AAE 251 HOMEWORK #1

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TEAM: R06

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DUE: JAN 22 2019 (TUE) 10:00AM

EQUATIONS

(1) The Atmospheric Pressure at "Pause" State

$$p = p1 * exp((-1) * g * (h - h1)/R/T)$$

(2) The Atmospheric Pressure at "Sphere" State

$$p = p1 * (T/T1)^(- g/R/T_h)$$

where $T_h = (T - T1)/(h - h1)$

(3) The Temperature at Certain Altitude

$$T = T1 + T_h(h - h1)$$

(4) The Density of Atmosphere at Certain Altitude

$$d = p/R/T$$

(5) The Speed of Sound

$$a = sqrt(y * p/d)$$

where $y = gamma = 1.4$

PREPARATION

```
altitude_ft = 0:500:100000; % Altitude vector in feet (ft)
altitude_m = 0:1:30480;     % Altitude vector in meters (m)
g_si = 9.81;                % Gravitational acceleration (m/s^2)
g_eng = 32.174;             % Gravitational acceleration (ft/s^2)
R_si = 287;                 % Gas constant (J/kg/K)
R_eng = 1716.27;            % Gas constant (ft^2/s^2R)
gamma = 1.4;                % Adiabatic Index or Isentropic Expansion
                            % Constant


lapse_rate_m = [-6.5*power(10,-3), 3*power(10,-3),
 -4.5*power(10,-3), ...
```

```
    4*power(10,-3)];          % Temperature lapse rates (K/m)
lapse_rate_ft = lapse_rate_m / 3.28084 * 1.8;
                              % Temperature lapse rates (R/ft)

mark_height_m = [0, 11, 25, 47, 53, 79, 90, 105]*1000;
                              % Height at which the the state changes
                              % from "pause" to "sphere" or vice versa
                              % (m)
mark_height_ft = mark_height_m * 3.28084;
                              % Height corresponding to mark_height_m
                              % in feet (ft)
initial_temp_m = [288.16, 216.66, 282.66, 165.66, 256.66];
                              % Initial temperatures (K) where the
                              % state changes from "pause" to "sphere"
                              % or vice versa
initial_temp_ft = [518.688, 389.988, 515.988, 298.188, 461.988];
                              % Initial temperatures (R) where the
                              % state changes from "pause" to "sphere"
                              % or vice versa
```

Temperature

Finding the temperature by altitude (K)

```
% Feet
temp_ft = tempCal(initial_temp_ft, altitude_ft, mark_height_ft,...
    lapse_rate_ft);

% Meters
temp_m = tempCal(initial_temp_m, altitude_m, mark_height_m, ...
    lapse_rate_m);
```

Pressure

Finding pressure by altitude (Pa) or (lb/ft^2)

```
% Feet
pressure_ft = pressureCal(g_eng, R_eng, temp_ft, initial_temp_ft,...
    altitude_ft, mark_height_ft, lapse_rate_ft, "ENG");

% Meters
pressure_m = pressureCal(g_si, R_si, temp_m, initial_temp_m,...
    altitude_m, mark_height_m, lapse_rate_m, "SI");
```

Density

Finding the density (kg/m^3) or (slugs/ft^3)

```
% Feet
density_ft = pressure_ft ./ temp_ft / R_eng;

% Meters
density_m = pressure_m ./ temp_m / R_si;
```

Speed of Sound

Finding the speed of sound (m/s) or (ft/s)

```
% Feet
sound_speed_ft = sqrt(gamma .* pressure_ft ./ density_ft);

% Meters
sound_speed_m = sqrt(gamma .* pressure_m ./ density_m);
```

