

TEAMS Monthly Middle School Math Challenge, November 2016

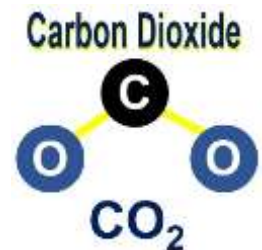
Directions: Copy and distribute to your students. Coaches may e-mail their student's answers to teams@tsaweb.org --subject line: MS Math Challenge. Make sure to include the student's name, your name, your school, city and state. Correct entries for that month will be placed in a drawing and one name 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 changed from 353 parts-per-million (ppm) in 1990 to 379 ppm in 2005.



Math challenge question

What was the rate change of carbon dioxide (in ppm per year) observed between these two points in time?

Solution:

$$\text{Rate of Change } CO_2 = \frac{[CO_2]_{2005} - [CO_2]_{1990}}{2005 - 1990}$$

Where:

$[CO_2]_{2005}$ = carbon dioxide concentration in 2005 = 378 ppm

$[CO_2]_{1990}$ = carbon dioxide concentration in 1990 = 353 ppm

$$\text{Rate of Change } CO_2 = \frac{378 \text{ ppm} - 353 \text{ ppm}}{2005 - 1990}$$

$$\text{Rate of Change } CO_2 = 1.67 \text{ ppm/year}$$

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 $\geq C$
- C_{low} – the concentration breakpoint that is $\leq C$

The table of breakpoints from the EPA is:

O ₃ (ppb)	O ₃ (ppb)	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/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 3.24 ppm. What AQI based level of health concerns should be reported?

Solution: $AQI = [(50 - 0)/(4.4 - 0)] (3.24 - 0) + 0 = 36$ – in the 'good' range