You have 70 minutes.

No notes, books, calculators, computers, etc. are allowed.

Show all of your work, in as organized a manner as possible. Incorrect answers with solid work often earn partial credit. Correct answers without explanatory work rarely earn full credit.

Define any notation that you introduce. For example, if you write "$P(A)$", but neither I nor you have defined an event A, then that writing is not good.

Perform as much algebraic simplification as you can. Do not bother to do non-trivial arithmetic unless it is specifically requested. Mark your final answer clearly.

Good luck.

A. In your state there are R Republicans, D Democrats, and I independents. Each adult belongs to one and only one of these categories. Within this context, for each of the following distributions, ask a question in plain English, such that the answer is a random variable that follows the given distribution. Be sure to indicate how the parameters of the distribution depend on R, D, I, and any other relevant information.

A.A. Bernoulli:

A.B. geometric:

A.C. binomial:

A.D. hypergeometric:

A.E. negative binomial:

B. You're a physicist studying subatomic particles. Each time you run your experiment, a single particle is produced. It's a *blorgon* 1% of the time. You can't directly detect this kind of particle, but you can detect its decay products. The blorgon decays to a *flapjack* 2/3 of the time, while non-blorgons decay to flapjacks only 1/3 of the time.

B.A. You observe a flapjack. What is the probability that the experiment produced a blorgon?

B.B. Imagine running the experiment many times. What's the probability that you observe a flapjack coming from a blorgon before you observe a flapjack coming from a non-blorgon?

C. You are playing a game. There are 100 boxes. One of the boxes contains \$1, one contains \$2, and so on. That is, for each integer k such that $1 \le k \le 100$, exactly one of the boxes contains \$$k$. You pick n of the boxes, uniformly randomly without replacement. Let X be the value of the most valuable box that you pick. Find the support and PMF of X, in terms of n.

D. You live in a city consisting of two-way streets laid out on a giant grid. All streets run east-west or north-south. You may U-turn at any intersection, but you are not allowed to U-turn in the middle of a block. In the following questions, each drive begins and ends at an intersection.

D.A. One day, you want to drive to an appointment that is E blocks east and N blocks north of your home. For efficiency, you will drive only east and north; you will never drive west or south. How many ways are there to complete the drive?

D.B. On another day, you are driving for pleasure. You will drive an even number T of blocks, and you don't care where you end up. How many different drives can you take?

D.C. Continuing part B: In how many different locations can you end up? (Answer on back.)