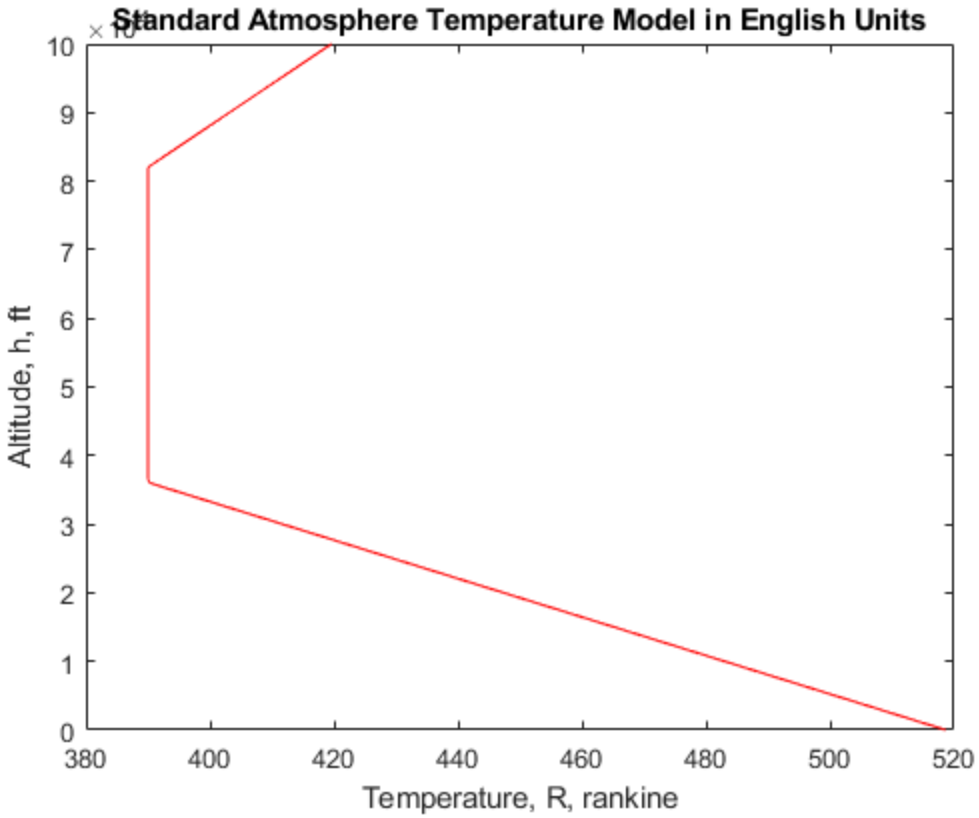
Generating Table

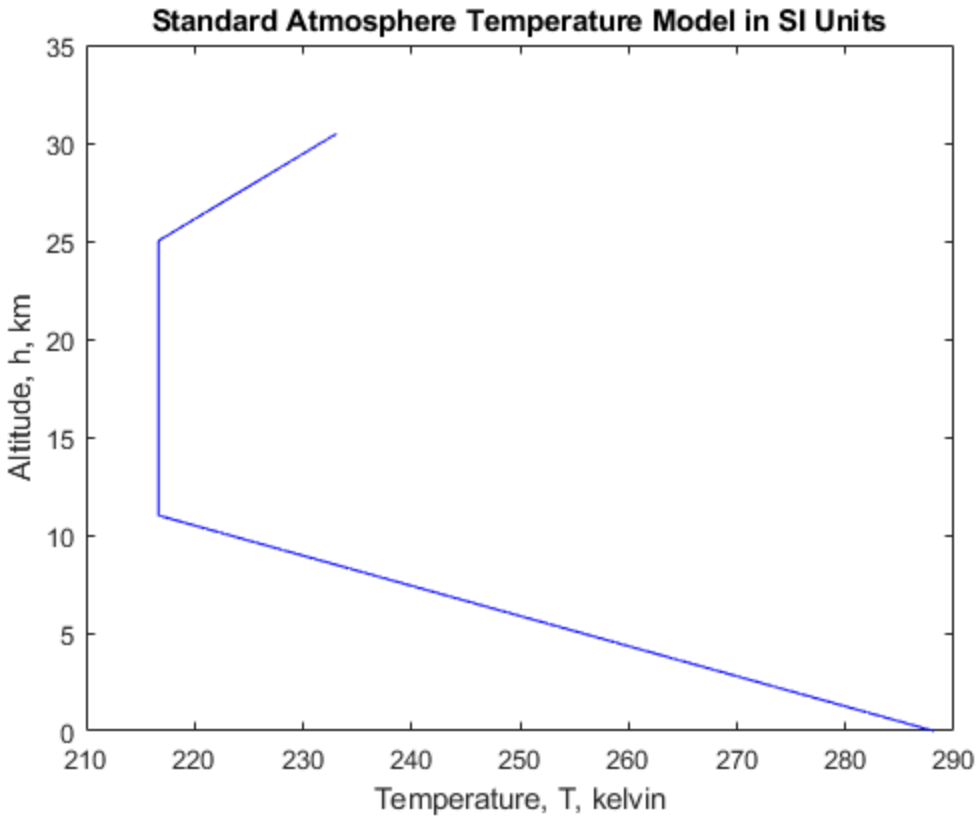
```
% Feet
T_ft = table(altitude_ft, temp_ft, pressure_ft, density_ft,...
    sound_speed_ft);

% Meters
T_m = table(altitude_m, temp_m, pressure_m, density_m,...
    sound_speed_m);
```

