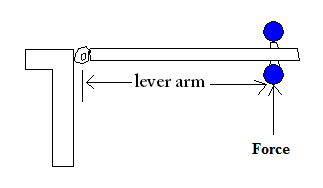
**TORQUE**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date/Time:\_\_\_\_\_\_\_\_\_\_\_

Purpose: To investigate torque by doing the following activities:  
    a. Measuring an unknown mass                                               
    b. Measuring the mass of a meter stick

Apparatus: Meter stick, unknown mass, knife edge clamp, knife edge support, 3 mass-hangers, mass set, lab jack, electronic balance, and string loops.

Theory: Introduction to torque

    Think about the everyday activity of opening a door, just for a moment.



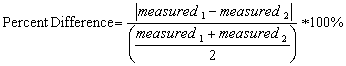
Q: What do you think you do to the door, when you open it?

A: You apply a torque.

Torque = Lever-arm X Force; Torque is a vector. Torque comes in clockwise and counter clockwise directions. Clockwise direction is the direction in which a mechanical clock turns. The opposite direction is called counter clockwise.

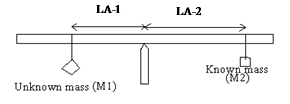
The door knob is kept away from the hinge in order to have a greater lever-arm. Imagine how hard it will be to open, if the knob is kept closer to the hinge.

Lever-arm is the perpendicular distance between the line of action of the force and axis of rotation.



a. Measuring an unknown mass

Meter stick is supported at the center of gravity.



Unknown mass will try to rotate the meter stick counter   
clockwise and known mass will try to rotate the meter   
stick clockwise.

Counterclockwise torque = Unknown mass X Lever-Arm-1

Clockwise torque = Known mass X Lever-Arm-2

For balance, counterclockwise torque = clockwise torque.

Unknown mass X Lever-Arm-1 = Known mass X Lever-Arm-2

Unknown mass can be determined using the above equation.

DATA for Unknown Mass  
  
Location of the center of gravity (C.G) = \_\_\_\_\_\_\_\_ cm

Location of the unknown mass          = \_\_\_\_\_\_\_\_\_ cm    \_\_\_\_\_\_\_\_\_cm    \_\_\_\_\_\_\_\_\_\_cm

Location of the known mass              = \_\_\_\_\_\_\_\_\_ cm    \_\_\_\_\_\_\_\_\_cm    \_\_\_\_\_\_\_\_\_\_cm

|  |  |  |  |
| --- | --- | --- | --- |
| Known mass, M2 (g) | Lever-arm for known mass, MA-2 | Lever-arm for unknown mass, MA-1 | Unknown mass, M1 |
| 200 | - | - | - |
| 250 | - | - | - |
| 300 | - | - | - |
| Average of the unknown mass, M1 | | | - |
| Unknown mass measured using electronic balance | | | - |
| % difference | | | - |

b. Measuring the mass of a meter stick (M)

Now you need to move the support point away from the center of gravity (C.G). This way you get the rotation effect of M, mass of the meter stick.



DATA for Mass of Meter Stick

Location of the center of gravity (C.G) = \_\_\_\_\_\_\_\_ cm.

Location of the support point               = \_\_\_\_\_\_\_\_ cm    \_\_\_\_\_\_\_\_\_\_cm    \_\_\_\_\_\_\_\_\_cm

Location of the known mass                = \_\_\_\_\_\_\_\_ cm    \_\_\_\_\_\_\_\_\_\_cm    \_\_\_\_\_\_\_\_\_cm

|  |  |  |  |
| --- | --- | --- | --- |
| Known mass, m (g) | Lever-arm for known mass, l | Lever-arm for mass of meter stick, L | Mass of meter stick, M |
| 100 | - | - | - |
| 150 | - | - | - |
| 200 | - | - | - |
| Average of the mass of meter stick, M | | | - |
| Mass of meter stick measured using electronic balance | | | - |
| % difference | | | - |

**Exercises from Chap2:**

|  |  |
| --- | --- |
| **6.** | Why can't you open a door by pushing its doorknob directly toward or away from its hinges? |
| http://edugen.wiley.com/edugen/courses/crs2936/common/art/pixel.gif | http://edugen.wiley.com/edugen/courses/crs2936/common/art/pixel.gif |

|  |  |  |
| --- | --- | --- |
| **7.** | |  | | --- | |  |   Why can't you open a door by pushing on its hinged side? |
| http://edugen.wiley.com/edugen/courses/crs2936/common/art/pixel.gif | http://edugen.wiley.com/edugen/courses/crs2936/common/art/pixel.gif |

|  |  |
| --- | --- |
| **8.** | It's much easier to carry a weight in your hand when your arm is at your side than it is when your arm is pointing straight out in front of you. Use the concept of torque to explain this effect. |
| http://edugen.wiley.com/edugen/courses/crs2936/common/art/pixel.gif | http://edugen.wiley.com/edugen/courses/crs2936/common/art/pixel.gif |

|  |  |  |
| --- | --- | --- |
| **9.** | |  | | --- | |  |   A gristmill is powered by falling water, which pours into buckets on the outer edge of a giant wheel. The weight of the water turns the wheel. Why is it important that those buckets be on the wheel's outer edge? |

**Problems from Chap2:**

|  |  |  |
| --- | --- | --- |
| **1.** | |  | | --- | |  |   When you ride a bicycle, your foot pushes down on a pedal that's 17.5 cm (0.175 m) from the axis of rotation. Your force produces a torque on the crank attached to the pedal. Suppose that you weigh 700 N. If you put all your weight on the pedal while it's directly in front of the crank's axis of rotation, what torque do you exert on the crank? |
| **6.** | When you push down on the handle of a doll-like wooden nutcracker, its jaw pivots upward and cracks a nut. If the point at which you push down on the handle is five times as far from the pivot as the point at which the jaw pushes on the nut, how much force will the jaw exert on the nut if you exert a force of 20 N on the handle? (Assume that all forces are at right angles to the lever arms involved.) |