PROBLEM SET 8 SOLUTIONS
Physics 2021

1a.   **Core**

R_{core} = **3500 km** R_{earth} = **6350 km**

$[\ R_{core}^3\ /\ R_{earth}^3\ ]$ = $[\ 3500^3\ /\ 6350^3\ ]$ = **0.17** = **17%**

1b.   **Mantle**

R_{core} = **3500 km** R_{mantle} = **6320 km** R_{earth} = **6350 km**

$[\ (R_{mantle}^3 - R_{core}^3)\ /\ R_{earth}^3\ ]$ = $[\ (6320^3 - 3500^3)\ /\ 6350^3\ ]$ = **0.82** = **82%**

1c.   **Crust**

1.00 - (0.17 + 0.82) = **0.01** = **1%**

2. $V = 4\pi/3\ R^3 = (4\pi/3)\ (1300 \times 10^3\ m)^3 = 9.2 \times 10^{18}\ m^3$

$M = \rho\ V = (13{,}000\ kg/m^3)\ (9.2 \times 10^8\ m^3)$

$M = 1.2 \times 10^{23}\ kg$ $M_{earth} = 5.94 \times 10^{24}\ kg$

$M\ /\ M_{earth} = 1.2 \times 10^{23}\ kg\ /\ 5.97 \times 10^{24}\ kg = 0.02$

3. $M_{earth} = 5.97 \times 10^{24}\ kg$ $R_{earth} = 12{,}756\ km\ /\ 2 = 6.378 \times 10^6\ m$

$\rho = M\ /\ V = (5.97 \times 10^{24}\ kg)\ /\ [(4\pi/3)\ (6.378 \times 10^6\ m)^3\ ]$

= **5,500 kg/m³** = **5.5 g/cm³**

4.   **The distance from South America to Africa is approximately 6,600 km.**

$d = v\,t$ $t = (6{,}600\ km \times 10^5\ cm/km)\ /\ (3\ cm/yr)$ = **220 million years**

5. Hydrogen either escaped or combined with oxygen to form water.
Carbon combined with oxygen to form carbon dioxide; most is trapped in rocks.
Nitrogen combined with hydrogen to form ammonia or combined with itself (N_2).

6a. Albedo $= 0.39$

Light reflected $= (0.39)(1.75 \times 10^{17} \text{ W}) = 6.8 \times 10^{16} \text{ W}$

6b. Light absorbed $= (0.61)(1.75 \times 10^{17} \text{ W}) = 1.07 \times 10^{17} \text{ W}$

6c. $R_{earth} = 6.38 \times 10^6$ m

Surface Area $= 4 \pi r^2 = 4 \pi (6.38 \times 10^6 \text{ m})^2 = 5.1 \times 10^{14} \text{ m}^2$

Power radiated per $m^2 = (1.07 \times 10^{17} \text{ W}) / (5.1 \times 10^{14} \text{ m}^2)$

$= 209 \text{ W} / \text{m}^2$

6d. Stefan-Boltzmann Law $F = \sigma T^4$

$T = [F / \sigma]^{0.25} = [209 \text{ W/m}^2 / 5.67 \times 10^{-8} \text{ W} / \text{m}^2 \text{ K}]^{0.25}$

$= 246 \text{ K} = -27^{\circ}\text{C}$

6e. The Earth's temperature is higher due to the greenhouse effect.