SCANDAL! EXCLUSIVE!
CELEBRITIES CAUGHT DOING
BINARY “ARITHMETIC”

Behind that smile... you know that she's guilty of using base 17!

The Shocking Tale as Discovered by Asad B. Sayeed.
Getting to base 8 and 16

- Base 10: Your usual decimal numbers.
- Base 2: Your usual binary numbers.
- You can have all kinds of bases.
  - two particularly handy bases are 8 (octal) and 16 (hexadecimal).
  - Counting to ten in octal: 1, 2, 3, 4, 5, 6, 7, 10.
  - Octal 10 is just 8 in the decimal world. Octal 12 is decimal 10.
  - Counting to ten in base 16: 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10.
  - Hex 10 is decimal 16. Hex A is decimal 10.
Handy conversions

➲ Every three binary digits is one octal digit:

\[
\begin{align*}
111 & 000 & 010 & 101_2 \\
= & 7 & 0 & 2 & 5_8
\end{align*}
\]

➲ Every four binary digits is one hexadecimal digit.

\[
\begin{align*}
1110 & 0001 & 0101_2 \\
= & E & 1 & 5_{16}
\end{align*}
\]

➲ Why does this work?

Jen was on to his base conversion plan all along!
Three and Four

- Every octal digit corresponds to three binary digits.
- This works because there are $2^3 = 8$ possibilities for three binary digits AND there are 8 possibly values for one octal digits.
- Same for hexadecimal, but with $2^4 = 16$.
- Does NOT work for decimal: no correspondence.
Conversions: SHOCKER!

- We are not evil robots: we still think in decimal! How to convert?
- Simple: use definition of number system. Calculate in decimal for every digit: \( \text{value} \times \text{base}^{\text{position}-1} \) and take sum.
- Try:
  - \( \text{AFBF}_{16} \)
  - \( 4056_8 \)
  - \( 1011101111110100_2 \)—it may be faster to convert to another base.
  - For fun, GE4F in base 17...
We do, of course, want to go from decimal to other bases.

Use repeated integer division:
- divide by the desired base
- record remainder as least significant digit.
- keep doing this to the quotient until the quotient is zero.

Try it
- 4539 to octal
- 23466 to hexadecimal
- 193 to base 17
Addition

Addition of hex or octal numbers is easy: just like decimal numbers. Carry, etc, etc.

Try:
- base 16: 1AF6 + EF22
- base 8: 477 + 213
- base 36: 12Z + QDE
- ...
Negatives

“...I did NOT USE 1's complement with that program!”

- Obviously, representing negatives is easy: just take your negative representation in binary and...convert it to octal or hex digits!
- Taking the 2's complement negative of an octal number: subtract every digit from seven:
  - Try negating 312 in octal and comparing it to the binary representation in 2's complement.
  - Try the same thing in base 16...
Floats

They consist of a mantissa and an exponent.
You represent them separately...so you convert them separately to octal and/or hex.

Mantissa and exponent? What will Charles think?!