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Q01.

The single die has four side with the numbers 1 through 4. So when the die is thrown, there are four possible outcomes: 1, 2, 3, 4. The probability of each of the numbers will be rolled is 1/4.

If there are two of this four sided die, let's make a table to show all the possible total outcomes of this two four sided die.

| Die 1 \ Die 2 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 2 | 3 | 4 | 5 | 6 |
| 3 | 4 | 5 | 6 | 7 |
| 4 | 5 | 6 | 7 | 8 |

So from the table we can see that the range of possible totals of the values showing on the two dice is 2 to 8. So form the table we can see that the chances of totals of these two four sided die appearing: 2 and 8 is 1/16, 3 and 7 is 2/16, 4 and 6 is 3/16 and 5 is 4/16.

Q02.

Now we have an eight sided die with numbers 1,2,3,3,4,5,5,5. The probability of appearing number 1, 2 and 4 is 1/8, for number 3 is 1/4 and lastly for number 5 is 3/8.

| Numbers | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 5 |
|---|---|---|---|---|---|---|---|---|
| Probability | 1/8 | 1/8 | 1/8 | 1/8 | 1/8 | 1/8 | 1/8 | 1/8 |

If there are two of this eight sided die, let's make a table to show all the possible outcomes of this two eight sided die.

| Die 1 \ Die 2 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 5 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 6 |
| 2 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 7 |
| 3 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 8 |
| 3 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 8 |
| 4 | 5 | 6 | 7 | 7 | 8 | 9 | 9 | 9 |
| 5 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 10 |
| 5 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 10 |
| 5 | 6 | 7 | 8 | 8 | 9 | 10 | 10 | 10 |

So from the table we can see that the total possible outcomes are 64 and the range of possible totals of the values showing on the two dice is from 2 to 10. So form the table we can see that the chances of totals of these two four sided die appearing: 2 is 1/64; 3 is 2/64; 4 is 5/64; 5 is 6/64; 6 is 12/64; 7 is 10/64; 8 is 13/64; 9 is 6/64 and 10 is 9/64.

Q03.

To compute the probability of each pair of dices lets select the pairs first form those four dice.

Dice pairs: (1, 2), (1, 3), (1, 4), (2, 3), (2, 4), (3, 4)

**Dice Pair (1, 2):**

| Dice 02 \ Dice 01 | 1 | 2 | 3 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|
| 0 | 0,1 | 0,2 | 0,3 | 0,9 | 0,10 | 0,11 |
| 1 | 1,1 | 1,2 | 1,3 | 1,9 | 1,10 | 1,11 |
| 7 | 7,1 | 7,2 | 7,3 | 7,9 | 7,10 | 7,11 |
| 8 | 8,1 | 8,2 | 8,3 | 8,9 | 8,10 | 8,11 |
| 8 | 8,1 | 8,2 | 8,3 | 8,9 | 8,10 | 8,11 |
| 9 | 9,1 | 9,2 | 9,3 | 9,9 | 9,10 | 9,11 |

So from the table we can see that the probability of Dice 01 will have the highest value will be (22/36 = 0.611….) and Dice 02 will have the highest value will be (12/36 = 0.333….). The winner of these pair will be Dice 01.

**Dice Pair (1, 3):**

| Dice 03 \ Dice 01 | 1 | 2 | 3 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|
| 5 | 5,1 | 5,2 | 5,3 | 5,9 | 5,10 | 5,11 |
| 5 | 5,1 | 5,2 | 5,3 | 5,9 | 5,10 | 5,11 |
| 6 | 6,1 | 6,2 | 6,3 | 6,9 | 6,10 | 6,11 |
| 6 | 6,1 | 6,2 | 6,3 | 6,9 | 6,10 | 6,11 |
| 7 | 7,1 | 7,2 | 7,3 | 7,9 | 7,10 | 7,11 |
| 7 | 7,1 | 7,2 | 7,3 | 7,9 | 7,10 | 7,11 |

So from the table we can see that the probability of Dice 01 will have the highest value will be (18/36 = 0.5) and Dice 03 will have the highest value will be (18/36 = 0.5). So the both pair of these dices will have the same probability of wining.