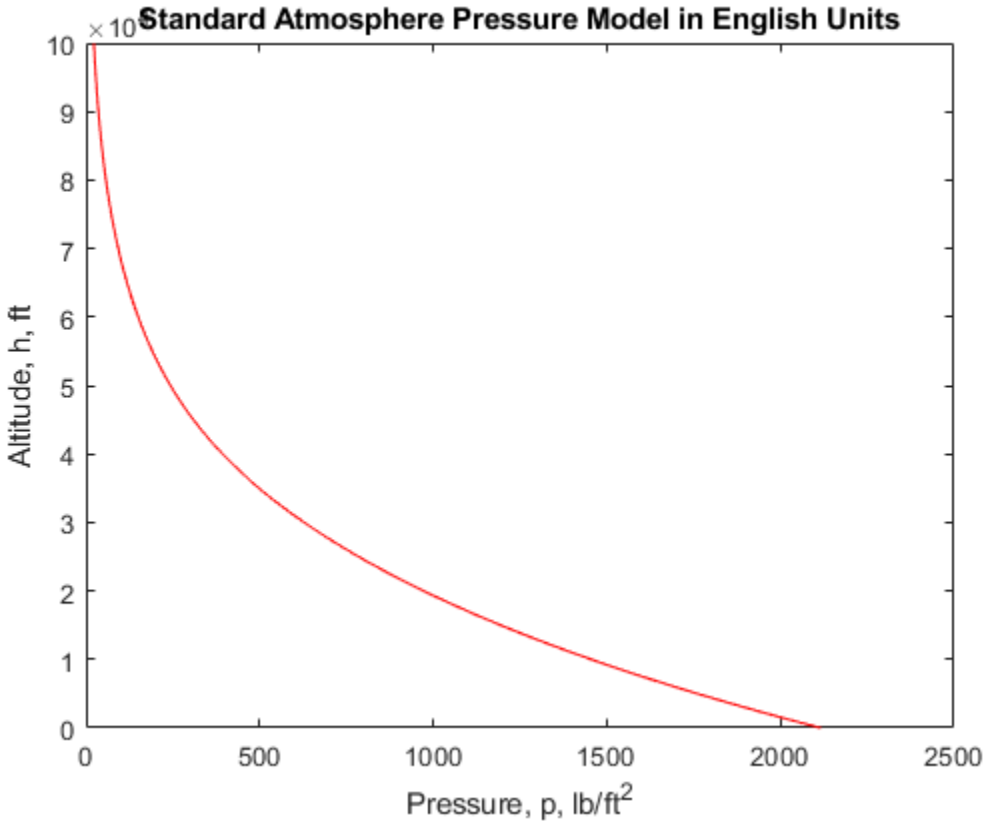
Generating Graphs

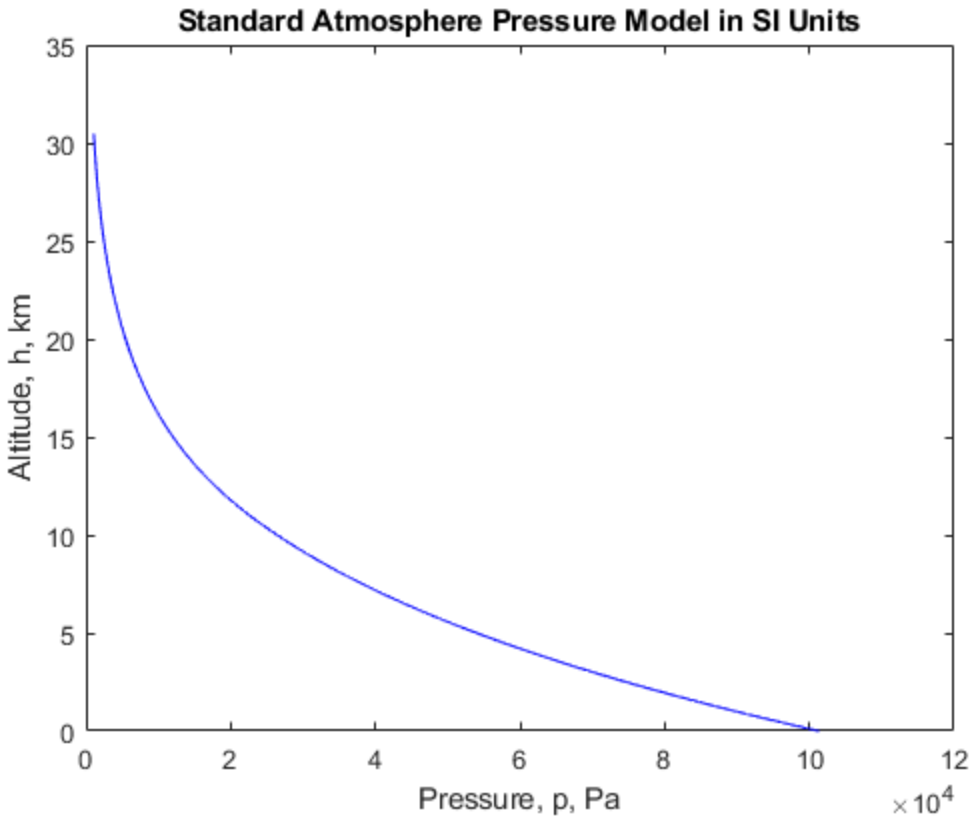
```
% Altitude by Temp (ft)
figure
plot(temp_ft, altitude_ft, '-r')
ylabel('Altitude, h, ft')
xlabel('Temperature, R, rankine')
title('Standard Atmosphere Temperature Model in English Units')

% Altitude by Temp (m)
figure
plot(temp_m, altitude_m / 1000, '-b')
ylabel('Altitude, h, km')
xlabel('Temperature, T, kelvin')
title('Standard Atmosphere Temperature Model in SI Units')

% Altitude by Pressure (ft)
figure
plot(pressure_ft, altitude_ft, '-r')
ylabel('Altitude, h, ft')
xlabel('Pressure, p, lb/ft^2')
title('Standard Atmosphere Pressure Model in English Units')

% Altitude by Pressure (m)
figure
plot(pressure_m, altitude_m / 1000, '-b')
ylabel('Altitude, h, km')
xlabel('Pressure, p, Pa')
title('Standard Atmosphere Pressure Model in SI Units')

% Altitude by Density  (ft)
figure
plot(density_ft, altitude_ft, '-r')
ylabel('Altitude, h, ft')
xlabel('Density, d, slugs/ft^3')
title('Standard Atmosphere Density Model in English Units')
```

