Name- Surname......................................Student Code........................

Prince of Songkla University
Faculty of Engineering

Mid-term Examination: 1st Semester
Date: 6th October 2015
Subject: 231-436 Com App for Chem Eng

Academic Year: 2015
Time: 9.00 – 12.00
Room: Com 1

ทุจริตในการสอบ โทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

- อนุญาตให้นำเอกสาร ตำรา และ พจนานุกรมอิเล็กโทรนิก เข้าห้องสอบได้
- ปิดการรับ-ส่งสัญญานโทรศัพท์มือถือ ทุกรุ่นในห้องสอบ
- ห้ามหยิบยืมเอกสาร จากผู้อื่น
- เขียนชื่อ และรหัสทุกหน้า
- กรณีกระดาษคำตอบไม่พอให้ใช้ด้านหลังได้
- ใช้ดินสอทำข้อสอบได้
- ข้อสอบมีทั้งหมด 4 ข้อ (12 หน้า รวมปก)

ข้อ	**คะแนนเต็ม**	**คะแนนที่ได้**
1	40	
2	40	
3	45	
4	40	
	165	

รศ.ดร. ลือพงศ์ แก้วศรีจันทร์
ผู้ออกข้อสอบ

Name- Surname...Student Code........................

1. a (20 points): In a gas-separation plant, the feed-to-butane splitter has the following constituents:

Component	**Mole %**
C_3	1.9
i-C_4	51.5
n-C_4	46.0
C_5+	0.6
Total	100

The flow rate is 5804 kg mol/day. If the overhead and the bottoms streams from the butane splitter have the following compositions. What are the rates of the overhead and bottoms streams in kg mol/day

	Mole %	
Component	Overhead	Bottoms
C_3	3.4	-
i-C_4	95.7	1.1
n-C_4	0.9	97.6
C_5+	-	1.3
Total	100.0	100.0

(a) Set up linear equation:

(b) Put the variables into POLYMATH linear equation solver

						beta
1						
2						
3						
4						
5						

- Overhead flow rate =
- Bottoms flow rate =

Name- Surname..Student Code........................

1. b (20 points): A polymer blend is to be formed from the three compounds whose compositions and approximate formulas are listed in the table. Determine the percentages of each compound A, B, and C to be introduced to the mixture to achieve the desired composition

	Compound (%)			
Composition	A	B	C	Desired mixture
$(CH_4)_x$	25	35	55	30
$(C_2H_6)_x$	35	20	40	30
$(C_3H_8)_x$	40	45	5	40
Total	100	100	100	100

Put the variables into POLYMATH linear equation solver

						beta
1						
2						
3						
4						
5						

- Percentage of A =
- Percentage of B =
- Percentage of C =

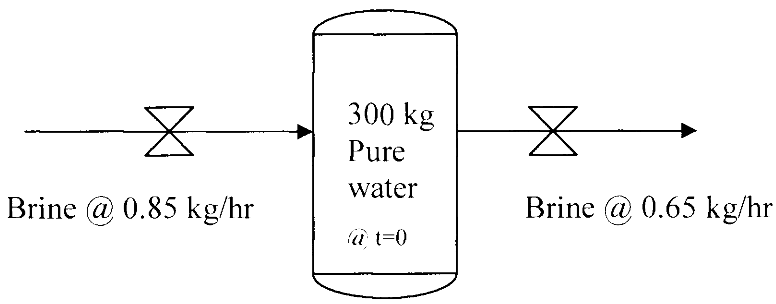
How would you decide to blend compounds A, B, C and D [$(CH_4)_x$ = 10 %, $(C_2H_6)_x$ = 30 % , $(C_3H_8)_x$ = 60 %] to achieve this desired mixture

Give the answer and explanation

Name- Surname...Student Code.........................

