
Hometown Planets
Scaling the planetary orbits to your hometown

How far away are all of the planets?

- The solar system is so huge and the planets are such great distances apart that it is hard to get an idea of how “close” they really are to one another.
- What could we do to get a better idea of how close planets are to one another and to Earth?
- Change the distances to something we can relate to in everyday life! This is called *scaling* or *scale modeling*.

Scaling…like climbing a wall?

- No silly! The *scaling* or *scale modeling* we are using is for adjusting distances to larger or smaller units in order to better view an object or distance.
- Architects use this all of the time. Blueprints are a small scale version of what they are building.
- So we can do the same thing by drawing a small scale version of the solar system.

Understanding Scale Ratios

- All scale models use ratios.
- A ratio is a comparison of two things.
- For example, if I ask you for the ratio of oranges to apples that means I am asking you to compare how many of each fruit. What's the ratio?
  - You have four oranges and five apples so the ratio of oranges to apples is four to five or 4:5.

Understanding Scale Ratios

- In models the *scale ratio* is the comparison of the true distance to the distance on the model.

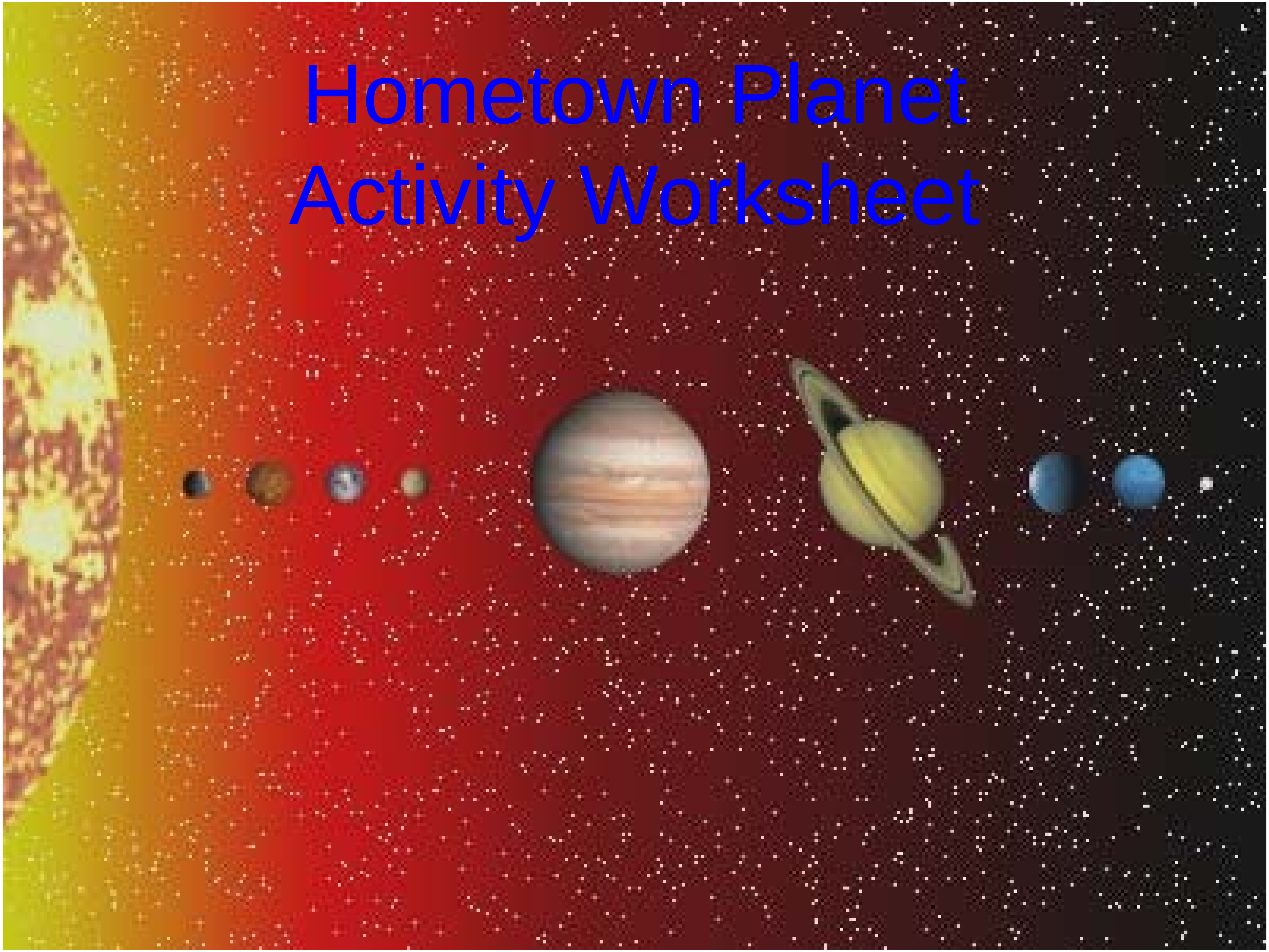
- Write down an example of a scale ratio that you would see on a map.
  - 10 *mi* : 1 *in* (10 miles = 1 inch)
  - 25 *km* : 10 *cm* (25 kilometers = 10 centimeters)
  - Or anything else that is the true distance compared to the distance on the map

Understanding Scale Factors

- In models the *scale factor* is how many times smaller the model is than the actual object or distance.
- It is determined by dividing the actual distance by the distance on the model.
- So, if the scale ratio was 30 *in* : 10 *in* then the scale factor would be 30 divided by 10 or 3. The model is three times smaller.

Understanding Scale Factors

- How do you get the scale factor if the scale ratio was 5 *ft* = 2 *in* or 5 *ft* : 2 *in*?
- To get the correct scale factor the units must be the SAME for both distances.
- Conversion (unit change): $5\ ft \times \frac{12\ in}{1\ ft} = 60\ in$
- Scale factor: $\frac{60\ in}{2\ in} = 30$


Hometown Planet
Activity Worksheet

Scaling Planetary Orbits to Hometown Distances

- Here is a table of the planetary orbit distances.
- The first step to make a planetary orbit model is to convert the units from *km* to *mi.*

***Pluto is technically a dwarf planet, but we still like it!*

Planet	**Distance from the Sun (*km*)**
Mercury	5.79×10^{7}
Venus	1.08×10^{8}
Earth	1.50×10^{8}
Mars	2.28×10^{8}
Jupiter	7.78×10^{8}
Saturn	1.43×10^{9}
Uranus	2.87×10^{9}
Neptune	4.50×10^{9}
**Pluto	5.91×10^{9}

Converting Units

- Start with the units you have and end with the units you need!
  - We have *km* and need to get to *mi.*
- This conversion is kind of tricky, so here are the units for the steps in between:

$$1.0\ km \times \frac{1000\ m}{1.0\ km} \times \frac{100\ cm}{1.0\ m} \times \frac{1.00\ in}{2.54\ cm} \times \frac{1.0\ ft}{12\ in} \times \frac{1.0\ mi}{5{,}280\ ft} = 0.62137\ mi$$

- Since 1.0 *km* = **0.62137 *mi*** (number **A**), multiplying the orbit distances by number **A** will convert *km* to *mi*.

Choosing A Scale Factor

- To make sure that most of the planetary orbits are within our hometown area, set the largest orbit equal to 40 *mi*.
- What is the scale ratio?
  - Pluto's orbit : model distance
  - $3.67 \times 10^9 \; mi : 40 \; mi = \dfrac{3.67 \times 10^9 \; mi}{40 \; mi} = 9.17 \times 10^7$
- This number, 9.17×10^7, is scale factor **B**.
- Using the new planetary distances (in miles) divide by this number to correctly scale down the distances for the model.

