Name _____

# D3: Apportionment

Class Prep Assignment                                     Due at the beginning of next class

**Apportionment** is the problem of dividing up a fixed number of people or items among groups of different sizes. For example, we use apportionment to determine the number of representatives for each state in the US House of Representatives, or to divide school busses among districts.

## Rules of Apportionment

1. The people/items can only be divided into _____.

2. We must use the _____of people/items being divided.

3. Each group must get _____ of the people/items being divided up.

4. The number of people/items assigned to each group should be _____ to the size of the group. (Exact is rarely possible so get as close as possible).

---

### Apportionment Methods and Steps

1. Find the divisor: The number of people each person should represent (decimal)

2. Divide the population by the divisor to get the standard quota.

**Hamilton's Method (vetoed in 1792, used from 1850-1900):** Cut off decimal to find initial or minimum number. Then give any extra seats in order of the highest decimal remainders

**Jefferson's Method (used from 1792-1830):** Cut off the decimal to find the initial or minimum number. Lower the divisor so that there are no leftover seats

**Webster's Method (used in 1840):** Instead of cutting off the decimal, round it to find the initial or minimum number. Then lower the divisor if needed so there are no leftover seats.

**Hill-Huntington Method (used 1941-present):** Instead of rounding using 0.5 or higher, use the geometric mean $\sqrt{x(x+1)}$ to round the initial or minimum number.

---

Part of U.S. history is the 3/5 compromise between the North and the South in 1787, in which slaves were counted as 3/5 of a person for representation. When the slaves were freed in 1863 they were counted as whole people. Black men were given the right to vote in 1870, and all women in 1920. http://www.aaregistry.org/historic_events/view/three-fifths-compromise

**Name** _____

**Example 1.** PCC has four campuses and 45 full-time math instructors. The number of students at each campus is given in terms of full-time equivalency (FTE). How can we divide up the math instructors fairly?

2016-17 Academic Year Data: https://www.pcc.edu/ir/factsheet/Factbook/201617/swr5yrt2012-2016.pdf

## a. Use Hamilton's method to apportion the math instructors.

| Campus | Students (FTE) | Standard Quota | Initial or Minimum | Final |
|--------|----------------|----------------|--------------------|-------|
| Sylvania | 8871 | | | |
| Cascade | 4841 | | | |
| Rock Creek | 6797 | | | |
| Southeast | 2722 | | | |
| **Total** | | | | |
| **Divisor:** | | | | |

## b. Use Jefferson's method to apportion the math instructors.

| Campus | Students (FTE) | Standard Quota |
|--------|----------------|----------------|
| Sylvania | 8871 | |
| Cascade | 4841 | |
| Rock Creek | 6797 | |
| Southeast | 2722 | |
| **Total** | 23,231 | |
| **Divisor:** | | |

## c. Use Webster's method to apportion the math instructors.

| Campus | Students (FTE) | Standard Quota |
|--------|----------------|----------------|
| Sylvania | 8871 | |
| Cascade | 4841 | |
| Rock Creek | 6797 | |
| Southeast | 2722 | |
| **Total** | 23,231 | |
| **Divisor:** | | |

d. Use Hill-Huntington's method to apportion the math instructors.

| Campus | Students (FTE) | Standard Quota |
|--------|----------------|----------------|
| Sylvania | 8871 | |
| Cascade | 4841 | |
| Rock Creek | 6797 | |
| Southeast | 2722 | |
| **Total** | **23,231** | |

**Divisor:**

## More D2: Voting Power

**Example 2.** Let's look at the actual number of full-time math instructors per campus and compare the voting power of each campus. Decisions about math curriculum and textbooks are made in a democratic process. Note, there are also many talented part-time faculty that vote as well, so this is an oversimplified example.

| Campus | Students (FTE) | FT Math Instructors | Students (FTE) per FT math instructor |
|--------|----------------|---------------------|----------------------------------------|
| Sylvania | 8871 | 18 | |
| Cascade | 4841 | 8 | |
| Rock Creek | 6797 | 13 | |
| Southeast | 2722 | 6 | |
| **Total** | **23,231** | **45** | |

Name _____

## D4: Gerrymandering and Solutions

<u>Class Prep Assignment</u>                              <u>Due at the beginning of next class</u>
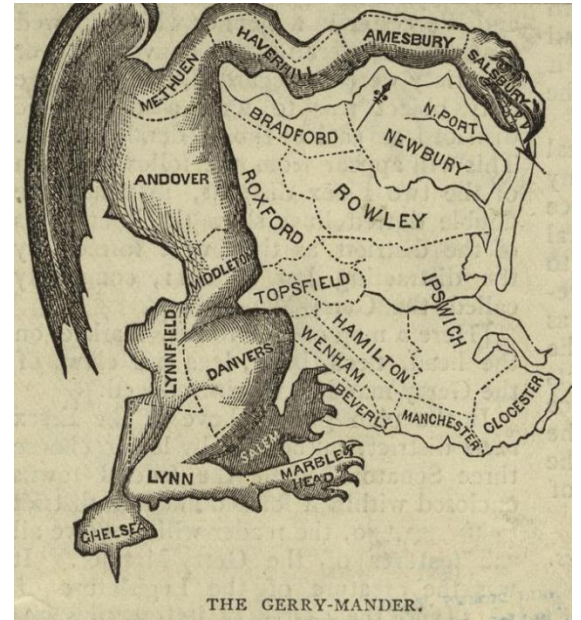
Apportionment determines how many representatives are given to each state. Then each state draws the districts that elect one representative each.

Watch the videos and look for the following information.

1. How often does redistricting happen?

2. What are the two rules for drawing district lines?
   1.

   2.

3. Who determines where the district lines are drawn?



THE GERRY-MANDER.

4. There are two types of gerrymandering.

     What is cracking?

     What is packing?

5. What is gerrymandering?

Name _____

## How to Measure Gerrymandering: The Efficiency Gap

Example 1. The votes are shown for five districts in a hypothetical state. Determine the number of seats won and calculate the efficiency gap.

**Election Results:**

Democrats win

_____ seats

Republicans win

_____ seats

| District | D Votes | R Votes | D Wasted Votes | R Wasted Votes |
|----------|---------|---------|----------------|----------------|
| 1 | 75 | 25 | | |
| 2 | 60 | 40 | | |
| 3 | 43 | 57 | | |
| 4 | 48 | 52 | | |
| 5 | 49 | 51 | | |
| Total | | | | |

Efficiency Gap = $\dfrac{\text{Party A Wasted Votes} - \text{Party B Wasted Votes}}{\text{Total Votes}}$ =

A maximum efficiency gap of _____% is currently being proposed.

Adapted from: https://www.brennancenter.org/sites/default/files/legal-work/How_the_Efficiency_Gap_Standard_Works.pdf

### More information
Democracy vs. Math: https://www.nytimes.com/2017/08/29/magazine/the-new-front-in-the-gerrymandering-wars-democracy-vs-math.html

Efficiency Gap Infographics for each state: https://www.azavea.com/blog/2017/07/19/gerrymandered-states-ranked-efficiency-gap-seat-advantage/

Article about project REDMAP (REDstricting Majority Project):

https://qz.com/1009713/gerrymandering-definition-guide-to-understanding-gill-v-whitford-supreme-court-case/