2. (40 points) A well-mixed tank of initially 300 kg of pure water needs to replace with brine solution. At time zero a brine solution (20 % salt by weight) is being filled with an inlet flow of 0.85 kg/hr at the same time the outlet flow of the brine solution from the tank is 0.65 kg/h. (1) What is the total weight and concentration of the brine in the tank after the opening of the valves for 10 and 15 hours? (2) At what time the weight per cent brine in the tank reach 2.9 %? (3) At what time the weight of solution in the tank will be equal to 315 kg ?

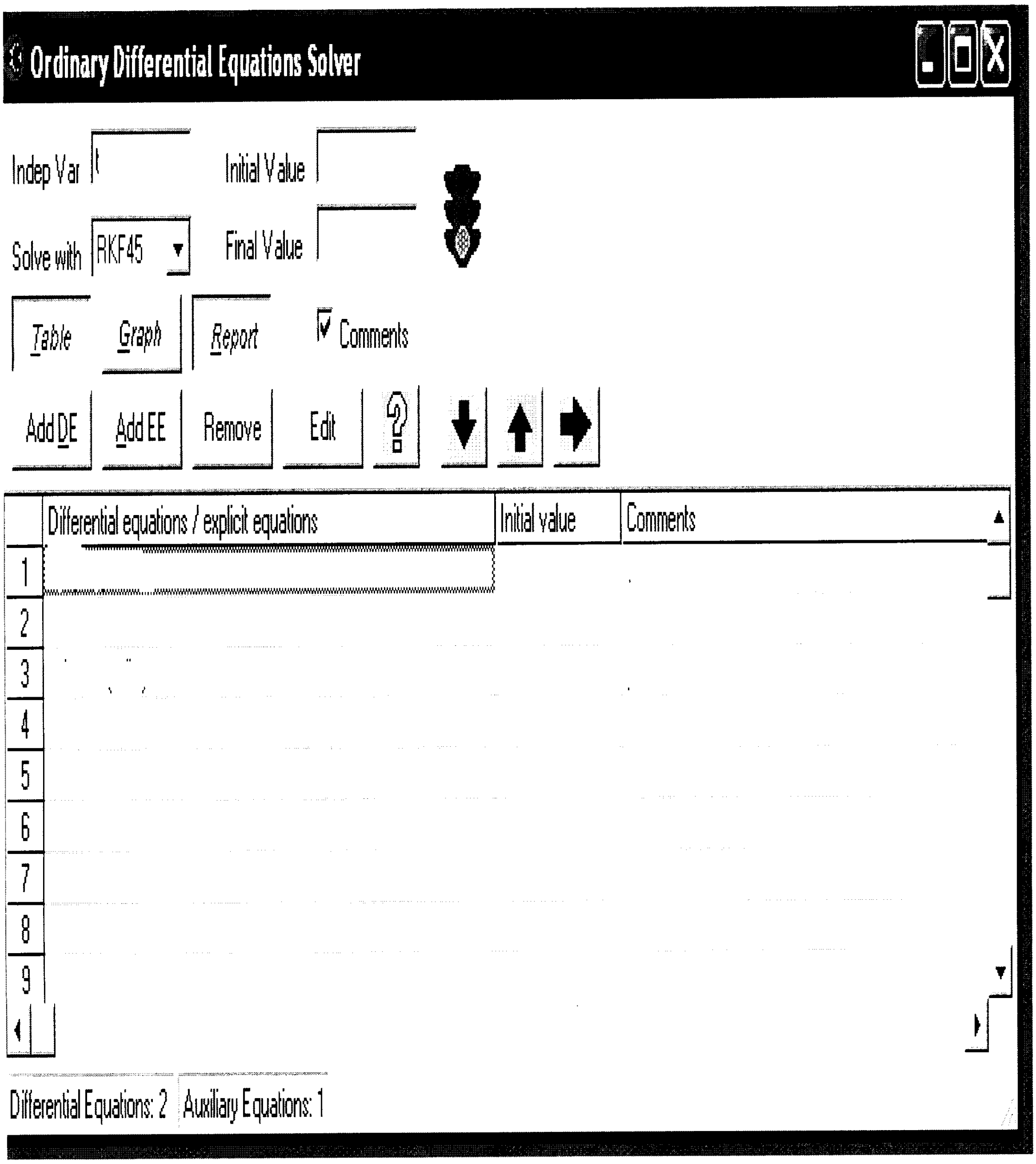
Assume no overflow from the tank since the volume of the tank is very large.



