```
% Kathryn Atherton
% ABE 202 Homework
% Alcohol Metabolism

function ABE202homework20417
    % dose
    D = 8 * 46.2 * 0.5 * 0.78924;

    [t,y] = ode45(@metmodel, [0 24], [0;0;0], [], D);
    figure(1)
    plot(t,y(:,2))
    hold on
    plot (t,y(:,3))
    title('Alcohol and Acetaldehyde Concentrations')
    xlabel('Time, hours')
    ylabel('Concentrations, g/ml')
    legend('Alcohol', 'Acetaldehyde')

    peakethanol = max(y(:,2));
    peakacetaldehyde = max(y(:,3));
    maxtimeethanol = find(y(:,2) == peakethanol);
    maxtimeacetaldehyde = find(y(:,3) == peakacetaldehyde);
    timeethanol = t(maxtimeethanol);
    timeacetaldehyde = t(maxtimeacetaldehyde);

    D = 0;
    peakethanoldrive = 0;

    while peakethanoldrive < 0.08
        D = D + 1;
        [t,y] = ode45(@metmodel, [0 24], [0;0;0], [], D);
        peakethanoldrive = max(y(:,2));
    end

    drinks = D / (46.2 * 0.5 * 0.78924);

    D = 0;
    peakethanoldrivehet = 0;

    while peakethanoldrivehet < 0.08
        D = D + 1;
        [t,y] = ode45(@metmodelhet, [0 24], [0;0;0], [], D);
        peakethanoldrivehet = max(y(:,2));
    end

    drinkshet = D / (46.2 * 0.5 * 0.78924);

    D = 0;
    peakethanoldrivehom = 0;

    while peakethanoldrivehom < 0.08
        D = D + 1;
```

```
        [t,y] = ode45(@metmodelhom, [0 24], [0;0;0], [], D);
        peakethanoldrivehom = max(y(:,2));
    end

    drinkshom = D / (46.2 * 0.5 * 0.78924);

    % Number One %
    fprintf('1): \n');
    fprintf('   Full equation for dB/dt: \n');
    fprintf('      dB/dt = Ka * I - (Vadhmax * B - A * Vadhrev) /
 (Kmadh + B + A * Kadhrev)\n');
    fprintf('   Full equation for dA/dt: \n');
    fprintf('      dA/dt = dAdt = ((Vadhmax * B - A * Vadhrev) /
 (Kmadh + B + A * Kadhrev)) - ((Valdhmax * A) / (Kmaldh + A))\n')
    fprintf('\n');

    % Number Two %
    fprintf('2): \n');
    fprintf('   Plot alcohol and acetaldehyde concentration for
 situation:\n');
    fprintf('      see plot.\n');
    fprintf('   Peak blood alcohol content:\n');
    fprintf('      %f M\n', peakethanol);
    fprintf('   Peak blood acetaldehyde content:\n');
    fprintf('      %f M\n', peakacetaldehyde);
    fprintf('   Time after consumption peak blood alcohol level
 occurs:\n');
    fprintf('      %f hrs\n', timeethanol);
    fprintf('   Time after consumption peak blood acetaldehyde level
 occurs:\n');
    fprintf('      %f hrs\n', timeacetaldehyde);
    fprintf('\n');

    % Number Three %
    fprintf('3): \n');
    fprintf('   Drinks to reach Indiana legal limit for driving:\n');
    fprintf('      %f drinks\n', drinks);
    fprintf('\n');

    % Number Four %
    fprintf('4): \n');
    fprintf('   Does slower ALDH rate affect blood alcohol content in
 mutants? \n');
    fprintf('      Yes, as the amount of acetaldehyde affects the dB/
