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**PETROLEUM ENGINEERING 310
EXAM # 1**

Rules: The only thing you are not allowed to do is to talk to your neighbors, or to think loud. This is an Open Book, notes, and homework test.

Do all your work on the test paper; if you use extra paper for any question, please attach it immediately after that question.

Remember to show all your work!!!! Answers with no evidence of calculations where they are required will not be graded. State any assumption you make.

The point value of each question is written in bold phase after the question. Total number of point is 110. If you get everything right you will have a bonus that can help later on. If not, you can get 90 out of 110 and still make an "A".

**Relax, you have plenty of time, you can do it, and do it well.
Good Luck!**

1. (a) The following hydrocarbon species are named incorrectly. In each case tell why the name is wrong and give the correct name. Draw the structural formula for the substance (**5 pts)**

(a) 4-methylpentane

(b) 3,5,5-trimethylhexane

(c) 1,3-dimethylcyclopropane

(b) What general physical properties have these substances ?. Are they combustible?. If so, what is the reaction taking place?.(**5 pts**)

2. You have to decide upon a fuel to charge a lighter. The following information is given to you.

- The highest pressure the lighter can withstand without breakage is 250 psia.
 - You want to use your lighter safely (not necessarily for smoking) during cold winter days and hot summer days. Let's suppose that $T_{\max} = 100^{\circ}\text{F}$ and $T_{\min} = 0^{\circ}\text{F}$.
 - The atmospheric pressure in your living area is around 15 psia.
- The following pure fluids are available to you, and let's suppose that they all cost the same.

(1) methane, (2) propane, and (3) n-butane.

(a) Provide engineering arguments with regards to the selection of fluid (1), (2) or (3)

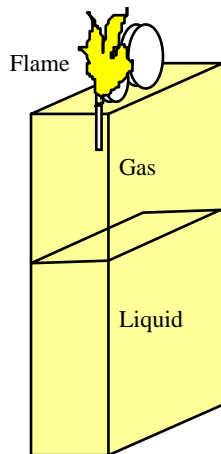
(5 pts)

(b) Provide engineering arguments with regards to the rejection of the other two fluids.(5 pts)

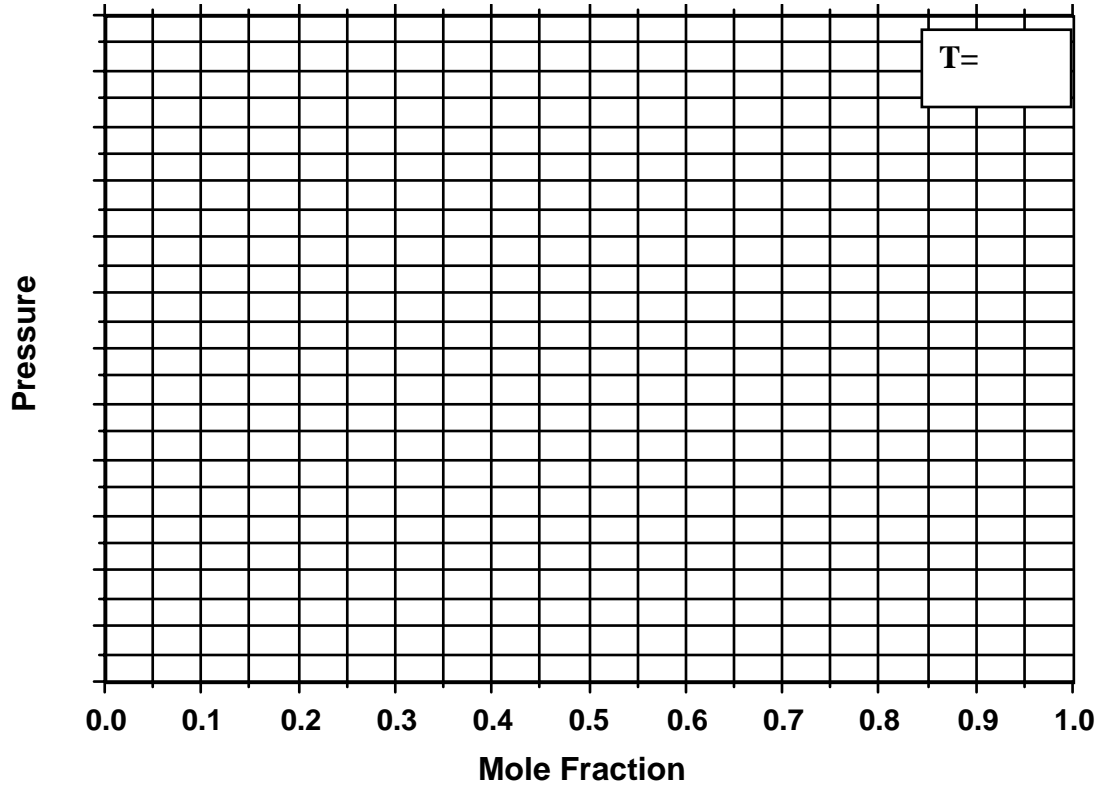
(c) Suppose that the pressure inside this lighter is 100 psig with the valve closed. What is the temperature at these conditions?. (2 pts)

Later, the valve is opened, some of the combustible fluid you've chosen leaves the lighter and a spark starts a combustion process. Assume that the temperature inside the lighter remains constant.

