

1. By 2020, NASA plans to launch a Mars Sample Return mission that would use robotic systems and a Mars ascent rocket to collect and send samples of Martian rocks, soils, and atmosphere to Earth for detailed analysis. An artists conception of the launch from the surface of Mars is shown at the right. The mission planner will need to know the escape velocity from Mars. Find its value.



2. Pioneer 10 was launched from Cape Canaveral on March 3, 1972 with a mass of 259kg. It has gone on to become the first artificial object to leave the solar system. To design the spacecraft NASA needed to know the energy needed for it to leave the solar system starting from Earth. Find that number.



3. (a) Find the energy required to lift the 70,000kg space shuttle orbiter to an altitude of 800km and (b) the additional energy needed to put it into orbit.



4. 118P/Shoemaker-Levy is a comet discovered by astronomers Carolyn and Eugene M. Shoemaker and David Levy. It is a short-term comet expected back in mid 2016. It has an aphelion distance of  $7.43 \times 10^{11}$  m and a perihelion distance of  $3.02 \times 10^{11}$  m. Find the speed at both aphelion and perihelion.