Chem 455 – Homework # 1A Due Friday April 8 by noon in Glennis Rayermann's mailbox in Bagley Hall

Late homework is not accepted for ANY credit.
Turn in only this front page. Keep the following pages and all of your work for future reference.

This homework set is intended as a quick way for you to test your math skills and refresh them up to the level needed to ***begin*** CHEM 455. Questions of these types will appear in lectures and exams, so treat this seriously. *You will be graded on whether you complete this part of the homework, not on how many questions you answer correctly.*

This homework consists of two "self-tests". Questions appear on one side of the sheet and the answers are on the back. Please try all of the problems in the first self-test before looking at the answers and recording your score below. If you get everything right on the first self-test, then there is no need to do the second one. Most students improve dramatically by the second time through.

Name:_____

Did you get all questions 1A-18A correct on the first try? (circle an answer) YES / NO

Mark an "X" through those questions you got wrong the first time you attempted them.

1A 2A 3A 4A 5A 6A 7A 8A 9A 10A 11A 12A 13A 14A 15A 16A 17A 18A

1B 2B 3B 4B 5B 6B 7B 8B 9B 10B 11B 12B 13B 14B 15B 16B 17B 18B

MATHEMATICS SELF-TUTORIAL, CHEM455

Evaluate and/or simplify the expressions without a calculator. While you are allowed to use a calculator on the homeworks and exams, most students who complain that the exams are "too long" also lose time on "remedial" topics.

Do not convert fractions to decimals. Complete this page entirely before turning to the next page.

QUESTION SET A

1A) use the quadratic equation to solve $2x^2 - x + 8 = 0$ for x

2A) if y = (5+2i), what is $(y^*)(y)$

3A) express (2+3i) / (4-2i) in the form a+bi

4A) $\int_0^{\pi} \sin(x) = ?$

5A) $(a^2bc^{-1})(ab^{-3}) = ?$

6A) $|i| = ?$

7A) $|2-7i| = ?$

8A) express 3+3i in $re^{i\theta}$ form

9A) express $2e^{(i\pi/3)}$ in a+bi form

10A) Dimensional analysis: What are the units for angular momentum? Show that Planck's constant has units of angular momentum.

11A) For values of x which are close to 1, $\ln(x) \approx x - 1$. This problem uses a Taylor expansion to show that this is true. Use a Taylor Series to approximate ln(1.05) = ? to first order.

12A) $f(x) = (x^{4/3} - 2x^{-2})^5$ $^{df}/_{dx} = ?$ (no need to multiply out)

13A) $f(x) = (1 - x^4)/x$ $^{df}/_{dx} = ?$ (no need to multiply out)

14A) simplify $e^{2\ln 3}$

15A) find the maximum and minimum of the equation $f(x) = x^3 - 27x$ over the range x=-5..5

16A) $\int_{x=1}^{3} 2x^2 dx = ?$

17A) $\frac{\partial}{\partial x}\left(2x^4y^6 + \frac{3}{x^2}\right) = ?$

18A) For objects with a radius of 2 meters, what are the a) circle's perimeter, b) circle's area, c) sphere's surface area, and d) sphere's volume? (express as multiples of π. Include units!)

Grade questions 1A-17A. Make sure that you understand the answers before turning to the next page.

	ANSWER SET A	REASONS
1A)	$\frac{1+3i\sqrt{7}}{4}, \frac{1-3i\sqrt{7}}{4}$	$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$
2A)	29	$(a+bi)(a-bi)=a^2+b^2$
3A)	$\frac{1}{10}+\frac{4}{5}i$	$\frac{a+bi}{c+di} = \frac{a+bi}{c+di}\cdot\left(\frac{c-di}{c-di}\right)$
4A)	2	$\int \sin(x) = -\cos(x)$
5A)	$a^3b^{-2}c^{-1}$	$a^x a^y = a^{x+y}$
6A)	1	$\lvert y\rvert = \sqrt{y^* y}$
7A)	$\sqrt{53}$	$\lvert y\rvert = \sqrt{y^* y}$
8A)	$\sqrt{18}e^{i\pi/4}$	$a+bi=\lvert a+bi\rvert e^{i\ atan(b/a)}$
9A)	$1+i\sqrt{3}$	$e^{i\theta}=\cos(\theta)+i\sin(\theta)$
10A)	$kg\cdot m^2\cdot s^{-1}$	$J\cdot s = N\cdot m\cdot s = kg\cdot m\cdot s^{-2}\cdot m\cdot s = kg\cdot m^2\cdot s^{-1}$
11A)	$\ln(x) = \ln(a) + (x-a)(1/a)$ $\ln(1.05) = 0 + (1.05-1)(1/1) = 0.05$	Taylor Series: $f(x) = f(a) + (x-a)f'(a) + (1/2!)(x-a)^2 f''(a)\ldots$ To first order, for $x \approx 1$, set $a=1$ so that $\ln x \approx (x-1)$
12A)	$5(x^{4/3} - 2x^{-2})^4(^4/_3 x^{1/3} + 4x^{-3})$	for $f(x) = cx^n$, $^{df}/_{dx} = ncx^{n-1}$, where c is a constant
13A)	$-4x^3(^1/_x) + (1-x^4)(-1/x^2)$	$^d/_{dx}(g(x)\cdot h(x)) = (^d/_{dx}g(x))(h(x)) + (g(x))(^d/_{dx}h(x))$ you will make fewer mistakes with the product rule
14A)	$(e^{\ln 3})^2 = (3)^2 = 9$	$e^{\ln x} = x$
15A)	x = 3 is min, x = -3 is max	min occurs at $^{df}/_{dx} = 0$ and $^{d^2f}/_{dx^2} > 0$ max occurs at $^{df}/_{dx} = 0$ and $^{d^2f}/_{dx^2} < 0$
16A)	$\frac{2}{3}x^3\Big\rvert_{x=1}^{3} = \frac{2}{3}(27-1) = \frac{52}{3}$	$\int ax^n dx = \left(\frac{1}{n+1}\right)ax^{n+1} \quad for\ n \neq -1$
17A)	$8x^3y^6 - 6/x^3$	Partial derivatives treat all other variables as constants.
18A)	4π meters, 4π (meters)^2	perimeter of circle = $2\pi r$, area of circle = πr^2 (hint: perimeter = $\frac{\partial}{\partial r}$ (area))
	16π (meters)^2, $^{32}/_3\,\pi$ (meters)^3	surface area of sphere = $4\pi r^2$, volume of sphere = $^4/_3\pi r^3$ (hint: surface area = $\frac{\partial}{\partial r}$ (volume))