Another Conversion…

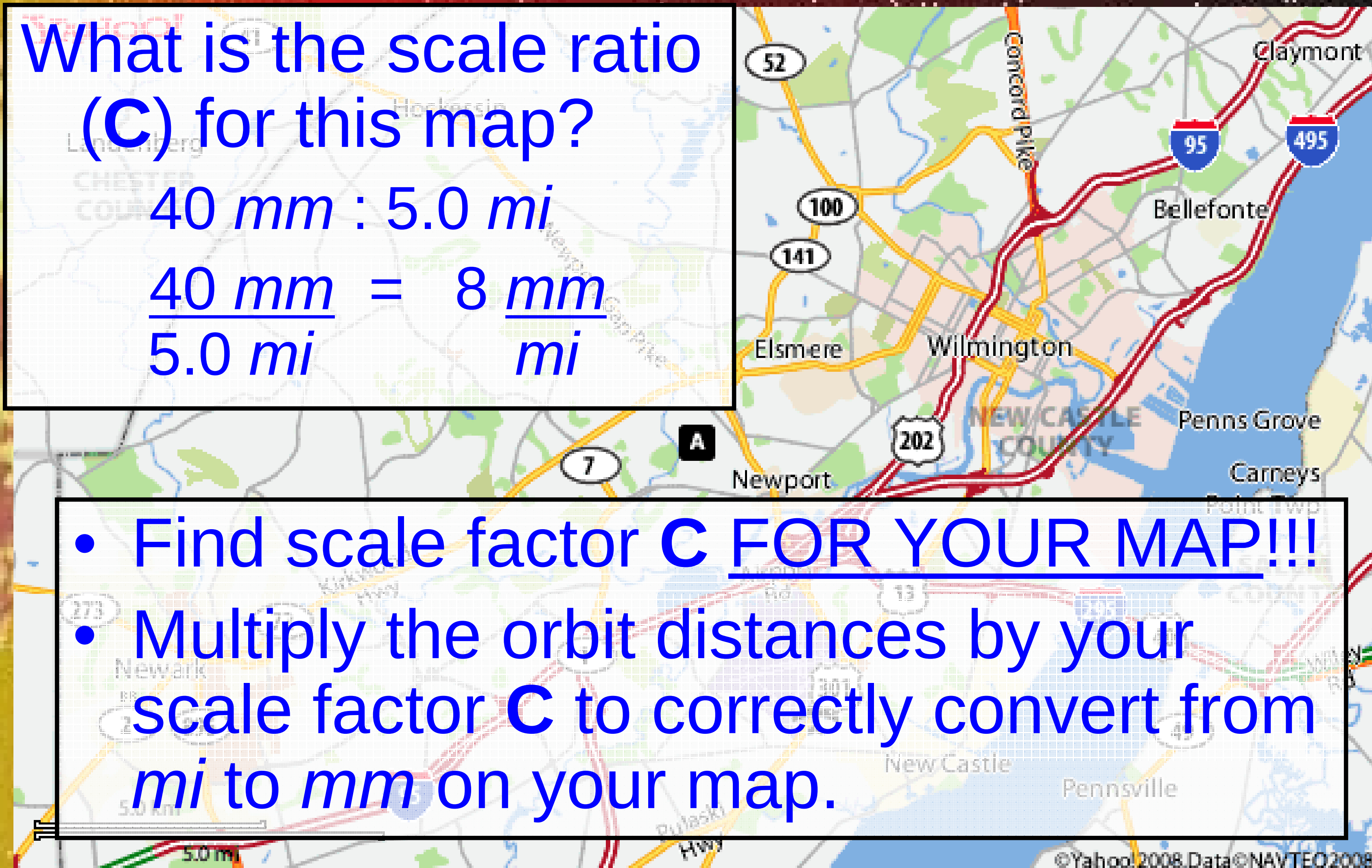
- Now the model orbits need to fit on a map. What is the unit we need to convert to?
  - – We have *mi* and need to get to *mm.*
- This one is easier than the last conversion because there is a scale bar on a map.

A map of Delcastle…

What is the scale ratio (**C**) for this map?

40 *mm* : 5.0 *mi*

$$\frac{40\ mm}{5.0\ mi} = 8\ \frac{mm}{mi}$$



- Find scale factor **C** <u>FOR YOUR MAP</u>!!!
- Multiply the orbit distances by your scale factor **C** to correctly convert from *mi* to *mm* on your map.

Hometown Planet Maps

- **Map W:** Scale ratio 46 *mm* : 1.0 *mi*
  - 46 *mm* ÷ 1.0 *mi* = 46 *mm/mi*
- **Map X:** Scale ratio 57 *mm* : 5.0 *mi*
  - 57 *mm* ÷ 5.0 *mi* = 11.4 *mm/mi*
- **Map Y:** Scale ratio 57 *mm* : 10.0 *mi*
  - 57 *mm* ÷ 10.0 *mi* = 5.7 *mm/mi*
- **Map Z:** Scale ratio 38 *mm* : 25 *mi*
  - 38 *mm* ÷ 25 *mi* = 1.52 *mm/mi*

Planetary Orbit Distances Converted to Miles

Planet	Distance from the Sun (*km*)	Distance from the Sun (*mi*)
Mercury	5.79×10^{7}	3.60×10^{7}
Venus	1.08×10^{8}	6.71×10^{7}
Earth	1.50×10^{8}	9.32×10^{7}
Mars	2.28×10^{8}	1.42×10^{8}
Jupiter	7.78×10^{8}	4.83×10^{8}
Saturn	1.43×10^{9}	8.89×10^{8}
Uranus	2.87×10^{9}	1.78×10^{9}
Neptune	4.50×10^{9}	2.80×10^{9}
**Pluto	5.91×10^{9}	3.67×10^{9}

Planetary Orbit Distances Scaled Down for Model

Planet	Actual distance from the sun (*mi*)	Model distance from the Sun (*mi*)
Mercury	3.60×10^7	0.392
Venus	6.71×10^7	0.731
Earth	9.32×10^7	1.02
Mars	1.42×10^8	1.54
Jupiter	4.83×10^8	5.27
Saturn	8.89×10^8	9.68
Uranus	1.78×10^9	19.4
Neptune	2.80×10^9	30.5
**Pluto	3.67×10^9	40.0

Planetary Orbit Distances Scaled Down for Mapping

Planet	Distance from the Sun (*mi*)	Map W (mm)	Map X (mm)	Map Y (mm)	Map Z (mm)
Mercury	0.392	18	4	2	0.6
Venus	0.731	34	8	4	1.1
Earth	1.02	47	12	6	1.6
Mars	1.54	71	18	9	2
Jupiter	5.27	242	60	30	8
Saturn	9.68	445	110	55	15
Uranus	19.4	892	221	111	29
Neptune	30.5	1403	348	174	46
**Pluto	40.0	1840	456	228	61

