Team Worksheet 1: Background Information

The Wonderville Aeronautical and Astronomy Research Labs are looking for a prototype design for an Asteroid Harvester. Use the following activities to help your team understand how a robotic arm can grasp, move and rotate and why materials are so important.

The rules for the challenge are:

- Maximum mass for the arm is 5kg. (Arms lighter in weight will score higher while over limit will score lower)
- The harvester will need to collect individual types of samples from a container and sort them into separate piles by the harvester. Samples include: rock samples, marbles, brass bolts, iron bolts. Samples will be worth different points pending on difficulty.
- The harvester will need to collect samples from a minimum 50 cm away.
- No complete building kits such as Lego, K-Nex, Mechano
- The students will have 1 minute to collect as many samples as they can.

Grasping: Within your group, have group members take turns trying to grasp objects (like a pen) with just 2 index fingers and write with it. Try grasping a small object with just one arm with fingers taped together. Comment on the difficulty or ease

_____

_____

What structural adaptation allows humans to:

i) Grasp objects easily? _____

ii) Grip objects? _____

What is the difference between grasping and gripping?_____

_____

Extending: You may want your design to extend. Muscles attached to bone contract and extend to allow your forearm to move from your upper arm with your elbow as a joint. A kitchen drawer will also extend when you pull it out, How?

_____

_____

_____

Moving and rotating: The challenge requires your design to rotate. How can your neck rotate? What about a ceiling fan?

_____

_____

Mass: your team needs to consider the mass of the arm your constructing and the mass of the objects that it will be able to collect. What materials are strong yet lightweight, are any of these usable?_____

If your object is too heavy the entire arm may topple if it tries to lift it.

Research: report on the construction of the CANADARM using the CSA website (http://www.space.gc.ca/asc/index.html). Describe how it works and moves, grasps, and the materials used.

Team Worksheet 2: Planning and Brainstorming

1. Create a list of places where you think or know where Robotic arms are used here on Earth and write the function next to it.

Location	Use

2. Your 'arm' has to pick up and move samples. Look at the sample materials that you have to be able to pick up. List what is unique to each.

Samples	Qualities
Rocks	
Iron Bolts	
Brass Bolts	
Marbles	

3. Brainstorm the different ways that your arm need can pick up these objects:

_____
_____
_____
_____

4. Think of reasons why mass is important to consider in space exploration.

_____
_____
_____
_____

5. Why would analyzing samples from an asteroid be worth the trouble?

_____
_____
_____
_____

6. Each team member should produce a sketch of their idea to create an arm for the challenge. Make sure you clearly understand what it is supposed to do.

Team Worksheet 3: Preliminary Drawing

1. Share everyone's initial sketch as a group, and discuss what features are common and that everyone likes. Categorize the features into the following functions:

Function	Feature
Act as a base that the arm can be attached to and move upon.	
Grasp the different objects.	
Apply forces to the arm from the area of the base. How will the harvester move?	
Allow the harvester to rotate.	
Extension / Retraction	

2. Think about the different methods of transferring force remotely. What factors do you need to consider? (motions, grasping, extending, retracting, rotating, lifting and lowering)

_____
_____
_____
_____
_____
_____
_____
_____

3. Research the internet and find other designs that your team may consider. Think back to Science 7 & 8 for other ideas.

_____
_____
_____
_____
_____
_____
_____
_____

4. Compile a single, initial design and sketch it. Consider all the features that your harvester will need to have to do its job. Use vectors to show the different forces in the arm when grasping, lifting, and moving.

Team Worksheet 4: Materials

What materials will be required to construct the harvester designed by your group?

Material considerations:

Wood, cardboard, tape, string, straws, syringes, tubing / hoses, retort stands, screws, axles, pieces of rubber, wire, battery (9V), switches, plastics, sheet metal, PVC plumbing pipe, copper tubing.

Apply:

Consider the diagram / sketch your team compiled, indicate the type of materials you may require to construct your design. Need to modify your design?

Name	Material to Bring	Due Date

Team Worksheet 5a: Building the Arm

Below is your checklist to make sure you remember the rules of the challenge. Your teacher will decide how much class time will be dedicated in class and how much time will be required outside of class to construct your harvester.

Remember the rules are:

- Maximum mass for the arm is 5kg. (Arms lighter in weight will score higher while over limit will score lower)
- The harvester will need to collect individual types of samples from a container and sort them into separate piles by the harvester. Samples include: rock samples, marbles, brass bolts, iron bolts. Samples will be worth different points pending on difficulty. (See worksheet 5a for the setup)
- The harvester will need to collect samples from a minimum 50 cm away.
- No complete building kits such as Lego, K-Nex, Mechano
- The students will have 1 minute to collect as many samples as they can.

