91. (a) The total energy is conserved, so there is no difference between its values at aphelion and perihelion.

(b) Since the change is small, we use differentials:

$$dU = \left(\frac{GM_E M_S}{r^2}\right) dr \approx \left(\frac{\left(6.67 \times 10^{-11}\right)\left(1.99 \times 10^{30}\right)\left(5.98 \times 10^{24}\right)}{\left(1.5 \times 10^{11}\right)^2}\right)\left(5 \times 10^9\right)$$

which yields $\Delta U \approx 1.8 \times 10^{32}$ J. A more direct subtraction of the values of the potential energies leads to the same result.

(c) and (d) From the previous two parts, we see that the variation in the kinetic energy ΔK must also equal 1.8×10^{32} J. So, with $\Delta K \approx dK = mv\,dv$, where $v \approx 2\pi R/T$, we have

$$1.8 \times 10^{32} \approx \left(5.98 \times 10^{24}\right)\left(\frac{2\pi\left(1.5 \times 10^{11}\right)}{3.156 \times 10^7}\right)\Delta v$$

which yields a difference of $\Delta v \approx 1$ km/s in Earth's speed (relative to the Sun) between aphelion and perihelion.