ME 201
Thermodynamics

Practice Problems: Unit Manipulations

Perform the following unit manipulations.

a. A jet engine provides a thrust (force) of 2,000 lb_f with a velocity of 600 km/hr. What is the power produced in horsepower?

Solution

Power = Force x Velocity
Convert to SI
Force = 2000 (lb_f) x 4.448 (N/lb_f) = 8896 N
Velocity = 600 (km/hr) x 0.278 [(m/s)/(km/hr)] = 166.8 m/s
Power = 8896 (N) x 166.8 (m/s) = 1,483,853 (N m/s) = 1484 (kW)
Covert to hp
Power = 1484 (kW) / 0.7457 (kW/hp) = 1990 hp

b. What is the potential energy (in kJ) of a 1.25 ton aircraft at an elevation of 50,000 ft?

Solution

Potential Energy = Mass x Gravitational Acceleration x Elevation
Convert to SI
Mass = 1.25 (ton) x 907.18 (kg/ton) = 1134 kg
Gravitational Acceleration = 9.8 m/s^2
Elevation = 50,000 (ft) x 0.305 (m/ft) = 15,250 m
Potential Energy = 1134 (kg) x 9.8 (m/s^2) x 15,250 (m) = 1.695×10^8 ($kg\ m^2/s^2$)
Covert to kJ
Potential Energy = 1.695×10^8 ($kg\ m^2/s^2$) = 1.695×10^8 (N m)
= 1.695×10^8 (J) x 0.001 (kJ/J) = 1.695×10^5 kJ

c. Determine the kinetic energy (in Btu) of a 0.50g baseball thrown at 97 mph.

Solution

Kinetic Energy = 1/2 x Mass x Velocity Squared

Convert to SI

Mass = 0.5 (gm) x 10^{-3} (kg/gm) = 5 x 10^{-4} kg

Velocity = 97 (mph) x 0.447 [(m/s)/(mph)] = 43.4 m/s

Kinetic Energy = 0.5 x 5 x 10^{-4} (kg) x $[43.4]^2$ (m^2/s^2) = 0.47 J

Covert to Btu

Kinetic Energy = 0.478 (J) / 1055 (J/Btu) = 4.45 x 10^{-4} Btu