

Name: _____

These problems are mostly taken from Rob Ellis with permission, with the requirement that they **must not** be shared outside this class.

- (1) *Sandwiches-R-We*
 - (a) The sandwich peddler says “We have Tuna, Tofu, Snail, or Gazelle fillings on White, Whole Wheat, or Rye bread.” How many distinct sandwiches are possible?
 - (b) “Oh, you can also add cheese to any sandwich, if you want.” Now how many sandwiches are possible?
 - (c) “Oh, didn’t I mention that we have 49 kinds of cheese?” Same question.
 - (d) “Today only, we are offering a special: your sandwich comes with either soup or salad (but not both). The soup choices are lemon and wonton; the salad choices are caesar, house, and garden.” How many ways are there to order?
 - (e) What if you can decline a side? How many orders?
 - (f) What if, as a student, you are allowed to have both salad and soup if you want? How many ways?
- (2) *Yogurt-R-Not-We* This ice cream shop sells 31 flavors. In a *triple cone*, you get to pick flavors for your top scoop, middle scoop, and bottom scoop. *Order matters*, e.g., [top:vanilla middle:chocolate bottom:berry] is different from [top:berry middle:vanilla bottom:chocolate]. How many distinct cones are possible?
- (3) (a) You own 100 children’s books, but opting for sanity, only allow your child to choose 3 (different stories) for bedtime reading. As it turns out, the order is *terribly important*. How many possibilities are there?
 - (a’) What if you allow your child to repeat a book (as 2 or all 3 of the stories). How many possibilities now?
 - (b) You can fit 40 of the 100 books on your bookshelf. How many ways are there to choose and arrange 40 books on the bookshelf?
 - (c) You get rid of the bookshelf and store all of your books in a single comically tall pile. How many different arrangements are possible?
- (4) Back to Yogurt-R-Not-We.
 - (a) Alice, being an adventurous sort, insists on having three distinct flavors in her triple cone. How many cones can she order?
 - (b) Bob is picky, but not so much as Alice: he just insists that consecutive scoops are different. (E.g., [top:vanilla middle:chocolate bottom:vanilla] is OK for Bob.) How many cones can Bob order?
 - (c) Eve doesn’t care about having different flavors, but she always springs for the cone made of cookie dough instead of waffle. But cookie dough is one of the 31 flavors of ice cream, and she doesn’t want that as the bottom flavor (inside the cone!); she’s fine with it as either of the top two scoops. How many different cones are possible for Eve?
 - (d) Alice decides she wants the cookie dough cone too. She also then doesn’t want cookie dough ice cream as her bottom scoop, and she maintains her adventurous spirit and wants all distinct flavors. How many possible?
 - (e) Bob, feeling left out, also decides to get the cookie dough cone. He has the same aversion to cookie-dough-overload in the bottom scoop, and still wants consecutive flavors of ice cream to be different.
- (5) Repeat (3), now that you’ve realized that you actually have 5 copies of the same book “Goodnight Loon” (and the 95 remaining books are all distinct). [*This won’t change some of the answers, and some of the answers become much more difficult.*]