538 Riddler Classic

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Question: From Alec Stein, inspired by conversations with Jesse Zymet and Adam Greenberg, comes a puzzle that is sure to make you lose your marbles:

At the Riddler Marble Shop, there are four enormous bags of marbles for you to acquire. They are labeled "red," "green," "blue" and "assorted." Being the purist that you are, you want to select two bags of marbles that are not assorted, and you'd settle for some combination of red, green or blue.

However, noticing your interest in the bags, the shopkeeper alerts you. "Buyer beware," she warns. "Some jerk switched around the labels on all four bags. Right now, every single bag is incorrectly labeled." To give you a chance of properly identifying the bags you would like, she has kindly allowed you to take two — and only two — marbles out of any of the bags, one at a time.

How can you guarantee that neither of the two bags you take is assorted?

Solution: First, note that as all of the bags are incorrectly labelled, whichever bag is labelled "assorted" must not be assorted. However, it is still valuable to know which color marbles are in this bag. So, to begin, draw a marble from this bag and note its color C.

Now, draw a marble from the bag with the label C.

There are two possible cases that emerge:

Case 1: The marble drawn has color C. In this case, we know that the bag with the label C must be the "assorted" bag. This is because we have already drawn a marble with color C from the bag labelled "assorted", and we know that the bag labelled "assorted" cannot be the true "assorted" bag. So, we can take any two of the bags not labelled with the color C.

Case 2: The marble drawn does not have color C, but another color D.

We have the following information about each of the bags:

- The bag labelled "assorted" is truly the bag with marbles of the color C.

- The bag labelled C can either be the bag with marbles of the color D or the "assorted" bag (it CANNOT be C both because we know the bag labelled "assorted" is C and as we know all bags are incorrectly labelled and it CANNOT be a third color E as we have drawn a marble of color D from this bag).

- The bag labelled D can either be the bag with marbles of a third color E or the "assorted" bag (it CANNOT be C as we know the bag labelled "assorted" is C and it CANNOT be D as we know all bags are incorrectly labelled).

- The bag labelled E can either be the bag with marbles of the color D or the "assorted" bag (it CANNOT be C as we know the bag labelled "assorted" is C and it CANNOT be E as we know all bags are incorrectly labelled).

Note that the bags labelled C and E have the same two possible identities: D and "assorted". So, any ordering that assigns one of these identities to the bag labelled D is impossible. Therefore, we know that the bag labelled D MUST contain only marbles of color E. So, in this case, we can take the bags labelled D and "assorted". This strategy guarantees two non-"assorted" bags in all cases.