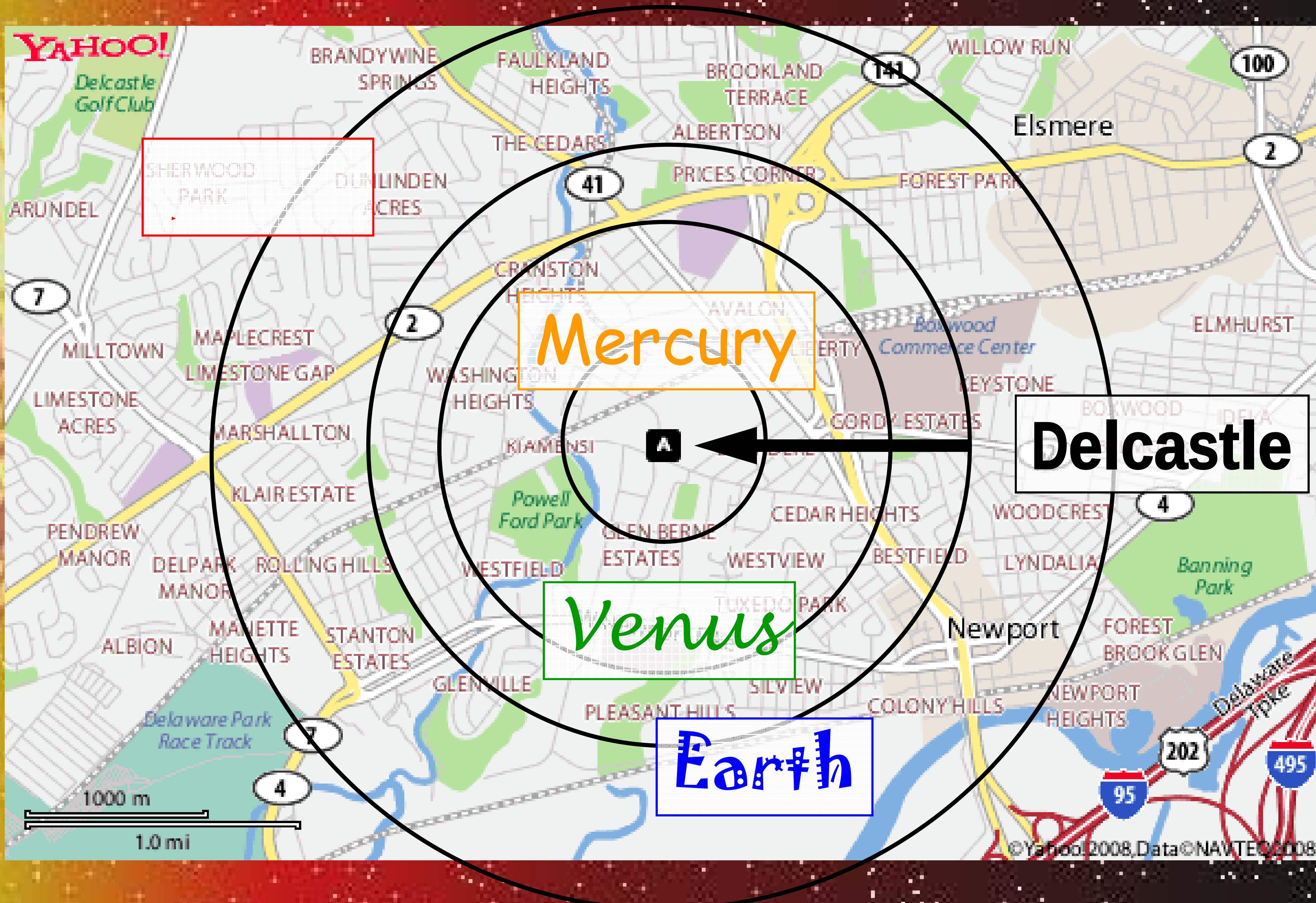
Mapping Hometown Planets

- Plot the orbits using the planetary orbit distances scaled for your map and a compass.
- Trace each orbit twice!! Sometimes the compass shifts while being used and could give an incorrect orbit.
- Once the orbits are mapped, identify a well-known landmark for each planetary orbit.

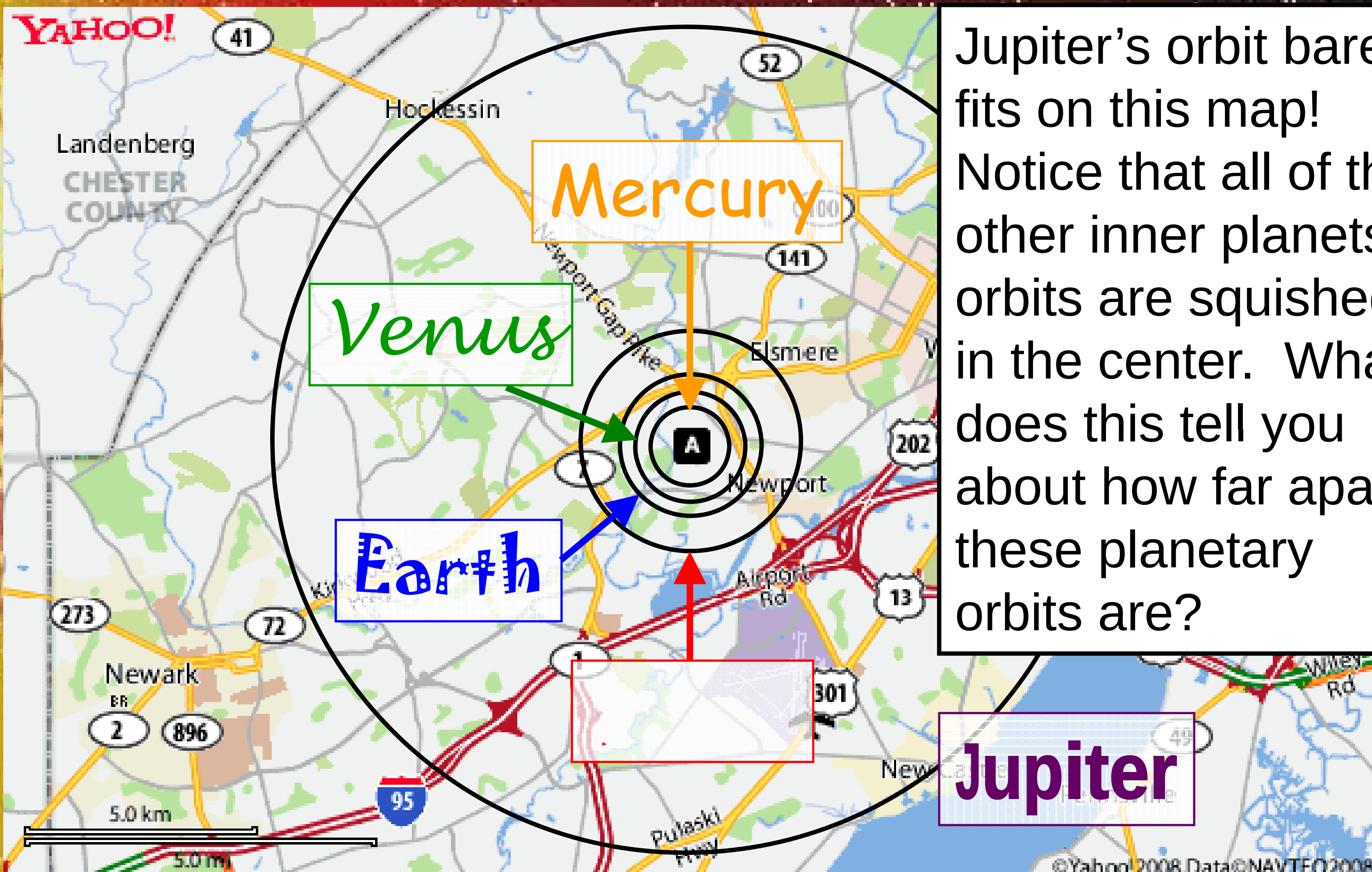
Hometown Planet Maps

- **Map W: Inner Planets**
  - Scale ratio 1.0 mi : 33 mm
- **Map X: Inner Planets + Jupiter**
  - Scale ratio 5.0 mi : 40 mm
- **Map Y: Mars, Jupiter and Saturn**
  - Scale ratio 10.0 mi : 40 mm
- **Map Z: Outer Planets**
  - Scale ratio 25.0 mi : 27 mm

