This is a purely individual assignment. Prepare your answers to the following questions in a plain ASCII text file or a Word document. No other formats will be graded. Submit your file to the Curator system by the posted deadline for this assignment. No late submissions will be accepted without special permission from your instructor.

You will submit your answers to the Curator System (www.cs.vt.edu/curator) under the heading `OOC04`.

1. [10 points each] For each part, identify and carefully describe a definite relationship between figures **X** and **Y**. Then consider figure **Z** and choose a figure from **1**-**5** that has the same relationship to **Z** that **Y** has to **X**.

a)

Figure X consists of three dots and a "trident" shape, which has the points at its tips. Figure Y could be obtained from figure X by flipping the "trident" up-to-down about its base, away from the dots.

Now, figure Z has a "vee" instead of a trident, and the "vee" is oriented to the right instead of to the top (comparing to figure X). If we apply the same idea to Z, the closest interpretation seems to be that we flip the "vee" right-to-left about its base.

That would yield figure 3.

b)

Figure X consists of three geometric shapes, oriented from left to right. We can transform figure X into figure Y by placing the first shape below the second shape, and enclosing both in an expanded copy of the third shape.

If we apply the same transformation to figure Z, we would put the square below the circle, and enclose both in an expanded triangle --- that corresponds to figure 3.

c)

We can transform figure X into figure Y by rotating the figure 90 degrees clockwise and then flipping it 180 degrees about a vertical axis. (There are other ways to achieve the same effect.)

If we apply the same transformation to figure Z, we would obtain figure 3 (again).

2. [10 points each] For each part, describe an analogic relationship between the given pair of words by stating a relationship sentence (see the notes), and choose a pair of words from the given list of candidates that the most accurately possesses the same relationship. (It is perfectly acceptable for you to consult a dictionary if you like.)

a) EXPAND : VOLUME

ascend : flight
proliferate : number
bend : flexibility
cool : temperature
deflect : heading

proliferate : number

To _____ a thing increases its _____ .

Expanding something increases its volume; proliferating something increases the number of those things.

Bending something might increase its flexibility… or not.
Cooling something will decrease its temperature.
Deflecting something will change its heading.
ascend : flight doesn't seem to exhibit any even roughly similar relationship.

b) MUTTER : INDISTINCT

demand : obedient
plead : obligatory
flatter : commendable
drone : monotonous
confirm : proven

To mutter is to speak indistinctly, so we have a qualitative relationship:

drone : monotonous

To _____ is to do a thing in a(n) _____ manner.

No other word pair here seems to have a reasonably similar relationship.

c) PEST : IRKSOME

salesclerk : courteous
expert : proficient
enigma : unexpected
leader : nondescript
accuser : indicted

expert : proficient

A _____ is probably _____ .

A salesclerk may be courteous, but there is no guarantee of that.
An enigma could very well be expected. A leader is unlikely to be nondescript. An accuser is not usually indicted.

3. [20 points] The two-player game of Partito begins with three piles of small stones, one with 8 stones, one with 13 stones, and one with 21 stones. On each turn, the current player must choose a pile of stones and divide it into two smaller piles. Aside from the rule that a pile may not be empty, there are no restrictions on how many stones may be in each of the piles a player creates. The loser is the player who cannot carry out a valid move.

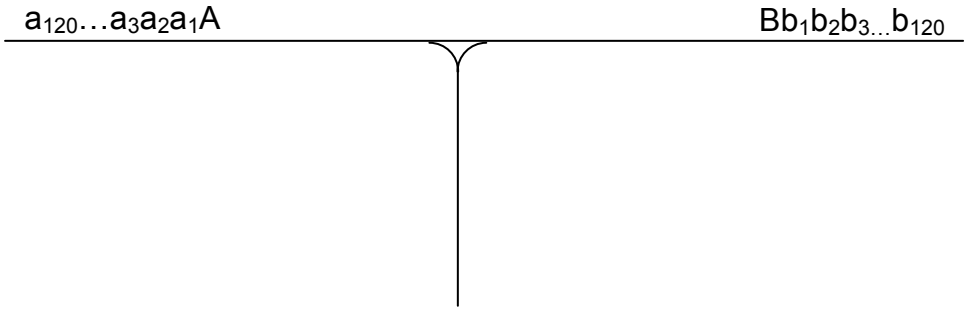
What strategy, if any, can the player who goes first use to guarantee that he wins? What strategy, if any, can the player who goes second use to guarantee that she wins?

There is an invariant lurking in this problem. To begin with, there are 3 piles of stones. After each player makes a move, the number of piles is increased by 1. So, the number of piles always equals 3 plus the number of moves that have been made.

