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| **Rule 1:** | Take any number, square its digits, then add them together. Continue with the next number. | |
| **Example 1:** | 23  ↓  13  ↓  10  ↓  … | (2 × 2) + (3 × 3) = 4 + 9 = 13  (1 × 1) + (3 × 3) = 1 + 9 = 10  …  and so on. This is a ‘Happy Number’. |
| **Example 2:** | 20  ↓  4  ↓  16  ↓  37  ↓  … | (2 × 2) + (0 × 0) = 4 + 0 = 4  (4 × 4) = 16  (1 × 1) + (6 × 6) = 1 + 36 = 37  …  and so on. This is a ‘Sad Number’. |
| 1. Continue with the two examples and see what happens. 2. Investigate the number chains started by   a) 29 b) 45 c) 31 d) 7 e) 230 f) 12   1. What do you notice about all the ‘*sad*’ numbers? 2. What happens if you reorder the digits of a ‘*happy*’ number? Investigate and give reasons for your answer. 3. Investigate what happens if you insert zeros into a happy number. 4. Experiment with some numbers of your own and draw up a table showing the happy and sad numbers that you have found. | | |

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| **Rule 2:** | Choose a number and call it *n*. If *n* is odd, multiply by 3, then add 1. If *n* is even, divide by 2. Continue with your new number to form a chain. | |
| **Example 1:** | 6  ↓  3  ↓  10  ↓  5  ↓  … | is even; so divide by 2  is odd; multiply by 3, add 1  is even; divide by 2  is odd; multiply by 3, add 1  … |
| **Example 2:** | 32 → 16 → 8 → … | |
| 1. Finish the two examples. 2. Investigate the number chains started by   a) 26 b) 48 c) 7 d) 29 e) 35 f) 89   1. What do you notice about all your number chains with this rule? 2. Make up your own rule. Investigate the patterns that your rule creates. | | |