Class 9a:

Team Project Analysis I

9a.1 Mass Properties Report of One Part

INFORMATION PROVIDED

IN

SOLIDWORKS MASS PROPERTIES REPORTS

1. **DENSITY** is the mass or the weight per unit volume of the material the part is made from.

2. **MASS**: The mass of a body is the measure of its property to resist change in its steady motion. The mass depends on the volume of the body and the density of the material of which the body is made. In this case with SolidWorks, mass is equivalent to weight.

3. **VOLUME**: The volume of a body is the total volume of space enclosed by its boundary surfaces.

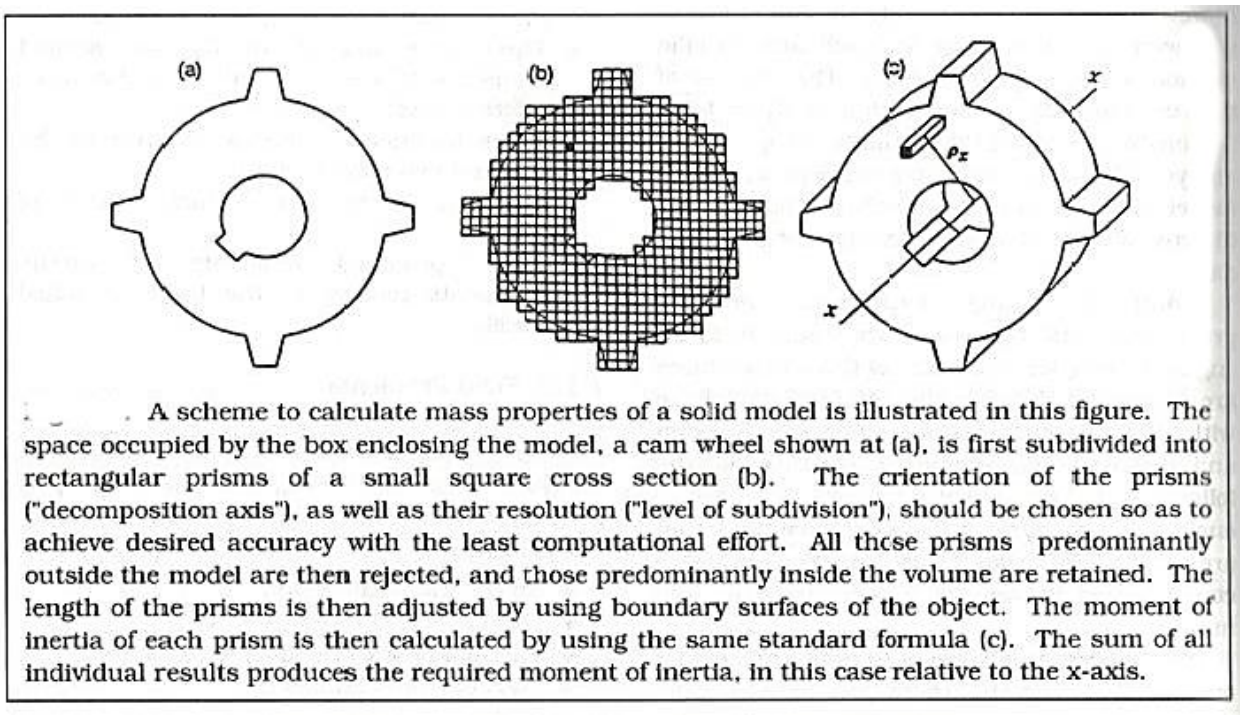
4. **SURFACE AREA**: The surface area is the total area of the boundary surfaces defining the solid model.

5. **CENTER OF MASS**: Center of Mass (or Centroid) of a volume is the origin of coordinate axes for which first moments of the volume are zero. It is considered the center of a volume. For a homogeneous body in a parallel gravity field, mass center and center of gravity coincide with the centroid.

6. **PRINCIPAL AXES OF INERTIA AND PRINCIPAL MOMENTS OF INERTIA**: Principal moments of inertia are extreme (maximal, minimal) moments of inertia for a body. They are associated with principal axes of inertia which have its origin at the centroid, and the direction of each usually given by the three unit-vector components. For these axes, the products of inertia are zero.

7. **MOMENTS OF INERTIA**: A moment of inertia is the second moment of mass of a body relative to an axis, usually X, Y, or Z. It is a measure of the body's property to resist change in its steady rotation about that axis. It depends on the body's mass and its distribution around the axis of interest.

Figure 9a.1 Mass properties are physical attributes of a mechanical part that relate to how the component will behave in an environment. Above is a listing of typical mass properties generated for a SolidWorks Mass Properties Report (MPR).



A scheme to calculate mass properties of a solid model is illustrated in this figure. The space occupied by the box enclosing the model, a cam wheel shown at (a), is first subdivided into rectangular prisms of a small square cross section (b). The orientation of the prisms ("decomposition axis"), as well as their resolution ("level of subdivision"), should be chosen so as to achieve desired accuracy with the least computational effort. All these prisms predominantly outside the model are then rejected, and those predominantly inside the volume are retained. The length of the prisms is then adjusted by using boundary surfaces of the object. The moment of inertia of each prism is then calculated by using the same standard formula (c). The sum of all individual results produces the required moment of inertia, in this case relative to the x-axis.

Figure 9a.2 A scheme to calculate mass properties by subdividing the solid into small rectangular prisms.

