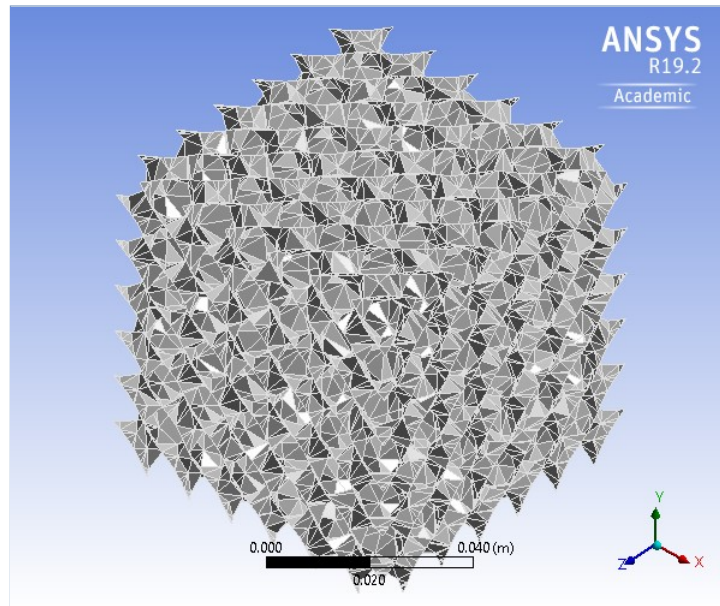




## Project

First Saved	Saturday, February 9, 2019
Last Saved	Saturday, February 9, 2019
Product Version	19.2 Release
Save Project Before Solution	No
Save Project After Solution	No



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## Units

TABLE 1

Unit System	Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Angle	Degrees
Rotational Velocity	rad/s
Temperature	Celsius

## Model (A4)

### Geometry

TABLE 2  
Model (A4) > Geometry

Object Name	Geometry
State	Fully Defined
<b>Definition</b>	
Source	H:\Google Drive\College Stuff\Studies\Thesis (Project)\Models\Schwarz D\Schwarz D V2.sat
Type	ACIS
Length Unit	Millimeters
Element Control	Program Controlled
Display Style	Body Color
<b>Bounding Box</b>	
Length X	7.e-002 m
Length Y	7.e-002 m
Length Z	7.e-002 m
<b>Properties</b>	
Volume	5.3049e-005 m³
Mass	5.5171e-002 kg
Surface Area(approx.)	6.6311e-002 m²
Scale Factor Value	1.
<b>Statistics</b>	
Bodies	1
Active Bodies	1
Nodes	25118
Elements	30994
Mesh Metric	None
<b>Update Options</b>	
Assign Default Material	No
<b>Basic Geometry Options</b>	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Independent
Parameter Key	ANS;DS
Attributes	No
Named Selections	No
Material Properties	No
<b>Advanced Geometry Options</b>	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	Yes
Compare Parts On Update	No
Analysis Type	3-D
Mixed Import Resolution	None
Clean Bodies On Import	No
Stitch Surfaces On Import	No
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

TABLE 3

<b>Model (A4) &gt; Geometry &gt; Parts</b>	
Object Name	<i>Part 1</i>
State	Meshed
<b>Graphics Properties</b>	
Visible	Yes
Transparency	1
<b>Definition</b>	
Suppressed	No
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Thickness	8.e-004 m
Thickness Mode	Manual
Offset Type	Middle
Behavior	None
<b>Material</b>	
Assignment	ABS plastic
Nonlinear Effects	Yes
Thermal Strain Effects	Yes
<b>Bounding Box</b>	
Length X	7.e-002 m
Length Y	7.e-002 m
Length Z	7.e-002 m
<b>Properties</b>	
Volume	5.3049e-005 m³
Mass	5.5171e-002 kg
Centroid X	-0.23537 m
Centroid Y	0.13163 m
Centroid Z	0.28835 m
Moment of Inertia Ip1	4.5601e-005 kg·m²
Moment of Inertia Ip2	4.5504e-005 kg·m²
Moment of Inertia Ip3	4.5538e-005 kg·m²
Surface Area(approx.)	6.6311e-002 m²
<b>Statistics</b>	
Nodes	25118
Elements	30994
Mesh Metric	None

