SARSEF 2025-2026 Lab Notebook

Brainstorm Topics

Medicine

- ☐ Tylenol vs Advil effectiveness
- ☑ ~~Phlyem analysis~~
- ☑ ~~Allergies what determines different reaction severity for same stimulant~~
- ☐ Wet hair relation to sickness and immune system

Environment

- ☑ ~~Fireworks and alternatives~~
- ☐ Risks related with different cooking methods (ex. Fry, boil, bake, …)
- ☐ Exposure risks
- ☑ ~~Develop something to measure microplastics~~

Animal

- ☑ ~~Analyze effective ness of different bonding methods4j8u 8890~~
- ☑ ~~Test animal vs human disease capabilities (why some only affect one r he other)~~
- ☑ ~~Find a system to know an animal's thoughts or if they are "lying"~~

Tylenol vs Advil	Wet hair study	Exposure risks	Cooking methods
Limitations: Its a chemical analysis that would require lab environment	LImitations: Difficult o set up a testable experiment without violating ethical principles	Limitations: Would be observational and might not be the most accurate	Limitations: Needs access to electrical testing equipment

Potential Question

1. How does distance from an active smoker affect $PM_{2.5}$ and PM_{10} concentrations over time in real-world environments?
2. How quickly do airborne particulate concentrations decrease after smoking stops at varying distances from the source?
3. What is the relationship between distance and secondhand smoke particle concentration under outdoor conditions?
4. How do environmental factors (wind speed, humidity, temperature, pressure) influence secondhand smoke particulate matter dispersion?
5. Does wind speed significantly alter the decay rate (λ) of smoke particle concentration?
6. Which factor has the greatest effect on secondhand smoke exposure: distance, time after exposure, or environmental conditions?
7. Is time after exposure or distance more effective at reducing secondhand smoke exposure?
8. Do $PM_{2.5}$ and PM_{10} concentrations disperse at different rates in outdoor environments?
9. At what distance and time does secondhand smoke exposure fall below typical background levels?
10. Are short-duration exposures to secondhand smoke sufficient to elevate particulate concentrations above baseline air quality?

Potential Research Method

1. Before each observation begins, I will wear a K53 mask and use a measuring tape to establish fixed distances from the smoker.

2. During active smoking, air quality measurements will be recorded at each marked distance (10-yard markings up to 30 yards) every 5 minutes over 30 minutes using a Temtop indoor air quality monitor.

2 Recorded measurements will include PM2.5, PM10, AQI, total volatile organic compounds (tVOC), formaldehyde (HCHO), temperature, and humidity.

3. Once the participant finishes smoking, an initial post-exposure air quality measurement will be taken at the same location.

4. Additional measurements will then be recorded every 10 minutes from the same position to observe changes in air quality over time after exposure.

5. Throughout the observation period, environmental factors, wind, and initial air quality will be recorded

6. After completing each observation session, I will remove the K53 mask by handling only the straps and avoiding contact with the front of the mask. The mask will be placed directly into a designated trash bag or container.

7. After each observation session, the exterior of the Temtop air quality monitor will be disinfected using alcohol wipes or an approved disinfectant. Special care will be taken to avoid liquid contact with sensors, ports, or electronic openings. The device will be allowed to air dry completely before being stored or reused.

8. After mask removal and equipment handling, I will wash my hands thoroughly with soap and water for at least 20 seconds. If soap and water are not immediately available, hand sanitizer will

be used until proper hand washing can be performed. Hand hygiene will be completed before leaving the observation area.

Materials Needed

- ☐ Temtop Indoor Air Quality Monitor (LKC 1000S+ 2nd) to measure PM2.5, PM10, AQI, formaldehyde (HCHO), total volatile organic compounds (tVOC), temperature, and humidity
- ☐ K53 mask worn throughout data collection for personal protection
- ☐ Measuring tape or pre-measured distance markers
- ☐ Stopwatch or phone timer
- ☑ ~~Data recording sheet or laptop with data export software~~
- ☑ ~~Participant consent forms~~
- ☐ Notebook for recording observations (location, ventilation, weather conditions)
- ☐ Disinfectant Wipes
- ☑ ~~Hand sanitizer~~

Final Procedure

1. Before each observation begins, I will wear a N95 mask and use a measuring tape to establish fixed distances from the smoker.

2. During active smoking, air quality measurements will be recorded at each marked distance (1.5 m markings up to 9m) every 5 minutes over 25 minutes using a Temtop indoor air quality monitor.