dt equation (A). The mutation makes the dB/dt process slower, which
 keeps the blood-alcohol content higher, longer. \n');
    fprintf('   Number of drinks to reach legal limit for mutant
 genotypes: \n');
    fprintf('      Heterozygous: %f drinks\n', drinkshet);
    fprintf('      Homozygous: %f drinks\n', drinkshom);
    fprintf('\n');

    % Bonus %
    fprintf('Bonus): \n');
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    fprintf('   Component used in hangover "cures": \n');
    fprintf('      ALDH\n');
    fprintf('   Why?\n');
    fprintf('      ALDH is the enzyme which breaks down the toxic
 byproduct of the breakdown of ethanol, acetaldehyde.\n');
    fprintf('      If ALDH malfunctions or is inhibited, acetaldehyde
 cannot be properly broken down, leading to adverse \n');
    fprintf('      side effects that are seen in hangovers.\n');
    fprintf('\n');

end

function dydt = metmodel(t,y,D)

    % Constants %
    Kemax = 10.2; % per hour
    a = 0.00167; % g^-2
    Ka = 25.1; % per hour
    V = 44.100; % ml
    Vm = 0.202; % mg/ml * hr
    Km = 0.0818; % %mg/ml
    Vadhmax = 0.184;
    Valdhmax = 0.246;
    Kadhrev = 1;
    Vadhrev = 3.26;
    Kmadh = 0.014; % %mg/ml
    Kmaldh = 0.0000528; % %mg/ml

    Ke = Kemax / (1 + a * D^2);

    % Amount of Alcohol in Places Tracked %

    I = y(1); % amount of alcohol in intestine
    B = y(2); % amount of alcohol in body/blood
    A = y(3); % amount of acetaldehyde in body/blood

    % determining F
    if D <= 11.2
        F = 0.785;
    elseif D <= 22.4
        F = 0.96;
    else
        F = 1;
    end

    % Differential Equations %

    dIdt = Ke * (F * D / V) * exp(-(Ke * t)) - Ka * I; % need to find
 I
    dBdt = Ka * I - (Vadhmax * B - A * Vadhrev) / (Kmadh + B + A *
 Kadhrev); % need to find B
    dAdt = ((Vadhmax * B) - (A * Vadhrev)) / (Kmadh + B + (A *
 Kadhrev)) - (Valdhmax * A) / (Kmaldh + A); % ???, need to find A
```

```
    dydt = [dIdt; dBdt; dAdt];
end

function dydt = metmodelhet(t,y,D)

    % Constants %
    Kemax = 10.2; % per hour
    a = 0.00167; % g^-2
    Ka = 25.1; % per hour
    V = 44.100; % ml
    Vm = 0.202; % mg/ml * hr
    Km = 0.0818; % %mg/ml
    Vadhmax = 0.184;
    Valdhmax = 0.246;
    Kadhrev = 1;
    Vadhrev = 3.26;
    Kmadh = 0.014; % %mg/ml
    Kmaldh = 0.0000528 * 0.7; % %mg/ml

    Ke = Kemax / (1 + a * D^2);

    % Amount of Alcohol in Places Tracked %

    I = y(1); % amount of alcohol in intestine
    B = y(2); % amount of alcohol in body/blood
    A = y(3); % amount of acetaldehyde in body/blood

    % determining F
    if D <= 11.2
        F = 0.785;
    elseif D <= 22.4
        F = 0.96;
    else
        F = 1;
    end

    % Differential Equations %

    dIdt = Ke * (F * D / V) * exp(-(Ke * t)) - Ka * I; % need to find
 I
