Name: _____ Student ID _____
Nickname: _____ Group: _____

Prince of Songkla University
Faculty of Engineering

Exam: Mid-Term, Semester I **Academic Year: 2011 – 2012**
Date: August 1, 2011 **Time: 1:30 – 4:30 PM**
Subject: 230-301 **Room: R200, S102**
Basic Chemical Engineering I

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 5 problems and 10 pages (not including this page). Place your name and the student ID number on every page. Students are allowed to use only a pen or pencil and a calculator. They can also bring in one page of notes (Half Sheet of A4 Paper, Front Only), a conversions table and a dictionary. No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Problem	Points Value	Score
1	25	
2	20	
3	15	
4	20	
5	20	
Total	100	

Exam prepared by
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July 24, 2011

PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 10 PAGES OF THE EXAM BEFORE BEGINNING
(not including the cover sheet).
GOOD LUCK!

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1. Conversions of Units: **(25 Points)**

1.1 Convert

(a) 9.45 g/(s)(in^3) to lb_m/(day)(ft^3) **(5 points)**

(b) 20.93 Btu/[(hr)(ft^2)(°F/ft)] to kJ/[(min)(m^2)(°C/cm)] **(5 points)**

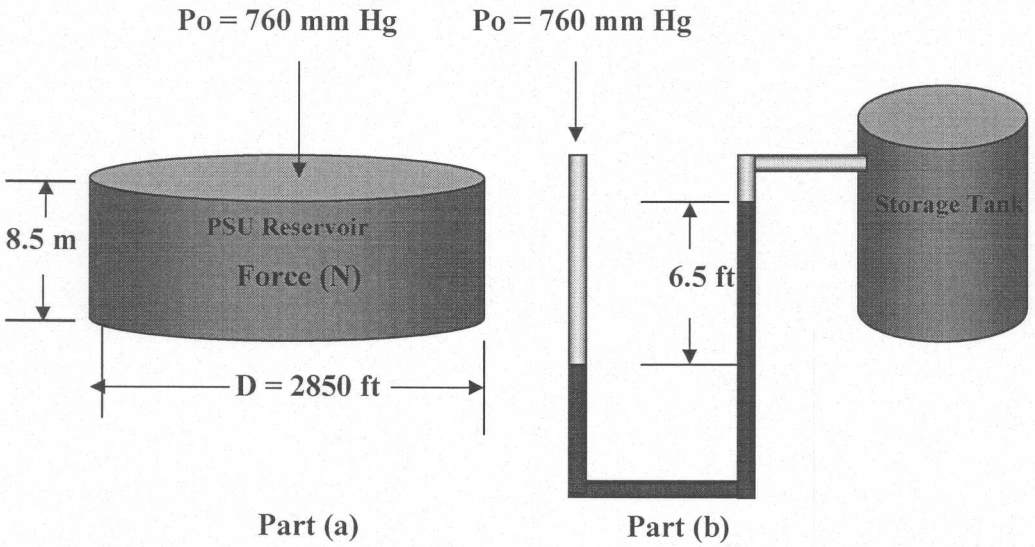
1.2 Water is flowing through a 2.0-inch diameter pipe with a velocity of 6 m/s.

(a) What is the kinetic energy of the water in (ft)(lb_f)/lb? **(5 points)**

(b) What is the flow rate in gal/min? **(10 points)**

2. From the figures below, answer the following questions. **(20 Points)**

(a) What is the total force exerted on the bottom of reservoir in Newton? **(10 points)** (Hint: Determine the total pressure at the bottom of the reservoir in Pa units.)
(b) What is the pressure inside the storage tank in psig if water is used as the fluid inside the manometer? **(10 points)**



3. Bananas purchased for 40 Baht/kg is vacuum-fried to produce snack products. The weight of the peel is 1/3 the weight of the banana and must be removed before frying. The peeled bananas contain 75% water and are fried at 120°C to produce snack products containing only 2% water. The cost of removing the water is 200 Baht/10 kg of water. Answer the following questions. **(15 Points)**

   (a) How much water is removed per 100 kg of snack products produced? **(5 points)**
   (b) How much profit will you make per year if your fry 40 kg of peeled bananas per batch, 8 batches per day, operate 25 days per month, and 12 months per year. The selling price of the vacuum-fried bananas is 35 Baht/bag. Each bag contains 50 g of product. **(10 points)**

