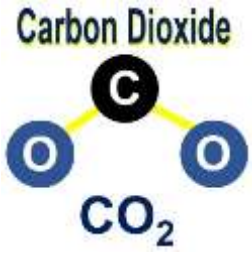
TEAMS Monthly High School Math Challenge, November 2016

Directions: Copy and distribute to your students. Coaches may e-mail their student's answers to teams@tsaweb.org --subject line: HS Math Challenge. Make sure to include the student's name, your name, your school, city and state. Correct entries for that month will be placed in a drawing and one name will be randomly drawn on the 2nd Friday of the month following the challenge. The student whose name is drawn will be sent a $25 Visa gift card via their TEAMS coach.

Rules:

1) E-mailed answers must be received by 11:59PM on the last day of the month.
2) All parts to the monthly question must be answered correctly. If two questions are posed, both must be answered correctly.
3) Answers submitted must be for the current month's posted problem.
4) One entry per student per month allowed.

Challenge 1



The global carbon dioxide concentration in the atmosphere in 2016 surpassed 400 parts-per-million (ppm) for the first time. While the unit ppm is often used to express the concentration of CO_2 in the atmosphere, it is also common to show the concentration as a percent of the atmospheric make up.

Math challenge question

What percent of the atmosphere is carbon dioxide if the concentration is 400 ppm?

Solution: To convert 400 parts-per-million of carbon dioxide gas to the corresponding percentage of carbon dioxide gas in air, divide the concentration in ppm by 10,000.

400 ppm / 10,000 = 0.04%

This occurs because ppm actually refers to part-per-million or 1 per 1,000,000 of something. Because a percentage means 1 per 100 of something, to convert from part per million to a % value, you have to divide by 10,000.

Challenge 2

Air pollution is typically presented as a numerical Air Quality Index (AQI). The AQI is a piecewise linear function, or a function that can vary for given ranges of values. The AQI for the United States is as shown:

AQI	AQI
I_{low} - I_{high}	**Category**
0-50	Good
51-100	Moderate
101-150	Unhealthy for Sensitive Groups
151-200	Unhealthy
201-300	Very Unhealthy
301-400	Hazardous
401-500	

The equation to convert from concentration of an airborne pollutant to AQI is as follows:

$$AQI = \frac{I_{high} - I_{low}}{C_{high} - C_{low}} (C - C_{low}) + I_{low}$$

Where:

- AQI - the Air Quality Index for a given pollutant
- I_{high} – The index breakpoint for C_{high}
- I_{low} - the index breakpoint for C_{low}
- C_{high} – the concentration breakpoint that is ≥ C
- C_{low} – the concentration breakpoint that is ≤ C

The table of breakpoints from the EPA is:

O_3 (ppb)	**O_3 (ppb)**	**$PM_{2.5}$ ($\mu g/m^3$)**	**PM_{10} ($\mu g/m^3$)**	**CO (ppm)**	**SO_2 (ppb)**	**NO_2 (ppb)**	**AQI**	**AQI**
C_{low} - C_{high} *(avg)*	C_{low} - C_{high} *(avg)*	C_{low}- C_{high} *(avg)*	C_{low} - C_{high} *(avg)*	C_{low} - C_{high} *(avg)*	C_{low} - C_{high} *(avg)*	C_{low} - C_{high} *(avg)*	I_{low} - I_{high}	**Category**
0-54 (8-hr)	-	0.0-12.0 (24-hr)	0-54 (24-hr)	0.0-4.4 (8-hr)	0-35 (1-hr)	0-53 (1-hr)	0-50	Good
55-70 (8-hr)	-	12.1-35.4 (24-hr)	55-154 (24-hr)	4.5-9.4 (8-hr)	36-75 (1-hr)	54-100 (1-hr)	51-100	Moderate
71-85 (8-hr)	125-164 (1-hr)	35.5-55.4 (24-hr)	155-254 (24-hr)	9.5-12.4 (8-hr)	76-185 (1-hr)	101-360 (1-hr)	101-150	Unhealthy for Sensitive Groups
86-105 (8-hr)	165-204 (1-hr)	55.5-150.4 (24-hr)	255-354 (24-hr)	12.5-15.4 (8-hr)	186-304 (1-hr)	361-649 (1-hr)	151-200	Unhealthy
106-200 (8-hr)	205-404 (1-hr)	150.5-250.4 (24-hr)	355-424 (24-hr)	15.5-30.4 (8-hr)	305-604 (24-hr)	650-1249 (1-hr)	201-300	Very Unhealthy
-	405-504 (1-hr)	250.5-350.4 (24-hr)	425-504 (24-hr)	30.5-40.4 (8-hr)	605-804 (24-hr)	1250-1649 (1-hr)	301-400	Hazardous
-	505-604 (1-hr)	350.5-500.4 (24-hr)	505-604 (24-hr)	40.5-50.4 (8-hr)	805-1004 (24-hr)	1650-2049 (1-hr)	401-500	

Math challenge question

Calculate the AQI for a city with a measured 8-hour carbon monoxide concentration of 19.2 ppm. What AQI based level of health concerns should be reported?

Solution: AQI = [(300-201)/(30.4-15.5)] (19.2-15.5) + 201 = 225.58