponding equivalent CO_2 concentration?

$$\Delta F = \Delta F_{CO_2} + \Delta F_{other} = 3.7 + 1.0 = 4.7 \frac{W}{m^2}$$

$$c_{CO_2} = c_0 e^{\frac{\Delta F}{5.35}} = 278 e^{\frac{4.7}{5.35}} = 670 \text{ ppmv}$$