**Dice Pair (1, 4):**

| Dice 04 \ Dice 01 | 1 | 2 | 3 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|
| 3 | 3,1 | 3,2 | 3,3 | 3,9 | 3,10 | 3,11 |
| 4 | 4,1 | 4,2 | 4,3 | 4,9 | 4,10 | 4,11 |
| 4 | 4,1 | 4,2 | 4,3 | 4,9 | 4,10 | 4,11 |
| 5 | 5,1 | 5,2 | 5,3 | 5,9 | 5,10 | 5,11 |
| 11 | 11,1 | 11,2 | 11,3 | 11,9 | 11,10 | 11,11 |
| 12 | 12,1 | 12,2 | 12,3 | 12,9 | 12,10 | 12,11 |

So from the table we can see that the probability of Dice 01 will have the highest value will be (12/36 = 0.333….) and Dice 04 will have the highest value will be (22/36 0.611….). The winner of these pair will be Dice 04.

**Dice Pair (2, 3):**

| Dice 03 \ Dice 02 | 0 | 1 | 7 | 8 | 8 | 9 |
|---|---|---|---|---|---|---|
| 5 | 5,0 | 5,1 | 5,7 | 5,8 | 5,8 | 5,9 |
| 5 | 5,0 | 5,1 | 5,7 | 5,8 | 5,8 | 5,9 |
| 6 | 6,0 | 6,1 | 6,7 | 6,8 | 6,8 | 6,9 |
| 6 | 6,0 | 6,1 | 6,7 | 6,8 | 6,8 | 6,9 |
| 7 | 7,0 | 7,1 | 7,7 | 7,8 | 7,8 | 7,9 |
| 7 | 7,0 | 7,1 | 7,7 | 7,8 | 7,8 | 7,9 |

So from the table we can see that the probability of Dice 02 will have the highest value will be (22/36 = 0.611….) and Dice 03 will have the highest value will be (12/36 0.333….). The winner of these pair will be Dice 02.

**Dice Pair (2, 4):**

| Dice 04 \ Dice 02 | 0 | 1 | 7 | 8 | 8 | 9 |
|---|---|---|---|---|---|---|
| 3 | 3,0 | 3,1 | 3,7 | 3,8 | 3,8 | 3,9 |
| 4 | 4,0 | 4,1 | 4,7 | 4,8 | 4,8 | 4,9 |
| 4 | 4,0 | 4,1 | 4,7 | 4,8 | 4,8 | 4,9 |
| 5 | 5,0 | 5,1 | 5,7 | 5,8 | 5,8 | 5,9 |
| 11 | 11,0 | 11,1 | 11,7 | 11,8 | 11,8 | 11,9 |
| 12 | 12,0 | 12,1 | 12,7 | 12,8 | 12,8 | 12,9 |

So from the table we can see that the probability of Dice 02 will have the highest value will be (16/36 = 0.444….) and Dice 04 will have the highest value will be (20/36 0.555….). The winner of these pair will be Dice 04.

**Dice Pair (3, 4):**

Dice 03

| Dice 04 | 5 | 5 | 6 | 6 | 7 | 7 |
|---|---|---|---|---|---|---|
| 3 | 3,5 | 3,5 | 3,6 | 3,6 | 3,7 | 3,9 |
| 4 | 4,5 | 4,5 | 4,6 | 4,6 | 4,7 | 4,9 |
| 4 | 4,5 | 4,5 | 4,6 | 4,6 | 4,7 | 4,9 |
| 5 | 5,5 | 5,5 | 5,6 | 5,6 | 5,7 | 5,9 |
| 11 | 11,5 | 11,5 | 11,6 | 11,6 | 11,7 | 11,9 |
| 12 | 12,5 | 12,5 | 12,6 | 12,6 | 12,7 | 12,9 |

So from the table we can see that the probability of Dice 03 will have the highest value will be (22/36 = 0.611….) and Dice 04 will have the highest value will be (12/36 0.333….). The winner of these pair will be Dice 03.

From above six pairs we can see that how many times which dice wins.

Dices

| Pairs | Dice 01 | Dice 02 | Dice 03 | Dice 04 |
|---|---|---|---|---|
| Pair (1,2) | √ | | | |
| Pair (1,3) | | | | |
| Pair (1,4) | | | | √ |
| Pair (2,3) | | √ | | |
| Pair (2,4) | | | | √ |
| Pair (3,4) | | | √ | |

These are Nontransitive set of dice, where Dice 04 rolls higher 2 times than Dice 01, 02 and 03 roll higher.