Here's a map of Delcastle…

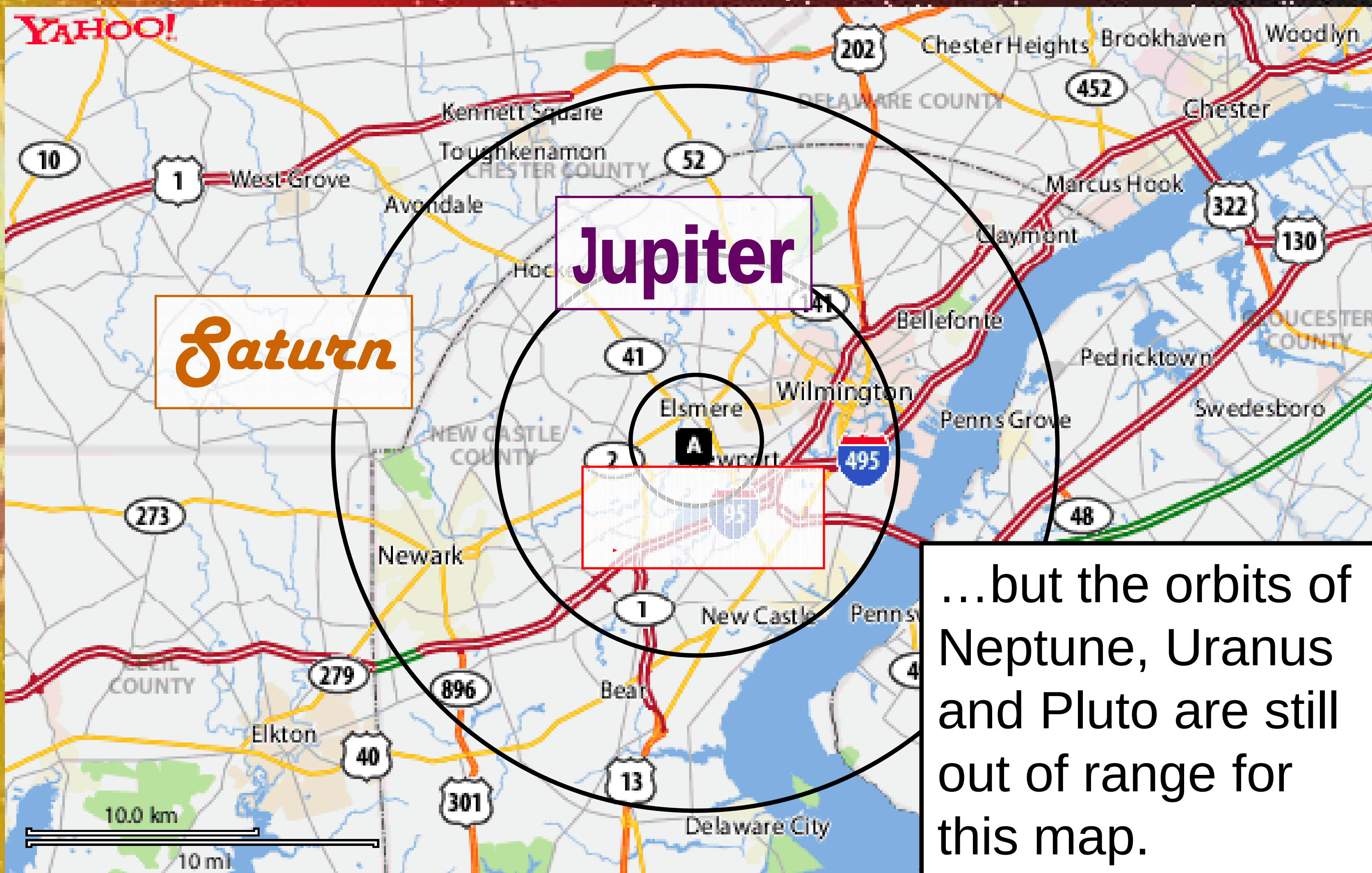


Still too small for the large orbits!



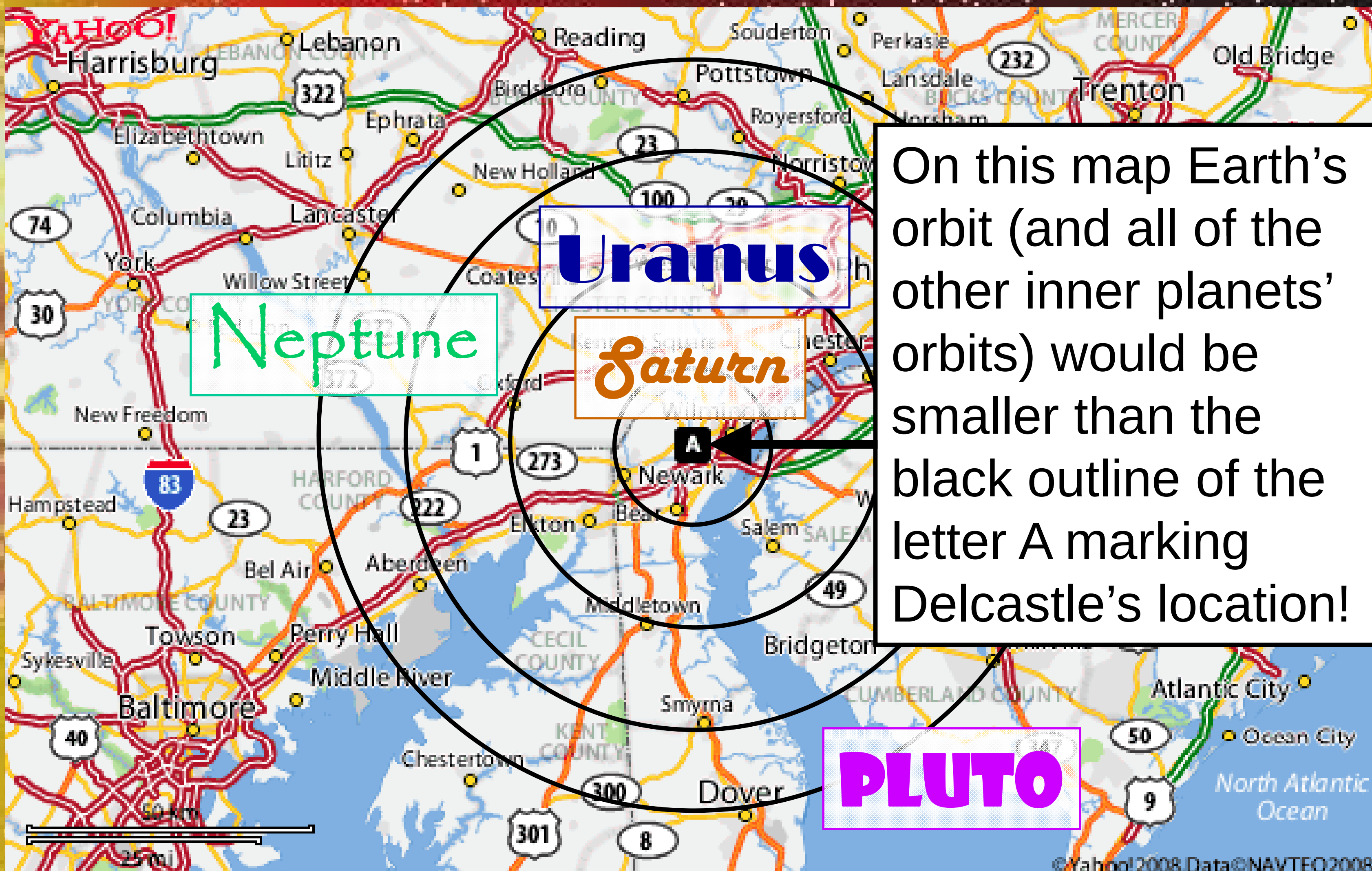
Jupiter's orbit barely fits on this map! Notice that all of the other inner planets' orbits are squished in the center. What does this tell you about how far apart these planetary orbits are?

This is a little better….



…but the orbits of Neptune, Uranus and Pluto are still out of range for this map.

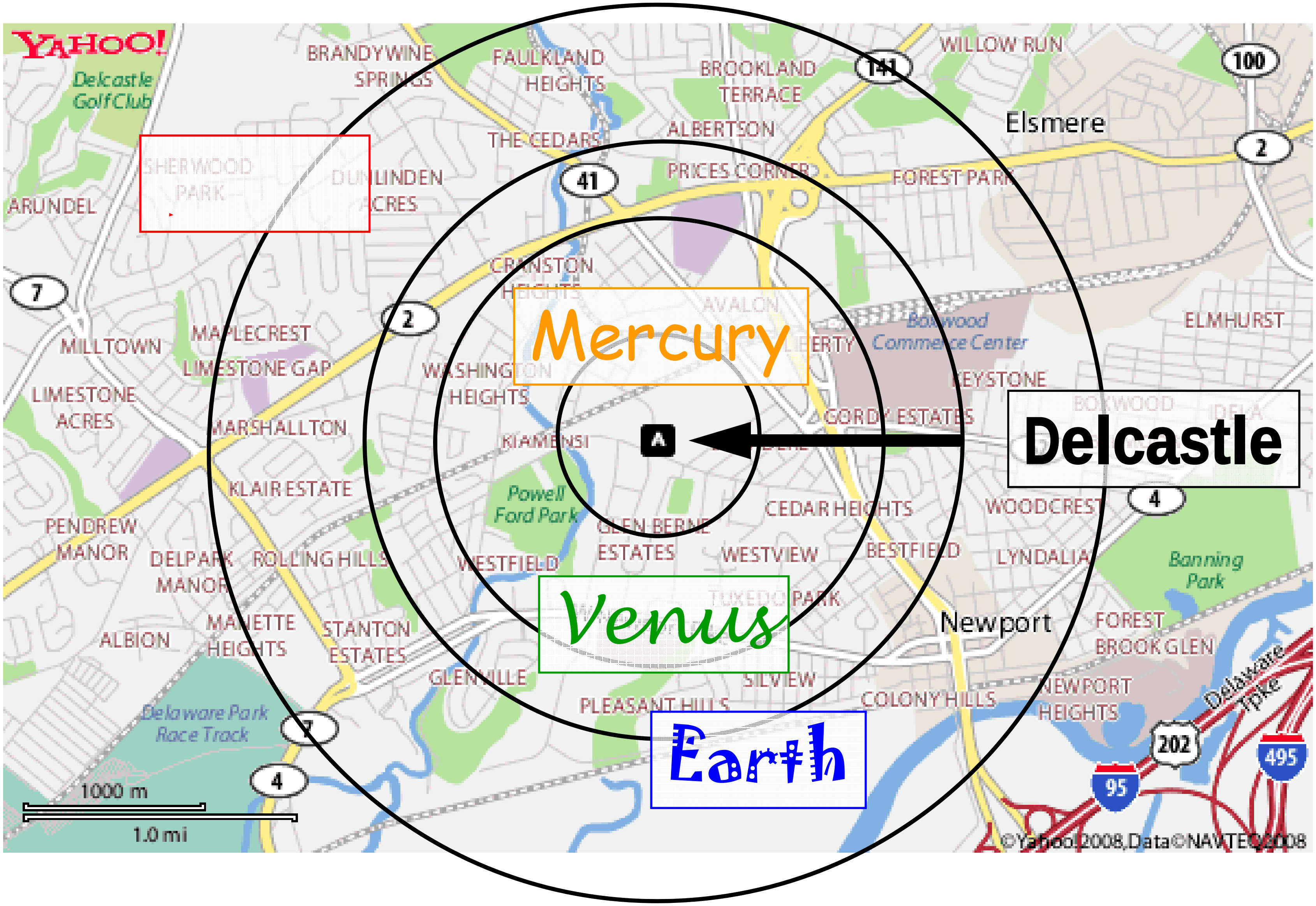
Finally fit in Pluto, but where is Earth?



