(3) Given that the temperature in the Earth's crust increases at the rate of 20 °C per kilometer of depth, how cold would the Earth become with the sun turned off?

If we use the figure given in our One-page Handbook (January 1983) for the thermal conductivity of a nonmetallic solid, 10^{-2} cal deg^{-1} cm^{-1} s^{-1}, we find that a gradient of 20 degrees per kilometer of depth implies an upward heat flow of 8×10^{-6} watt/cm^2. The temperature at which a black body radiates at that rate is 34 K. It would be 50 K if the mean emissivity were as low as 0.2. Allowing for our ignorance, we'll guess that the eventual temperature would be somewhere between 40 K and 60 K. Of course we have assumed that the radioactivity, which is the source of most of this heat, continues undiminished through the cooling off period. Whether that is justified is a question that suggests another problem.