(d) What is the pressure inside the lighter while the fluid is burning ?. **Hint:** A (PV) diagram for a pure substance can help to answer this question. (3 pts)



3. Sketch a typical (Pressure, Composition) diagram for a binary mixture of n-butane and n-hexane. Use the Cox charts (page 56 McCain) to identify some important points, for example the saturation pressure (or vapor pressure) of the pure components. You can select any temperature you want for this. The following grid will help you in your sketch. Label everything: vapor, liquid, 2-phase region, dew curve, bubble curve etc. **(10 pts)**



4. You have mixture of 70% moles of methane and 30% moles of ethane at 60°F and 100 psia. You would be losing money if you sell a gas that has so much ethane because ethane can be sold separately at a higher price. Therefore you decide to cool down this mixture to produce a gas with less ethane than the original. Suppose that you brought the original mixture to (minus) -160°F holding constant the pressure at 100 psia.
- (a) What is the composition (y_1, y_2) of the gas mixture produced? **(5 pts)**
 - (b) What is the composition (x_1, x_2) of the liquid mixture produced? **(5 pts)**
 - (c) What is the dew-point temperature for this pressure? **(5 pts)**
 - (d) What is the bubble-point temperature for this pressure? **(5 pts)**
 - (e) If you apply this cooling process to 5000 cubic feet of gas. How many moles of vapor have been produced?. **(10 pts)**

Hint: To determine the initial number of moles at this low pressure you can use the ideal gas law.

To solve this problem you need to use one of the following temperature composition diagrams for mixtures of ethane and methane (same as Figure 2-24 from your text book). Indicate the cooling path and label all the required points in the graph.

5. Given the following ternary phase diagram for mixtures of methane, propane and n-pentane at 160°F and 1500 psia.

(here goes a ternary plot – at the time of developing this exam (1994) a picture was attached)

(a) Indicate in the graph a mixture of 55% methane, 35% n-pentane and 10% propane and indicate the state of the mixture (gas, liquid, both?) **(5 pts)**

(b) Indicate the composition and relative amounts of the vapor and liquid phases of a 55 mole percent methane and 25% of n-pentane at 1500 psia and 160°F. **(5 pts)**

<i>Gas</i> _____ % methane _____ % propane _____ % n-pentane	<i>Liquid</i> _____ % methane _____ % propane _____ % n-pentane
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Vapor % =

(c) If the pressure of the system is reduced to 500 psia, holding the temperature constant. Sketch how would the ternary graph look like. **(5 pts)**

(d) If the temperature of the system is increased to 300°F (holding pressure constant at 1500 psia).. Sketch how would the ternary diagram look like. **(5 pts)**

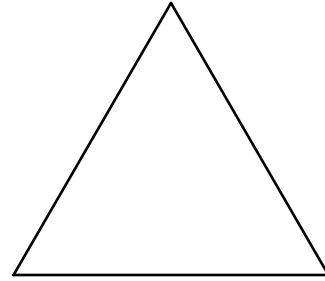
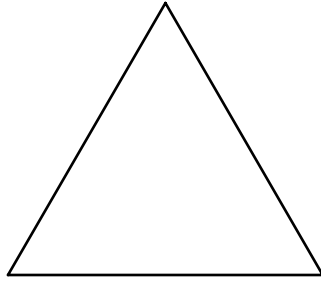
Hint: The Cox charts will help for parts c and d.

P=500 psia

T=160°F

P=1500 psia

T=300°F



6. (a) Assume the following gas mixture behaves like an ideal gas. Calculate the mass of the gas mixture contained in a 1.5 ft³ vessel at 100°F and 2500 psia. **(10 pts)**

Component	Composition (mole fraction)	T _c (°F)	P _c (psia)	M _w		
methane (C ₁)	0.80	-116.67	666.4	16.043		
ethane (C ₂)	0.10	89.92	706.5	30.070		
propane (C ₃)	0.10	206.06	616.0	44.097		
	1.00					

- (b) Now, since the pressure is not very low, you thought that you may be making an error by assuming IDEAL gas behavior. To remove this doubt calculate the z factor for this gas, and the mass that the 1.5 ft³ cylinder will hold. How much error would you be making in part (a) by ignoring the z factor? **Hint:** Use the z factor charts. **(15 pts)**

(No z-factor for this exam, do not panic!)