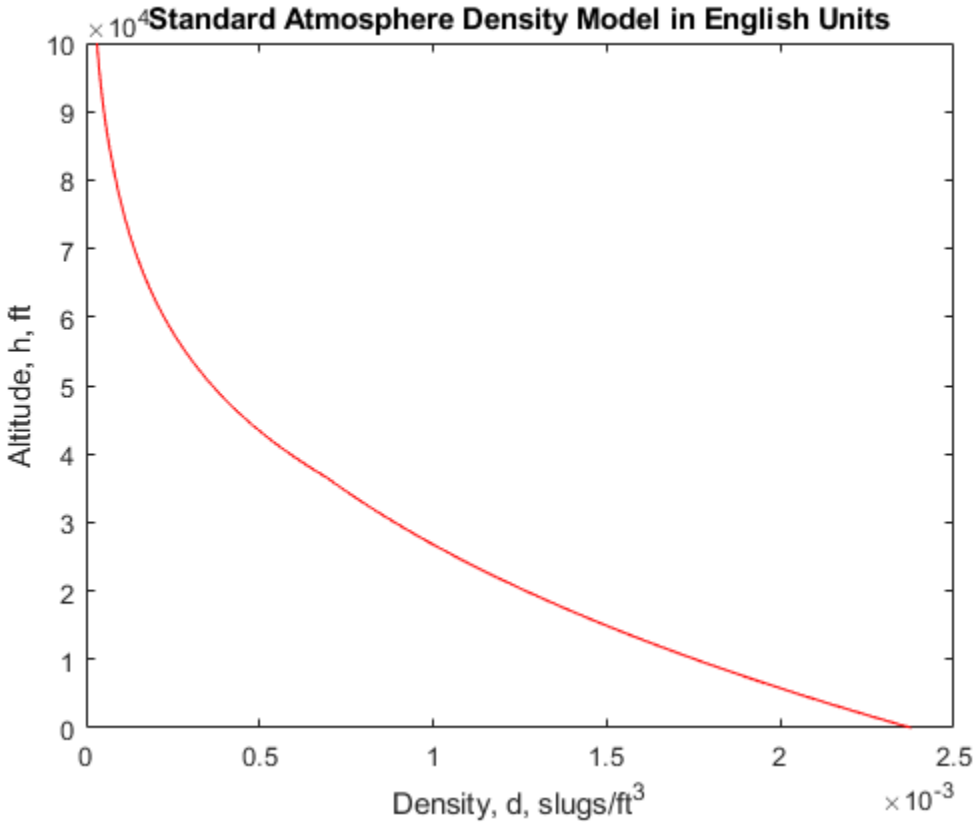
```
% Altitude by Density (m)
figure
plot(density_m, altitude_m / 1000, '-b')
ylabel('Altitude, h, km')
xlabel('Density, d, kg/m^3')
title('Standard Atmosphere Density Model in SI Units')

% Altitude by Speed of Sound (ft)
figure
plot(sound_speed_ft, altitude_ft, '-r')
ylabel('Altitude, h, ft')
xlabel('Speed of Sound, a, ft/s')
title('Standard Atmosphere Sound of Speed Model in English Units')

% Altitude by Speed of Sound (m)
figure
plot(sound_speed_m, altitude_m / 1000, '-b')
ylabel('Altitude, h, km')
xlabel('Speed of Sound, a, m/s')
title('Standard Atmosphere Sound of Speed Model in SI Units')
```

