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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) 121. 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) 891. 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.
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