### Coordinate Systems

**TABLE 4**  
**Model (A4) > Coordinate Systems > Coordinate System**

Object Name	<i>Global Coordinate System</i>
State	Fully Defined
<b>Definition</b>	
Type	Cartesian
Coordinate System ID	0.
<b>Origin</b>	
Origin X	0. m
Origin Y	0. m
Origin Z	0. m
<b>Directional Vectors</b>	
X Axis Data	[ 1. 0. 0. ]
Y Axis Data	[ 0. 1. 0. ]
Z Axis Data	[ 0. 0. 1. ]

### Mesh

**TABLE 5**  
**Model (A4) > Mesh**

Object Name	<i>Mesh</i>
State	Solved
<b>Display</b>	
Display Style	Use Geometry Setting
<b>Defaults</b>	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	2.3e-003 m
<b>Sizing</b>	
Use Adaptive Sizing	No
Growth Rate	Default (1.2)
Mesh Defeaturing	Yes
Defeature Size	Default (1.15e-005 m)
Capture Curvature	Yes
Curvature Min Size	Default (2.3e-005 m)
Curvature Normal Angle	Default (30.0°)
Capture Proximity	No
Bounding Box Diagonal	0.12124 m
Average Surface Area	5.657e-006 m²
Minimum Edge Length	5.8577e-005 m
<b>Quality</b>	
Check Mesh Quality	Yes, Errors
Error Limits	Standard Mechanical
Target Quality	Default (0.050000)
Smoothing	Medium
Mesh Metric	None
<b>Inflation</b>	
Use Automatic Inflation	None

Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	2
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
<b>Advanced</b>	
Number of CPUs for Parallel Part Meshing	Program Controlled
Straight Sided Elements	No
Rigid Body Behavior	Dimensionally Reduced
Triangle Surface Mesher	Program Controlled
Topology Checking	Yes
Use Sheet Thickness for Pinch	No
Pinch Tolerance	Default (2.07e-005 m)
Generate Pinch on Refresh	No
Sheet Loop Removal	No
<b>Statistics</b>	
Nodes	25118
Elements	30994

## Steady-State Thermal (A5)

**TABLE 6**  
**Model (A4) > Analysis**

Object Name	Steady-State Thermal (A5)
State	Solved
<b>Definition</b>	
Physics Type	Thermal
Analysis Type	Steady-State
Solver Target	Mechanical APDL
<b>Options</b>	
Generate Input Only	No

**TABLE 7**  
**Model (A4) > Steady-State Thermal (A5) > Initial Condition**

Object Name	Initial Temperature
State	Fully Defined
<b>Definition</b>	
Initial Temperature	Uniform Temperature
Initial Temperature Value	22. °C