Note: At t=0, there is no brine in the tank,
Two valves opened at time zero

Name- Surname...Student Code........................

2.1 Fill the blanks of **Initial** value, **Final** value and put **Differential** equations and **Explicit** equations (do not forget comments!)



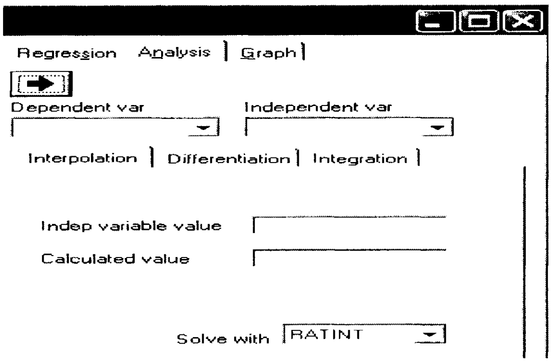
-What is the total weight and concentration of the brine in the tank after the opening of the valves for 10 hours and 15 hours?

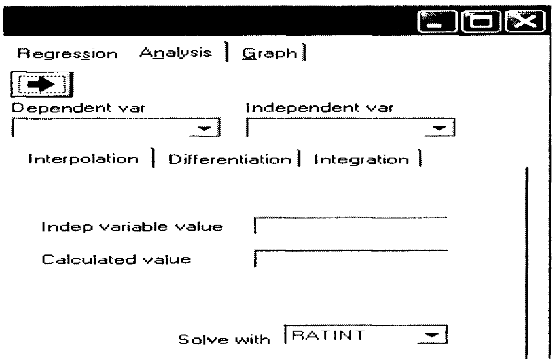
Solution

Time (hr)	Total weight (kg)	Brine concentration (%)
10		
15		

Name- Surname..Student Code........................

-Calculate the time that the weight per cent brine in the tank is 2.90 % and the time that the total weight of the solution in the tank is 315.0 kg by mean of the following windows.





<u>Time for 2.9 % Salt</u>

<u>Time for total weight = 315.0 kg</u>

Name- Surname...Student Code........................

3. (45 points) Experimental measurements of the density of benzene vapor at 563.15 K are given in the table and the figure below. Using (i) the van Der Waals equation of state: $(P+\frac{a}{v^2})(v-b)=RT$, determine parameter a and b by nonlinear regression method; (ii) the Redlich-Kwong equation of state: $P=\frac{RT}{v-B}-\frac{A}{T^{\frac{1}{2}}v(v+B)}$, determine parameter A and B by nonlinear regression method and (iii) the virial equation of state : $\frac{Pv}{RT}=1+\frac{C}{v}+\frac{D}{v^2}$, determine parameter C and D by multiple linear regression method.

P **(atm)**	***v*** **(cm^3/mole)**	***P*** **(atm)**	***v*** **(cm^3/mole)**
30.64	1114	38.39	771
31.60	1067	40.04	707
32.60	1013	41.79	646
33.89	956	43.59	591
35.17	900	45.48	506
36.63	842	47.07	443
		48.07	386

3.1 Calculate RT for this problem

	value	**Unit**
R		
R*T		

3.2 Write down model equations and initial guesses of the following ***(Note: try to use method of mrgmin instead of L-M)***

	model equations	Initial guess	Regression results
Van Der Waals		a = b =	a = b = R^2=
Redlich-Kwong		A= B=	A = B = R^2=

Name- Surname...Student Code........................