2 Recorded measurements will include PM2.5, PM10, AQI, total volatile organic compounds (tVOC), formaldehyde (HCHO), temperature, and humidity.

3. Once the participant finishes smoking, an post-exposure air quality measurement will be taken after 10 minutes at the same location.

4. Before and after the observation [[eriod, environmental factors will be recorded

5. After completing each observation session, I will remove the N95 mask by handling only the straps and avoiding contact with the front of the mask. The mask will be placed directly into a designated trash bag or container.

7. After each observation session, the exterior of the Temtop air quality monitor will be disinfected using alcohol wipes. Special care will be taken to avoid liquid contact with sensors, ports, or electronic openings. The device will be allowed to air dry completely before being stored or reused.

8. After mask removal and equipment handling, I will wash my hands thoroughly with soap and water for at least 20 seconds. If soap and water are not immediately available, hand sanitizer will be used until proper hand washing can be performed. Hand hygiene will be completed before leaving the observation area.

Data

Trial 1

Initial Conditions

Wind: 10 mph = 4.4704m/s

Temperature 62°F = 289.817 K

Humidity: 29%

Pressure: 28.82 inHg = 0.9632 atm

PM2.5 = 0.1 ug/m^3

PM10 = 0.02 ug/m^3

Particles/L = 24 per/L

HCHO: 0.01 mg/m^3

TVOC: 0.02mg/m^3

AQI: 1

Unadjusted Data at different times

5 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	0.7	0.3	0.1	0.1	0.2	0.0
PM 10 (ug/m^3)	0.7	0.5	0.2	0.3	0.3	0.2
Particles (per/L)	210	173	47	47	45	46
HCHO (mg/m^3)	0.02	0.02	0.02	0.01	0.02	0.01
TVOC (mg/m^3)	0.03	0.01	0.01	0.01	0.01	0.01
AQI (device)	7	11	4	5	5	3

Did they exhale during measurement? No

If so, in what direction (assume you are measuring from the “south”): N/A

10 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.6	0.4	0.3	1.7	0.8	0.6
PM 10 (ug/m^3)	2.5	0.5	0.6	3.3	0.9	1.1
Particles (per/L)	335	121	85	369	232	109
HCHO (mg/m^3)	0.01	0.01	0.01	0.01	0.02	0.01
TVOC (mg/m^3)	0.02	0.02	0.01	0.02	0.03	0.02
AQI (device)	7	2	1	7	6	3

Did they exhale during measurement? Yes, in the middle of measuring

If so, in what direction (assume you are measuring from the “south”): East

15 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	18.5	8.7	3.5	2.7	1.3	1.1
PM 10 (ug/m^3)	21.1	13.1	5.7	4.9	4.6	2.1
Particles (per/L)	6730	1164	584	504	366	202
HCHO (mg/m^3)	0.01	0.01	0.01	0.01	0.02	0.01
TVOC (mg/m^3)	0.03	0.03	0.02	0.03	0.01	0.02
AQI (device)	154	132	14	11	7	4

Did they exhale during measurement? Yes, at the beginning

If so, in what direction (assume you are measuring from the “south”): Southwest

20 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	60.1	38.1	4.7	1.4	2.5	2.3
PM 10 (ug/m^3)	101	73.3	9.5	3.5	4.6	4.5
Particles (per/L)	9860	1292	933	421	490	360
HCHO (mg/m^3)	0.02	0.01	0.02	0.01	0.01	0.01
TVOC (mg/m^3)	0.04	0.01	0.04	0.02	0.03	0.02
AQI (device)	135	28	19	20	11	11

Did they exhale during measurement? Once at the start and once at the end

If so, in what direction (assume you are measuring from the “south”): 1st - southwest 2nd - north

25 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.0	2.2	0.8	1.9	25.5	15.0
PM 10 (ug/m^3)	1.7	3.0	1.6	3.2	59.2	22.4
Particles (per/L)	148	377	231	275	5180	2026
HCHO (mg/m^3)	0.01	0.01	0.01	0.01	0.04	0.01
TVOC (mg/m^3)	0.03	0.04	0.02	0.03	0.04	0.03
AQI (device)	4	9	3	4	109	57