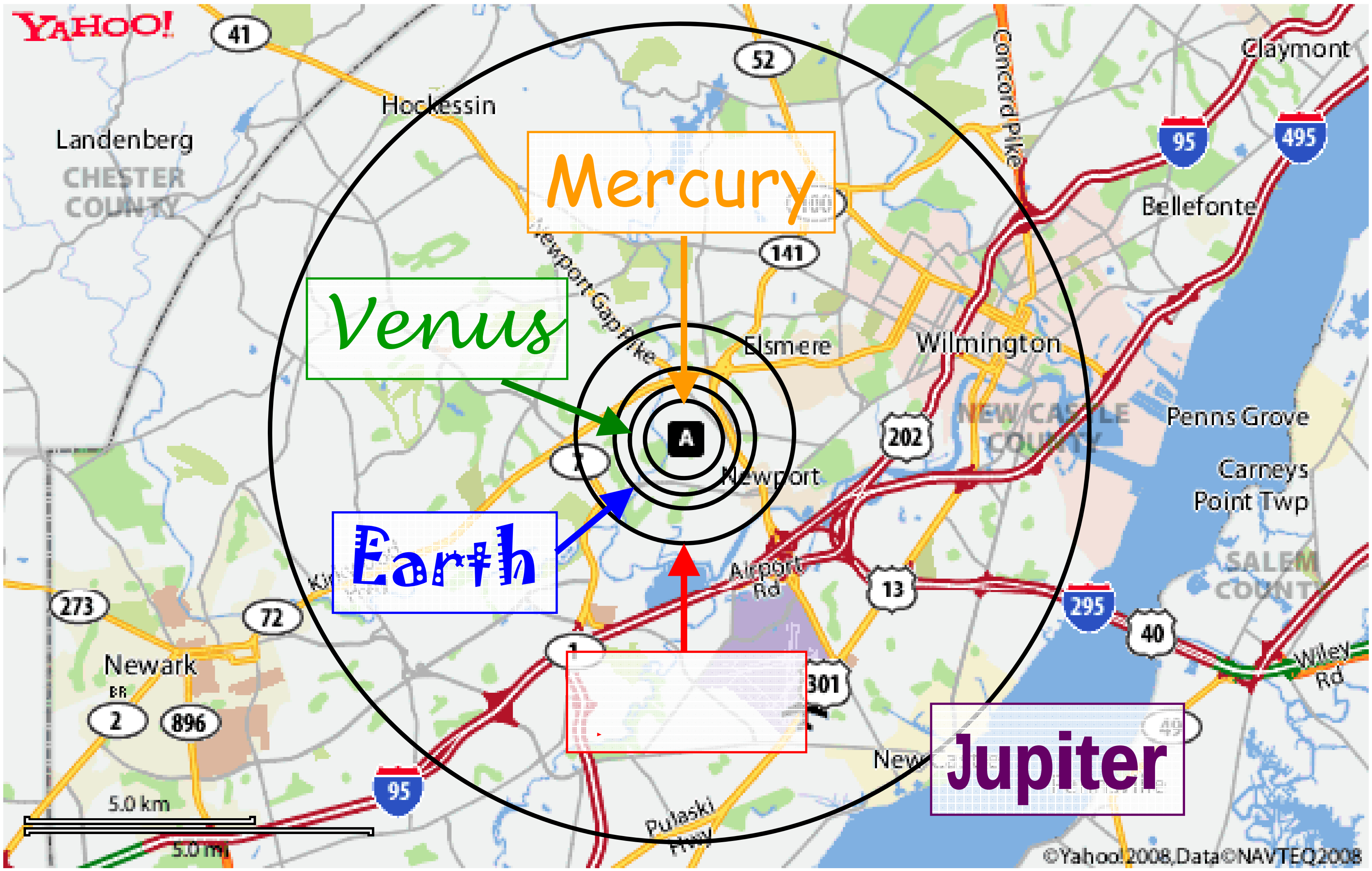
On this map Earth's orbit (and all of the other inner planets' orbits) would be smaller than the black outline of the letter A marking Delcastle's location!

EXTRA SLIDES

Map W



Map X



YAHOO!
Hockessin
Landenberg
CHESTER COUNTY
Mercury
Venus
Earth
Jupiter
Elsmere
Wilmington
Newport
Claymont
Bellefonte
Penns Grove
Carneys Point Twp
SALEM COUNTY
NEW CASTLE COUNTY
Newark
Airport Rd
Concord Pike
Newport Gap Pike
Pulaski Hwy
Wiley Rd
5.0 km
5.0 mi
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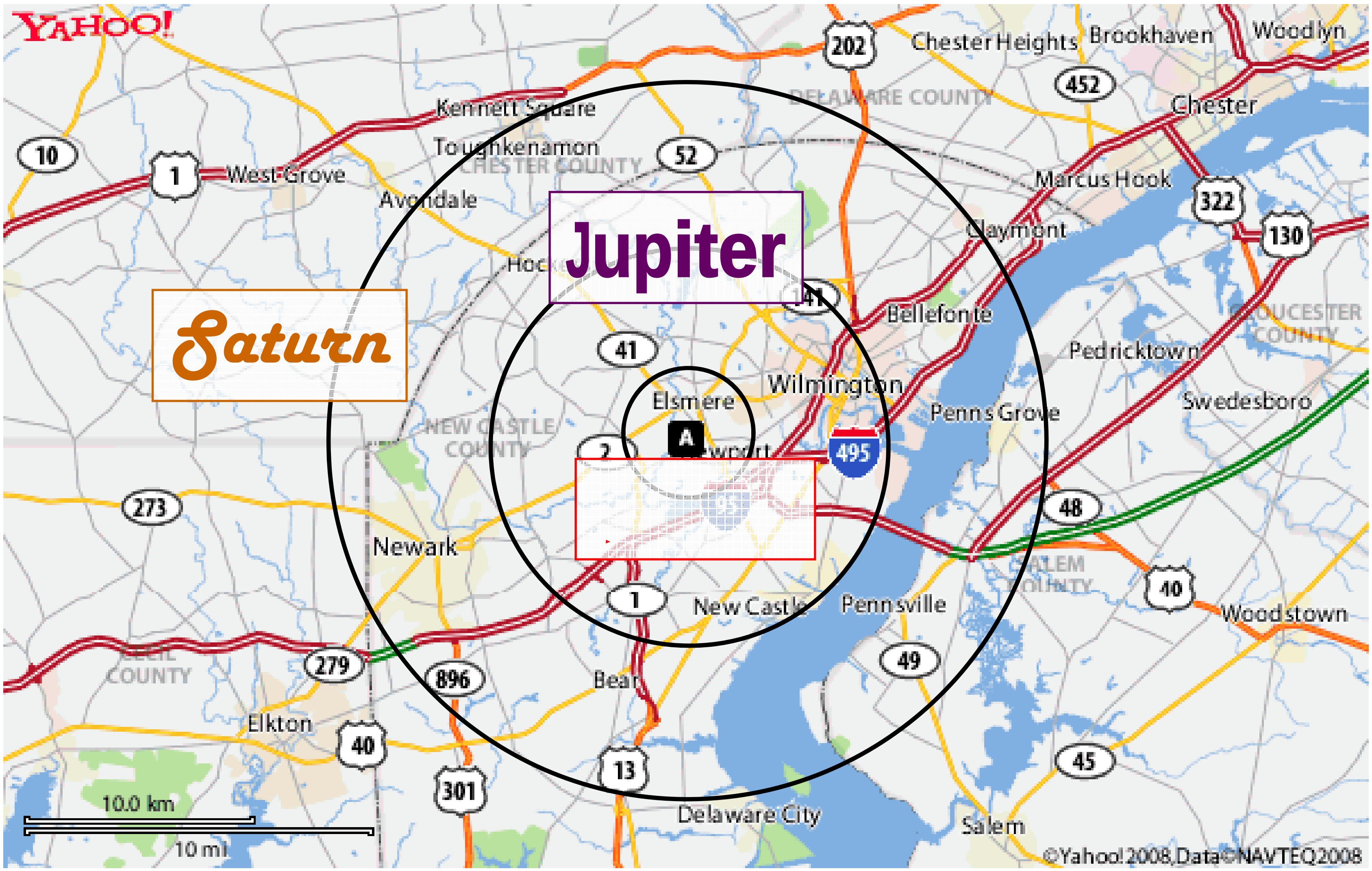
Map Y