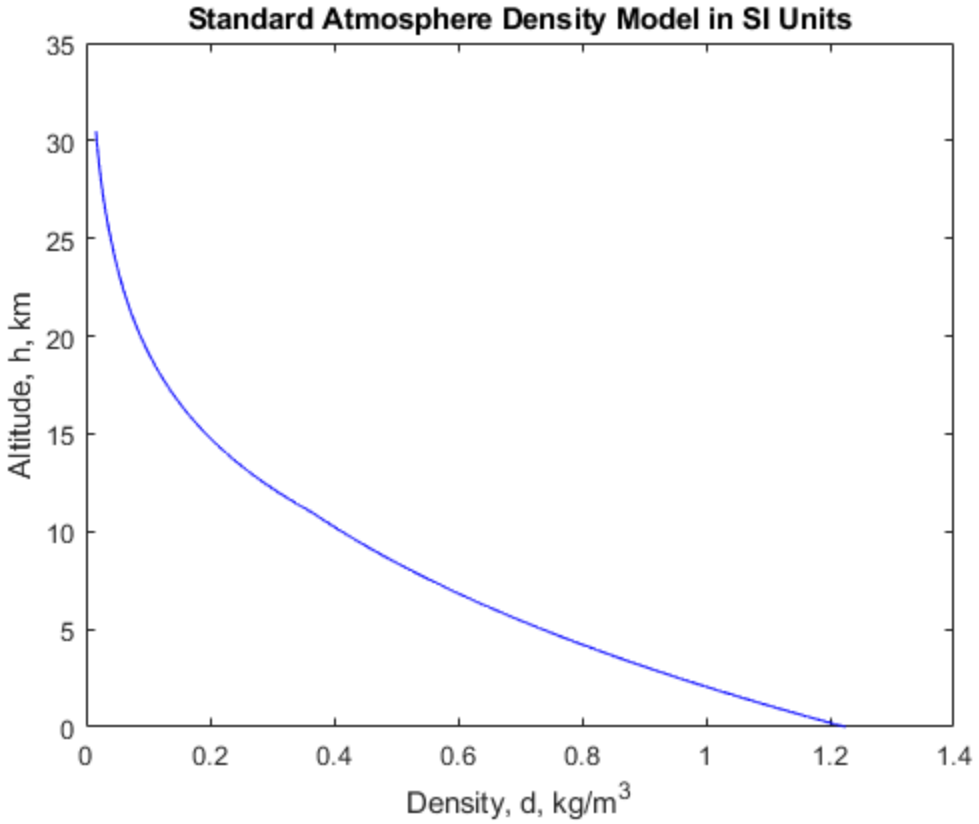


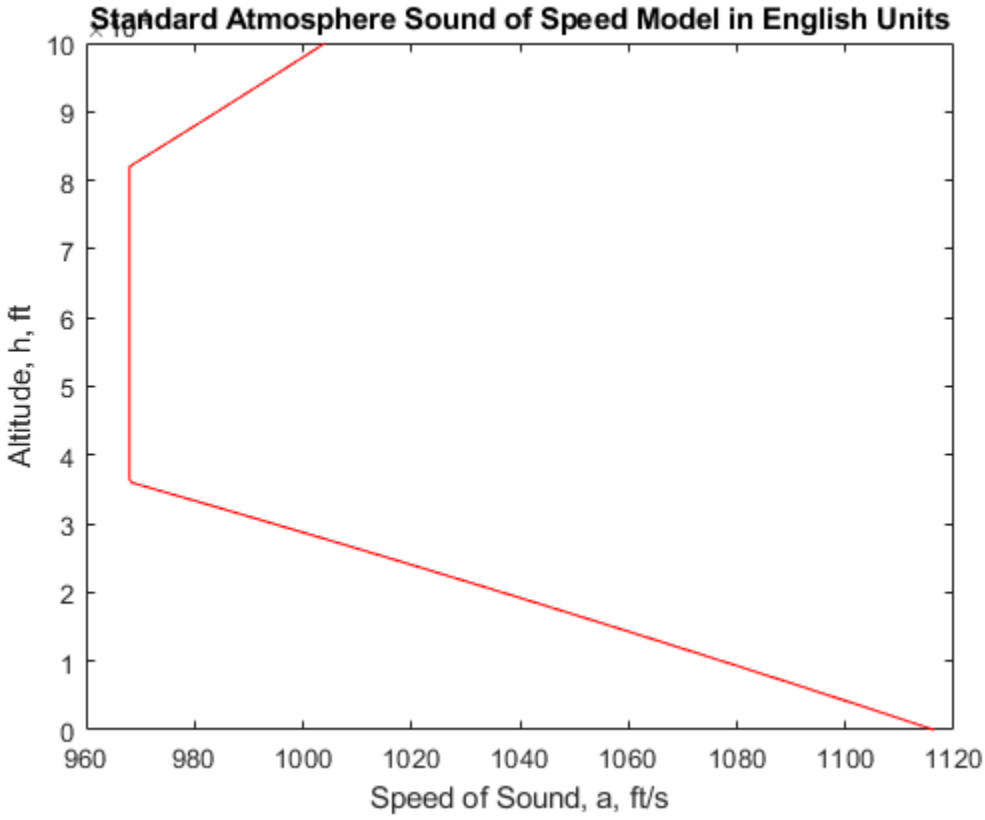

Standard Atmosphere Temperature Model in SI Units
Altitude, h, km
Temperature, T, kelvin
0
5
10
15
20
25
30
35
210
220
230
240
250
260
270
280
290