Did they exhale during measurement? Yes, at the end

If so, in what direction (assume you are measuring from the “south”): South

<u>10-minute Post-Smoking Conditions</u>

Wind: 8 mph = 3.576m/s

Temperature 65.7°F = 291.872 K

Humidity: 33%

Pressure: 28.82 inHg = 0.9632 atm

PM2.5 = 1.7 ug/m^3

PM10 = 5.6 ug/m^3

Particles/L = 180 per/L

HCHO: 0.01 mg/m^3

TVOC: 0.02mg/m^3

AQI: 5

Adjusting PM 2.5

$$PM_{corrected} = \frac{PM_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$PM_{2.5_Trial1_corrected} = PM_{measured} \bullet \frac{(1\ atm)(289.82\ K)(1 + 0.1\ s/m(4.4704 m/s))}{(1 + 0.25(0.29)^2)(0.9632\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.431$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 0.4 ug/m^3

C(2) = 0.4 ug/m^3

C(3) = 0.3 ug/m^3

C(4) = 0.1 ug/m^3

$$\lambda_1 = -\frac{1}{30s} ln(\frac{0.4\ ug/m^3}{0.4\ ug/m^3}) = 0\ s^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{0.3\ ug/m^3}{0.4\ ug/m^3}) = 0.01 s^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{0.1\ ug/m^3}{0.3\ ug/m^3}) = 0.04\ s^{-1}$$

$$\lambda_{avg} = \frac{(0s^{-1}) + (0.01s^{-1}) + (0.04s^{-1})}{3} = 0.02\ s^{-1}$$

$$\mathrm{PM}_{2.5_Trial1_corrected} = PM_{measured} \bullet e^{0.02s^{-1}t} \bullet 1.431$$

Adjusting PM 10

$$\mathrm{PM}_{corrected} = \frac{PM_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\mathrm{PM}_{10_Trial1_corrected} = PM_{measured} \bullet \frac{(1\ atm)(289.82\ K)(1 + 0.07\ s/m(4.4704 m/s))}{(1 + 0.1(0.29)^{1.3})(0.9632\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.2998$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 0.4 ug/m^3

C(2) = 0.2 ug/m^3

C(3) = 0. 2 ug/m^3

C(4) = 0.2 ug/m^3

$$\lambda_1 = -\frac{1}{30s} ln(\frac{0.2\ ug/m^3}{0.4\ ug/m^3}) = 0.0231 s^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{0.2\ ug/m^3}{0.2\ ug/m^3}) = 0 s^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{0.2\ ug/m^3}{0.2\ ug/m^3}) = 0 s^{-1}$$

$$\lambda_{avg} = \frac{(0.0231s^{-1}) + (0s^{-1}) + (0s^{-1})}{3} = 0.008\text{s}^{-1}$$

$$\text{PM}_{10_\text{Trial1_corrected}} = PM_{measured} \bullet e^{0.008s^{-1}t} \bullet 1.2998$$

Adjusting Particles/L

$$\text{Particles/L}_{\text{corrected}} = \frac{Particles/L_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\text{Particles/L}_{\text{_Trial1_corrected}} = PM_{measured} \bullet \frac{(1\ atm)(289.82\ K)(1 + 0.02\ s/m(4.4704m/s))}{(1 + 0.15(0.29)^{1.5})(0.9632\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.075$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 29

C(2) = 26

C(3) = 26

C(4) = 24

$$\lambda_1 = -\frac{1}{30s} ln(\frac{26\ Particles/L}{29\ Particles/L}) = 0.0036\ \text{s}^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{26\ Particles/L}{26\ Particles/L}) = 0\text{s}^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{24\ Particles/L}{26\ Particles/L}) = 0.0027\ \text{s}^{-1}$$

$$\lambda_{avg} = \frac{(0.0036s^{-1}) + (0.01s^{-1}) + (0.0027s^{-1})}{3} = 0.002\ s^{-1}$$

$$PM_{Particles/L_Trial1_corrected} = PM_{measured} \bullet e^{0.002s^{-1}t} \bullet 1.075$$

Adjusting AQI

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

PM10 (µg/m^3)	PM2.5 (µg/m^3)	AQI	Category
0–54	0–15.4	0–50	Good
55–154	15.5–40.4	51–100	Moderate
155–254	40.5–65.4	101–150	Unhealthy for sensitive groups
255–354	65.5–150.4	151–200	Unhealthy
355–424	150.5–250.4	201–300	Very unhealthy
425–504	250.5–350.4	301–400	Hazardous
505–604	350.5–500.4	401–500	

