SOLUTION

TQ3 **[10 points]**

3.1 Since the path between A and B is parabolic, the total energy of the spacecraft is zero,

$$E_{AB} = 0, \qquad \leftrightarrow \quad \varepsilon = 1.$$

So, when you get to point B, then

$$E = \frac{1}{2}mv_B^2 - \frac{GMm}{r_B} = 0; \qquad \text{[1 point]}$$

From where

$$v_B = \sqrt{\frac{2GM}{r_B}} \qquad \text{[1 point]}$$

Replacing with available values

$$v_B = \sqrt{\frac{2 \times (6{,}67\times10^{-11}) \times (6{,}4\times10^{23})}{6{,}8\times10^{6}}} \approx 3,55\ km\ s^{-1} \qquad \text{[1 point]}$$

3.2 There are two possible solutions

Solution A

Immediately after breaking the total energy and the angular momentum change since the braking force is tangential, but along the elliptical path BC the values with which it passes through are conserved and take on during the entire journey. C; then applying conservation of energy between points B' (immediately after braking) and C as well as conservation of the angular momentum between B' and C, we have

$$\frac{1}{2}mv_{B'}^2 - \frac{GMm}{r_B} = \frac{1}{2}mv_C^2 - \frac{GMm}{R_M} \quad Eq.\ 1 \qquad \text{[1 point]}$$

$$L = mv_{B'}r_B = mv_C R_M \quad Eq.\ 2 \qquad \text{[1 point]}$$

From these two equations we solve for v_C and it's result is used to calculate the total energy in C which gives us:

$$E_{elipse} =- \frac{GMm}{R_M + r_B} \approx \ -2.10 \times 10^{11} J \quad Eq.\ 3a \qquad \text{[2 points]}$$

In both methods, this and next, two points for getting the equation and two points for calculation + negative sign + unit.