3.3 Name column 3, 4, 5...and fill in the values of row 07 (at 38.39 atm and 771 cm^3/mol) for each column (only three degits needed).

Data Table

R007 : C005 =

								C08	C09
01	30.64	1114							
02	31.60	1067							
03	32.60	1013							
04	33.89	956							
05	35.17	900							
06	36.63	842							
07	38.39	771							
08	40.04	707							
09	41.79	646							
10	43.59	591							
11	45.48	506							
12	47.07	443							
13	48.07	386							
14									

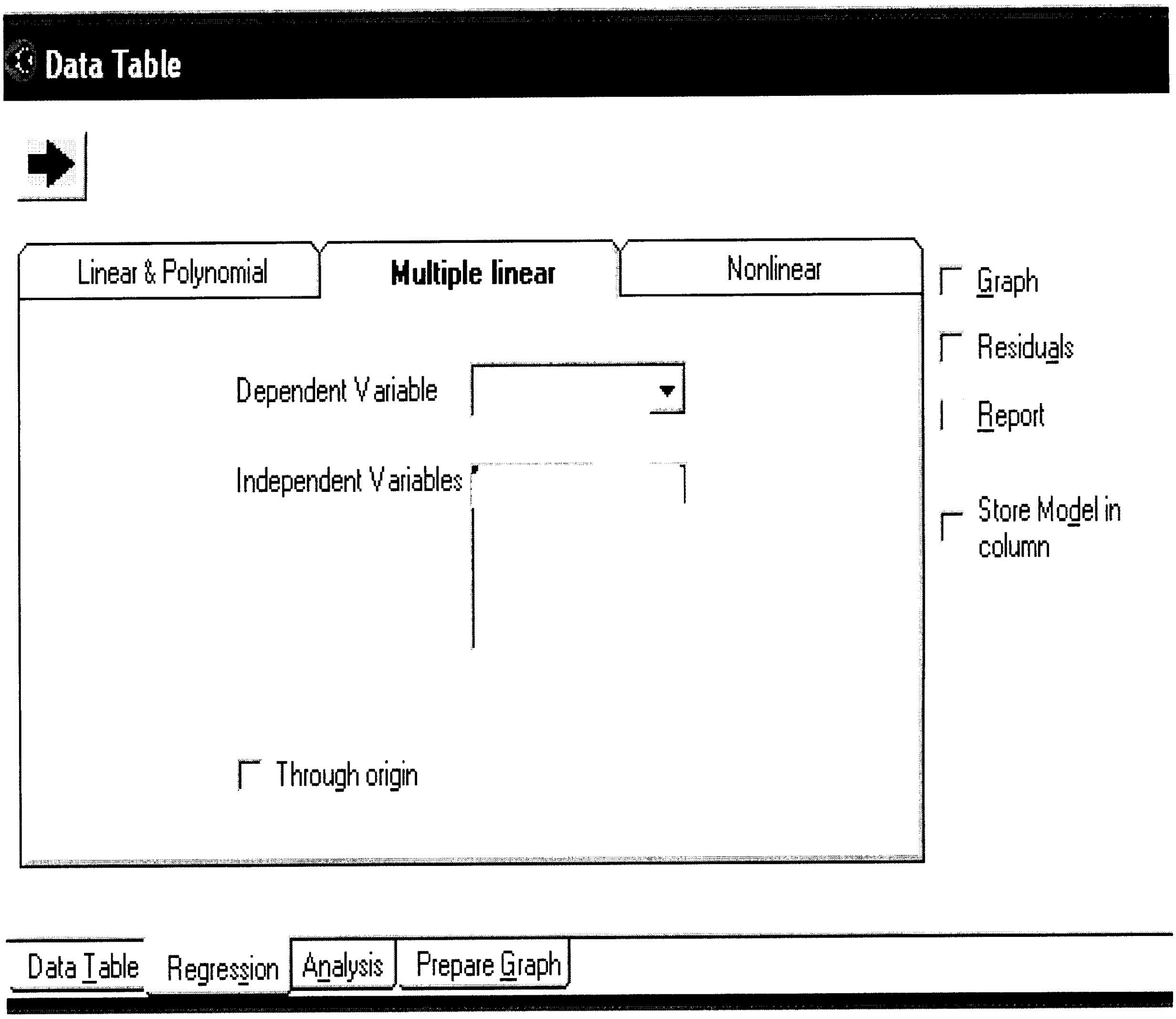
Data Table | Regression | Analysis | Prepare Graph

