



# 2006 Missions



## Individual Atom Manipulation

Mission: Move individual atoms accurately. The robot must remove at least 1 white atom from the blue surface without removing any red atoms. Counting atoms left on the surface, a count of fewer than 8 red atoms is worth no points. A count of 8 red atoms and 7 or 6 white atoms is worth **30** points. A count of 8 red atoms and 5 or fewer white atoms is worth **40** points.

Background: Lots of structures and processes involve materials loosely combined, like a pile of bricks, or material moving

unpredictably, like thundershowers. But when we apply science, engineering, and work on the "macro" scale, we can turn bricks into cities and pipe water into our homes. Materials can be made or moved atom by atom, allowing special new properties and uses. Nanotechnology is about applying science, engineering, and work on the "nano" scale, where measurements range up to about 100 nanometers—the size of a few molecules—and where everything is moving and shaking.

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### **Smell**

**Mission:** Transfer molecules from the pizza toward the nose. The robot must get pizza molecules completely off the paper plate for **5** points each, and transferred to the yellow or black areas of the person's head or neck for an additional **10** points each.

**Background:** Do you realize that when you smell something yummy or disgusting, it means that molecules from that substance have reached your nose? You can't even see them, but they're there. Imagine trying to work with these nano scale objects to invent things and solve problems...that's nanotechnology!

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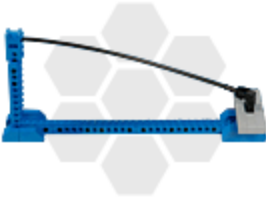


### **Stain-Resistant Fabric**

**Mission:** Test some stain-resistant fabric. The robot must deliver the dirt trap to its location mark and completely dump out the tester's dirt dumper. The dirt trap at its mark is worth **15** points, and the dirt dumper when empty is worth **15** points. The dirt pieces are Bonus Objects, worth **5** points each in the dirt trap, and **3** points each everywhere else on the table. When removing dirt for a Bonus Loss, the referee takes stray pieces first, then pieces from the dumper, and pieces from the trap last.

**Background:** Nanotechnology can be thought of as the understanding and use of traditional sciences on the nano scale to achieve results we've never seen before, and those results are already finding their way into our daily lives. For example, a special treatment for fabric is already becoming available that can make it impossible to get your clothes wet or dirty!

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### **Atomic Force Microscopy**

**Mission:** Free the probe's nanotip. The robot must separate the nanotip from the material surface. The nanotip separated from the surface is worth **40** points.

**Background:** In the same way you can describe a surface as bumpy, sticky, or hot through the use of your finger on the large "macro" scale, the atomic force microscope can describe a surface atom by atom through the use of its probe on the nano scale. Unfortunately, the probe's nanotip often gets stuck on the surface, frustrating scientists.



### **Self-Assembly**

**Mission:** Start the self-alignment of atoms. The robot must cause the angled blue nanotube segments to align horizontally end to end. This alignment is worth **30** points.

**Background:** Atoms are super-super small, so it's very difficult and time consuming to work with them 1 by 1. For example, moving 3 atoms at a time (each water molecule has 2 hydrogen atoms and 1 oxygen atom), it would take about one hundred and seventy thousand million trillion loads to fill 1 teaspoon with water! With this in mind, an important part of nanotechnology is to find ways to get atoms and molecules to arrange themselves, sort of like magnets do.



### **Smart Medicine**

**Mission:** Target medicine to reach only a specific problem spot. The robot must release the Buckyball containing medicine into the person's arm. The Buckyball placed anywhere in the red/yellow channel of the arm bone is worth **50** points (even if it hasn't reached the problem spot).

**Background:** When we are given medicine, it usually circulates throughout the body, and often causes harmful side effects in unintended areas. But through nanotechnology, some medicines can be strategically placed inside special molecules like the C60

Buckyball molecules, that only allow delivery to the exact area where the medicine is needed.

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### **Nanotube Strength**

**Mission:** Lift the truck by a thin cable of carbon nanotubes. The robot must move the truck onto the lift frame and activate the lift. The truck completely on the frame is worth **20** points. The truck and frame supported completely and only by the cable is worth an additional **20** points.

**Background:** The carbon atom is of special interest in nanotechnology. One of the reasons for this is that carbon atoms can be arranged to form carbon nanotubes, which can form the basis of some unbelievably strong materials. Imagine a cable as thin as a toothpick, weighing one-sixth as much as a steel cable of the same size, yet it could support the weight of a car!

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### **Molecular Motor**

**Mission:** Deliver an adenosine triphosphate (ATP) molecule to power a molecular motor, causing it to spin and release energy. The robot must deliver 1 of the 2 ATP molecules through the molecular motor's black frame for **40** points (even if nothing else happens). The second ATP molecule represents a second chance to complete this mission, but points are only given for 1 delivered molecule.

**Background:** Atoms and molecules are always moving or shaking, like loose balloons in a room full of fans. This can make it hard to work with them, but the right molecule spinning a certain way can actually be used to do work. Molecular motors are molecules that can convert chemical energy from other molecules into rotational energy, like a power tool, to do work on a scale where no other mechanical tool could fit—work such as transporting other molecules or contracting muscles.



### **Space Elevator**

**Mission:** Operate the space elevator. At least one robot must cause the car with the yellow cargo to come down. If this mission is completed, no matter which robot or robots worked on it, both teams get 40 points.

**Background:** Do you know why the moon and other satellites don't fall to earth or escape into space? It's for the same reason that you can swing an open bucket of water in a vertical circle and the water stays in the bucket. The water is swinging fast enough to be thrown up into the air, but that force is balanced by the strength of your arm holding the bucket. In the same way, satellites are moving just fast enough and at just the right height to balance gravity's force on them, so they stay at the same place in space, sometimes above a particular spot on earth. Now imagine running a cable from the ground all the way to a satellite in space. If there were a cable material light enough and strong enough, like carbon nanotubes, could this be done? Could we send cargo or even people into space on an elevator, instead of on rockets?

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### **Fairness Bonus**

For 20 bonus points, an RCX robot must earn points in any 3 missions, or an NXT robot must earn points in any 6 missions.

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