Jupiter
Saturn
Kennett Square
Toughkenamon
West Grove
Avondale
Chester Heights
Brookhaven
Woodlyn
Chester
Marcus Hook
Claymont
Bellefonte
Elsmere
Wilmington
Penns Grove
Pedricktown
Swedesboro
Newark
New Castle
Pennsville
Bear
Elkton
Delaware City
Salem
Woodstown
DELAWARE COUNTY
CHESTER COUNTY
NEW CASTLE COUNTY
CECIL COUNTY
SALEM COUNTY
GLOUCESTER COUNTY
10.0 km
10 mi
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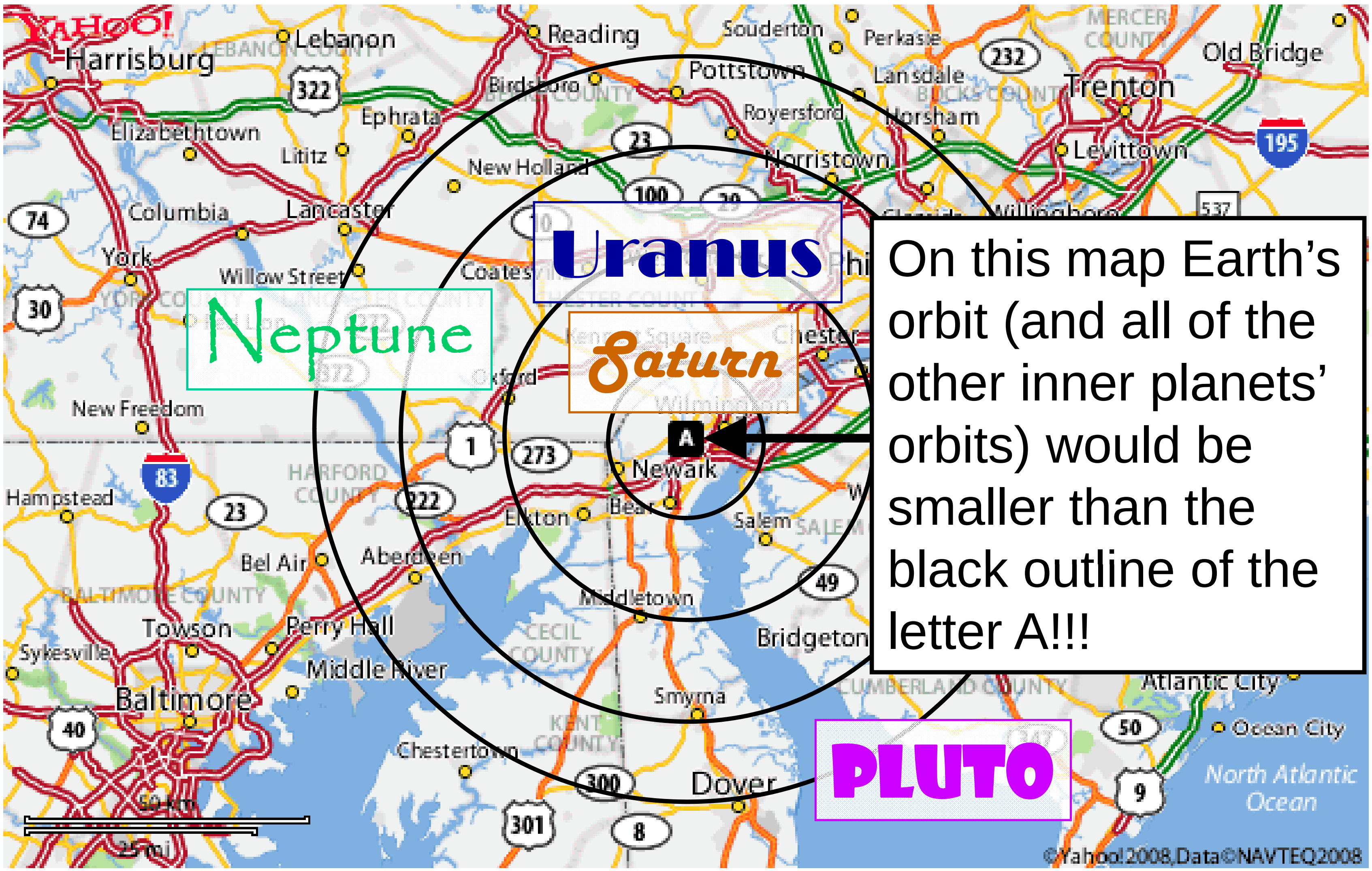
Map Z


Neptune
Uranus
Saturn
PLUTO
A
On this map Earth's orbit (and all of the other inner planets' orbits) would be smaller than the black outline of the letter A!!!
Harrisburg
Lebanon
Reading
Souderton
Perkasie
Old Bridge
Pottstown
Lansdale
Trenton
Elizabethtown
Ephrata
Birdsboro
Royersford
Horsham
Levittown
Lititz
New Holland
Norristown
Columbia
Lancaster
Willingboro
York
Willow Street
Coatesville
Chester
Oxford
Wilmington
New Freedom
Newark
Hampstead
HARFORD COUNTY
Elkton
Bear
Salem
Bel Air
Aberdeen
Middletown
BALTIMORE COUNTY
Towson
Perry Hall
Bridgeton
Sykesville
Middle River
CECIL COUNTY
Atlantic City
Baltimore
Smyrna
CUMBERLAND COUNTY
Ocean City
KENT COUNTY
Chestertown
Dover
North Atlantic Ocean
50 km
25 mi
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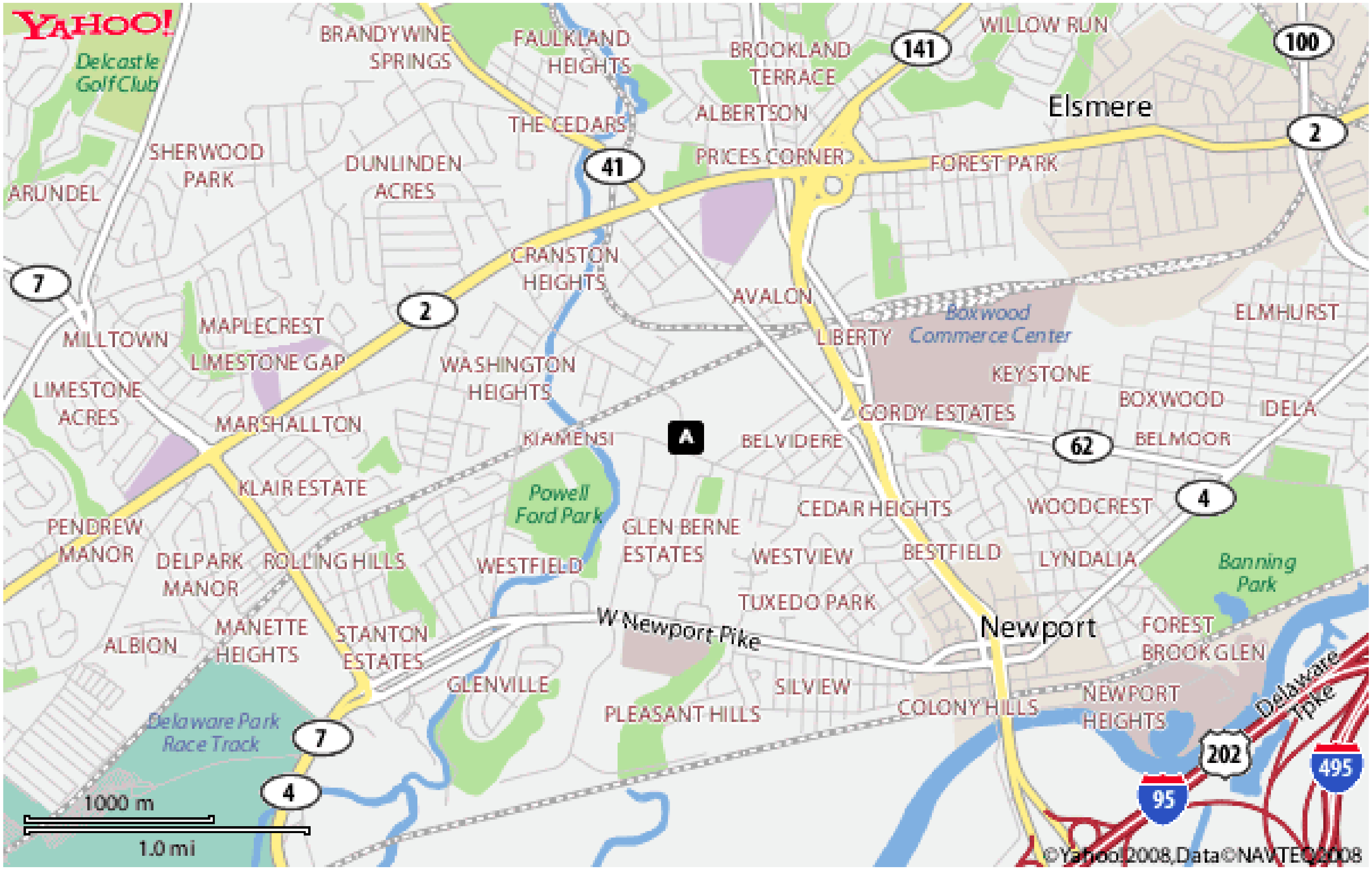
Map W