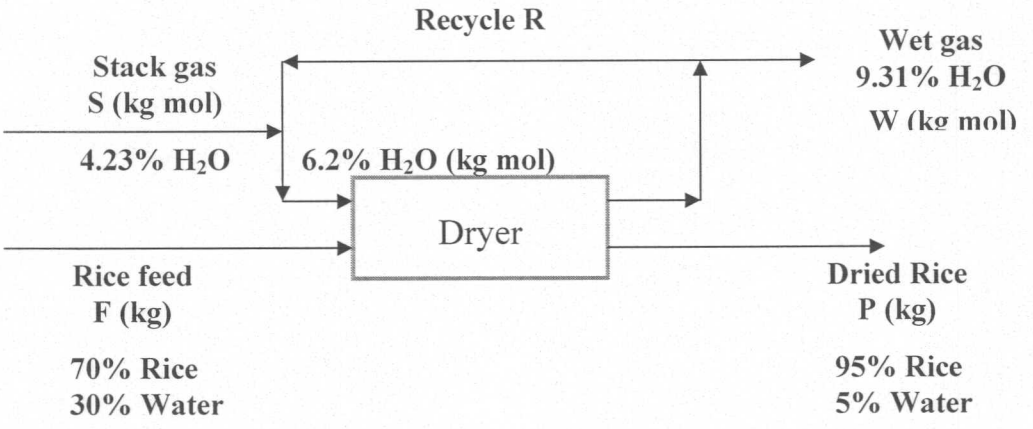
   HINT: Compute Revenue per batch and Cost of Raw Materials per batch plus Cost of Operation (removing water) per batch. Then, multiply it times the total number of batches for year.

4. A waste stream from a plant is being disposed of by burning in a flare with air. The waste gas has the following composition:

   CH_4: 30%, CO_2: 10%, CO: 8%, H_2: 10%, O_2:2%, H_2S: 2%, H_2O: 2%, N_2: 36%.

   The Orsat analysis of the exit gas shows 0.3% SO_2, along with CO_2, O_2, and N_2. Calculate the percent excess air and the complete Orsat analysis. **(20 Points)**

5. To save energy, stack gas from a furnace is used to dry rice. The flow sheet and known data are shown below. What is the amount of recycle gas (in lb mol) per 100 kg of P, if the concentration of water in the gas stream entering the dryer is 6.2%? (Hint: Do a mass balance for Rice and Water. Then, do mole balances for water and gas.) **(50 points)**



BONUS: (5 Points)

1. What is N'Brave's favorite Transformer character? (1.5 points)

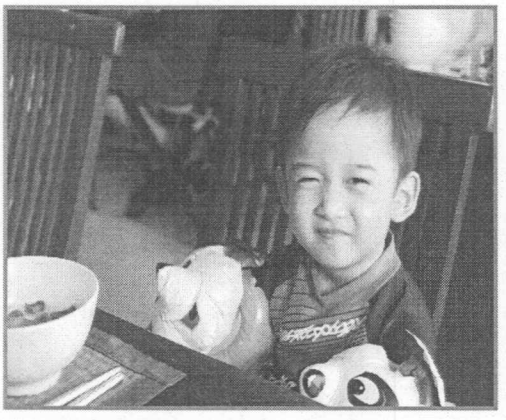
(a) Optimus Prime
(b) Bumblebee
(c) Iron Hide
(d) Sam

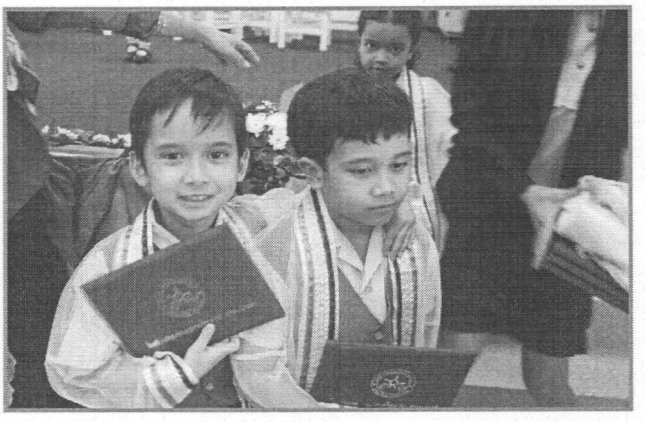
2. Where is N'Bright going to school now? (1.5 points)

(a) Na School (Anubarn Nakorn Hat Yai)
(b) Worapat School
(c) Saengthong Vittaya School
(d) Boonlert School

3. What is N'Bright's favorite restaurant? (2 points)

(a) Fuji
(b) KFC
(c) Pizza Company
(d) Hachiban





Constants:

$g = 32.2\ ft/s^2 = 9.81\ m/s^2$	$1 lb_m = 0.454\ kg$
$g_c = 32.174\ ft\text{-}lb_m/(lb_f\text{-}s^2)$	$1\ ft = 0.3048\ m$
$1\ Btu = 1.055 \times 10^3\ J$	$1\ m^3 = 264.172\ gal$
$1\ psia = 1\ lb_f/in^2 = 6.89476\ kPa$	$1\ Pa = 1\ N/m^2 = 1\ kg/(m\text{-}s^2)$
$1\Delta K = 1.8\Delta°R$	$1\Delta°C = 1.8\Delta°F$
$\rho_{H2O} = 62.4\ lb_m/ft^3 = 1\ g/cm^3$	$1\ J/s = 1\ W\ (Watt)$

Equations:

Pressure = Force/Area
Static Pressure: $P = \rho gh + Po$
Area of Circle = $\pi D^2/4$

CONGRATULATIONS! END OF EXAM!

