Project 2: Van Der Waals Equation

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Main Code

You can run this code section by section to test my each question.

You can also find my full code (so you don't have to copy my programs from this pdf) and the raw file (in Markdown) of this pdf on my Github: github.com/WangHaoZhe/Project2_VanDerWaalsEquation

```
% Project 2: Van Der Waals Equation
% Author: WangHaoZhe 522072910008
% Create Date: 2023/5/6
% Submit Date: 2023/5/6

%% Parameters
a = 3.592;
b = 0.04267;
R = 0.082054;
T = 298;
P = 1;
error = 2^(-16);
max_step = 100;

%% NewtonMethod
V = NewtonMethod(P,a,b,R,T,error,max_step);

%% Fixpoint
V = Fixpoint(P,a,b,R,T,error,max_step);

%% Plot V-T
t = linspace(50,300,100);
V = [];
for i=1:100
    V(end+1) = NewtonMethod(P,a,b,R,t(i),error,max_step);
end
plot(t,V);
```

Question 1: Iteration

Code

File Name: NewtonFunction.m

```
function y = NewtonFunction(x,P,a,b,R,T)
syms V;
f = V - ((R * T * V^2 / (P * V^2 +a) + b - V)./diff(R * T * V^2 / (P * V^2 +a) + b
- V, V));
y = subs(f,x);
end
```

File Name: NewtonMethod.m

```
function x = NewtonMethod(P,a,b,R,T,error,max_step)
    V_ini = (R * T) / P;
    step = 0;
    x_rev = V_ini;
    x_new = V_ini;

    while step < max_step
        x_old = x_new;
        x_new = NewtonFunction(x_old,P,a,b,R,T);
        x_rev(end + 1) = x_new;
        if    abs(x_new - x_old)<error
              x = x_rev(step+2);
              break
        end
        step = step + 1;
    end
end
```

Result

V = 24.3474899453862

File Name: Fixpoint.m

```
function x = Fixpoint(P,a,b,R,T,error,max_step)
    V_ini = (R * T) / P;
    step = 0;
    x_rev = V_ini;
    x_new = V_ini;
    f = @(V)R * T * V^2 / (P * V^2 +a) + b;

    while step < max_step
        x_old = x_new;
        x_new = f(x_old);
        x_rev(end + 1) = x_new;
        if abs(x_new - x_old) < error
            x = x_rev(step+2);
            break
```

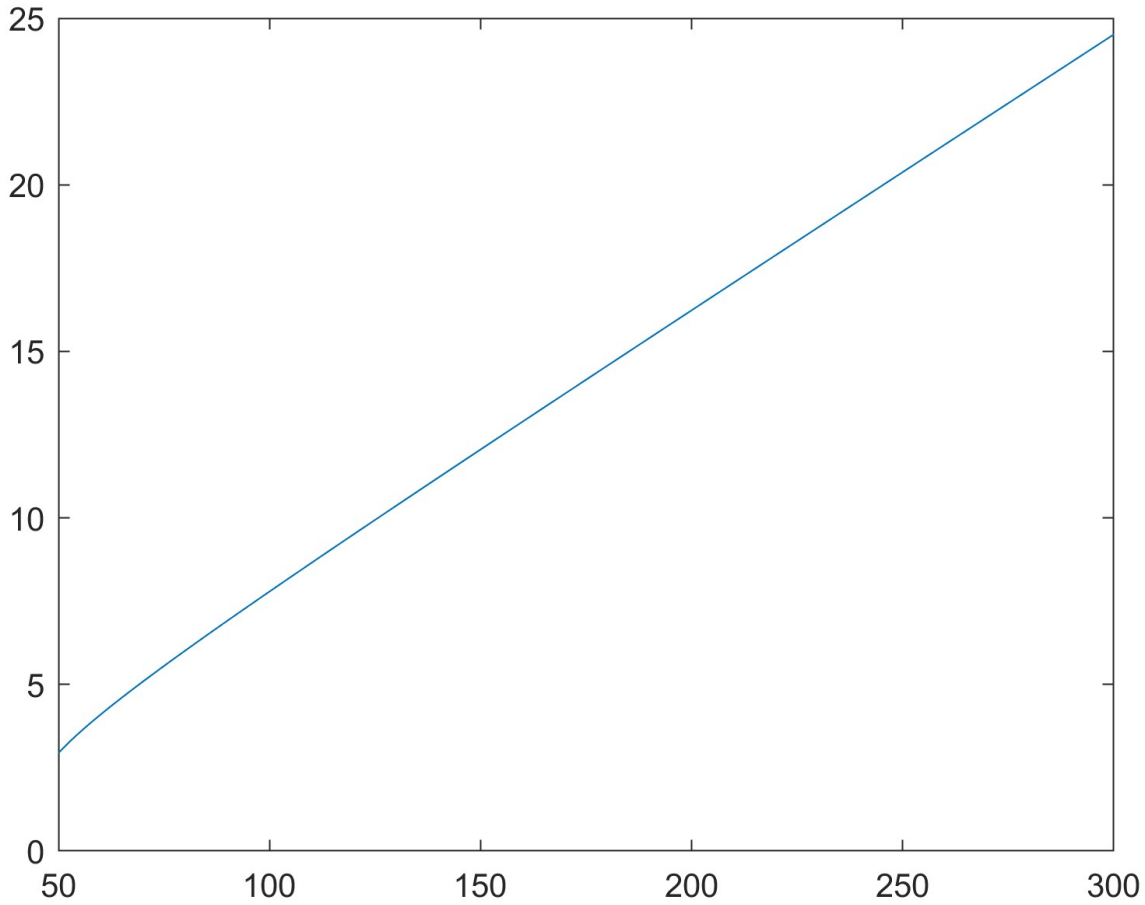
```
            end
            step = step + 1;
        end
    end
```

Result

V = 24.3474901260847

Question 2: Plot V-T

Result



V-T is not linear when T<70. Therefore, the Ideal Gas Law only applies to the case where T<70.

*The iteration Method does not convergence when T<46.2.