If you feel comfortable with questions 1A-18A and answered them all correctly on the first try, you may skip questions 1B-18B. If you want more practice or missed any of the previous questions, complete this page of questions. Complete this page entirely before turning to the next page, which contains the answers.

QUESTION SET B

1B) use the quadratic equation to solve $x^2 + x + 1 = 0$ for x

2B) if y = (3-i), what is $(y^*)(y)$

3B) express (5+i) / (1-9i) in the form a+bi

4B) $\int_0^{2\pi} \sin(x) = ?$

5B) $2^3 \cdot 4 = 2^?$

6B) $|1+i| = ?$

7B) $|3-i| = ?$

8B) express $3+4i$ in $re^{i\theta}$ form

9B) express $3e^{(i\pi/4)}$ in a+bi form

10B) Dimensional analysis: Show that Planck's constant times the speed of light divided by wavelength has units of energy.

11B) For small values of θ, $\sin(\theta) \approx ?$

12B) $f(x) = (5x^3 + x^{2/3})^4$ $\quad {}^{df}/_{dx} = ?$ (no need to multiply out)

13B) $f(x) = {}^{(1+x)}/_{(x^2-2)}$ $\quad {}^{df}/_{dx} = ?$ (no need to multiply out)

14B) simplify $2e^{3\ln 2}$

15B) find the maximum and minimum of the equation $f(x) = x^3 - 48x$ over the range x=-5..+5

16B) $\int_{x=1}^{2} 2x^3 dx = ?$

17B) $\partial/\partial t \, (8st^{-2} - 3s^{-3}t^4)$

18B) For objects with a radius of 3 meters, what are the a) circle's perimeter, b) circle's area, c) sphere's surface area, and d) sphere's volume? (express as multiples of π. Include units!)

ANSWER SET B

If you need more practice with differentiation and integrals, check out the worked problems at:
http://www.math.ucdavis.edu/~kouba/ProblemsList.html

1B) $\frac{-1}{2}+\frac{i\sqrt{3}}{2}, \frac{-1}{2}-\frac{i\sqrt{3}}{2}$

2B) 10

3B) $\frac{-2+23i}{41}$

4B) 0

5B) 5

6B) $\sqrt{2}$

7B) $\sqrt{10}$

8B) $5e^{\text{atan}(4/3)}$

9B) $\frac{3\sqrt{2}}{2}+i\frac{3\sqrt{2}}{2}$

10B) $J \cdot s \cdot m \cdot s^{-1} \cdot m^{-1} = J$

11B) θ

12B) $4(5x^3 + x^{2/3})^3 (15x^2 + {}^2/_3 x^{-1/3})$

13B) $\frac{1}{x^2-2}-\frac{2x(1+x)}{(x^2-2)^2}$

14B) $2(e^{\ln 2})^3 = 2 \cdot 2^3 = 2^4 = 16$

15B) x = 4 is min, x = -4 is max

16B) $\frac{15}{2}$

17B) $-16st^{-3} - 12s^{-3}t^3$

18B) 6π meters, 9π (meters)^2, 36π (meters)^2, 36π (meters)^3

CHEM455 - Homework 1B
Due Mon. April 11 by 4pm in Prof. Ginger's mailbox in Bagley Hall

This is HALF of homework #1. The other HALF is the math self-review, and is due on Friday. Turn your answers in on a separate page with your name at the top. Circle ALL answers. Staple your work together.

Textbook: P1.19, P2.9, P2.18

1) a) Calculate the frequency, ν, and the energy (in eV) per photon for electromagnetic radiation with a wavelength of 500 nm.
b) express the units in terms of wavenumbers (cm^{-1})
c) What 'color' is this radiation?
d) What is a general formula for finding the energy in eV of a photon whose wavelength we know in units of nm?
e) How much momentum does this 500 nm-wavelength photon have?
f) What speed would an electron have to travel to have the same momentum as this photon?

2) Suppose that a 100W source radiates 600 nm light uniformly in all directions. The human eye is remarkably sensitive. Assume that a person can detect see this light if only 20 photons per second enter a dark-adapted eye (pupil diameter of 7 mm). How far from the source can the light be seen under these conditions? What color is this light?

3) Solve the differential equation: $\frac{d^2x}{dt^2} + \omega^2 x(t) = 0$

For the time $t=0$ initial (boundary) conditions $x(0)=A$, $\dot{x}(0)=v_0$