Adjusted Data at Different Times

5 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.002	0.782	0.475	0.866	3.154	0
PM 10 (ug/m^3)	0.9098	0.826	0.420	0.801	1.02	0.863
Particles (per/L)	225.96	197.659	57.0198	60.546	61.554	66.813
AQI	4	3	2	4	13	0

10 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	2.2896	1.043	1.425	14.717	12.619	17.245
PM 10 (ug/m^3)	3.2495	0.826	1.260	8.812	3.055	4.747
Particles (per/L)	360.46	138.247	103.121	475.348	317.344	158.317
AQI	10	4	6	56	51	62

15 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	26.474	22.685	16.629	23.274	20.506	31.617
PM 10 (ug/m^3)	27.426	21.646	11.973	13.085	15.616	9.063
Particles (per/L)	7241.48	1329.912	708.501	649.256	500.638	293.395
AQI	81	73	60	74	68	92

20 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	86.003	99.344	22.330	12.1198	39.435	66.108
PM 10 (ug/m^3)	131.2798	120.623	19.955	9.346	15.616	19.4196
Particles (per/L)	10609.36	1476.157	1131.903	542.335	670.253	522.881
AQI	167	173	73	52	110	156

25 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.431	5.736	3.801	16.448	402.241	431.136
PM 10 (ug/m^3)	2.2096	4.957	3.361	8.545	200.965	96.667
Particles (per/L)	159.248	430.736	280.246	354.257	7085.536	2942.6598
AQI	8	32	21	60	435	454

<u>10-minute Post-Smoking Conditions</u>

Wind: 8 mph = 3.576m/s

Temperature 65.7°F = 291.872 K

Humidity: 33%

Pressure: 28.82 inHg = 0.9632 atm

PM2.5 = 2.284 ug/m^3

PM10 = 6.953 ug/m^3

Particles/L = 190.681 per/L

AQI: 9

Trial 2

Initial Conditions

Wind: 9 mph = 4.023 m/s

Temperature: 74.5°F = 290.706 K

Humidity: 37.3%

Pressure: 29.98 inHg = 1.002atm

PM2.5 = 0.5 ug/m^3

PM10 = 0.8 ug/m^3

Particles/L = 148 per/L

AQI: 2

HCHO: 0.02 mg/m^3

TVOC: 0.02 mg/m^3

5 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.5	2.3	2.8	1.0	1.4	1.2
PM 10 (ug/m^3)	14.5	36.1	4.7	1.9	2.5	2.4
Particles (per/L)	2549	361	482	274	260	212
HCHO (mg/m^3)	0.01	0.01	0.01	0.01	0.01	0.01
TVOC (mg/m^3)	0.01	0.01	0.01	0.01	0.02	0.02
AQI (device)	31	9	11	4	5	5

Did they exhale during measurement? Multiple times throughout measurement

If so, in what direction (assume you are measuring from the “south”): North

10 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	89.8	68.3	55.3	47.4	7.5	8.4
PM 10 (ug/m^3)	153.6	103.7	100.0	89.4	9.6	15.5
Particles (per/L)	13443	9130	8131	6379	344	1332
HCHO (mg/m^3)	0.01	0.02	0.02	0.02	0.01	0.02
TVOC (mg/m^3)	0.02	0.02	0.01	0.02	0.01	0.02
AQI (device)	124	160	143	101	6	35

Did they exhale during measurement? Yes, at the beginning and then at the end

If so, in what direction (assume you are measuring from the “south”): 1st - south 2nd - Northeast

15 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	15.6	4.7	4.6	2.1	1.7	2.2
PM 10 (ug/m^3)	26.7	23.1	14.0	5.7	3.1	4.0
Particles (per/L)	2448	903	583	540	394	397
HCHO (mg/m^3)	0.01	0.01	0.01	0.01	0.01	0.01
TVOC (mg/m^3)	0.03	0.04	0.06	0.01	0.02	0.04
AQI (device)	58	22	14	8	7	9

Did they exhale during measurement? Yes, at end

If so, in what direction (assume you are measuring from the “south”): Northeast

20 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	102.0	80	43.6	8.4	7.8	5.7
PM 10 (ug/m^3)	154.3	108	102.4	14.8	10.8	9.6
Particles (per/L)	8003	6328	8526	1031	946	801
HCHO (mg/m^3)	0.02	0.03	0.01	0.02	0.02	0.01
TVOC (mg/m^3)	0.02	0.01	0.02	0.02	0.04	0.03
AQI (device)	131	124	372	41	36	24

