Worksheet Activity: Divide and Conquer
Quicksort

Quicksort is a lot faster than selection sort, particularly for larger lists. In fact, it is one of the best methods known. This is how quicksort works.

1. Choose one of the objects at random, and place it on one side of the balance scales.

2. Now compare each of the remaining objects with it. Put those that are lighter on the left, the chosen object in the middle, and the heavier ones on the right. (By chance you may end up with many more objects on one side than on the other.)

3. Choose one of the groups and repeat this procedure. Do the same for the other group. Remember to keep the one you know in the center.

4. Keep repeating this procedure on the remaining groups until no group has more than one object in it. Once all the groups have been divided down to single objects, the objects will be in order from lightest to heaviest.

How many comparisons did this process take?

You should find that quicksort is a more efficient method than selection sort unless you happen to have chosen the lightest or heaviest weight to begin with.

If you were lucky enough to have chosen the middle weight, you should have taken only 14 comparisons, compared with the 28 for selection sort. At any rate the quicksort method will never be any worse than selection sort and may be much better!

Extra for Experts: If quicksort accidentally always chose the lightest object, how many comparisons would it use?

Variations and extensions
Many different methods for sorting have been invented. You could try sorting your weights using these:

- ***Insertion sort*** works by removing each object from an unsorted group and inserting it into its correct position in a growing list (see picture below). With each insertion the group of unsorted objects shrinks and the sorted list grows, until eventually the whole list is sorted. Card players often use this method to sort a hand into order.

- ***Bubble sort*** involves going through the list again and again, swapping any objects side-by-side that are in the wrong order. The list is sorted when no swaps occur during a pass through the list. This method is not very efficient, but some people find it easier to understand than the others.

- ***Mergesort*** is another method that uses ‘divide and conquer’ to sort a list of items. First, the list is divided at random into two lists of equal size (or nearly equal if there are an odd number of items). Each of the two half-size lists is sorted, and the two lists are merged together. Merging two sorted lists is easy—you repeatedly remove the smaller of the two items at the front of the two lists. In the figure below, the 40 and 60-gram weights are at the front of the lists, so the next item to add is the 40-gram weight. How do you sort the smaller lists? Simple—just use mergesort! Eventually, all the lists will be cut down into individual items, so you don’t need to worry about knowing when to stop.