3.4 Show mathematical formula used for each column

Column	Name	mathematical formula
03		
04		
05		
06		
07		

Name- Surname..Student Code........................

3.5 Show the window of multiple linear regression and selected independent variable and dependent variable.



3.5 Show your results of C, D and R^2 after regression

Name- Surname.......................................Student Code........................

4. a (15 points) A spherical tank of oil has 6 feet in diameter. An operator suggests the owner to put a 8 feet ruler as a dipstick to measure the level of oil and also can calculate the remaining volume of the oil in the tank (as shown in the figure). The volume of the oil left in the tank is

$$V = \pi h^2 (3r - h)/3$$

Where, r is the radius of the tank. Calculate h in which the volume of the oil is 2/3 of the total volume (V_{Tot})

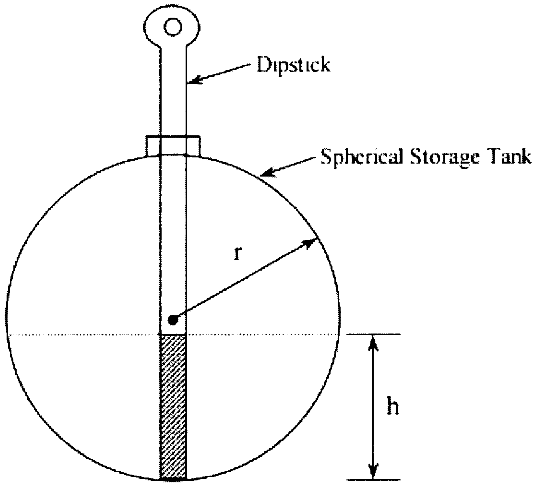
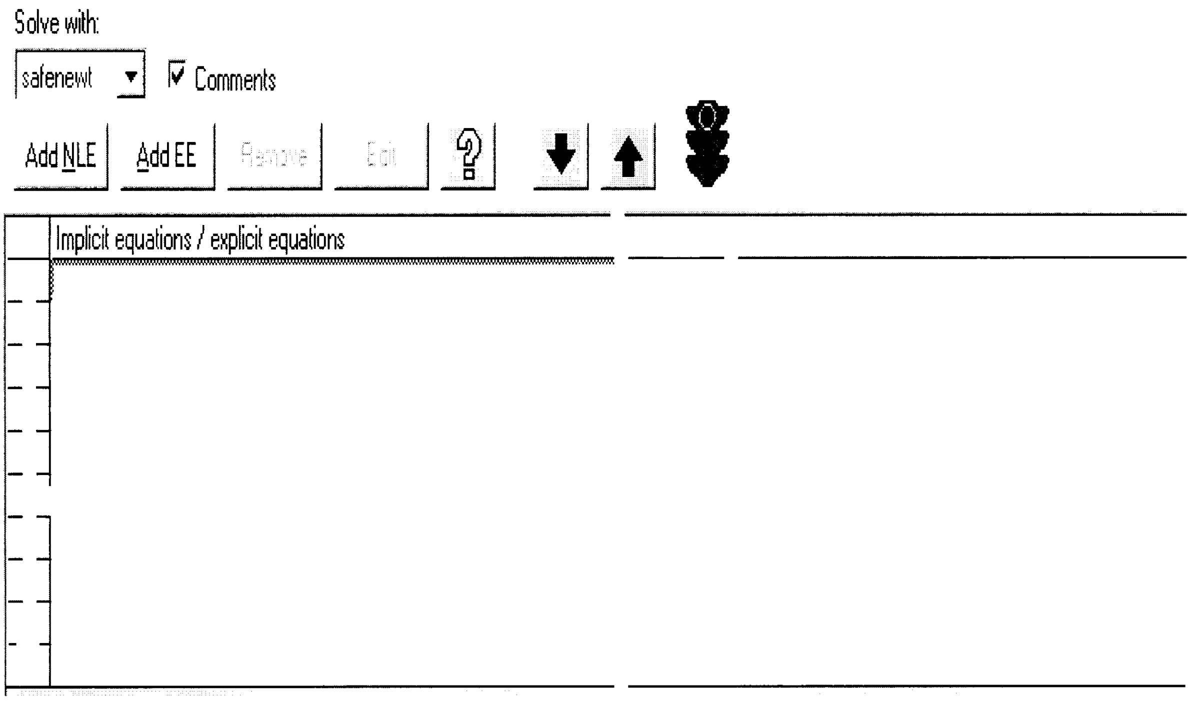