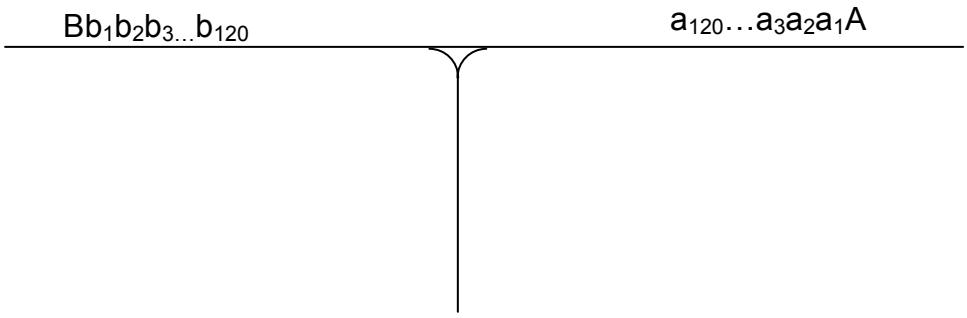
Now, the loser is determined when every pile contains a single stone, at which point there would be 42 piles. Hence the game will end after 39 moves. Hence, the game must end following a move by player 1, since player 1 makes moves 1, 3, 5, etc., and player 2 makes moves 2, 4, 6, etc.

Therefore, player 1 will always win the game, and strategy doesn't enter into it.

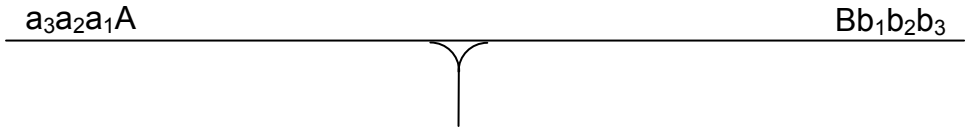
4. [20 points] Two trains, each consisting of an engine and 120 cars, must pass on a single track, with a dead-end siding as shown below. The siding can hold, at most, a single engine and 40 cars. Engines can move forward and backward, as far as necessary, and cars can be decoupled and recoupled, but in the end, the cars that make up each train must be in the same relative order as when the trains met, and the engines must be at the front of the trains. Note: it would almost certainly be good to include diagrams in your answer.



In other words, the goal is to achieve the following state:

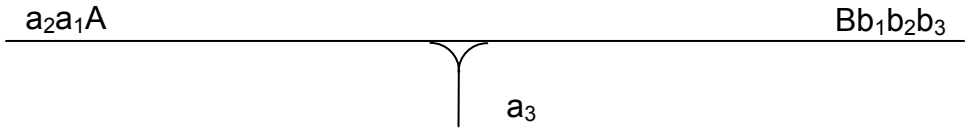


Consider a simpler, but essentially equivalent problem: suppose each engine is pulling 3 cars, and that the siding can hold only a single car (and an engine):

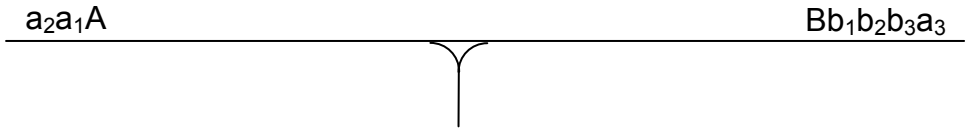


(This is an application of the wishful thinking heuristic, selecting a simpler variation of the original problem.)

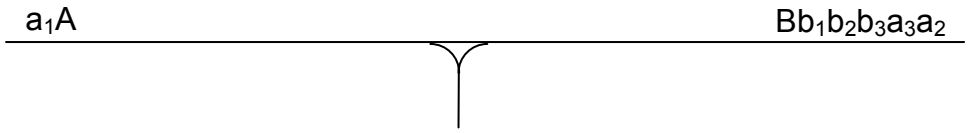
Move A to the east, then back it into the siding, uncouple a3 and then pull A forward and back it to the west:



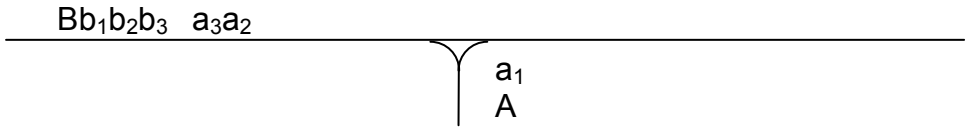
Now, pull B east past the siding, back into the siding, couple a3 to the end of B's cars and then return B to its original position:



