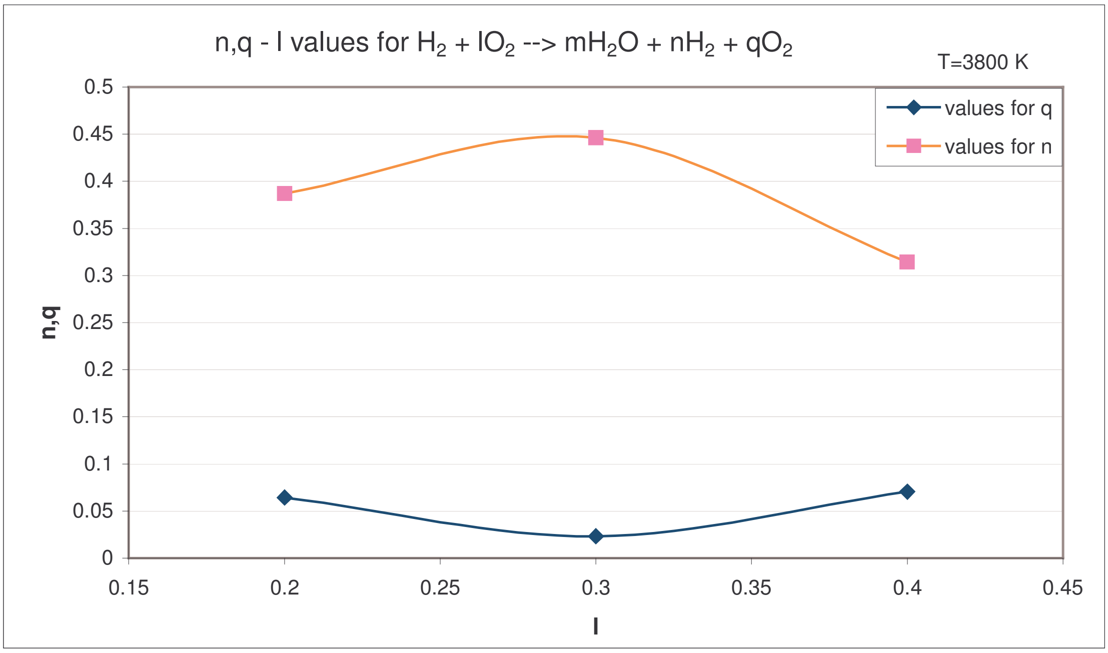
3.12 *l* moles of O_2 are mixed with 1 mole H_2. The entering temperature of the O_2 is 100 K and of H_2 is 200 K. Obtain and plot the enthalpy per mass of products for case where p_c =10 atm. Calculate for the values $l = 0.2$, 0.3, 0.4 and 0.5.

Answer

Assume T = 3800 K, where $K_p = 10^{0.413}$, and run program in Appendix for convenient values for assumed temperature. Results were obtained as below:

for $l = 0.2$ the q = 0.0064 and n = 0.387 was obtained. Enthalpy per mass is 2.663
for $l = 0.3$ the q = 0.0231 and n = 0.446 was obtained. Enthalpy per mass is 2.746
for $l = 0.4$ the q = 0.0706 and n = 0.341 was obtained. Enthalpy per mass is 2.560
for $l = 0.5$ reaction cannot take shape for that value, where $m < 0$.

Where Enthalpy per mass is (*enthalpy*)/($2+ l \times 32$).



Appendix 1

Source codes for Borland Turbo Pascal 7.0.

```
Program RocketPropulsionHW_1;

uses Crt;

procedure NIteration;
var  i, IterasyonSayisi : Integer;
     P, Kp, l, q : Real;
     A, B, C, D : Real;
     m, n : Real;
     DH, DH_Req, HH_RH2O, HH_H2O, HH_H2, HH_O2 : Real;
begin
     WriteLn('Copyright(c) 2002 Erkan Abdulhamitbilal, Astronautics Eng. - ITU');
     WriteLn('=================================================================');
     WriteLn('This module calculate mol values for the given reaction below:');
     WriteLn('');
     WriteLn('H2 + lO2 --> mH2O + nH2 + qO2');
     WriteLn('');
     WriteLn('Please enter values, respectively.');
     WriteLn('');
     Write('Enter a value for......l= '); ReadLn(l);
     if (l <= 0) or (l > 1) then begin
          WriteLn('l is element of heap of values between 0 and 1.');
          Exit;
     end;
     Write('Enter a value for P(atm)= '); ReadLn(P);
     Write('Enter a value for.....Kp= '); ReadLn(Kp);
     Write('Enter iterasion....steps= '); ReadLn(IterasyonSayisi);
     A := 4 * (1-1/(P*Sqr(Kp)));
     B := 4 * (1-2*l) * (1-1/(P*Sqr(Kp)));
     C := Sqr((1-2*l) + ((4*l)/(P*Sqr(P*Kp)))*(2-l));
     D := (-4*Sqr(l)) / (P*Sqr(Kp));
     q := -(D/C);
     for i := 0 to IterasyonSayisi do begin
         q := q - (A*q*q*q + B*q*q + C*q + D)/(3*A*q*q + 2*B*q + C);
     end;
     WriteLn('---------------------------');
     WriteLn('q=', q);
     m := 2 * (l-q);
     n := 1 - 2*(l-q);
     WriteLn('m=', m);
     WriteLn('n=', n);
     WriteLn('');
     WriteLn('Enter values below from JANNAF Tables...');
     Write('Enter H - H298 value for H2O= '); ReadLn(HH_H2O);
     Write('Enter H - H298 value for H2 = '); ReadLn(HH_H2);
     Write('Enter H - H298 value for O2 = '); ReadLn(HH_O2);
     Write('Enter Hf298 value for reference H2O= '); ReadLn(HH_RH2O);
     WriteLn('--------------------------------------------------');
     DH := m*HH_RH2O;
     DH_Req := m*HH_H2O + n*HH_H2 + q*HH_O2;
     WriteLn('Note that Dh < DHreq ...');
     WriteLn('');
     WriteLn('   Dh=', DH);
     WriteLn('DHreq=', DH_Req);

end;

begin
     ClrScr;
     NIteration;
     ReadLn;
end.
```

Appendix 2

An output for *l* = 0.3 for source codes in Appendix 1:

```
Copyright(c) 2002 Erkan Abdulhamitbilal, Astronautics Eng. - ITU
================================================================
This module calculate mol values for the given reaction below:

H2 + lO2 --> mH2O + nH2 + qO2

Please enter values, respectively.

Enter a value for......l= 0.3
Enter a value for P(atm)= 10
Enter a value for.....Kp= 2.8
Enter iterasion....steps= 100
---------------------------
q= 2.31107636354864E-0002
m= 5.53778472729391E-0001
n= 4.46221527270609E-0001

Enter values below from JANNAF Tables...
Enter H - H298 value for H2O= 41.043
Enter H - H298 value for H2 = 28.457
Enter H - H298 value for O2 = 31.221
Enter Hf298 value for reference H2O= 57.5
-------------------------------------------------
Note that Dh < DHreq ...

   Dh= 3.18422621819482E+0001
DHreq= 3.61483970092377E+0001
```