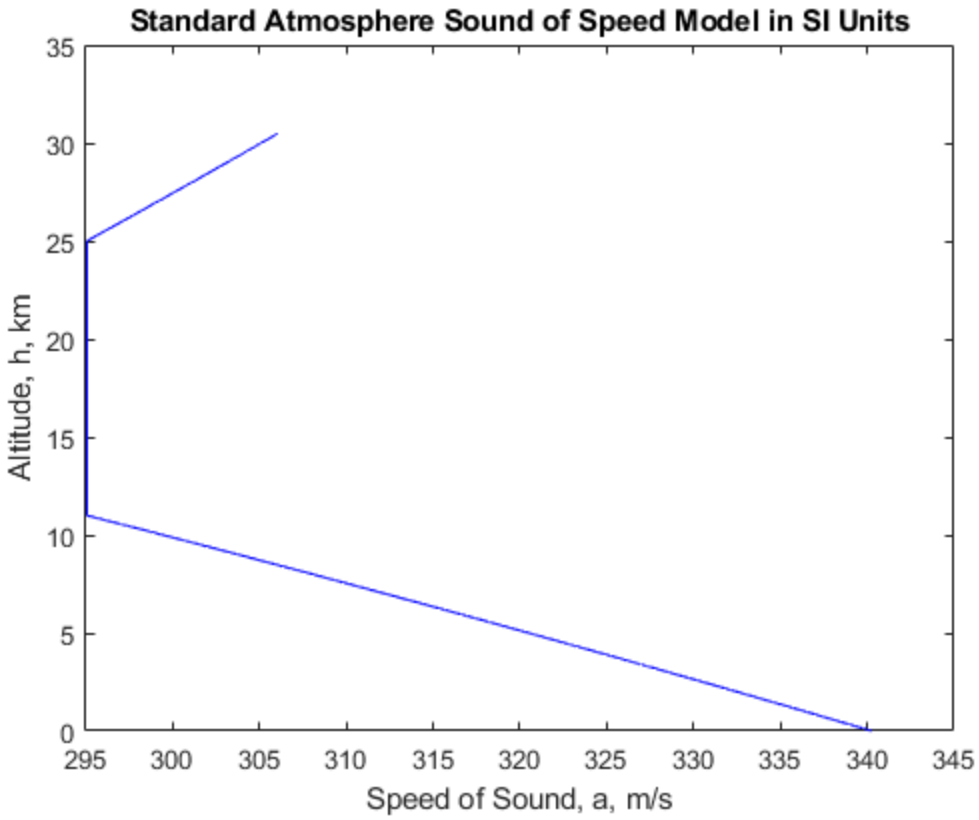

Standard Atmosphere Pressure Model in English Units
×10
Altitude, h, ft
Pressure, p, lb/ft2
0
1
2
3
4
5
6
7
8
9
10
0
500
1000
1500
2000
2500


Standard Atmosphere Pressure Model in SI Units
Altitude, h, km
Pressure, p, Pa
×10^4
0
5
10
15
20
25
30
35
0
2
4
6
8
10
12


×10^4
Standard Atmosphere Density Model in English Units
Altitude, h, ft
Density, d, slugs/ft^3
×10^-3
0
1
2
3
4
5
6
7
8
9
10
0
0.5
1
1.5
2
2.5


Standard Atmosphere Density Model in SI Units
Altitude, h, km
Density, d, kg/m3
0
5
10
15
20
25
30
35
0
0.2
0.4
0.6
0.8
1
1.2
1.4


Standard Atmosphere Sound of Speed Model in English Units
Altitude, h, ft
Speed of Sound, a, ft/s
0
1
2
3
4
5
6
7
8
9
10
960
980
1000
1020
1040
1060
1080
1100
1120



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