**🔍 Station 1: “Broken Arm Blueprint”**

**Standard:** HS-PS1-3  
**Objective:** Use **precision measurement** tools to measure and compare the physical properties of “replacement parts.”

**Goal:**

You're acting as a **biomedical engineer** helping to design a replacement rod for a broken arm. Your job is to **measure and test** different sample materials and decide which one is the best match for the “reference bone.”

**Materials Needed:**

* Calipers or ruler (for measuring diameter/thickness)
* Samples of rod-like materials (pencil, plastic straw, paper straw, wooden dowel, etc.)
* Digital scale or balance (for weight comparison)
* Optional: Spring + weights (to test compression)
* “Reference part” (plastic bone or wooden dowel marked as the ideal)
* Data recording sheet

**Student Directions:**

**Measure Size**

* Use the **calipers or ruler** to measure the **diameter and length** of each sample rod.
* Compare those measurements to the reference part.
* Record all your data in a chart.

**Data Example Table:**

| **Sample** | **Diameter (mm)** | **Length (cm)** | **Matches Reference? (Yes/No)** |
| --- | --- | --- | --- |
| Pencil |  |  |  |
| Dowel |  |  |  |

**2. Compare Strength (Qualitative Test)**

* Pick up each sample and gently press it down over a table edge to **feel stiffness** (Does it bend? How much?).
* Optional: Stack small weights on top or use a spring compression setup to test how much each sample resists force.
* Observe and record which ones **stay straight, bend, or collapse**.

**3. Check Weight or Density**

* Use a **digital scale** to find the mass of each sample.
* Consider how the **weight might affect comfort and usability** if it were inside a human arm.

**Density Tip:** A heavier but smaller part may be **denser**, meaning its material is more compact and possibly stronger.

**4. Choose the Best Match**

* Based on your data, pick the material that is **closest in size, strength, and weight** to the reference part.

**💬 Discussion Prompt:**

* **How does the bulk structure (the way the material is built or packed) affect its strength and function?**  
  → Think about bones—are they solid or hollow? Why?  
  → Why might we **not always want** the heaviest or hardest material?
* How does the bulk structure of a material relate to its strength or function?

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**Standard:** HS-PS1-3 – *Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength and properties of materials.*

**✅ ITEEA STEL Standards – High School**

**STEL 1E** – *Technological systems use energy, information, and physical resources to achieve goals.*  
→ Students use measurement tools (calipers, scales) as part of a **systematic approach** to select a biomaterial matching target specs.

**STEL 2E** – *Technological decisions should consider performance, safety, and sustainability.*  
→ Choosing a replacement rod involves **weighing trade-offs** (strength vs. weight vs. biocompatibility).

**STEL 3E** – *Systems thinking involves understanding how parts interact within a technological system.*  
→ The engineered “bone” must integrate with the human body’s forces, so students compare size, stiffness, and density.

**STEL 4E** – *Understanding and troubleshooting systems requires interpreting feedback from measurement and testing.*  
→ Students gather quantitative (diameter, length, mass) and qualitative (stiffness, bend) data to **evaluate candidate materials**.

**STEL 5E** – *Design involves identifying problems, proposing solutions, and testing and refining designs.*  
→ This activity mirrors the **engineer’s workflow**: define specs, measure samples, test performance, and pick the best match.

**✅ Common Core Math Standards – High School**

**CCSS.MATH.CONTENT.HSN-Q.A.1** – *Use units to understand problems and guide the solution of multi-step problems.*  
→ Students record and compare measurements (mm, cm, g), ensuring **consistent units** when evaluating materials.

**CCSS.MATH.CONTENT.HSN-Q.A.2** – *Define appropriate quantities for descriptive modeling.*  
→ Diameter, length, mass, and stiffness become key **quantitative descriptors** in their material-selection model.

**CCSS.MATH.CONTENT.HSN-Q.A.3** – *Choose a level of accuracy appropriate to limitations on measurement.*  
→ Caliper precision vs. ruler estimation; scale readability; students decide **how precise** each measurement must be.

**CCSS.MATH.CONTENT.6.SP.B.4–5** – *Display and summarize numerical data in relation to context.*  
→ Students tabulate their measurements, identify “matches,” and summarize which samples best align with the reference.

**CCSS.MATH.PRACTICE.MP4** – *Model with mathematics.*  
→ The comparison table and decision process form a **mathematical model** of material performance vs. design requirements.

**CCSS.MATH.PRACTICE.MP5** – *Use appropriate tools strategically.*  
→ Calipers, scales, and optional compression springs are used judiciously to **gather reliable data** for decision-making.

**✅ Summary**

This biomedical-engineering task integrates:

* **NGSS** investigation of material structure and properties
* **ITEEA STEL** systems thinking, measurement, and design iteration
* **Common Core Math** through precise measurement, data modeling, and tool selection