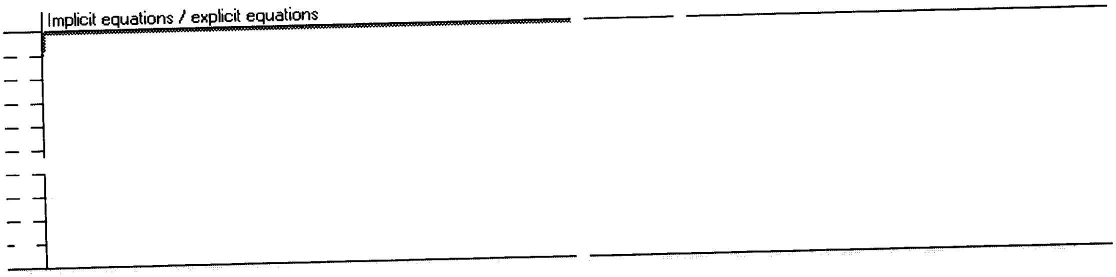
Figure Oil in a spherical storage tank.

Use Polymath to calculate 'h' by filling in the following window:



Name- Surname..Student Code........................

(continue)



	value	Unit
r		
h		
V_{Tot}		
V		

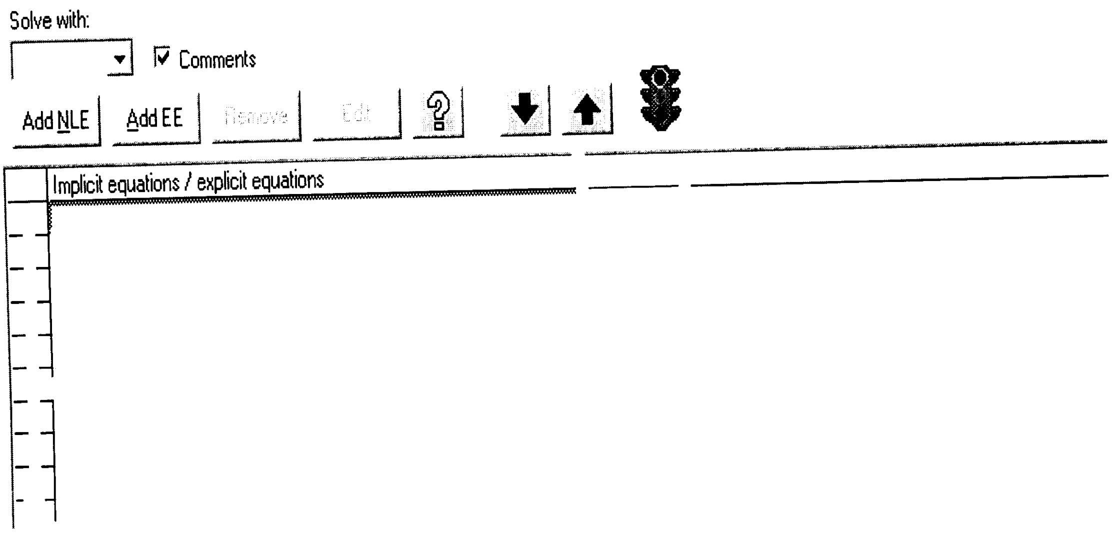
4. b (25 points) A 100 kg mole of feed gas with the following molar composition is burned with 50 % excess air in a furnace. What is the composition of the flue gas by mole percent?

