1. (15pts) Do this part on your own. Roll two dice 50 times.

a) Record how many times you get each of the possible sums on the dice in the first row.

b) In the second row, enter the empirical probabilities for each sum based on your 50 rolls. Then compute the theoretical probabilities for each sum and enter them in the third row of the table. Enter these numbers as fractions.

c) Find the difference between the rows P_E and P_T and write it in decimal form rounded to 4 decimal places, ignoring any minus signs (that is what $||$ stands for).

Sum on roll	2	3	4	5	6	7	8	9	10	11	12
Times occured	1	3	6	10	1	8	7	5	5	3	1
Empirical prob. P_E	$\frac{1}{50}$	$\frac{3}{50}$	$\frac{6}{50}$	$\frac{10}{50}$	$\frac{1}{50}$	$\frac{8}{50}$	$\frac{7}{50}$	$\frac{5}{50}$	$\frac{5}{50}$	$\frac{3}{50}$	$\frac{1}{50}$
Theoretical prob. P_T	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$
$|P_E - P_T|$	0.0078	0.0044	0.0367	0.0889	0.1189	0.0067	0.0011	0.0111	0.0167	0.0044	0.0078

Sum = 6 : (1,5), (2,4), (3,3), (4,2), (5,1) five outcomes give sum 6.

2. (15pts) Do this part with 3 classmates. Write their names in the space provided. Each of you has to fill in the table independently, but the last three rows of this table should be the same for everyone in your group (check!).

a) Copy the "Times occured" line from above into row "You" and do the same for each of your classmates.

b) Sum by column and enter the sums in the row "Total times occured".

c) Write the empirical probability for each sum on the dice as a fraction. Keep in mind that your number of experiments is now larger.

d) Find $|P_E - P_T|$ and write it in decimal form rounded to 4 decimal places. Are the numbers smaller than in the table above?

Sum on roll	2	3	4	5	6	7	8	9	10	11	12
You	1	3	6	10	1	8	7	5	5	3	1
Student 1	7	3	5	5	3	7	3	3	3	4	7
Student 2	1	2	2	4	5	7	15	4	4	4	2
Student 3	2	2	3	4	7	10	7	7	4	3	1
Total times occured	11	10	16	23	16	32	32	19	16	14	11
Empirical prob. P_E	$\frac{11}{200}$	$\frac{10}{200}$	$\frac{16}{200}$	$\frac{23}{200}$	$\frac{16}{200}$	$\frac{32}{200}$	$\frac{32}{200}$	$\frac{19}{200}$	$\frac{16}{200}$	$\frac{14}{200}$	$\frac{11}{200}$
$|P_E - P_T|$	0.0272	0.0055	0.0033	0.0038	0.0589	0.0067	0.0211	0.0161	0.0033	0.0144	0.0272
d)	B	B	S	S	S	=	B	B	S	B	B

In this case only half are smaller (S) compared to table above, although, generally, these should be more.

3. (10pts) License plates for the state of Thumbia consist of 8 characters. The first two are letters, the second two are numbers, the fifth is an emoji, the sixth is either an emoji or a letter, the seventh is a number and the eight can be a letter, number or emoji. If there are 49 emojis to choose from and letters are only uppercase, how many different license plates are possible in this state?

$$\overset{\uparrow}{\underset{26}{}}\ \overset{\uparrow}{\underset{26}{}}\ \overset{\uparrow}{\underset{10}{}}\ \overset{\uparrow}{\underset{10}{}}\ \overset{\uparrow}{\underset{49}{}}\ \overset{\uparrow}{\underset{10}{}}\ \overset{\uparrow}{\underset{}{}}\ \overset{\uparrow}{\underset{}{}} \quad \bigl[10 + 26 + 49 = 85$$

$$26 + 49 = 75$$

Number of possible license plates: $26 \cdot 26 \cdot 10 \cdot 10 \cdot 49 \cdot 75 \cdot 10 \cdot 85$
$$= 211,165,500,000 = 2.11 \times 10^{11}$$

4. (10pts) How many even four-digit numbers are there whose sum of digits is a number ending with 0? (For example, 6356 is one such number, $6 + 3 + 5 + 6 = 20$, and 20 ends with 0.) Assume the leftmost digit of the four-digit number is not zero.

The third digit is determined by others,

for example, if we chose $\underline{1}\ \underline{7}\ \underline{-}\ \underline{6}$

$$\overset{\uparrow}{\underset{1-9}{}}\ \overset{\uparrow}{\underset{0-9}{}}\ \overset{\uparrow}{\underset{0,2,4,6,8}{}}$$
$$9 \qquad 10 \qquad 1 \qquad 5$$

the only digits that fulfills condition
$1 + 7 + ? + 6$ ends with 0 is 6.

$9 \cdot 10 \cdot 1 \cdot 5 = 450$
numbers

5. (10pts) A die is rolled and a coin is tossed twice.
a) How many different outcomes are there to this experiment?
b) How many different outcomes have an even number on the die and exactly one head? List all the outcomes.

a) $\overset{1-6}{\underset{6}{}}\ \overset{H}{\underset{T}{\underset{2}{}}}\ \overset{H}{\underset{T}{\underset{2}{}}}$

$6 \cdot 2 \cdot 2 = 24$

b) Outcomes are

1HT	4HT
1TH	4TH
2HT	5HT
2TH	5TH
3HT	6HT
3TH	6TH

12 outcomes

P(even and exactly one head)
$$= \frac{12}{24} = \frac{1}{2}$$