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```
% ASEN 2002 Thermodynamics Design Laboratory Assignment: Atmospheric
% Satellites
clc
clear
close all
```

Constants

```
% Flight properties
mass_payload = 500; % [kg]
altitude = 25000; %[m]

% Balloon Material Properties
% (average of values given on matweb for polyester film)
density_material = 1255; % [kg/m^3]
FS = 1.5; % Factor of Safety
YS = 27.6*10^6; % [Pa]

% Gas properties
gage_pressure = 10;       % [Pa]
R = 8.314;                % [Nm/kmol]
molar_mass_helium = 4.0026e-03; % [kg/mol]
R_helium = 2077.1;        % [J/kgK]

% Radiation Constants
sigmaSB = 5.670*(10^-8); % [J/(K^4m^2s)] - Stephan Boltzman constant
alphasb = .6;            % Absortivity of the sun-balloon system
epsilonb = .8;           % Emissivity of the balloon
alphaeb = epsilonb;      % Absortivity of the earth-balloon system
qsun = 1353;             % [W/m^2] - Solar irradiance
qearth = 237;            % [W/m^2] - Earth irradiance
```

Calculate temperature of the balloon at day and night

```
temp_day = (((alphasb*qsun)+(alphaeb*qearth))/
(epsilonb*sigmaSB*4))^.25;
temp_night = ((alphaeb*qearth)/(epsilonb*sigmaSB*4))^.25;
fprintf('temp_day: %.3f, temp_night: %.3f\n', temp_day, temp_night);
```

```
temp_day: 272.564, temp_night: 179.794
```

Calculate atmospheric conditions based on the 1976 standard atmosphere at 25km

```
[temp_25km, speed_of_sound_25km, pressure_25km, density_25km] = ...
    atmoscoesa(altitude, 'None'); % [k, m/s, Pa, kg/m^3]
```

Calculate the density of helium at 25km conditions

```
density_helium_day = (pressure_25km + 10)/(R_helium * temp_day); %
 [kg/m^3]
density_helium_night = (pressure_25km + 10)/(R_helium * temp_night); %
 [kg/m^3]
```

Calculate radius of balloon at night (launch time)

```
radius_night = nthroot((mass_payload/((((4*pi)/3)*density_25km)-
(((4*pi)/3)...
    *density_helium_night)-((4*pi*density_material*gage_pressure*FS)/
(2*YS)))), 3); % [m]
```

Calculate mass of balloon material

```
mass_material =
 (4*pi*density_material*gage_pressure*FS*(radius_night^3))/(2*YS); %
 [kg]
```

Calculate # of moles and mass of helium present at night

```
volume_helium_night = (4/3)*pi*radius_night^3; % [m^3]
moles_helium_night = ((pressure_25km +
 gage_pressure)*volume_helium_night)/(R*temp_night); % [mol]
```

```
mass_helium_night = moles_helium_night * molar_mass_helium; % [kg]
```

Calculate the volume of the helium at the day-time temperature

Note that pressure and # of moles remains constant as temperature increases, thus volume must increase. We'll vent gas later

```
volume_helium_day = (moles_helium_night*R*temp_day)/(pressure_25km +
 gage_pressure);
```

Calculate how much helium we need to vent

```
volume_delta = volume_helium_day - volume_helium_night;
moles_delta = ((pressure_25km + gage_pressure)*volume_delta)/
(R*temp_day);
mass_delta = moles_delta*molar_mass_helium;
```

Calculate final (daytime) mass of helium

```
mass_helium_day = mass_helium_night-mass_delta;
```

Published with MATLAB® R2020a