Other Problems Using Binary Numbers

Problem 1. Convert the following multiples of 3 into base 2:

0:	15:	30:
3:	18:	33:
6:	21:	36:
9:	24:	39:
12:	27:	42:

Do you see a pattern to the binary representations for multiples of three?

Problem 2. Convert:

23 base 4 into base 2:

32 base 4 into base 2:

11 base 4 into base 2:

26 base 8 into base 2:

67 base 8 into base 2:

11 base 8 into base 2:

Is there a sneaky way tho do these conversions?

Problem 3. If you have a penny, a nickel, a dime, a quarter, and a half dollar, how many different combinations of heads and tails can you get with those five coins?

Problem 4. Suppose you and a friend are playing a game in which your friend chooses a number from 1 to 128, and you try to guess the number. For each guess, your friend responds either "Higher" or "Not Higher" depending on whether or not the chosen number is higher than the guess. What is the maximum number of guesses you need to determine the number?

Problem 5. Remember that a set is a collection of things. We say set A is a subset of set B if every member of set A is a member of set B. (Notice this makes the empty set a subset of any set.) Suppose a given set has seven members. How many different subsets does this set have?

Problem 6 (Hard)**.** How many different ways can you add positive whole numbers to total six? (Order matters. So, $2 + 4$ is considered different from $4 + 2$. Also, 6 is acceptable as a sum.)

Problem 7 (Hard)**.** The following are Nim losing positions:

(1 stones, 1 stones) (2 stones, 2 stones) (3 stones, 3 stones)
(1 stones, 2 stones, 3 Stones) (1 stones, 4 stones, 5 stones)
(2 stones, 4 stones, 6 stones) (2 stones, 5 stones, 7 stones)
(3 stones, 4 stones, 7 stones) (3 stones, 5 stones, 6 stones)

Convert each pile into its base 2 representation. Is there something that characterizes losing positions? Does this allow you to distinguish winning from losing positions?

Which of the following four pile Nim positions is a loser?
(1 stones, 3 stones, 4 stones, 6 stones) (1 stones, 2 stones, 4 stones, 6 stones)