**TABLE 8**  
**Model (A4) > Steady-State Thermal (A5) > Analysis Settings**

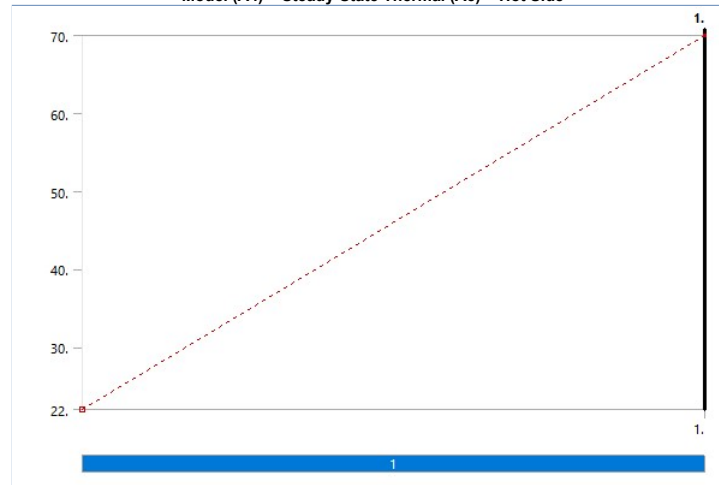
Object Name	Analysis Settings
State	Fully Defined
<b>Step Controls</b>	
Number Of Steps	1.
Current Step Number	1.
Step End Time	1. s
Auto Time Stepping	Program Controlled
<b>Solver Controls</b>	
Solver Type	Program Controlled
Solver Pivot Checking	Program Controlled
<b>Radiosity Controls</b>	
Radiosity Solver	Program Controlled
Flux Convergence	1.e-004
Maximum Iteration	1000.
Solver Tolerance	0.1 W/m²
Over Relaxation	0.1
Hemicube Resolution	10.
<b>Nonlinear Controls</b>	
Heat Convergence	Program Controlled
Temperature Convergence	Program Controlled
Line Search	Program Controlled
<b>Output Controls</b>	
Calculate Thermal Flux	Yes
Nodal Forces	No
Contact Miscellaneous	No
General Miscellaneous	No
Store Results At	All Time Points
<b>Analysis Data Management</b>	
Solver Files Directory	C:\Users\faisa\AppData\Local\Temp\WB_FAISALWALKS_faisa_17588_2\unsaved_project_files\dp0\SYS\MECH\
Future Analysis	None
Scratch Solver Files Directory	
Save MAPDL db	No
Contact Summary	Program Controlled
Delete Unneeded Files	Yes
Nonlinear Solution	No
Solver Units	Active System
Solver Unit System	mks

**TABLE 9**  
**Model (A4) > Steady-State Thermal (A5) > Loads**

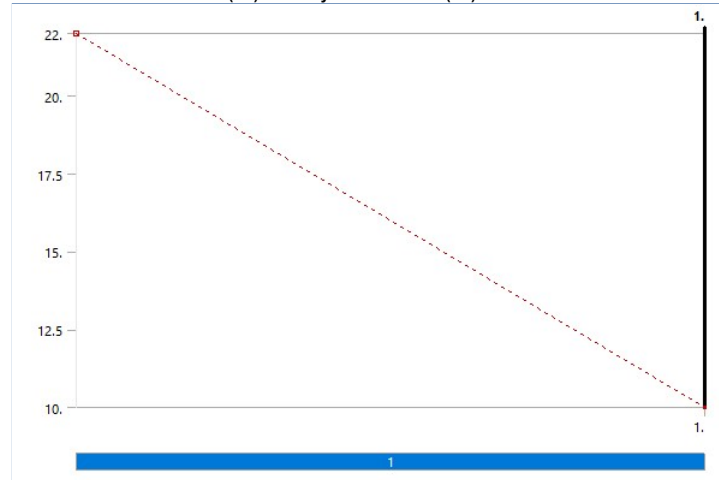
Object Name	Hot Side	Cold Side
State	Fully Defined	
<b>Scope</b>		
Scoping Method	Geometry Selection	
Geometry	1180 Faces	1173 Faces

Definition	
Type	Temperature
Magnitude	70. °C (ramped)   10. °C (ramped)
Suppressed	No

**FIGURE 1**  
Model (A4) > Steady-State Thermal (A5) > Hot Side



**FIGURE 2**  
Model (A4) > Steady-State Thermal (A5) > Cold Side



### Solution (A6)

**TABLE 10**  
Model (A4) > Steady-State Thermal (A5) > Solution

Object Name	<i>Solution (A6)</i>
State	Solved
<b>Adaptive Mesh Refinement</b>	
Max Refinement Loops	1.
Refinement Depth	2.
<b>Information</b>	
Status	Done
MAPDL Elapsed Time	3. s
MAPDL Memory Used	313. MB
MAPDL Result File Size	15.813 MB
<b>Post Processing</b>	
Beam Section Results	No
On Demand Stress/Strain	No

