Mathematics 131 – Calculus for Physical and Life Sciences 1
Precalculus Review Problems
August 29, 2007

The following problems will not be collected or graded. They are similar to questions on the first diagnostic quiz to be given in class on Friday, August 31.

1. Find all values of x that satisfy the given inequality or inequalities:
   a) $-4x \geq 20$ – *Answer:* all $x \leq -5$.
   b) $x + 1 > 4$, or $x + 2 < -1$ – *Answer:* all $x > 4$ together with all $x < -3$ (could also be written as a union of intervals: $(-\infty, -3) \cup (4, +\infty)$)
   c) $x + 3 > 1$ and $x - 2 < 1$ – *Answer:* all x between -2 and 3, or $-2 < x < 3$ (could also be written as the interval $(-2, 3)$.)

2.
   a) Rewrite using positive exponents only: $\frac{x^{-1/3}}{x^{1/2}}$ – *Answer:* $\frac{1}{x^{5/6}}$
   b) Simplify: $(x^2y^{-3})(x^{-5}y^3)$ – *Answer:* $x^{-3} = \frac{1}{x^3}$
   c) Simplify: $\left(\frac{x^3}{-27y^{-6}}\right)^{-2/3}$ – *Answer:* $\frac{9}{x^2y^4}$
   d) Simplify: $\left(\frac{x^{-3}}{y^{-2}}\right)^2 \left(\frac{y}{x}\right)^4$ – *Answer:* $\frac{y^8}{x^{10}}$

3. A salesperson's monthly commission is 15% on all sales over \$12000. If the goal is to make a commission of at least \$3000 per month, what monthly sales figure should he or she attain? – *Answer:* Call the monthly sales figure x. (Assuming no commission on the sales under 12000), we want $(.15)(x - 12000) \geq 3000$ so $x \geq 32000$.
4. Factor:
   a) $7a^4 - 42a^2b^2 + 49a^3b$ – *Answer:* $7a^2(a^2 - 6b^2 + 7ab)$
   b) $xe^{-2x} - x^3e^{-x}$ – *Answer:* $xe^{-x}(e^{-x} - x^2)$
   c) $6ac + 3bc - 4ad - 2bd$ – *Answer:* $(2a + b)(3c - 2d)$
   d) $3x^2 - 6x - 24$ – *Answer:* $(3x + 6)(x - 4)$
   e) $9x^2 - 16y^4$ – *Answer:* $(3x - 4y^2)(3x + 4y^2)$ (difference of squares)

5. Solve for x:
   a. $x^2 + x - 12 = 0$ – *Answer:* $x = 3, -4$ (factor the quadratic)
   b. $4x^3 + 2x^2 - 2x = 0$ – *Answer:* $x = 0, 1, -1/2$ (factor)
   c. $8x^2 - 8x - 3 = 0$ – *Answer:* $x = \frac{2 \pm \sqrt{10}}{4}$ (using the quadratic formula)

6. Simplify:
   a. $\frac{2a^2 - 2b^2}{b - a} \cdot \frac{4a + 4b}{a^2 + 2ab + b^2}$ – *Answer:* -8 (factor and cancel!)
   b. $\frac{58}{3(3 + t^2)} + \frac{1}{3}$ – *Answer:* $\frac{t^2 + 61}{3(3 + t^2)}$

c. $\frac{2x}{2x-1} - \frac{3x}{2x+5}$ – *Answer:* $\frac{-2x^2+13x}{(2x-1)(2x+5)}$

d. $\frac{1+\frac{1}{x}}{1-\frac{1}{x^2}}$ – *Answer:* $\frac{x}{x-1}$

e. $\frac{2x(x+1)^{-1/2}-(x+1)^{1/2}}{x^2}$ – *Answer:* $\frac{x-1}{x^2\sqrt{x+1}}$

7. Let $f(x) = (x+1)^3$ and $g(x) = x^2 - 1$.
   a) What is the function $f(g(x))$? – *Answer:* $f(g(x)) = x^6$
   b) What is the function $g(f(x))$? – *Answer:* $g(f(x)) = (x+1)^6 - 1$
   c) What is the function $f(x)g(x)$? – *Answer:* $(x+1)^3(x^2-1) = (x+1)^4(x-1)$
   d) What is the domain of the function $\frac{f(x)}{g(x)}$? – *Answer:* all real numbers $x \neq -1, 1$.

8.
   b) Let $f(x) = x^2 - 2x + 3$. Simplify as far as possible: $\frac{f(a+h)-f(a)}{h}$. – *Answer:* $2a - 2 + h$.
   b) Same question for $f(x) = \frac{1}{\sqrt{x}}$. – *Answer:*

$$\begin{aligned}\frac{\frac{1}{\sqrt{a+h}} - \frac{1}{\sqrt{a}}}{h} &= \frac{\sqrt{a} - \sqrt{a+h}}{h\sqrt{a}\sqrt{a+h}} \\ &= \frac{\sqrt{a} - \sqrt{a+h}}{h\sqrt{a}\sqrt{a+h}} \cdot \frac{\sqrt{a} + \sqrt{a+h}}{\sqrt{a} + \sqrt{a+h}} \\ &= \frac{-1}{\sqrt{a}\sqrt{a+h}(\sqrt{a} + \sqrt{a+h})}\end{aligned}$$

9. Express in terms of the sine and cosine functions and simplify:

$$g(x) = \csc^2(x) + \sec^2(x)$$

Answer:

$$\begin{aligned}\csc^2(x) + \sec^2(x) &= \frac{1}{\sin^2(x)} + \frac{1}{\cos^2(x)} \\ &= \frac{\cos^2(x) + \sin^2(x)}{(\sin(x)\cos(x))^2} \\ &= \frac{1}{\left(\frac{1}{2}\sin(2x)\right)^2} \\ &= \frac{4}{\sin^2(2x)}\end{aligned}$$

(Note: $\frac{1}{(\sin(x)\cos(x))^2}$ is also an acceptable answer.)