# Quiz 1

1. A particular point on the surface of planet Mars is to be viewed continuously from a spacecraft orbiting Mars. Determine the height of the orbit of this spacecraft above the surface of Mars. You can assume the period of rotation of Mars about its axis to be 24 hours and 40 minutes. The mass of the planet Mars is $6.419\times 10^{23}$ kg and its diameter is 6805 km. You can neglect the attraction of the star Sun and the other planets. The value of the universal gravitational constant is $6.670\times10^{-11}$ $Nm^2/kg^2$.

2. A solid propellant is formulated to give a Characteristic velocity (C*) of 2200 m/s. The chamber pressure is 7 MPa. The gases are expanded in the nozzle to the ambient pressure of 0.1 MPa.. The ideal thrust coefficient of the nozzle is 1.8.

Determine the rate in kg/s at which the propellant must burn in order to generate a thrust of $10^3$ kN. You can assume the C* efficiency as 0.97 and the thrust correction coefficient as 0.92.

3. A space mission performed by an electrical rocket requires an incremental velocity of 1.5 km/s. The mass of payload required is 1500 kg. If the efflux jet velocity of the propellant used is 18000 m/s and the structural mass fraction of the vehicle is 0.2, estimate:

a. The propellant mass required.
b. The overall mass

4. The C* of a composite propellant is 2200 m/s. The combustion products of this propellant have a molecular mass of 22 g/mole and a temperature of 2600 K.

Aluminium powder is added to the above propellant to improve its specific impulse. The molecular mass of the products increases to 24 g/mole while the temperature of the combustion products increases to 3200K on addition of aluminium. If the specific heat ratio of the combustion products of the aluminized and non-aluminized propellants remain the same, determine the C* of the aluminized propellant.

If the above aluminized propellant is used in a solid propellant rocket having a thrust coefficient of 1.2, what is the specific impulse of the rocket?

5. An oxidizer-rich mixture of kerosene and oxygen at 25$^o$C at a mixture ratio of 4 is burnt in a gas generator to generate hot combustion products for driving a turbine. If the molecular formula for kerosene is given by $C_{12}H_{26}$, determine:

a) Energy release per kg of kerosene
b) Molecular mass of combustion products.

The heat of formation $\Delta H_f^o$ in kJ/mole for kerosene = – 160, $CO_2$= – 390, and $H_2O(l)$= –280.