

Topic C

"Part 2: Physical Properties"

(Web Version: 02-16-01)

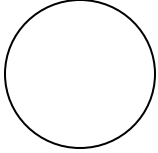
1

Table 6
Row 9 & ff.

The Physical Properties

- Table 6
 - Third Group and ff.
 - Rows 9 and ff.
- Includes
 - Radius
 - Oblateness
 - Mass
 - Mean Density
 - etc.

Planet




2

Terms

Do you know difference between . . .

- Size
- Circumference
- Volume
- Mass
- Density

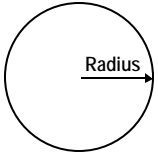


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Size

Do you know difference between . . .

- Size = radius or diameter
- Circumference = distance around
- Volume = space inside
- Mass = amount of material
- Density = compactness (mass per unit volume)

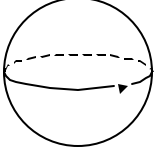


4

Circumference

Do you know difference between . . .

- Size = radius or diameter
- Circumference = distance around
- Volume = space inside
- Mass = amount of material
- Density = compactness (mass per unit volume)

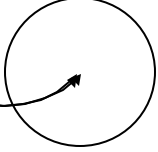


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Volume

Do you know difference between . . .

- Size = radius or diameter
- Circumference = distance around
- Volume = space inside
- Mass = amount of material
- Density = compactness (mass per unit volume)

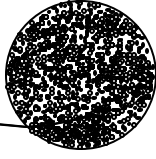


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Mass

Do you know difference between . . .

- Size = radius or diameter
- Circumference = distance around
- Volume = space inside
- Mass = amount of material
- Density = compactness (mass per unit volume)



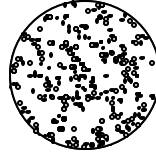
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Density

Do you know difference between . . .

- Size = radius or diameter
- Circumference = distance around
- Volume = space inside
- Mass = amount of material
- Density = compactness (mass per unit volume)



Less Dense

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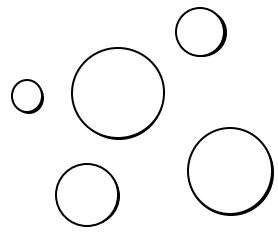
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Sizes (Radii or Diameters)

Table 6
Row 9

Remember — look for

- Groupings
- Patterns
- Extremes
- Similarities
- Exceptions to “rules”



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Example: Groups/Patterns

Table 6
Row 9

- Any Overall Patterns to Size (Radius)?
- Yes — Two Groups

Group	Small	Large
Location	Inner Solar System	Outer Solar System
Exceptions?	Pluto	(Sun)
Range	Pluto to Earth	Neptune to Jupiter

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Similarities: Twins

Need to distinguish between

- Twin planets
- Double planets

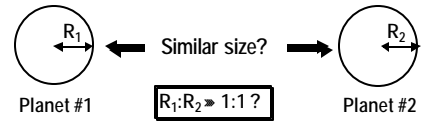
They do not mean the same thing!

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Twin Planets

- Two or more objects *similar in size* (i.e., ratio of radii nearly one to one — 1:1)
- Can you find *two good* examples?



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Earth – Venus

Twin Planets

Earth Venus

1.00 : 0.95

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Uranus – Neptune

Twin Planets

Uranus Neptune

1.00 : 0.97

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Jupiter – Saturn

“Imperfect” Twins

Though many planets not twins,
matching planets helps one judge & recall sizes

Jupiter Saturn

1.00 : 0.84

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What Are Double Planets?

(Drawn to Scale)

Earth-Moon Martian System
(Phobos & Deimos) Pluto-Charon

Now compare these to those on next slide →

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More Planetary Satellites

(Jupiter scaled down to size of Earth)

Jovian Galilean Satellites Saturn & Titan Uranus Satellites Neptune & Triton

Which two out of the nine are *double planetary systems*?

(Only largest satellites shown)

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Oblateness

Table 6
Row 10

- Some planets appear “flattened”
- A measure of planetary “roundness”
- We call it *oblateness*

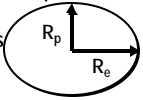
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Table 6
Note 10

Oblateness

- Oblateness *compares*
 - 1) *Difference* between Equatorial & Polar Radii: ($R_e - R_p$)
to
 - 2) Equatorial Radius: R_e
- Oblateness = $(R_e - R_p) / R_e$

R_e = Equatorial Radius
 R_p = Polar Radius



See Note 10

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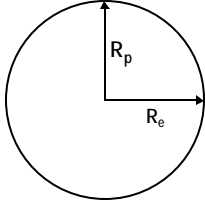
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Table 6
Row 10

Example: Earth

$R_e = 4,000 \text{ mi.}$
 $R_e - R_p = 13 \text{ mi.}$

Oblateness = $13 \text{ mi.} / 4,000 \text{ mi.}$
 = $1/300$ (0.3 %)