CH_4: 60 %; C_2H_6: 20 %; CO: 5 %; O_2: 5 %; N_2: 10 %

$$CH_4 + 2O_2 \leftrightarrow CO_2 + 2H_2O$$
$$C_2H_6 + \tfrac{7}{2}O_2 \leftrightarrow 2CO_2 + 3H_2O$$
$$CO + \tfrac{1}{2}O_2 \leftrightarrow CO_2$$

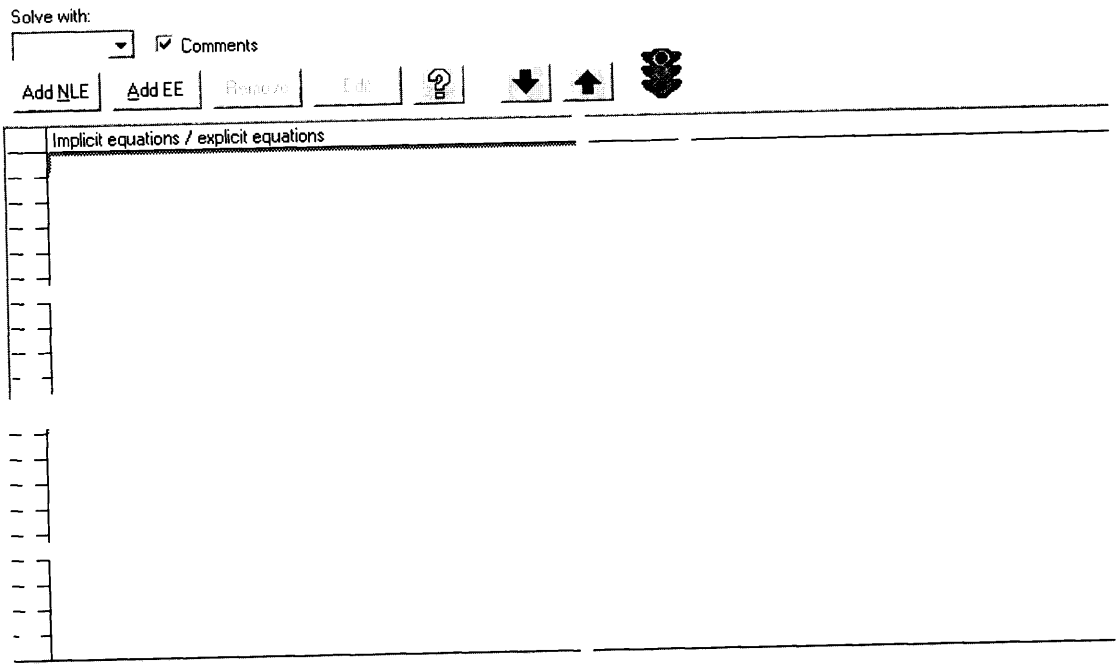
Mole fractions of O_2 and N_2 in air are 0.21 and 0.79, respectively.

Use Polymath to calculate moles of 'CO_2 and H_2O' by filling in the following window:



Name- Surname..Student Code........................

(Problem 4b continued)



Fill in the moles and molar percentage of the following gases in the table

	Reactants			Products		
substance	moles	mass (kg)	% mole	moles	mass (kg)	% mole
N_2						
O_2						
CO_2						
H_2O						
CH_4						
C_2H_6						
CO						
Total						