**TABLE 11**  
Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Solution Information

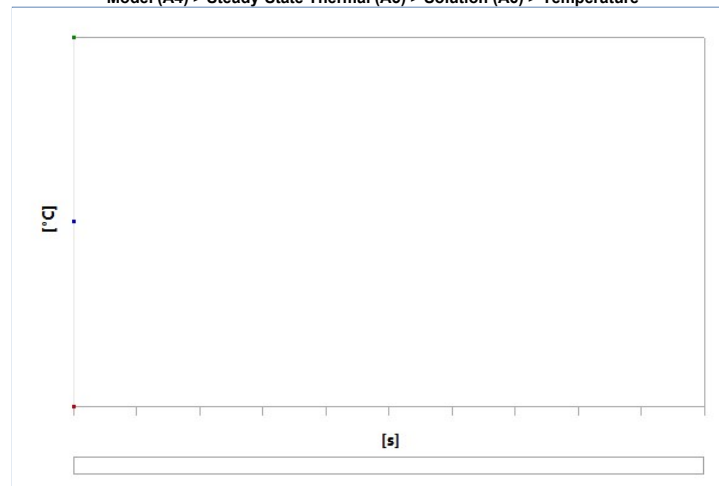
Object Name	<i>Solution Information</i>
State	Solved
<b>Solution Information</b>	
Solution Output	Solver Output
Update Interval	2.5 s
Display Points	All
<b>FE Connection Visibility</b>	
Activate Visibility	Yes
Display	All FE Connectors
Draw Connections Attached To	All Nodes

Line Color	Connection Type
Visible on Results	No
Line Thickness	Single
Display Type	Lines

**TABLE 12**  
**Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Results**

Object Name	Temperature	Total Heat Flux
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Position		Top/Bottom
Definition		
Type	Temperature	Total Heat Flux
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	9.9983 °C	0. W/m²
Maximum	70.013 °C	667.82 W/m²
Average	40.134 °C	149.69 W/m²
Minimum Occurs On	Part 1	
Maximum Occurs On	Part 1	
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

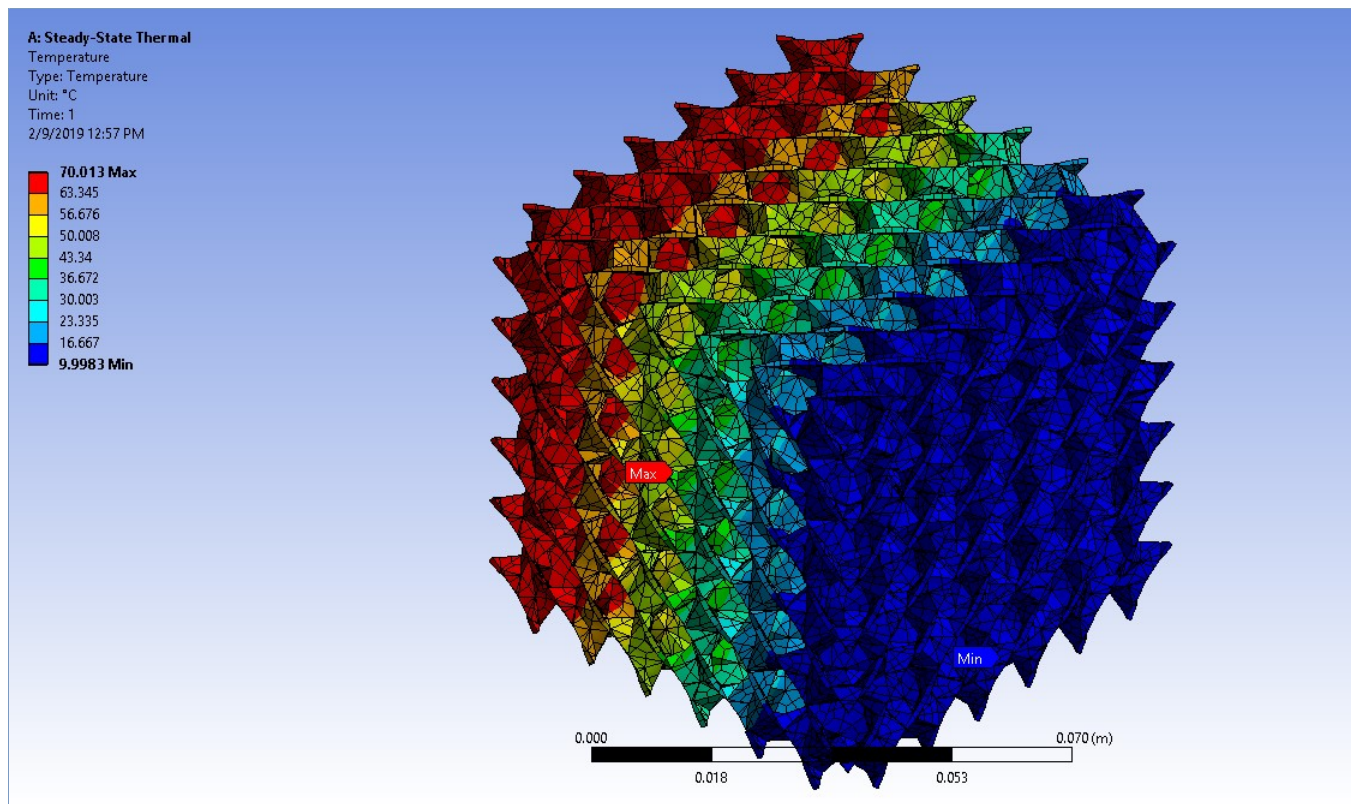
**FIGURE 3**  
**Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Temperature**



