South Dakota School of Mines & Technology
CENG 448/548
Homework Assignment Two

Work individually.

1. Find the binary and hexadecimal representations of the numbers in the following table, using the specified format. Also write in the scale factor of each number.

Variable Name	Decimal Value	Fixed Point Format	8-bit Binary Representation	Scale Factor
a	2.375	S(3,4)	0 010 0110	3+4+1=8
b	−2.375	S(3,4)	1 010 0110	3+4+1=8
c	3.5	S(6,1)	0 0000011 1	6+1+1=8
d	0.5	U(1,7)	0 1000000	1+7=8
e	−0.5	U(1,7)	Unsigned #s can't represent - #s	1+7=8

2. Perform the following calculations using your binary representations for each of the variables from problem 1. For each result, show the binary representation, the scale factor, the fixed point format, and the decimal value.

Calculation	Binary Result	Fixed Point Format	Scale Factor	Decimal Value
$x = a - b$	0 0100 1100	S(4,4)	1+4+4=9	4.75
$y = a \times c$	<------	S(10,5)	1+10+5=16	8.3125
$z = b \div d$	V	S(5,11)	1+5+11=16	-4.75

0 0000001000 00000

1 00100 11000000000

3. Write a program in C using MPLAB X to perform the calculations in problem 2. Store your argument variables as `int8_t` data types. If required, use larger integer types to store your results. **Do not use floating point variables or operations.**

```
template <size_t I, size_t F>
void multiply(const Fixed<I,F> &lhs, const Fixed<I,F> &rhs, Fixed<I,F> &result, typename
std::enable_if<type_from_size<I+F>::next_size::is_specialized>::type* = 0) {

    typedef typename Fixed<I,F>::next_type next_type;
    typedef typename Fixed<I,F>::base_type base_type;

    static const size_t fractional_bits = Fixed<I,F>::fractional_bits;

    next_type t(static_cast<next_type>(lhs.to_raw()) * static_cast<next_type>(rhs.to_raw()));
    t >>= fractional_bits;
    result = Fixed<I,F>::from_base(next_to_base<base_type>(t));
}
```