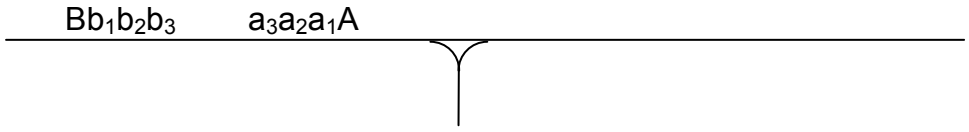
Now, repeat the process and attach a2 to the end of B's cars:



Now, move A and its remaining car onto the siding and then pull B west past the siding and uncouple the two cars that belong to A:



Then, back A and its car out of the siding, towards the west, and couple its two cars to the end:

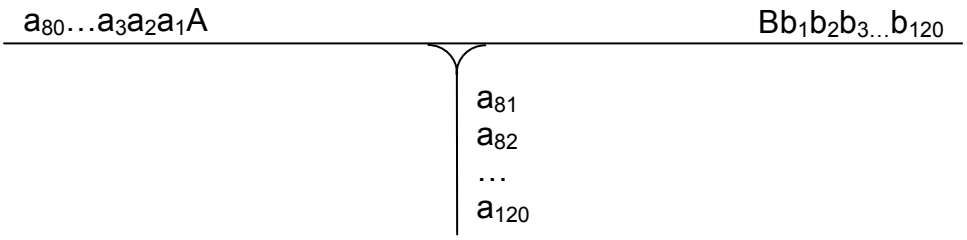


And now each train can proceed on its way…

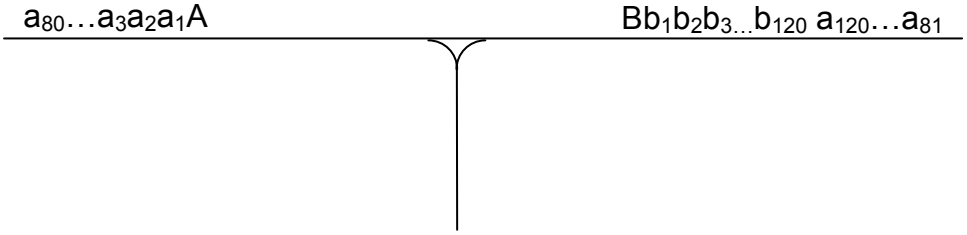
To solve the original problem we only need to observe that in both problems, the siding is capable of holding 1/3 of the cars that were originally attached to either engine plus an engine.

So, we have the following solution to the original problem.

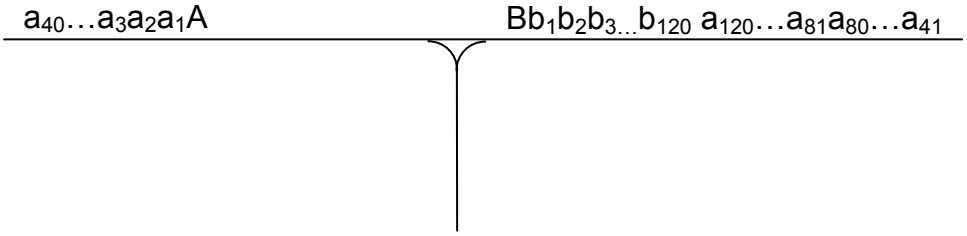
first, move A forward past the siding, back it in and uncouple in front of a81, then return A to its original location, leaving 1/3 of its cars on the siding:



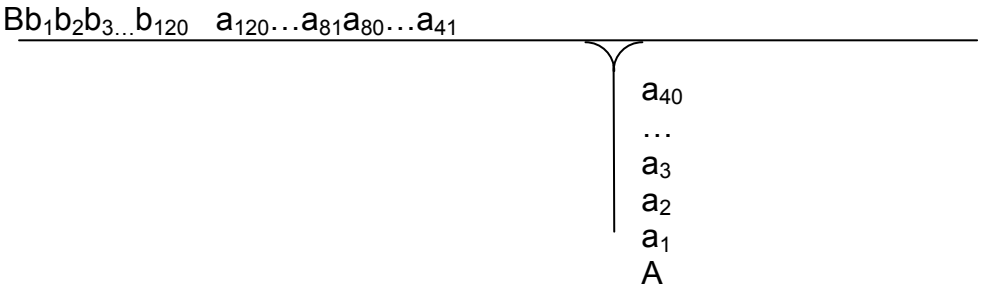
Then, pull B past the siding, back it in and couple b120 to a81, and then return B to its original position:



Now, repeat that process to transfer a80…a41 to B:



Then, pull A into the siding and move B west past the siding and uncouple between b120 and a120:



Then back A out of the siding, to the west, couple car a41 to car a40 and the trains may proceed