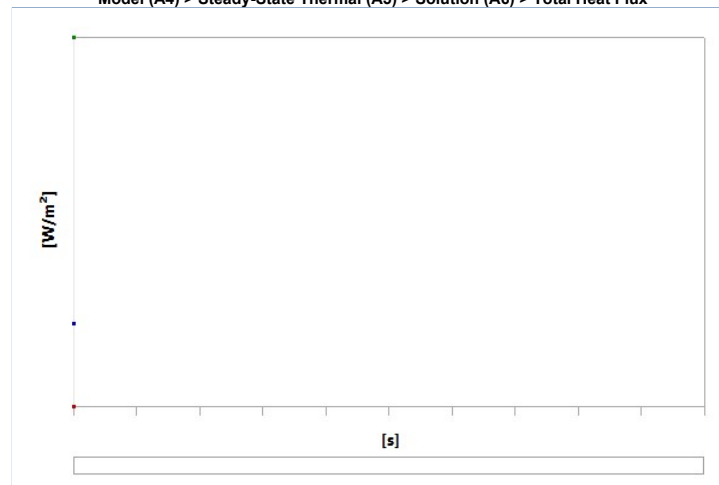
**TABLE 13**  
**Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Temperature**

Time [s]	Minimum [°C]	Maximum [°C]	Average [°C]
1.	9.9983	70.013	40.134

**FIGURE 4**  
**Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Temperature > Temperature**



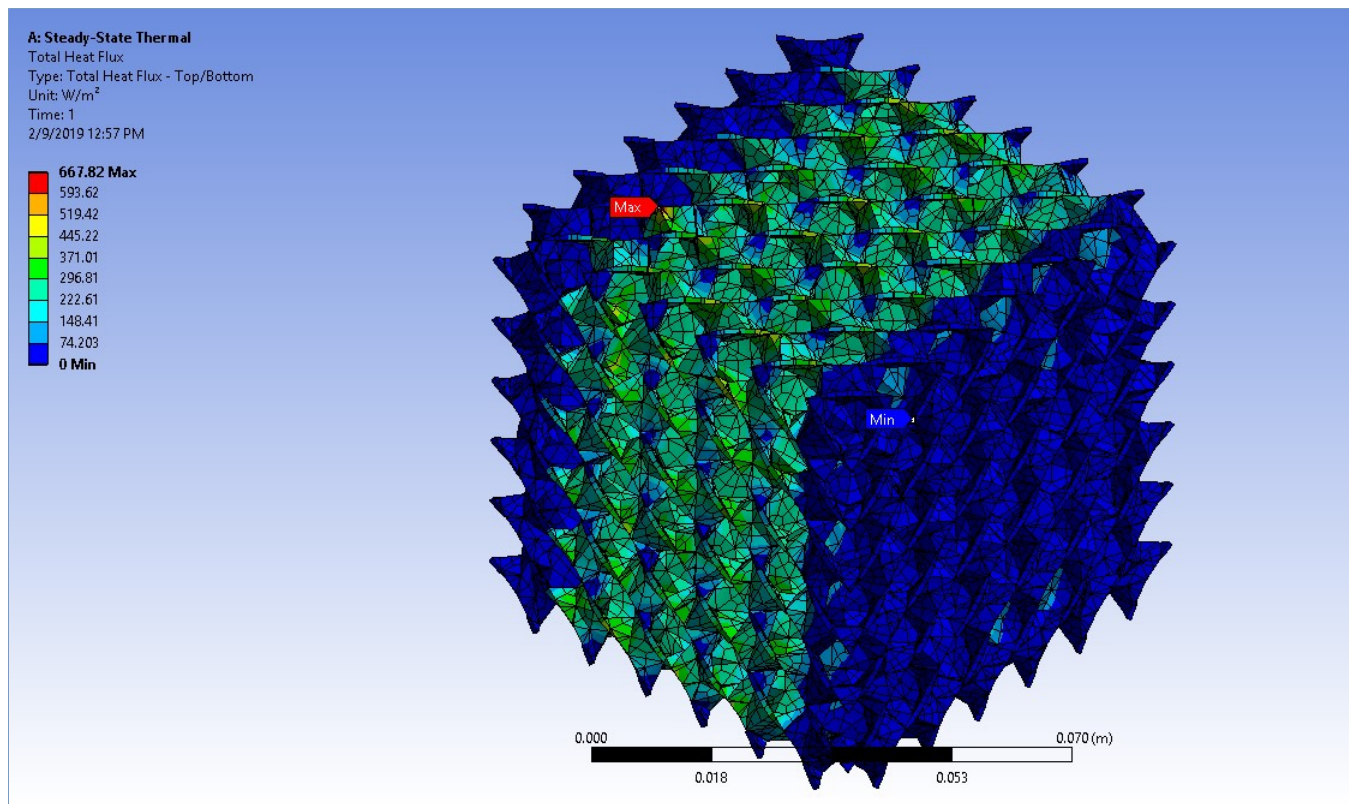
**FIGURE 5**  
Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Total Heat Flux



**TABLE 14**  
Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Total Heat Flux

Time [s]	Minimum [W/m²]	Maximum [W/m²]	Average [W/m²]
1.	0.	667.82	149.69

**FIGURE 6**  
Model (A4) > Steady-State Thermal (A5) > Solution (A6) > Total Heat Flux > Heat Flux



## Material Data

### ABS plastic

**TABLE 15**

ABS plastic > Constants

Resistivity	9.95e+013 ohm m
-------------	-----------------

**TABLE 16**

ABS plastic > Density

Density kg m <sup>-3</sup>
1040

**TABLE 17**

ABS plastic > Isotropic Elasticity

Young's Modulus Pa	Poisson's Ratio	Bulk Modulus Pa	Shear Modulus Pa
2.39e+009	0.399	3.9439e+009	8.5418e+008

**TABLE 18**

ABS plastic > Isotropic Thermal Conductivity

Thermal Conductivity W m <sup>-1</sup> C <sup>-1</sup>
0.258

**TABLE 19**

ABS plastic > Isotropic Secant Coefficient of Thermal Expansion

Coefficient of Thermal Expansion C <sup>-1</sup>
9.54e-005
Zero-Thermal-Strain Reference Temperature C
22

**TABLE 20**

ABS plastic > Specific Heat Constant Pressure

Specific Heat J kg <sup>-1</sup> C <sup>-1</sup>
1720

**TABLE 21**

ABS plastic > Color

Red	Green	Blue
0	153	255

**TABLE 22**

ABS plastic > Tensile Yield Strength

Tensile Yield Strength Pa
4.14e+007

**TABLE 23**

ABS plastic > Tensile Ultimate Strength

Tensile Ultimate Strength Pa
------------------------------



4.43e+007