    dBdt = Ka * I - (Vadhmax * B - A * Vadhrev) / (Kmadh + B + A *
 Kadhrev); % need to find B
    dAdt = ((Vadhmax * B) - (A * Vadhrev)) / (Kmadh + B + (A *
 Kadhrev)) - (Valdhmax * A) / (Kmaldh + A); % ???, need to find A

    dydt = [dIdt; dBdt; dAdt];
end

function dydt = metmodelhom(t,y,D)

    % Constants %
    Kemax = 10.2; % per hour
    a = 0.00167; % g^-2
    Ka = 25.1; % per hour
```

```
    V = 44.100; % ml
    Vm = 0.202; % mg/ml * hr
    Km = 0.0818; % %mg/ml
    Vadhmax = 0.184;
    Valdhmax = 0.246;
    Kadhrev = 1;
    Vadhrev = 3.26;
    Kmadh = 0.014; % %mg/ml
    Kmaldh = 0.0000528 * 0.55; % %mg/ml

    Ke = Kemax / (1 + a * D^2);

    % Amount of Alcohol in Places Tracked %

    I = y(1); % amount of alcohol in intestine
    B = y(2); % amount of alcohol in body/blood
    A = y(3); % amount of acetaldehyde in body/blood

    % determining F
    if D <= 11.2
        F = 0.785;
    elseif D <= 22.4
        F = 0.96;
    else
        F = 1;
    end

    % Differential Equations %

    dIdt = Ke * (F * D / V) * exp(-(Ke * t)) - Ka * I; % need to find
 I
    dBdt = Ka * I - (Vadhmax * B - A * Vadhrev) / (Kmadh + B + A *
 Kadhrev); % need to find B
    dAdt = ((Vadhmax * B) - (A * Vadhrev)) / (Kmadh + B + (A *
 Kadhrev)) - (Valdhmax * A) / (Kmaldh + A); % ???, need to find A

    dydt = [dIdt; dBdt; dAdt];
end
```

1):
Full equation for dB/dt:
*dB/dt = Ka * I - (Vadhmax * B - A * Vadhrev) / (Kmadh + B + A * Kadhrev)*
Full equation for dA/dt:
*dA/dt = dAdt = ((Vadhmax * B - A * Vadhrev) / (Kmadh + B + A * Kadhrev)) - ((Valdhmax * A) / (Kmaldh + A))*

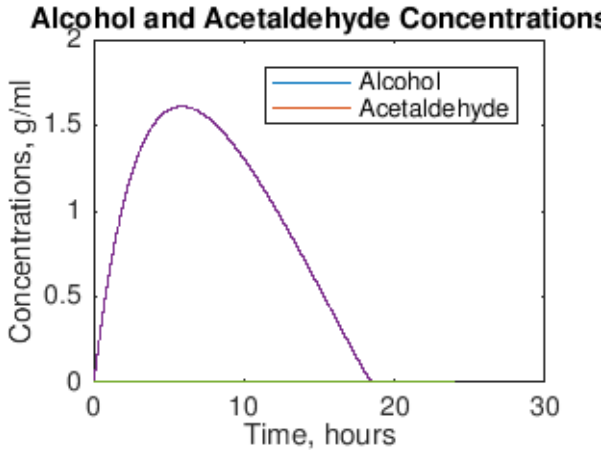
2):
Plot alcohol and acetaldehyde concentration for situation:
see plot.
Peak blood alcohol content:
1.610078 M
Peak blood acetaldehyde content:
0.000151 M

```
   Time after consumption peak blood alcohol level occurs:
      5.854020 hrs
   Time after consumption peak blood acetaldehyde level occurs:
      5.861963 hrs

3):
   Drinks to reach Indiana legal limit for driving:
      0.438802 drinks

4):
   Does slower ALDH rate affect blood alcohol content in mutants?
      Yes, as the amount of acetaldehyde affects the dB/dt equation
 (A). The mutation makes the dB/dt process slower, which keeps the
 blood-alcohol content higher, longer.
   Number of drinks to reach legal limit for mutant genotypes:
      Heterozygous: 0.438802 drinks
      Homozygous: 0.438802 drinks

Bonus):
   Component used in hangover "cures":
      ALDH
   Why?
      ALDH is the enzyme which breaks down the toxic byproduct of the
 breakdown of ethanol, acetaldehyde.
      If ALDH malfunctions or is inhibited, acetaldehyde cannot be
 properly broken down, leading to adverse
      side effects that are seen in hangovers.
```



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