```
%% Initialization: Driver, Driven, and Nozzle Conditions

% Driver Tube (station 4), Gas = Air
p4 = 82; % [psi]
t4 = 297; % [K]
% t4 = 4.775944444444444e+02;
gamma4 = 1.4;
r4 = 287; % [J/(kg*K)]
a4 = sqrt(gamma4 * r4 * t4); % [m/s]

% Driven Tube (station 1), Gas = Air
p1 = 14.7; % [psi]
t1 = 297; % [K]
gamma1 = 1.4;
r1 = 287; % [J/(kg*K)]
a1 = sqrt(gamma1 * r1 * t1); % [m/s]
l1 = 5; % [m]

% Ratios
p4p1 = p4 / p1;
t4t1 = t4 / t1;
a4a1 = a4 / a1;
gg_1 = (gamma1 + 1) / (gamma1 - 1);
g2g_1 = (2 * gamma1) / (gamma1 + 1);
gg_4 = (gamma4 + 1) / (gamma4 - 1);
g2g_4 = (2 * gamma4) / (gamma4 + 1);

% Nozzle Mach Number
Mdesign = 4;

%% Incident Shock
% find pressure and temperature ratios across the incident shock
    % solve for p2/p1 using eq. 7.94
    p2p1_func = @(p2p1_ratio) p2p1_ratio*((1 - ((gamma4 - 1) * (1/a4a1) * ...
        (p2p1_ratio - 1)) / (sqrt(2 * gamma1 * (2 * gamma1 + (gamma1 + ...
        1) * (p2p1_ratio - 1)))))^(-2 * gamma4 / (gamma4 - 1))) - p4p1;
    p2p1_guess = 1;
    p2p1 = fsolve(p2p1_func, p2p1_guess, optimset('Display', 'off'));

    % solve for t2/t1 using eq. 7.10
    t2t1 = p2p1 * ((gg_1 + p2p1) / (1 + gg_1 * p2p1));

% find wave velocity, W, of the incident shock
Wi = a1 * sqrt((1 / g2g_1) * (p2p1 - 1) + 1); % [m/s]

% find Mach number of the incident shock, Ms using eq. b/t 7.11 and 7.12
Ms = Wi / a1; % gives the same result as eq. 7.13 below
% Ms = sqrt(g2g * (p2p1 - 1) + 1); % eq. 7.13

% find induced velocity up behind the wave using eq. 7.16
```

```
up = (a1 / gamma1) * (p2p1 - 1) * ((g2g_1 / (p2p1 + (1/gg_1)))^0.5); %[m/s]

% find induced particle mach number using eq. 7.17
Mp = (up / a1) * sqrt(1 / t2t1);

% Check p4/p1 with eq. 8 from GALCIT-6 CalTech
check = (1 + g2g_1 * (Ms^2 - 1)) / ((1 - (gamma4 - 1) / (gamma1 + 1) * ...
    a1 / a4 * (Ms^2 - 1) / Ms)^(2 * gamma4 / (gamma4 - 1)));
%% Calculations: Reflected Shock
% find reflected shock Mach number using eq. 7.23
Mr_func = @ (Mr_var) (Ms / (Ms^2 - 1)) * sqrt(1 + (2 * (gamma1 - 1) / ...
    (gamma1 + 1)^2) * (Ms^2 - 1) * (gamma1 + (1 / Ms^2))) - ...
    (Mr_var / (Mr_var^2 - 1));
Mr = fzero(Mr_func, Ms, optimset('Display', 'off'));

% calculate pressure ratio after reflected shock, p5/p2 adapting eq. 7.12
% using the reflected shock Mach (Mr) instead of incident shock Mach (Ms)
    % Note: refere to eq. 3.57 where M1 = Mr
p5p2 = 1 + g2g_1 * (Mr^2 - 1);

% calculate pressure ratio p5/p1
p5p1 = 1 + 2 * (p2p1 - 1) * ((1 + (0.5 + 1 / gg_1) * (Ms^2 - 1)) / ...
    (1 + 1 / gg_1 * (Ms^2 - 1)));
% check = p5p2 * p2p1;

% calculate temperature ratio, T5/T2 adapting eq. 3.59 where M1 = Mr
t5t2 = (1 + g2g_1 * (Mr^2 - 1)) * ((2 + (gamma1 - 1) * Mr^2) / ...
    ((gamma1 + 1) * Mr^2));
```

```
% static temperature and speed of sound after reflected shock
t5 = t5t2 * t2t1 * t1; % [K]

% static pressure after reflected shock
p5 = p5p1 * p1; % [psi]

% Station 5 conditions
disp('STATION 5 CONDITIONS (after reflected shock):');
```

```
STATION 5 CONDITIONS (after reflected shock):
```

```
disp(['Pressure (P5): ',num2str(p5),' [psi]']);
```

```
Pressure (P5): 67.1457 [psi]
```

```
fprintf('***Calculated P5 appears to very closely represent experimental
results***')
```

```
***Calculated P5 appears to very closely represent experimental results***
```

```
disp(['Temperature (T5): ',num2str(t5),' [K]',newline]);
```

```
Temperature (T5): 470.2028 [K]
```

```
fprintf('The calculated T5 temperature is much higher than temperatures you would
get in other tunnels')
```

```
The calculated T5 temperature is much higher than temperatures you would get in other tunnels
```

```
fprintf('*** This allows for higher enthalpy tests ***')
```

```
*** This allows for higher enthalpy tests ***
```