1 Algebra

Simultaneous Equations Solve for x and y (What are the values of x and y):

x + 2y = 6
x - y = 3

Summation What is the value of the following given $x = j + 1$.

$$\sum_{i=0}^{2} x^i$$

Summation Calculate the following:

$$\sum_{k=1}^{5} (3k - 2)$$

Logarithms TRUE or FALSE log(a/b) = log(a)-log(b)

Logarithms TRUE or FALSE log(a/b) = log(a)/log(b)

Logarithms TRUE or FALSE log(a+b) = log(a)+log(b)

Logarithms TRUE or FALSE log(a^b) = b*log(a)

Lines Draw the line $4x + 2y = 4$.

Lines Answer the following, given that $y = ax^2 + bx$

- If $a = 2$, is y a linear function of x?
- If $a = 0$, is y a linear function of x?

Lines Write the equation for a line with slope 5 and y-intercept 2.

Lines A line passes through the points (2,5) and (6,-4). What is the equation of this line?

Exponents Which is greater, the value of $(99^{900})^3$ or $(99^{900}) * (99^3)$?

Factoring Factor $x^2 - 64$ into two terms that are linear in x.

Factoring How many unique solutions (roots) could an equation of the form $ax^3 + bx^2 + c$ have, where a, b, and c are real numbers?

Functions Explain why $y^2 = x - 2$ is not a function.

2 Calculus

Differentiation What are the derivatives of the following equations with respect to x?

- $3x^2$
- e^{-x}
- $\cos(2x^2)$
- $\sin(3x^2)$

Chain Rule Recall that $\frac{d}{dx} \sin x = \cos x$. Find $\frac{d}{dx} h(x)$ when:

$$h(x) = \sin x^2$$

Chain Rule Differentiate $y = \ln(\cos^5(3x^4))$.

Differentiation Determine $\frac{dy}{dx}$ given that $y = \sin(3x + 4y)$.

Partial Derivatives Let $f(x, y, z) = 3x^2 + 2y + e^{\sin(\log(z!))}$. What is the partial derivative of f with respect to y (written: $\frac{\partial}{\partial y} f(x, y, z)$)?

Partial Derivatives For $f = 3x^2 + xy^2 + \frac{1}{y}$, find (a) $\frac{df}{dx}$ (b) $\frac{df}{dy}$

Integral(conceptual) The equation $f(x) = \sqrt{9 - x^2}$ represents a semicircle of radius 3 for $-3 \leq x \leq 3$. What is the integral of $f(x)$ over the region $-3 \leq x \leq 3$? (Hint: the area of a whole circle is $\pi * r^2$.

Integral What is the integral of $5x - x^5 + 8$?

Integral What is the integral of e^{-3x}?

Integral Integrate x^3 from 2 to 6.

3 Stats and Probability

Statistics Complete the questions below given the following set of values: -3, -1, 1, 3, 5.

a Find the mean (average) value of this set and call it μ.

b Solve the following:

i $(\mu - (-3))^2 = ?$
ii $(\mu - (-1))^2 = ?$
iii $(\mu - (1))^2 = ?$
iv $(\mu - (3))^2 = ?$
v $(\mu - (5))^2 = ?$

c Take the average of the five values above and refer to it as σ^2 (the notation for variance). $\sigma^2 = ?$

d What is the standard deviation?

Coin flips You flip a fair coin 5 times and all 5 times it lands heads. What is the probability that the sixth flip will land tails?

Combinatorics What is the value of $\binom{6}{4}$?

Expected Value You are in a casino (obviously you are over age 21), and you see two games. In one, you have a 40% chance of winning \$50, and a 60% chance of losing \$20. In the other you have a 90% chance of losing \$1 and a 10% chance of winning \$220. Which game will win you more money? Now imagine that you have only a budget of \$40 to spend on gambling, after which you're wiped out and have to go home. Which game would you rather play? Why?

Expected Value Imagine you're running a black-market casino at midnight on Thursdays in the alley behind your apartment. The only game you have is as follows. The player pays you x dollars, rolls a fair six-sided die, and is given the number of dollars that correspond to the number shown on the die (six dollars if the player rolls a six, etc). If you want to break even in the long run, what should you set x to be?

T-test (select the correct choice from each set of options) To perform a T-test, you are assuming that your data are distributed according to a

(T / Gaussian / Poission / Binomial) distribution with (known / unknown) mean and unknown variance. (BONUS: If the variance of the data distribution from 1 was somehow known (but the mean was not), what test would you perform instead?)

T-test Dario measures blood pressures in 100 people. He then gives them a drug and measures their blood pressure again (from the same people). He wants to see if the drug influences blood pressure. Should he use a paired or non-paired test?

4 Programming

Order of Operations Assuming that multiplication and division have precedence (as is common in programming languages), what is the value of a at the end of the programming fragment?

```
a = 6 + 3 - 10 / 5
```

For Loops Using any reasonable pseudocode, write a loop to add the numbers 1 through 100 and store in the variable sum.

For Loops What is the value of j at the end of the program fragment below? (the notation for i=1:10 means the same thing as $for(i = 1; i <= 10; i++)$ or in plain language i will start with the value 1, each time through the loop i will be incremented and the looping will stop after i goes above 10.

```
for i=1:10
    j = i+1
end
```

For Loops What is the value of x at the end of the program fragment below?

```
x = 0
for i = 1:10
     x = x + 2
end
```

For Loops What does the following pseudocode output?

```
n = 5
for i = 1:n
    if i == 2 or 5
      print "0"
      n = n + 1
    else
      print "1"
    end
    i = i + 1
end
```

Nested For Loops After running the following pseudocode, what is the value of the variable x?

```
x = 0
for i = 1:5
    x = x - 1
    for j = 1:3
        x = x + 2
    end
end
```

Variables What are the values of a and b after running the following code?

```
a = 2
b = 3
a = a - b
b = b + a
a = b - a
```

Variables List the variables that will be in your memory after running the following program.

```
a = 6
b = TRUE
if b = FALSE
    c = 10
```

```
end
if a < 5
    d = a^2
else
    d = a^3
end
```

Variables In the following program, the variables dario and walter have the values of 123 and 312, respectively. Write some lines of pseudocode to swap the values of the variables (the # symbol indicates that the line is a comment and is ignored during program execution):

```
dario = 123
walter = 312
# insert pseudocode below




end
```

Conditionals After running the following pseudocode, what is the value of the variable t (> is the greater than operator)?

```
t = 5
if (t > 4)
    t = t+1
end
if (t > 7)
    t = t+1
end
if (t > 6)
    t = 3
end
```