1. The following data applies to a Boeing 777. Empty mass = 138,120 *kg*, design payload = 54,000 *kg*, design fuel load = 75,500 *kg*. Assume the airplane is designed to cruise at Mach 0.83 at 39,000 ft, that it has a lift to drag ratio of 20.5 during cruise, and has a design range of 8400 *km*.
   (a) Using standard atmosphere tables to get atmospheric temperature data, compute the cruise speed.
   (b) Estimate the thrust specific fuel consumption of the engines under cruise conditions.
   (c) An engine modification is proposed that would reduce the TSFC by 5% but would increase each engine weight by 100 kg. (The B-777 is a twin engine airplane.) Would the range be improved by this modification, assuming the airplane continued to carry the same fuel load and payload?

2. A ramjet is to propel an aircraft at *Mach* 3.5 at an altitude where the ambient temperature is 217 *K*. The engine maximum temperature is 2200 K. Use $|\Delta H_R|$ = 43 *MJ/kg* for the fuel. Assume $\gamma_h = 1.32$, and the following values for non-ideal components.

r_d	0.85	η_b	0.99
r_b	0.93	η_n	0.96

   Compute: (a) thermal efficiency; (b) propulsion efficiency; (c) overall efficiency of the engine.

3. Using a computer program or spreadsheet compute the variation with Mach number ($1 < M < 5$) of the design specific thrust $\Im / \dot{m}_a$, design *TSFC*, η_p, η_{th}, η_{ov} for a ramjet flying in an atmosphere at 220 *K*. Assume $r_d = 0.88$, $r_b = 0.94$, $r_n = 0.95$, $\eta_b = 0.98$. Assume $|\Delta H_R|$ = 45 *MJ/kg* for the fuel, $\gamma_h = 1.35$, and T_{max} = 2000 *K*. Plot the variation of $\Im / \dot{m}_a$ and *TSFC* with *M*. Change the maximum temperature to 2500 *K* and recompute and replot the variation of $\Im / \dot{m}_a$ and *TSFC* with *M*. How do $\Im / \dot{m}_a$ and *TSFC* change as T_{max} increases? Remember that the maximum fuel-air ratio *f* is limited to 0.0667 so high maximum temperatures may not be attainable at low design Mach numbers.