YAHOO!
Delcastle Golf Club
BRANDYWINE SPRINGS
FAULKLAND HEIGHTS
BROOKLAND TERRACE
WILLOW RUN
141
100
Elsmere
ALBERTSON
THE CEDARS
SHERWOOD PARK
DUNLINDEN ACRES
41
PRICES CORNER
FOREST PARK
2
ARUNDEL
CRANSTON HEIGHTS
7
AVALON
Boxwood Commerce Center
ELMHURST
MILLTOWN
MAPLECREST
LIBERTY
LIMESTONE GAP
WASHINGTON HEIGHTS
KEYSTONE
LIMESTONE ACRES
BOXWOOD
IDELA
MARSHALLTON
GORDY ESTATES
KIAMENSI
A
BELVIDERE
62
BELMOOR
KLAIR ESTATE
Powell Ford Park
4
CEDAR HEIGHTS
WOODCREST
PENDREW MANOR
GLEN BERNE ESTATES
DELPARK MANOR
ROLLING HILLS
WESTFIELD
WESTVIEW
BESTFIELD
LYNDALIA
Banning Park
TUXEDO PARK
W Newport Pike
Newport
ALBION
MANETTE HEIGHTS
STANTON ESTATES
FOREST BROOK GLEN
GLENVILLE
SILVIEW
COLONY HILLS
NEWPORT HEIGHTS
Delaware Park Race Track
PLEASANT HILLS
Delaware Tpke
202
495
95
1000 m
1.0 mi
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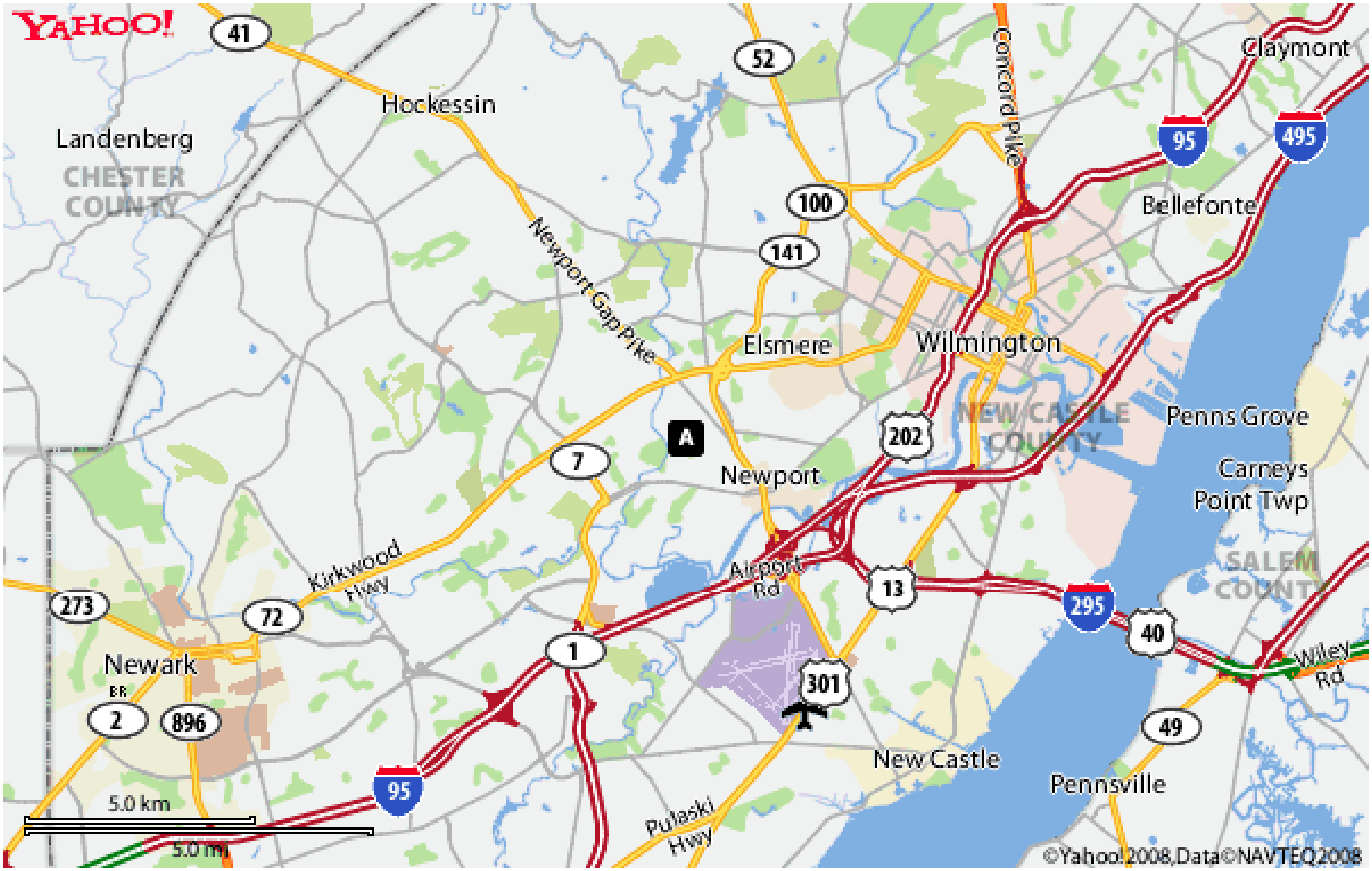
Map X


