Worksheet: Coincidences

The following examples illustrate the famous **second law of small numbers** by Richard Guy:

Tip: "if two numbers are equal then they ain't so"

Problem: Fermat: $2^{2^n} + 1$ is always prime.

```
Table[FactorInteger[2^(2^n)+1],{n,1,5}]
```

Problem: $331, 331, 3331, 33331, 333331, 3333331, 33333331$ are all prime ...

Worksheet: Designing number tricks

Magic with numbers can be done in various ways. Knowing some algebra helps.

> **Problem:**   Can you explain the following trick?
> Chose a number, add 10
> double the result
> subtract 4
> divide by 2
> subtract the original number
> You got 8!

Richard Briston's Math Assignments (1996) [1] has a creative way to make this more interesting:

> **Problem:**   Create a trick of your own. You must prove, using algebra, that your trick
> will always work.

> **Subject:**   Basic arithmetic

References

[1] R. Briston. Rich's math assignments. http://mathforum.org/briston/, 1996.

Worksheet: Palindromes etc

Problem: Explain the following structure:

$$
\begin{aligned}
1 \cdot 1 &= 1 \\
11 \cdot 11 &= 121 \\
111 \cdot 111 &= 12321 \\
1111 \cdot 1111 &= 1234321 \\
11111 \cdot 11111 &= 123454321 \\
111111 \cdot 111111 &= 12345654321
\end{aligned}
$$

Does this always give palindromes? What about $111111111111 * 111111111111$?

Problem: Explain the trick:

$$
\begin{aligned}
1 \cdot 9 + 2 &= 11 \\
12 \cdot 9 + 3 &= 111 \\
123 \cdot 9 + 4 &= 1111 \\
1234 \cdot 9 + 5 &= 11111 \\
12345 \cdot 9 + 6 &= 111111
\end{aligned}
$$

Problem: Look at the following number $39 * (\text{your age}) * 259$. Do you see something interesting?

Problem: Take your age and add the two digits. Put this in the middle of your age number, then divide by 11. What do you get? [It always works for high school kids, it surprisingly often works with everybody. Can you figure out when the trick does not work?]

Problem: What the teachers never taught us:

9 x 1 =	0	9
9 x 2 =	1	8
9 x 3 =	2	7
9 x 4 =	3	6
9 x 5 =	4	5
9 x 6 =	5	4
9 x 7 =	6	3
9 x 8 =	7	2
9 x 9 =	8	1
9 x 10 =	9	0

Problem: Chose 4 numbers in

$$
\begin{bmatrix}
1 & 2 & 3 & 4 \\
5 & 6 & 7 & 8 \\
9 & 10 & 11 & 12 \\
13 & 14 & 15 & 16
\end{bmatrix}
$$

such that none is in the same row and column. Claim: The four numbers add up to the same number. Can you explain why?

Subject: Arithmetic