Did they exhale during measurement? Yes, before

If so, in what direction (assume you are measuring from the “south”): Southeast

25 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	5.6	4.0	5.5	2.4	2.7	2.3
PM 10 (ug/m^3)	8.4	7.5	9.4	5.5	4.2	4.1
Particles (per/L)	1632	942	952	601	452	412
HCHO (mg/m^3)	0.01	0.02	0.01	0.02	0.01	0.01
TVOC (mg/m^3)	0.04	0.05	0.02	0.02	0.03	0.03
AQI (device)	34	16	30	14	8	10

Did they exhale during measurement? In the middle

If so, in what direction (assume you are measuring from the “south”): southwest

<u>10-minute Post-Smoking Conditions</u>

Wind: 9 mph = 4.023 m/s

Temperature: 72.10 °F = 295.428 K

Humidity: 43.2 %

Pressure: 29.94 inHg = 1.001 atm

PM2.5 = 1.9 ug/m^3

PM10 = 3.2 ug/m^3

Particles/L = 325 per/L

AQI: 7

HCHO: 0.02 mg/m^3

TVOC: 0.04 mg/m^3

Adjusting PM 2.5

$$\mathrm{PM}_{\text{corrected}} = \frac{PM_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\mathrm{PM}_{2.5_Trial2_corrected} = PM_{measured} \bullet \frac{(1\ atm)(290.706\ K)(1 + 0.1\ s/m(4.023 m/s))}{(1 + 0.25(0.373)^2)(1.002\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.319$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 1.8 ug/m^3

C(2) = 0.6 ug/m^3

C(3) = 0.6 ug/m^3

C(4) = 0.5 ug/m^3

$$\lambda_1 = -\frac{1}{30s} ln(\frac{0.6\ ug/m^3}{1.8\ ug/m^3}) = 0.04 s^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{0.6\ ug/m^3}{0.6\ ug/m^3}) = 0 s^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{0.5\ ug/m^3}{0.6\ ug/m^3}) = 0.01\ s^{-1}$$

$$\lambda_{avg} = \frac{(0.04^{-1}) + (0s^{-1}) + (0.01\ s^{-1})}{3} = 0.02\ s^{-1}$$

$$\mathrm{PM}_{2.5_Trial2_corrected} = PM_{measured} \bullet e^{0.02s^{-1}t} \bullet 1.319$$

Adjusting PM 10

$$\mathrm{PM}_{corrected} = \frac{PM_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\mathrm{PM}_{10_Trial2_corrected} = PM_{measured} \bullet \frac{(1\ atm)(290.706\ K)(1 + 0.07\ s/m(4.023m/s))}{(1 + 0.1(0.373)^{1.3})(1.002\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.214$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 1.0 ug/m^3

C(2) = 1.0 ug/m^3

C(3) = 0. 9 ug/m^3

C(4) = 0.8 ug/m^3

$$\lambda_1 = -\frac{1}{30s} ln(\frac{1.0\ ug/m^3}{1.0\ ug/m^3}) = 0s^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{0.9\ ug/m^3}{1.0\ ug/m^3}) = 0.004^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{0.8\ ug/m^3}{0.9\ ug/m^3}) = 0.004s^{-1}$$

$$\lambda_{avg} = \frac{(0s^{-1}) + (0.004s^{-1}) + (0.004s^{-1})}{3} = 0.003\text{s}^{-1}$$

$$\text{PM}_{10_\text{Trial2_corrected}} = PM_{measured} \bullet e^{0.003s^{-1}t} \bullet 1.214$$

Adjusting Particles/L

$$\text{Particles/L}_{\text{corrected}} = \frac{Particles/L_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\text{Particles/L}_{\text{_Trial2_corrected}} = PM_{measured} \bullet \frac{(1\ atm)(290.706\ K)(1 + 0.02\ s/m(4.023m/s))}{(1 + 0.15(0.373)^{1.5}(1.002\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.017$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 210

C(2) = 173

C(3) = 159

C(4) = 148

$$\lambda_1 = -\frac{1}{30s} ln(\frac{173\ Particles/L}{210\ Particles/L}) = 0.01\ \text{s}^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{159\ Particles/L}{173 Particles/L}) = 0.003\text{s}^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{148\ Particles/L}{159\ Particles/L}) = 0.002\ \text{s}^{-1}$$

$$\lambda_{avg} = \frac{(0.01s^{-1}) + (0.003s^{-1}) + (0.002s^{-1})}{3} = 0.005\ s^{-1}$$

$$PM_{Particles/L_Trial2_corrected} = PM_{measured} \bullet e^{0.005t} \bullet 1.017$$

