24: Solution

A simple Python script is below. (Try it on your favorite online Python IDE!)

```python
hands = []

for A in range(1, 14):
    for B in range(1, 14):
        for C in range(1, 14):
            for D in range(1, 14):
                if (A * D == (B * D - C) * 24):
                    hands.append([A, B, C, D])
                    print([A, B, C, D])

print("Total:  " + str(len(hands)))
```

Note denominators are cleared for the equation $AD = (BD - C) \cdot 24$ so the program doesn't need to handle fractions. This returns the following output:

```
[2, 1, 11, 12]       [8, 1, 8, 12]        [12, 1, 6, 12]
[3, 1, 7, 8]         [8, 2, 5, 3]         [12, 2, 3, 2]
[4, 1, 5, 6]         [8, 2, 10, 6]        [12, 2, 6, 4]
[4, 1, 10, 12]       [8, 3, 8, 3]         [12, 2, 9, 6]
[4, 2, 11, 6]        [8, 4, 11, 3]        [12, 2, 12, 8]
[6, 1, 3, 4]         [9, 1, 5, 8]         [12, 3, 5, 2]
[6, 1, 6, 8]         [9, 2, 13, 8]        [12, 3, 10, 4]
[6, 1, 9, 12]        [10, 1, 7, 12]       [12, 4, 7, 2]
[6, 2, 7, 4]         [12, 1, 1, 2]        [12, 5, 9, 2]
[6, 3, 11, 4]        [12, 1, 2, 4]        [12, 6, 11, 2]
[8, 1, 2, 3]         [12, 1, 3, 6]        [12, 7, 13, 2]
[8, 1, 4, 6]         [12, 1, 4, 8]        Total:  37
[8, 1, 6, 9]         [12, 1, 5, 10]
```
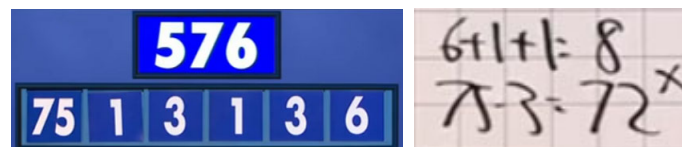
According to statistics from the website 4nums.com, the three quadruples (out of the 1362 total solvable quadruples) which take humans the longest time to solve are $(2, 3, 5, 12)$, $(1, 3, 4, 6)$, and $(1, 4, 5, 6)$, all three of which have solutions exclusively of the form $A/(B - C/D) = 24$.

24 is similar to the numbers round of ***Countdown***, a long-running British game show. There are 24 numbers to choose from: four large $(25, 50, 75, 100)$ and twenty small (two of each of the numbers 1-10). Contestants, of course, only get to choose the sizes of the six numbers they receive (small or large), not the actual numbers themselves. A 3-digit number is randomly generated, and contestants win points based on how close they can get to it in 30 seconds using any of the 6 numbers and the four arithmetic operations $(+, -, \times, \div)$.

Replacing Carol Vorderman in 2008, Rachel Riley is more than just a Vanna White-style hostess for the show: she not only checks the contestants' answers, but routinely finishes the rounds off by providing the best or better solutions purely from mental math.

A crossover *8 Out of 10 Cats Does Countdown* began in 2012, which was the same show but played (less seriously) by comedians and celebrity guests. In episode 5 of series 14, contestants failed to get close to 576. The contestants were incredulous when Rachel revealed an exact solution::

After a friendly ribbing for having no friends ("the numbers are my friends!"), she pointed out a better solution is $576 = 24^2 = ((75/3 + 1) \times ((1 + 3) \times 6)$.