When you are building your prototype remember:

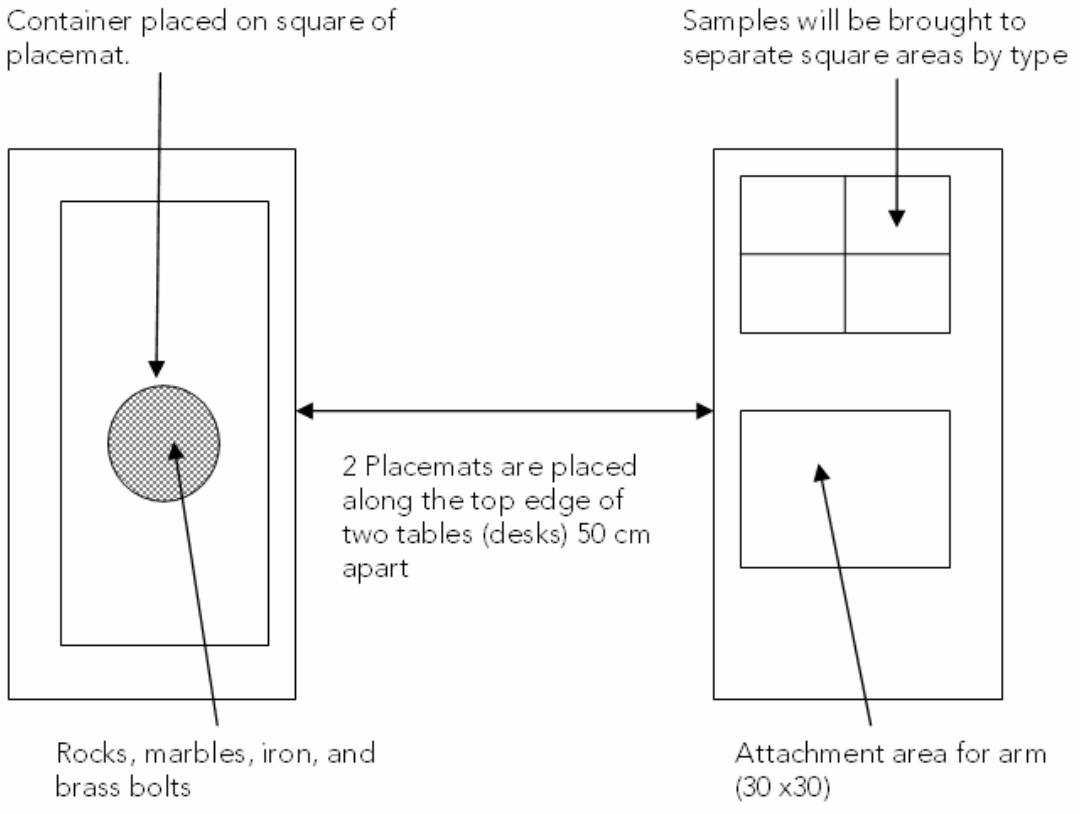
1. The harvester will need to reach across a 50cm gap and collect individual sample types and bring them back to the sorting area.
2. Your harvester can only collect/ 'grasp' the same type of sample at one time.
3. Samples must be mixed in the sample container
4. Samples must be placed / grouped in the collecting area according to type.
5. The harvester will be controlled from the area of the base. No force can be applied directly to the arm (i.e. The arm will move independently from the base)
6. The base must not be attached to the desk.
7. Set up a scenario and test your prototype. Time how long it takes to pick up an object(s). Remember this is a timed challenge. Your team will have only ONE MINUTE to collect as many samples as possible.
8. Once satisfied, consider the appearance, creativity, and name, of the harvester.

When you are designing your Harvester remember to keep in mind the following information that you will be asked to present in both your description and your video presentation:

1. What feature was the most unique to the structure?
2. How did your team accommodate the different types of samples to collect?
3. Explain what feature(s) /method(s) your team used to move the arm through the motion of picking up.
4. Why would there be any interest in surveying asteroids resources? Why remote technology?

Make sure that your team has a preliminary drawing for your design. Any modifications need to be changed on the drawing as well.

Team Worksheet 5b: Building the Harvester



Team Worksheet 6a: Scientific Drawing

Choose someone from your team who likes to draw.

See sample Drawing for an example.

Use an 8.5 x 11 unlined paper.

Strictly follow drawing guidelines found in the text resources available;

Science Focus – Page 479
Science in Action – Page 495

Use the following checklist to ensure that you have put everything on your scientific drawing:

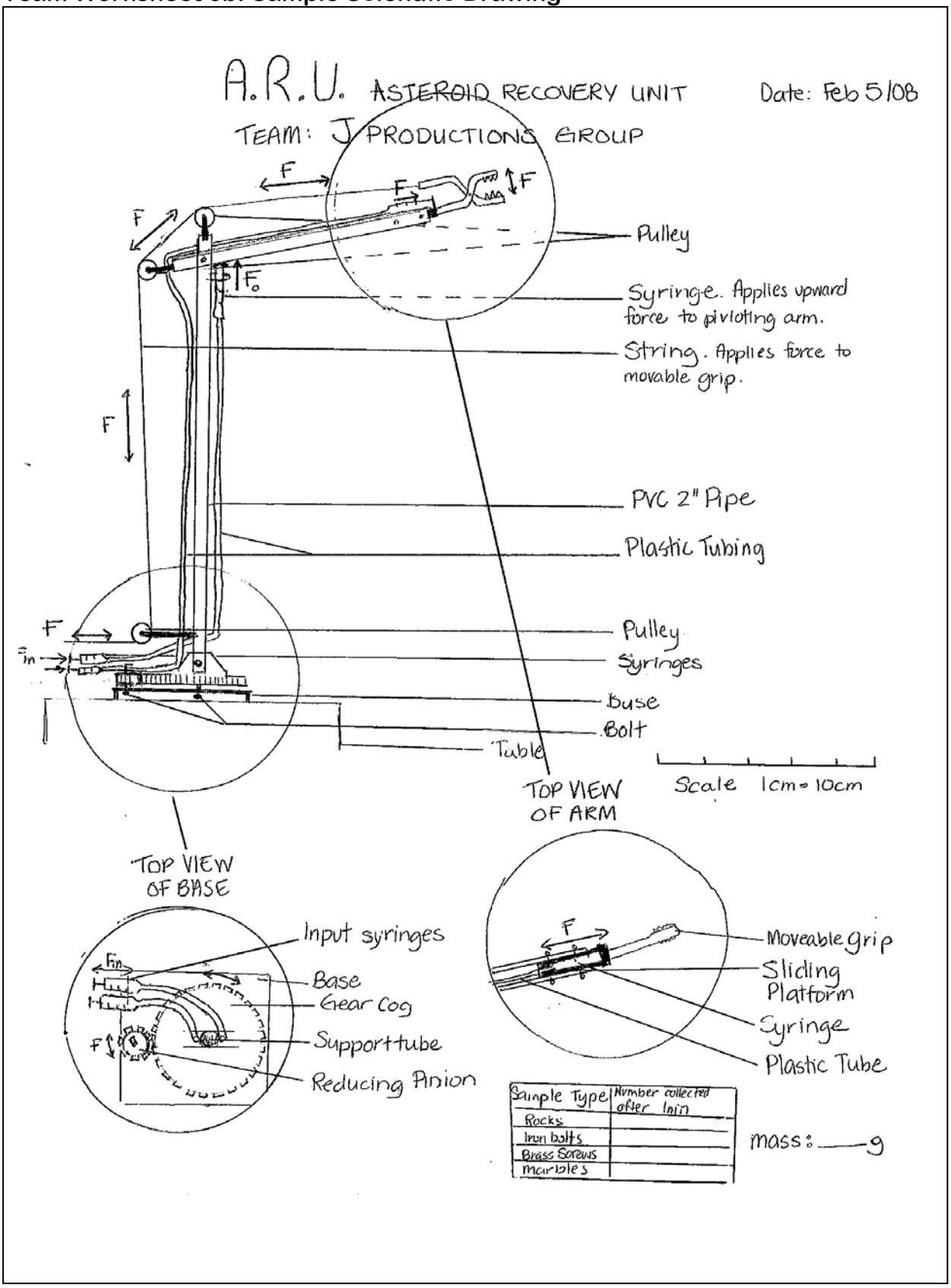
- ❑ Label:
  - o Name of your design
  - o Team Name
  - o Date
- ❑ Vectors to show forces applied
- ❑ Scale
- ❑ Table of Samples (see below)

TABLE OF SAMPLES:

Sample Type	Number collected after one minute
Rocks	
Iron Bolts	
Brass Bolts	
Marble	

Harvester Mass: _____(g)

Team Worksheet 6b: Sample Scientific Drawing



Team Worksheet 7: Presentations

Team work and clearly communicating is quite important in Science and Engineering. As part of the challenge your team must make a video about your harvester. **Each person must participate in the video**. Below is a checklist of the topics that you need to cover:

- ❑ Introduce the team and the name of your Harvester and its purpose.
- ❑ Show your harvester in action. It is during your presentation where you record how many samples your harvester was able to collect.
- ❑ Explain the most distinct feature that lent to the success of the design.
- ❑ What would your group change about your model.
- ❑ Compare the Canadarm to your own design.
- ❑ Discuss the importance of materials needed to construct the 'arm' and the importance of mass.
- ❑ Discuss how your team's arm picked up 'grasped' the different types of objects, were there special features.
- ❑ Explain why it would need to be versatile.
- ❑ Discuss the importance / need of remote technology in space.
- ❑ Discuss examples of the use this technology may have here on Earth.

Planning is paramount! Here are some helpful hints on how to plan your video:

1. Brainstorm ideas to include in each section
2. Each team member should prepare one part of the presentation. Remember, each person only has a limited time to speak. Therefore, some parts maybe longer or shorter, but the entire presentation can only be 2 minutes long!
3. Watch the 'Tips and Tricks' video to help you all the parts of your video – from filming to editing.
4. Practice and time your presentation! Write a script. If you have problems memorizing your lines, write them out on the blackboard or on a large sheet of paper.

Judges watch the presentations and this is where most of the points are scored. Make sure you cover all the topics and have a video that is easy to follow and watch.

In addition to your presentation you will also have to submit:

1. Image and description of your harvester
2. Scientific Drawing of your harvester.

Everything is submitted online at http://sciencechallenges.wonderville.ca.

GOOD LUCK!