CONVERSION FACTORS
(Read across)

VOLUME EQUIVALENTS

$in.^3$	ft^3	U.S. gal	liters	m^3
1	5.787×10^{-4}	4.329×10^{-3}	1.639×10^{-2}	1.639×10^{-5}
1.728×10^{3}	1	7.481	28.32	2.832×10^{-2}
2.31×10^{2}	0.1337	1	3.785	3.785×10^{-3}
61.03	3.531×10^{-2}	0.2642	1	1.000×10^{-3}
6.102×10^{4}	35.31	264.2	1000	1

MASS EQUIVALENTS

avoir oz	pounds	grains	grams
1	6.25×10^{-2}	4.375×10^{2}	28.35
16	1	7×10^{3}	4.536×10^{2}
2.286×10^{-3}	1.429×10^{-4}	1	6.48×10^{-2}
3.527×10^{-2}	2.20×10^{-3}	15.432	1

LINEAR MEASURE EQUIVALENTS

meter	inch	foot	mile
1	39.37	3.2808	6.214×10^{-4}
2.54×10^{-2}	1	8.333×10^{-2}	1.58×10^{-5}
0.3048	12	1	1.8939×10^{-4}
1.61×10^{3}	6.336×10^{4}	5280	1

POWER EQUIVALENTS

hp	kW	$(ft)(lb_f)/sec$	Btu/sec	J/sec
1	0.7457	550	0.7068	7.457×10^{2}
1.341	1	737.56	0.9478	1.000×10^{3}
1.818×10^{-3}	1.356×10^{-3}	1	1.285×10^{-3}	1.356
1.415	1.055	778.16	1	1.055×10^{3}
1.341×10^{-3}	1.000×10^{-3}	0.7376	9.478×10^{-4}	1

HEAT, ENERGY, OR WORK EQUIVALENTS

$(ft)(lb_f)$	kWh	hp-hr	Btu	calorie*	Joule
0.7376	2.773×10^{-7}	3.725×10^{-7}	9.484×10^{-4}	0.2390	1
7.233	2.724×10^{-6}	3.653×10^{-6}	9.296×10^{-3}	2.3438	9.80665
1	3.766×10^{-7}	5.0505×10^{-7}	1.285×10^{-3}	0.3241	1.356
2.655×10^{6}	1	1.341	3.4128×10^{3}	8.6057×10^{5}	3.6×10^{6}
1.98×10^{6}	0.7455	1	2.545×10^{3}	6.4162×10^{5}	2.6845×10^{6}
74.73	2.815×10^{-5}	3.774×10^{-5}	9.604×10^{-2}	24.218	1.0133×10^{2}
3.086×10^{3}	1.162×10^{-3}	1.558×10^{-3}	3.9657	1×10^{3}	4.184×10^{3}
7.7816×10^{2}	2.930×10^{-4}	3.930×10^{-4}	1	2.52×10^{2}	1.055×10^{3}
3.086	1.162×10^{-6}	1.558×10^{-6}	3.97×10^{-3}	1	4.184

*The thermochemical calorie = 4.184 J.

PRESSURE EQUIVALENTS

mm Hg	in. Hg	bar	atm	kPa	psia
1	3.937×10^{-2}	1.333×10^{-3}	1.316×10^{-3}	0.1333	1.934×10^{-2}
25.40	1	3.386×10^{1}	3.342×10^{-2}	3.386	0.4912
750.06	29.53	1	0.9869	100.0	1.415×10^{-3}
760.0	29.92	1.013	1	101.3	14.696
75.02	0.2954	1.000×10^{-2}	9.872×10^{-3}	1	0.1451
51.71	2.036	6.893×10^{-2}	6.805×10^{-2}	6.893	1

IDEAL GAS CONSTANT R

1.987 cal/(g mol)(K)
1.987 Btu/(lb mol)(°R)
10.73 $(psia)(ft^3)/(lb\ mol)(°R)$
8.314 $(kPa)(m^3)/(kg\ mol)(K) = 8.314\ J/(g\ mol)(K)$
82.06 $(cm^3)(atm)/(g\ mol)(K)$
0.08206 (L)(atm)/(g mol)(K)
21.9 $(in\ Hg)(ft^3)/(lb\ mol)(°R)$
0.7302 $(ft^3)(atm)/(lb\ mol)(°R)$

MISCELLANEOUS CONVERSION FACTORS

To convert from	To	Multiply by
angstrom	meter	1.000×10^{-10}
barrel (petroleum)	gal	42
centipoise	$(newton)(s)/m^2$	1.000×10^{-3}
torr (mm Hg, 0°C)	$newton/meter^2$	1.333×10^{2}
fluid oz	cm^3	29.57