YAHOO!
41
52
Hockessin
Landenberg
CHESTER COUNTY
Concord Pike
Claymont
95
495
100
Bellefonte
141
Newport Gap Pike
Elsmere
Wilmington
NEW CASTLE COUNTY
Penns Grove
202
A
7
Newport
Carneys Point Twp
Kirkwood Hwy
Airport Rd
13
295
SALEM COUNTY
273
72
40
1
Newark
BR
2
896
301
Wiley Rd
49
New Castle
95
Pennsville
5.0 km
5.0 mi
Pulaski Hwy
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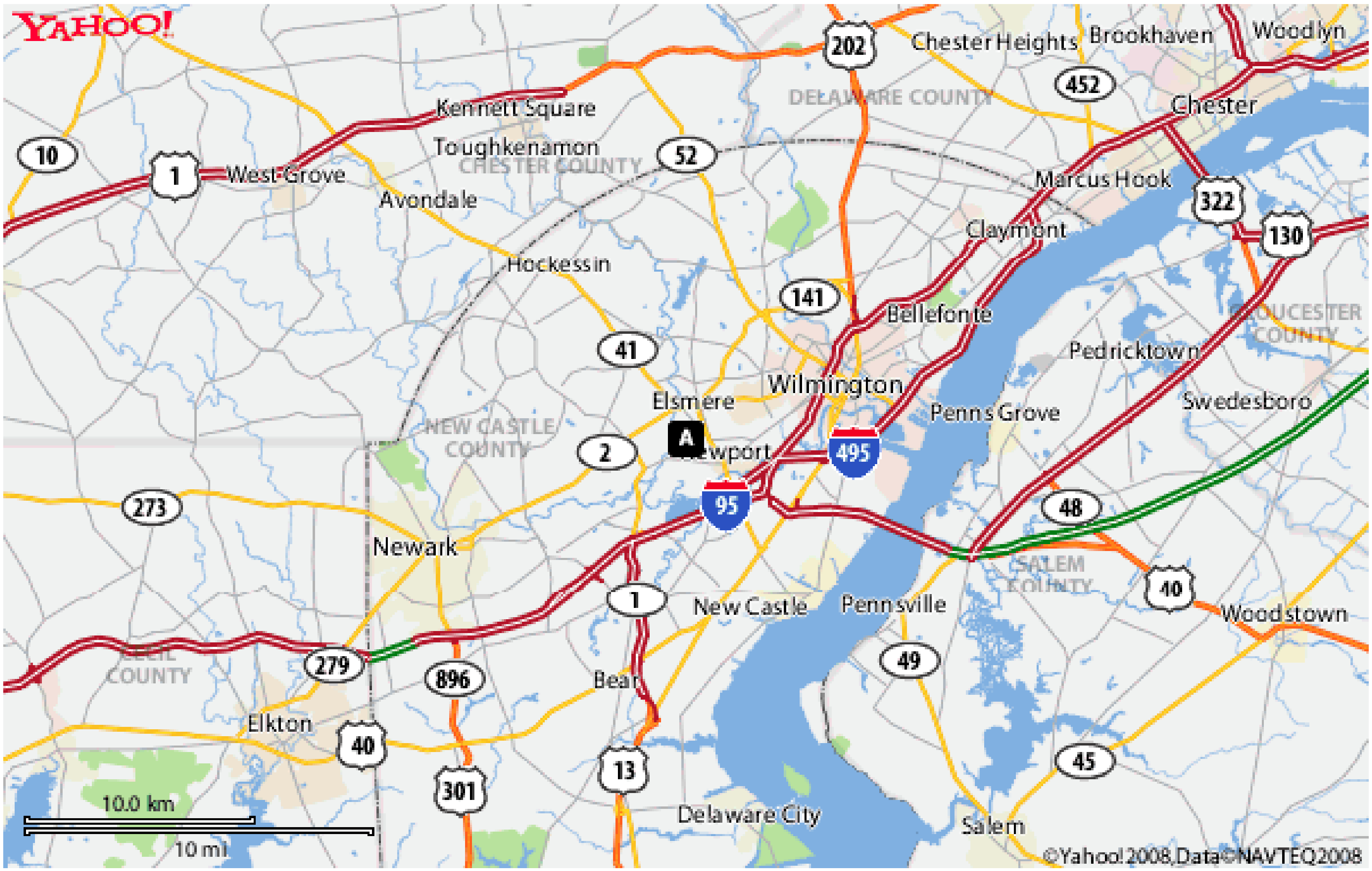
Map Y



YAHOO!
Chester Heights
Brookhaven
Woodlyn
Kennett Square
DELAWARE COUNTY
Chester
Toughkenamon
CHESTER COUNTY
West Grove
Avondale
Marcus Hook
Claymont
Hockessin
Bellefonte
Pedricktown
Wilmington
Elsmere
Penns Grove
Swedesboro
NEW CASTLE COUNTY
Newport
Newark
SALEM COUNTY
New Castle
Pennsville
Woodstown
CECIL COUNTY
Bear
Elkton
Delaware City
Salem
10.0 km
10 mi
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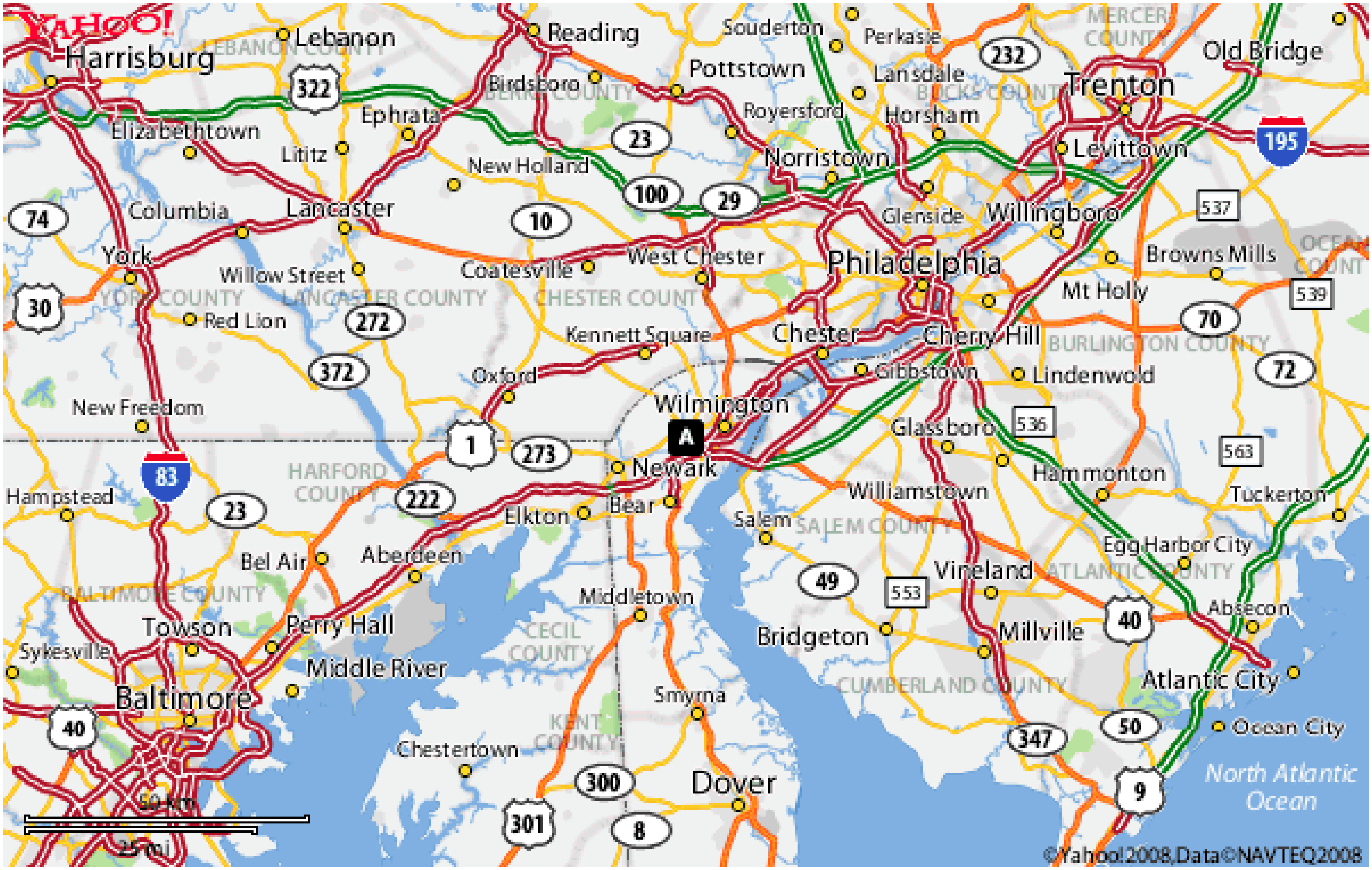
Map Z


Harrisburg
Lebanon
Reading
Souderton
Perkasie
Pottstown
Lansdale
Trenton
Old Bridge
Ephrata
Elizabethtown
Lititz
Royersford
Horsham
Norristown
Levittown
New Holland
Columbia
Lancaster
Glenside
Willingboro
York
Willow Street
Coatesville
West Chester
Philadelphia
Browns Mills
Mt Holly
Red Lion
Kennett Square
Chester
Cherry Hill
Oxford
Gibbstown
Lindenwold
New Freedom
Wilmington
Glassboro
Newark
Hammonton
Hampstead
Williamstown
Tuckerton
Elkton
Bear
Salem
Bel Air
Aberdeen
Egg Harbor City
Vineland
Middletown
Absecon
Towson
Perry Hall
Bridgeton
Millville
Sykesville
Middle River
Atlantic City
Baltimore
Smyrna
Ocean City
Chestertown
Dover
North Atlantic Ocean
50 km
25 mi
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