Adjusting AQI

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

PM10 (µg/m^3)	PM2.5 (µg/m^3)	AQI	Category
0–54	0–15.4	0–50	Good
55–154	15.5–40.4	51–100	Moderate
155–254	40.5–65.4	101–150	Unhealthy for sensitive groups
255–354	65.5–150.4	151–200	Unhealthy
355–424	150.5–250.4	201–300	Very unhealthy
425–504	250.5–350.4	301–400	Hazardous
505–604	350.5–500.4	401–500	

Adjusted Data at Different Times

5 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.979	5.528	12.262	7.979	20.355	31.791
PM 10 (ug/m^3)	17.603	47.953	6.831	3.022	4.35	4.569
Particles (per/L)	2592.333	426.552	661.693	437.023	481.805	456.434
AQI	10	23	52	34	68	45

10 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	118.446	164.15	242.172	398.227	109.047	222.5397
PM 10 (ug/m^3)	186.470	137.748	145.342	142.173	15.661	19.511
Particles (per/L)	13671.531	10787.875	11162.289	10174.336	637.465	2867.781
AQI	183	214	315	439	178	298

15 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	20.576	11.296	20.144	16.757	24.717	58.284
PM 10 (ug/m^3)	32.414	30.684	20.348	9.065	5.394	7.616
Particles (per/L)	2489.616	1066.972	800.346	861.286	730.119	854.737
AQI	69	51	68	60	78	154

20 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	134.538	192.2699	190.935	67.028	113.409	151.009
PM 10 (ug/m^3)	187.32	143.459	148.83	23.536	18.793	18.278
Particles (per/L)	8139.051	6328	11704.547	1644.418	17753.028	1724.544
AQI	191	242	241	157	181	201

25 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	7.3864	9.613	24.0858	19.151	39.257	60.933
PM 10 (ug/m^3)	10.198	9.962	13.662	8.7466	7.308	7.806
Particles (per/L)	1659.744	1113.053	1306.912	958.579	837.599	887.035
AQI	31	40	77	66	110	154

<u>10-minute Post-Smoking Conditions</u>

Wind: 9 mph = 4.023 m/s

Temperature: 72.10 °F = 295.428 K

Humidity: 43.2 %

Pressure: 29.94 inHg = 1.001 atm

PM2.5 = 2.521 ug/m^3

PM10 = 3.9297 ug/m^3

Particles/L = 333.564 per/L

AQI: 11

Trial 3

Initial Conditions

Wind: 6 mph = 2.682 m/s

Temperature: 77°F = 298.15 K

Humidity: 30.4%

Pressure: 29.93 inHg = 1 atm

PM2.5 = 0.8 ug/m^3

PM10 = 0.7 ug/m^3

Particles/L = 108 per/L

AQI: 3

HCHO: 0.01 mg/m^3

TVOC: 0.01 mg/m^3

5 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	3.3	4.7	3.1	1.6	1.8	0.8
PM 10 (ug/m^3)	6	6.7	4.2	2.0	3.3	1.9
Particles (per/L)	515	637	445	505	325	210
HCHO (mg/m^3)	0.01	0.02	0.02	0.01	0.01	0.02
TVOC (mg/m^3)	0.05	0.03	0.03	0.03	0.04	0.02
AQI (device)	6	7	7	10	7	8

Did they exhale during measurement? No

If so, in what direction (assume you are measuring from the "south"):

10 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.7	4.7	90.5	30.7	26.1	13.7
PM 10 (ug/m^3)	2.5	7.8	177.2	44.1	56.2	25.1
Particles (per/L)	330	798	150829	9967	4449	1920
HCHO (mg/m^3)	0.02	0.01	0.02	0.02	0.02	0.01
TVOC (mg/m^3)	0.02	0.02	0.04	0.03	0.01	0.02
AQI (device)	22	25	176	109	68	46

Did they exhale during measurement? Yes in the middle

If so, in what direction (assume you are measuring from the "south"): Southwest

15 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.2	1.0	0.8	0.3	2.1	2.5
PM 10 (ug/m^3)	2.0	1.9	1.9	0.8	23.6	13.2
Particles (per/L)	210	195	190	176	360	287
HCHO (mg/m^3)	0.01	0.01	0.02	0.02	0.02	0.01
TVOC (mg/m^3)	0.02	0.01	0.03	0.02	0.03	0.01
AQI (device)	4	4	3	5	24	16

