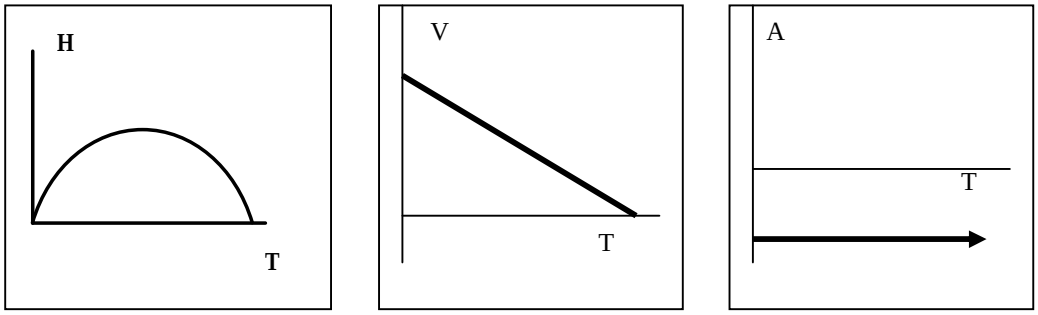
2003-2004

American Computer Science League

Problem #5

All-Star Contest

DIFFERENTIATE



PROBLEM: The topic of differentiation is important in the study of calculus. The leftmost figure shows a function *f* that represents the path of an object that is thrown in the air. The height H can be determined for any time T. The first derivative of *f* gives the middle figure. The line gives the velocity V of the object at any time T. The second derivative of *f* gives rightmost graph. The line represents the acceleration A at any time T. That is the constant force of gravity, –32 ft/sec^2 , acting on the object. This is just one of many examples of how the derivative is used.

The rules for finding F', the first derivative, are as follows:
1. If F (X) = C where C is a constant then F' (X) = 0
2. If F (X) = X^N where N is any nonzero real number, then F' (X) = NX^{N-1}.
3. If F (X) = AX^N where A and N are any nonzero real numbers then F' (X) = ANX^{N-1}.
4. The derivative of a sum is the sum of the derivatives of the terms.
5. To find F", the second derivative, apply the rules above to the first derivative.

INPUT: There will be 5 input lines. Each input will be a string representing a function. The ^ symbol will be used to show exponentiation. Fractional coefficients and exponents will be in X/Y form. Fractional exponents will be in parentheses.

OUTPUT: For each input print the first derivative and the second derivative. Note that coefficients of 1 and –1 are not allowed as in SAMPLE OUTPUT #10. Also only one sign is allowed between terms, that is 2X + - 6 is incorrect. Further, only fractional exponents will be in parentheses. Decimal coefficients and exponents are not allowed. All fractions must be reduced.

SAMPLE INPUT

1. 8
2. X^5
3. 5X^4
4. 3X^2 – 5X + 8
5. 4X^(1/2)

SAMPLE OUTPUT

1. 0	2. 0
3. 5X^4	4. 20X^3
5. 20X^3	6. 60X^2
7. 6X –5	8. 6
9. 2X^(-1/2)	10. –X^(-3/2)