Sample space = every element in relation to the question

Permutations without repeated letters = $n!$
↳ Use Mississippi if there are repeated numbers ↗ $\frac{n!}{2!2!1!\ldots}$

$\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Raised to the power questions → amount of choices raised to number of events
↳ flip a coin 5 times, odds you get 5 heads? $1/2^5$

Mutually Exclusive - the 2 events that are mutually exclusive can not happen at the same time.

$P(A) = P(A \cap B) + P(A \cap B^c)$ $P(A \cup B) = P(A) + P(A^c \cap B)$
$P(A \cup B) = P(A) + P(B) - P(A \cap B)$ $P(A \cap B^c) = P(A) - P(A \cap B)$
$P(A^c \cap B^c) = 1 - P(A \cup B)$

Discrete = limited options, whole numbers
Continuous = can be fractions, no limit.

CDF table = $F(0) = f(0)$, $F(1) = f(0) + f(1)$, $F(2) = f(0) + f(1) + f(2) + \ldots$

Probability density function, $f(x) = \frac{d}{dx} F(x)$
↳ put parameters in integral spots of PDF → $\int_0^{.2} f(x)\, dx$ ↙ $f(x)$, NOT $F(x)$

Probability distribution of discrete random variable x
↳ $f(x)$ = some function for x = some group of numbers
$1 = f(x_1) + f(x_2) + \ldots f(x_n)$ → solve for c.

Joint Probability density function → this is for x and y
↳ $f(x,y)$ = some function x = numbers, y = numbers
$1 = f(x_1, y_1) + f(x_1, y_2) \ldots f(x_n, y_n)$ → solve for c.
Sometimes, the numbers will be limited

Marginal Density Functions
- For both x and y, derive from 0 to ∞
$\int_0^{\infty} f(x,y)\, dy$ Marginal distribution of x used dy, vice versa.
- To check probability for these, when $(x \geq 2, y \geq 2)$ or something like that, use a double integral to check.

Marginal Distribution - usually on a chart of values
↳ Add up the rows or columns for which we are looking at
$x = x_1, x_2, x_3$ $y = y_1, y_2, y_3$ in a table of $y \cdot x$ values
$f_x(x_1) = f(x_1, y_1) + f(x_1, y_2) + f(x_1, y_3)$ for all values of x
↳ If its just a graph integrate like for marginal density functions
Bounds depend on function bounds for something like $val_1 < x < y < val_2$
bounds for dy are $\int_x^{val_2}$, bounds for dx are $\int_{val_1}^{y}$

Conditional Distribution of Marginal Distribution
↳ say $(X|Y)$, take x value of that index over Marginal distribution of that y value.

Conditional Distribution of $X|Y$ Distribution with function
↳ say $(X|Y) = \frac{f(x,y)}{F_Y(Y)}$

Independance = X and Y are independant, if $f(x,y) = f_x(x) \cdot f_y(y)$

Probability Distribution Function
↳ Solve probability of all cases, put into table {val : prob}

Expected value - once we have PDF, we can do this.
↳ multiply val · prob of all entries from PDF and add them.
(Marginal Densities are noted in above chapter notes)

Independance is true if $f_{XY}(0,0) = f_x(0) \cdot f_y(0)$

Using Marginal Density table
$E[X] = x_1(x_{1row}) + x_2(x_{2row}) + \dots + x_n(x_{nrow})$
$E[Y]$ → same but just with y.
$E[XY] = x_1y_1(P(x_1,y_1)) + x_1y_2(P(x_1,y_2)) + \dots x_ny_n(P(x_n,y_n))$ for all points in the table.
$Cov(X,Y) = E[XY] - E[X]E[Y]$
$E[x^2]$ = same as $E[x]$, but x values are squared, x_{row} stay the same though
$Var(x) = E[x^2] - (E[x])^2$ $Var(Y) = E[Y^2] - (E[Y])^2$ $\rho_{XY} = \frac{Cov(X,Y)}{\sqrt{Var(X)} \cdot \sqrt{Var(Y)}}$
Conditional densities → $X|Y$ → count up all values when y = val, take individual x values / y = val sum
Expected value = $E[X+Y] = E[X] + E[Y]$

Using Marginal Density Function
$E[x] = \int_L^U x f_x(x)\,dx$ $E[Y] = \int_L^U y f_Y(y)\,dy$ $E[XY] = \int_L^U \int_L^U xy\, f_{XY}(x,y)\,dy\,dx$ U, L are upper and lower bounds of the function.
$Cov(X,Y) = E[XY] - E[X] \cdot E[Y]$
$E[x^2] = \int_L^U x^2 f_x(x)\,dx$ $E[Y^2] = \int_L^U y^2 f_Y(y)\,dy$
$Var(x) = E[x^2] - (E[x])^2$ $Var(Y) = E[Y^2] - (E[Y])^2$ $\rho_{XY} = \frac{Cov(X,Y)}{\sqrt{Var(X)} \cdot \sqrt{Var(Y)}}$
Conditional densities $f_{X|Y} = \frac{f_{XY}(x,y)}{f_Y(y)}$

Cummulative Distribution Function in tabular Form
$f(0) = f(0)$, $f(1) = f(0) + f(1)$, $f(2) = f(0) + f(1) + f(2) + \dots$ →

x	1	2	....
f(x)	f(1)	f(2)	....

When CDF is given, Expected value = $E(x)$, Standard Deviation = $SD(x) = \sqrt{Var(x)}$
Find expected value of U = ... → multiply everything by E and solve.
Find variance of V = ... → multiply everything by var and solve.