Did they exhale during measurement? Yes, near the end

If so, in what direction (assume you are measuring from the “south”): North

20 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	9.7	95.4	72.1	54.4	12.3	2.9
PM 10 (ug/m^3)	13.4	158.6	79.9	68.9	33.6	4.6
Particles (per/L)	460	12869	8792	1164	489	169
HCHO (mg/m^3)	0.01	0.02	001	0.03	0.02	0.02
TVOC (mg/m^3)	0.03	0.03	0.02	0.01	0.02	0.01
AQI (device)	24	139	88	53	11	7

Did they exhale during measurement? Yes, near the beginning

If so, in what direction (assume you are measuring from the “south”): South

25 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	9.8	0.9	12.3	2.9	4.5	20.9
PM 10 (ug/m^3)	17.4	18.9	20.5	15.4	23.3	56.3
Particles (per/L)	354	346	240	251	390	6890
HCHO (mg/m^3)	0.02	0.01	0.02	0.02	0.01	0.01
TVOC (mg/m^3)	0.02	0.03	0.04	0.01	0.01	0.02
AQI (device)	13	6	8	7	3	98

Did they exhale during measurement? Yes, at the end

If so, in what direction (assume you are measuring from the “south”): East

<u>10-minute Post-Smoking Conditions</u>

Wind: 9 mph = 4.023 m/s

Temperature: 78.1 °F = 298.76

Humidity: 31.4%

Pressure: 29.91 inHg = 0.9996 atm

PM2.5 = 0.9 ug/m^3

PM10 = 2.6 ug/m^3

Particles/L = 245 per/L

AQI: 5

HCHO: 0.02 mg/m^3

TVOC: 0,01 mg/m^3

Adjusting PM 2.5

$$\mathrm{PM}_{\text{corrected}} = \frac{PM_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\mathrm{PM}_{2.5_Trial3_corrected} = PM_{measured} \bullet \frac{(1\ atm)(298.15\ K)(1 + 0.1\ s/m(2.682\ m/s))}{(1 + 0.25(0.304)^2)(1\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.240$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 1.4 ug/m^3

C(2) = 1.2 ug/m^3

C(3) = 1.1 ug/m^3

C(4) = 0.9 ug/m^3

$$\lambda_1 = -\frac{1}{30s} ln(\frac{1.2\ ug/m^3}{1.4\ ug/m^3}) = 0.01\ s^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{1.1\ ug/m^3}{1.2\ ug/m^3}) = 0.003 s^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{0.9\ ug/m^3}{1.1\ ug/m^3}) = 0.01\ s^{-1}$$

$$\lambda_{avg} = \frac{(0 s^{-1}) + (0.01 s^{-1}) + (0.0366 s^{-1})}{3} = 0.01\ s^{-1}$$

$$\mathrm{PM}_{2.5_Trial3_corrected} = PM_{measured} \bullet e^{0.01s^{-1}t} \bullet 1.240$$

Adjusting PM 10

$$\mathrm{PM}_{corrected} = \frac{PM_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\mathrm{PM}_{10_Trial3_corrected} = PM_{measured} \bullet \frac{(1\ atm)(298.15\ K)(1 + 0.07\ s/m(2.682m/s))}{(1 + 0.1(0.304)^{1.3})(1\ atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.164$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 1.0 ug/m^3

C(2) = 0.9 ug/m^3

C(3) = 0. 7 ug/m^3

C(4) = 0.7 ug/m^3

$$\lambda_1 = -\frac{1}{30s} ln(\frac{0.9\ ug/m^3}{1.0\ ug/m^3}) = 0.004s^{-1}$$

$$\lambda_2 = -\frac{1}{30s} ln(\frac{0.7\ ug/m^3}{0.9\ ug/m^3}) = 0.008^{-1}$$

$$\lambda_3 = -\frac{1}{30s} ln(\frac{0.7\ ug/m^3}{0.7\ ug/m^3}) = 0s^{-1}$$

$\lambda_{avg} = \frac{(0.004s^{-1}) + (0.008s^{-1}) + (0s^{-1})}{3} = 0.004\text{s}^{-1}$

$$\text{PM}_{10_\text{Trial3_corrected}} = PM_{measured} \bullet e^{0.004t} \bullet 1.164$$