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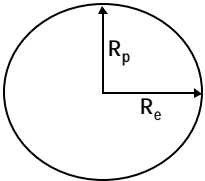
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Table 6
Row 10

Example: Saturn

$R_e = 38,000 \text{ mi.}$
 $R_e - R_p = 4,000 \text{ mi.}$

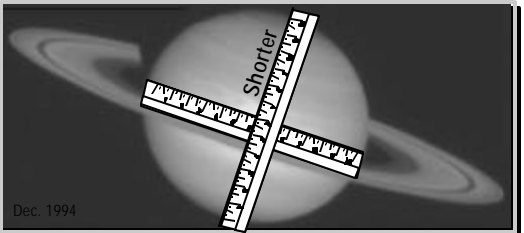
Oblateness = $4,000 \text{ mi.} / 38,000 \text{ mi.}$
 = $1/10$ (10 %)



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Saturn's Oblateness



Credit: Hubble Space Telescope— Reta Beebe (New Mexico State University), D. Gilmore, L. Bergeron (STScI), and NASA.

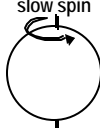
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What Makes Objects Oblate?

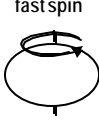
Answer . . . rate of rotation

slow spin



Small
Oblateness

fast spin



Large
Oblateness

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Table 6
Row 9


Oblateness & Planet Structure

Spin two objects at *same* rate . . .

steel



jello



Which object distends more?


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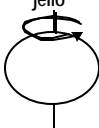
Answer

Jello distends more . . .

steel



jello



Oblateness depends on constitution

- Solid or fluid
- How material distributed

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Table 6
Row 11

Masses of Planets

Follows same pattern as radius

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Table 6
Row 12

Mean Density

- Recall . . .

$$\text{Mean Density} = \frac{\text{Mass}}{\text{Volume}}$$

- Answers question . . .


How compact is planet?

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Table 6
Row 12

Mean Density

- Recall . . .

$$\text{Mean Density} = \frac{\text{Mass}}{\text{Volume}}$$


- Usually compared to water

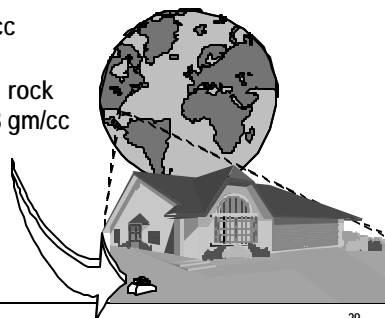
Mean Density = 1 gram per cubic centimeter
(for Water)

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Table 6
Row 12

Earth's Mean Density

- About 5.5 gm/cc
- Typical crustal rock only about 2-3 gm/cc

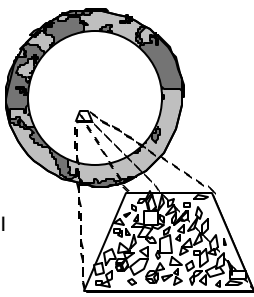


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Table 6
Row 12

Earth's Mean Density

- About 5.5 gm/cc
- Typical crustal rock only about 2-3 gm/cc
- Conclusion
 - Bulk of Earth dense material
 - Examples . . . *iron & nickel*



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Earth's Crust

What two elements dominate (75%) crust?

Three hints

Both common here!

Many rocks called silicates

One found here!

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Earth's Crust

What two elements dominate (75%) crust?

Answer

- ? (47%)
- ? (28%)

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Table 6
Row 12

Do Mean Densities Group?

Objects	Mean Densities (gm/cc)
Inner Planets	3 - 6
Outer Planets	3/4 - 2
Pluto (Small)	2
Sun (Large)	1-1/2

Here? though small!

though not outer

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Saturn

What is unusual about Saturn's mean density?

0.7 gm/cc

Answer: ?

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The Floating Planet

Saturn only planet that floats!

0.7 gm/cc

approx. 3-6 gm/cc approx. 1-2 gm/cc

Large Tub of Water

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Satellites, Asteroids, Comets

- See *Study Guide* Table 5
 - Item Nos. 4, 7 and 8
 - Look over at home
- Questions?
 - See text pg. 103 and following

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Table 5
Item 4

Notes on Planetary Satellites

Large Satellites (diameters over 500 mi.)

- Orbits Regular: prograde, nearly circular & coplanar
- Exception: *Triton* (Neptune) — retrograde orbit

Satellite Orbits

Triton
e and i both small

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Table 5
Item 4

Notes on Planetary Satellites

Small Satellites (diameters under 500 mi.)

- Orbits often discordant (irregular)
- Example — *Nereid* (Neptune) has $e = 3/4!$

Higher eccentricities
&
retrograde orbits
common

Nereid
 $e = 0.75$

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