Negative Numbers Homework

You should refer to the **homework policy** for details on how this homework should be submitted.

Attempt all questions and show all working.

Question 1

What is the largest negative number that can be held in 8-bits using two's complement?

Maximum number is 127.
[TOC]

```
    | -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
    | 0    |  1 |  1 |  1 | 1 | 1 | 1 | 1 | = all added together =
127
```

(**2 marks**)

Question 2

Convert the decimal numbers **11** and **9** to binary. Using 8-bits for each number, show your working in binary of subtracting 9 from 11 (11-9).

11= [TOC]

```
    |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
    |    0 | 0  |0   |   0| 1 | 0 | 1 | 1 | = 00001011 = 11 in
binary
```

9 = [TOC]

```
    |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
    |   0  |  0 |  0 |  0 | 1 | 0 | 0 | 1 | = 00001001 = 9 in binary
```

(11-9) = 11 + (-9)
-9 = [TOC]

```
   | -128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
   |   0  |  0 |  0 |  0 | 1 | 0 | 0 | 1 |
   |   1  |  1 |  1 |  1 | 0 | 1 | 1 | 0 |
 +1                                    1
   |   1  |  1 |  1 | 1  |0  |1  |1  | 1 |
   -9 = 11110111
```

2's compliment = [TOC]

```
    |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
    |  1   |  1 | 1  | 1  | 0 | 1 | 1 | 1 | = -9
   +|  0   | 0  | 0  | 0  | 1 | 0 | 1 | 1 | = 11
    |    0 | 0  | 0  | 0  | 0 | 0 |  1| 0 |
           1    1    1    1   1   1   1
```

Therefore 11-9 in binary = 00000010 = 2

(**4 marks**)

Question 3

Convert the decimal numbers **17** and **15** to binary. Using 8-bits for each number, show your working in binary of subtracting 17 from 15 (15-17).
17 = [TOC]

```
   |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
   |  0   |0   |0   |1   |0  |0  |0  |1  | = 17
   17 = 00010001 in binary
```

15 = [TOC]

```
   |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
   |  0   |0   |0   |0   |1  |1  |1  |1  | = 15
   15 = 00001111 in binary
```

(17-15) = 17 + (-15)
-15 = [TOC]

```
  |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
  |  0   |0   |0   |0   |1  |1  |1  |1  | = 15
  |  1   | 1  | 1  | 1  | 0 | 0 | 0 | 0 | = 1's compliment
 +1                                   1
  | 1    |1   | 1  | 1  | 0 | 0 | 0 | 1 | = -15
```

17 + (-15) = [TOC]

```
  |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
  |  0   | 0  | 0  | 1  |0  | 0 | 0 | 1 |= 17
 +|  1   |  1 | 1  |  1 | 0 | 0 | 0 | 1 |= -15
  |   0  |  0 | 0  |  0 | 0 | 0 | 1 | 0 |
  1      1    1    1               1
```

Therefore 17-15 = 00000010 = 2
(**4 marks**)

Question 4

Convert the decimal numbers **96** and **40** to binary. Using 8-bits for each number, show the binary pattern for **-96** and **-40**. Comment on your result of adding these two patterns together.
40 =

```
  |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
  |  0   |0   |1   |0   |1  |0  |0  |0  |
```

90 =

```
  |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
  |  0   |1   |0   |1   |1  |0  |1  |0  |
```

96 =

```
  |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
  |  0   |1   |0   |1   |1  |0  |1  |0  |
  |  1   |0   |1   |0   |0  |1  |0  |1  |= 1's compliment
 +1                                | 1 |
  |  1   |0   |1   |0   |0  |1  |1  |0  |
```

```
                                        1
    -96 = 10100110 in binary
```

40=

```
    |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
    |  0   |0   |1   |0   |1  |0  |0  |0  |
    |  1   |1   |0   |1   |0  |1  |1  |1  |= 1's compliment
   +1                                 | 1 |
    |  1   |1   |0   |1   |1  |0  |0  |0  |
                              1   1   1
     -40 = 11011000 in binary
```

Therefore (-96) + (-40) =

```
     |  128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
     |  1   |1   |0   |1   |1  |0  |0  |0  |= -40
    +|  1   |0   |1   |0   |0  |1  |1  |0  |= -96
     |    1 |  1 |  1 |  1 | 1 | 1 | 1 |0  |
```

(-96) + (-40) = 11111110 is the result however this isn't the correct answer when added up the correct answer should be -56.

Total 14 marks