Adjusting Particles/L

$$\text{Particles/L}_{\text{corrected}} = \frac{Particles/L_{measured}}{1+\alpha(\frac{RH_{initial}}{100})^{\beta}} \bullet \frac{P_0}{P_{initial}} \bullet \frac{T_{initial}}{T_0} \bullet (1 + ku) \bullet e^{\lambda t}$$

$$\text{Particles/L}_{\text{_Trial3_corrected}} = PM_{measured} \bullet \frac{(1\ atm)(298.15\ K)(1 + 0.02\ s/m(2.682m/s))}{(1 + 0.15(0.304)^{1.5})(1atm)(298\ K)} \bullet e^{\lambda t}$$

$$= PM_{measured} \bullet e^{\lambda t} \bullet 1.028$$

Calculate λ

$$\lambda = -\frac{1}{\Delta t} ln(\frac{C_{final}}{C_{initial}})$$

Δt = 30 seconds

Measurements for λ (taken in 30-second intervals before experimentation)

C(1) = 136

C(2) = 118

C(3) = 110

C(4) = 108

$\lambda_1 = -\frac{1}{30s} ln(\frac{118\ Particles/L}{136\ Particles/L}) = 0.005\ \text{s}^{-1}$

$\lambda_2 = -\frac{1}{30s} ln(\frac{110 Particles/L}{11\ 8 Particles/L}) = 0.002\text{s}^{-1}$

$\lambda_3 = -\frac{1}{30s} ln(\frac{108\ Particles/L}{110\ Particles/L}) = 0.001\ \text{s}^{-1}$

$$\lambda_{avg} = \frac{(0.0036s^{-1}) + (0.01s^{-1}) + (0.0027s^{-1})}{3} = 0.003\ s^{-1}$$

$$PM_{Particles/L_Trial3_corrected} = PM_{measured} \bullet e^{0.003s^{-1}t} \bullet 1.028$$

Adjusting AQI

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

PM10 (μg/m³)	PM2.5 (μg/m³)	AQI	Category
0–54	0–15.4	0–50	Good
55–154	15.5–40.4	51–100	Moderate
155–254	40.5–65.4	101–150	Unhealthy for sensitive groups
255–354	65.5–150.4	151–200	Unhealthy
355–424	150.5–250.4	201–300	Very unhealthy
425–504	250.5–350.4	301–400	Hazardous
505–604	350.5–500.4	401–500	

Adjusted Data at Different Times

5 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	4.092	7.867	7.004	4.8799	7.411	4.446
PM 10 (ug/m^3)	6.984	8.793	6.215	3.337	6.208	4.0298
Particles (per/L)	529.42	716.505	547.679	680.055	478.875	338.567
AQI	17	33	29	20	31	19

10 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	2.108	7.867	204.478	93.632	107.452	76.135
PM 10 (ug/m^3)	2.91	10.237	262.209	73.576	105.718	53.236
Particles (per/L)	339.24	897	185631.2	13421.995	6555.435	3095.471
AQI	9	33	254	164	177	161

15 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	1.488	1.674	1.808	0.915	8.646	13.893
PM 10 (ug/m^3)	2.328	2.494	2.811	1.335	44.394	27.9996
Particles (per/L)	215.88	219.338	233.840	237.009	530.447	462.709
AQI	6	7	8	4	41	55

20 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	12.028	159.683	162.905	165.915	50.638	16.116
PM 10 (ug/m^3)	15.598	208.148	118.231	114.952	63.205	9.756
Particles (per/L)	472.88	14475.195	10820.661	1567.493	720.523	272.466
AQI	50	210	213	216	138	59

25 Minute Measurements

	1.5 m	3 m	4.5 m	6 m	7.5 m	9 m
PM 2.5 (ug/m^3)	12.152	1.506	2.033	37.514	18.526	116.147
PM 10 (ug/m^3)	20.254	24.804	30.335	25.693	43.8299	119.409
Particles (per/L)	363.912	276.704	295.377	338.008	574.650	11108.230
AQI	51	23	28	106	64	182

<u>10-minute Post-Smoking Conditions</u>

Wind: 9 mph = 4.023 m/s

Temperature: 78.1 °F = 298.76

Humidity: 31.4%

Pressure: 29.91 inHg = 0.9996 atm

PM2.5 = 1.235 ug/m^3

PM10 = 3.269 ug/m^3

Particles/L = 258.667 per/L

AQI: 5

Works Cited