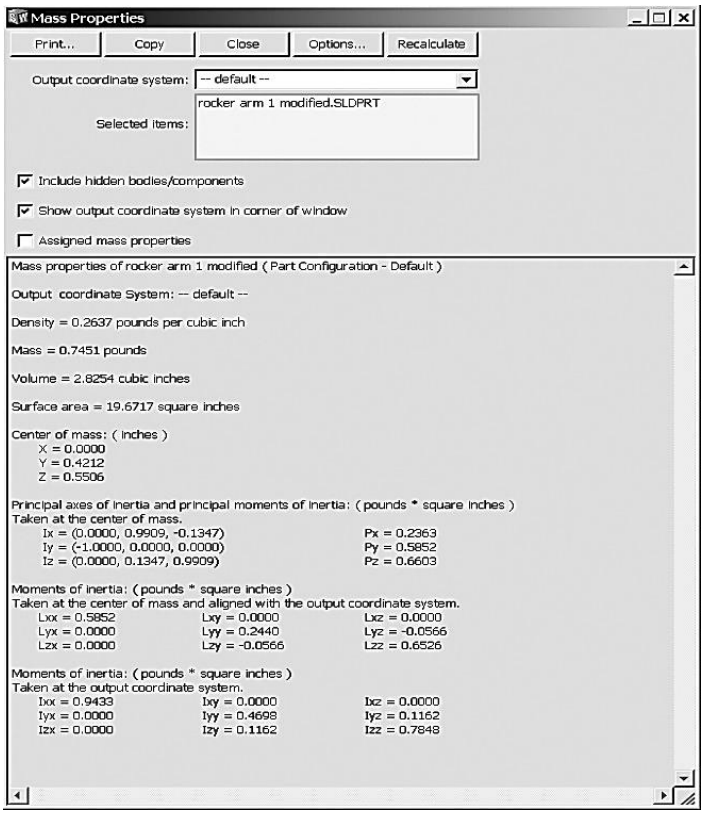


Figure 9a.3 A Mass Properties Report (MPR) display for the team project.

Material	Unit Weight (lbs/in^3)	Density (lbs-sec^2/in^4)
Aluminum	0.097	0.251×10^{-3}
Brass	0.307	0.794×10^{-3}
Chromium	0.259	0.671×10^{-3}
Copper	0.323	0.837×10^{-3}
Magnesium	0.063	0.163×10^{-3}
Plastic	0.036	0.093×10^{-3}
Rubber	0.041	0.106×10^{-3}
Steel	0.281	0.728×10^{-3}
Titanium	0.163	0.422×10^{-3}

Figure 9a.4 A listing of common materials and their densities that may be used for the team project mass properties analysis.

Example Calculation: Material is Mild Steel (density is 0.728×10^{-3} lbs-sec^2/in^4)

Weight = (unit weight)x(volume) = (0.281 lbs/in^3) x (1.00 in^3) = 0.281 lbs.

Mass = (density)x(volume) = (0.728×10^{-3} lbs-sec^2/in^4)x(1.00 in^3) = 0.728×10^{-3} lbs-sec^2/in.

Mass = (weight) / (gravity) = (0.281 lbs) / (386 in/sec^2) = 0.728×10^{-3} lbs-sec^2/in.

Figure 9a.5 An example calculation that shows the way to calculate weight and mass, using the proper English units. The volume is assumed to be a 1.00 inch unit cube.

Design Check #5:
Team Project: Mass Properties Analysis of One Part

Select one part from your project assembly device for which you are curious about its mass properties. Orient the part in SolidWorks so that the X-Y-Z axis is evident. Run a mass properties analysis of the part and get a formatted printout of the mass properties report (MPR) file. Use a word processing software to get the printout. On the mass properties report, identify the type of "material" used for the analysis of the part.

Based on your mass property report of the part, write a 1-2 page description that discusses one or more aspects of the mass properties of your part. For example, what does the moment of inertia about one of the axes tell you about how the part will behave when rotated? What does the surface area tell? What is the weight of the part? Be sure to state the proper units when discussing the mass properties. This description is an open-ended question, so it is up to your team to decide which aspect of the mass properties report you want to focus on.

For the design check #5 submission, include the following:

1. The standard team project cover sheet.
2. The 1-2 page typed discussion of your interpretation of the mass properties analysis of the selected part. Be sure to use the correct English units.
3. A picture (screen shot) of your SolidWorks part, including showing where the part origin was for the mass properties analysis.
4. The actual mass properties report of the part with the part material identified.

Team Name _____ Unique No. _____

Design Check No. 5 Grading Form

Grade

Cover Sheet (5 points)

1. Semester and Year
2. Project Title
3. Team Name and Logo
4. Team Members Names, Emails, Leader
5. Instructor Name and Section Unique No.

Discussion of Results (10 points)

1. Rationale for Part Selected
2. Rationale for Mass Property Selected
3. Proper Units Used
4. Resultant Values Listed
5. Interpretation of Results
6. Link Discussion to MPR Values
7. Relation of MPR Results to Overall Design
8. Font Style
9. Formatting Style
10. Writing and Grammar

Picture of Part Selected (5 points)

1. Orientation of Part Image
2. Image Quality
3. Origin Depicted
4. Use of Caption
5. Overall Graphical Quality

Mass Property Report (MPR) (5 points)

1. Printout Included
2. Part Material Included
3. Pertinent Mass Property Result(s) Highlighted
4. Font Style Used
5. Printout Format and Placement

Total Grade (25 points max.)