Gas Chromatography

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ELEC 400: Design Methodology
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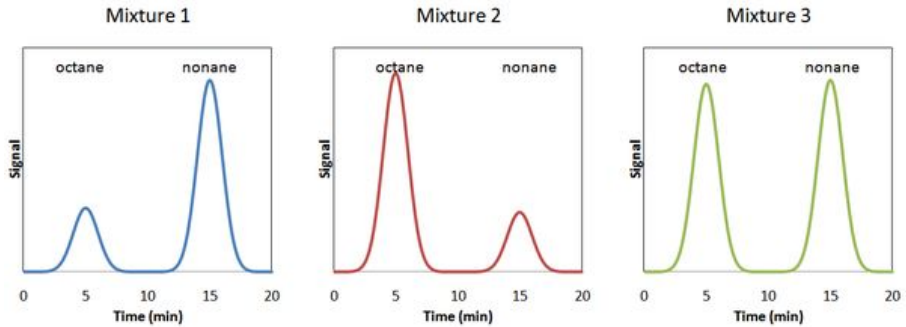
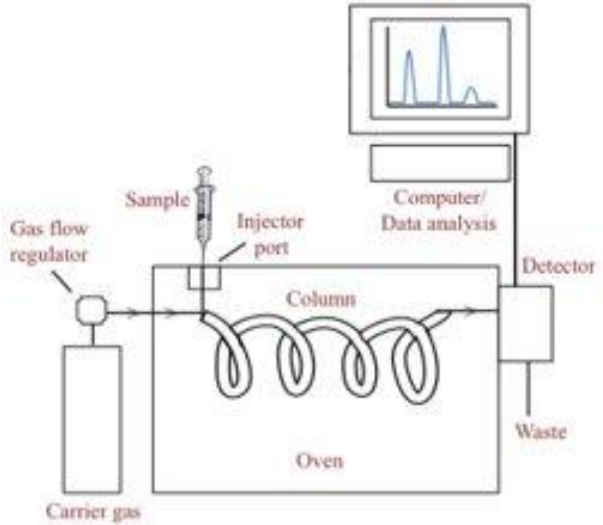
Overview

- **Problem Statement**
- **Objectives**
- **Investigation of Various Detectors**
  - Three Electronic (2 are TCD derivatives)
  - One Colorimetric
  - Two Configurations
- **Current Progress**
  - Prototype
  - Chromatograms
- **Development Plan**
- **References**

Gas Chromatography

- Qualitative and quantitative analysis of solutions with volatile components
- In lab, one delicate and expensive machine is operated by the TA





https://en.wikipedia.org/wiki/Response_factor

Objectives

- **Simple**: Student can operate
- **Accurate**: Detects impurities ≥ 5% of substance
- **Carrier gas**: Air > nitrogen > helium
- **Safe**
- **Durable and serviceable**: ≥ 2 weeks uptime / service
- **Economic**: ≤ $500/instrument
- **Documentation**

Materials

- Rhenium-tungsten
- Carbon-film resistor
- 1N4148 Diode

(1)

(2)

(3)

Carrier Gases

- Air (32 @ 125C)
- Nitrogen (32 @ 125C)
- Helium (190 @ 125C)

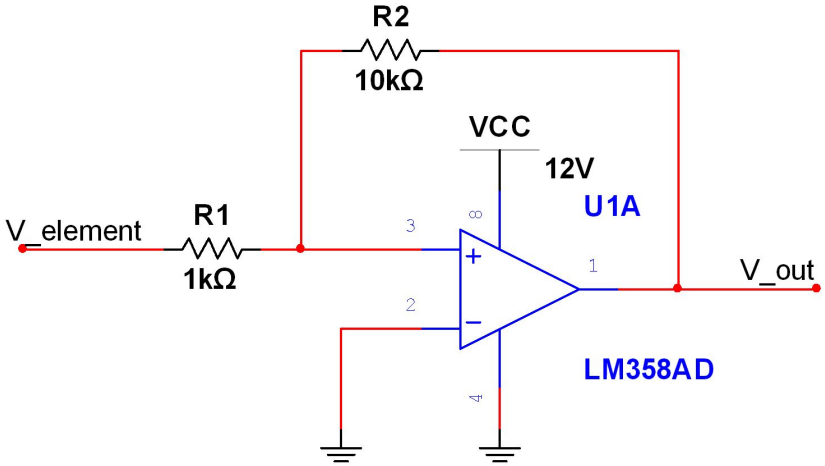
Compound	25°C	125°C	225°C
Acetone	11.5	20.2	30.6
Methane	34.2	49.1	66.5
Methanol	-	26.2	38.6
Ethanol	14.4	25.8	38.4
Hexane	-	23.4	35.4

Thermal Conductivity (mW/(m*K))

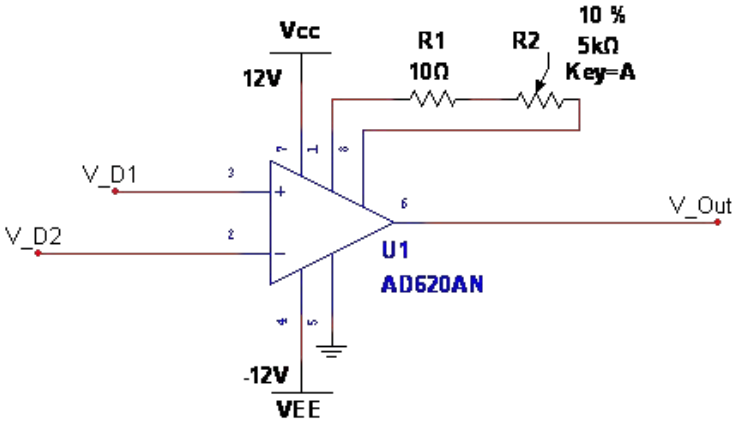
(1) https://www.bucksci.com/products/tcd-filament-tungsten-rhenium-includes-seal
(2) https://www.westfloridacomponents.com/G530APF08/2W+15K+ohm+Carbon+Film+Resistor+Paccom+RD200T.html
(3) https://www.digikey.com/product-detail/en/on-semiconductor/1N4148TR/1N4148FSCT-ND/9356376

Configurations

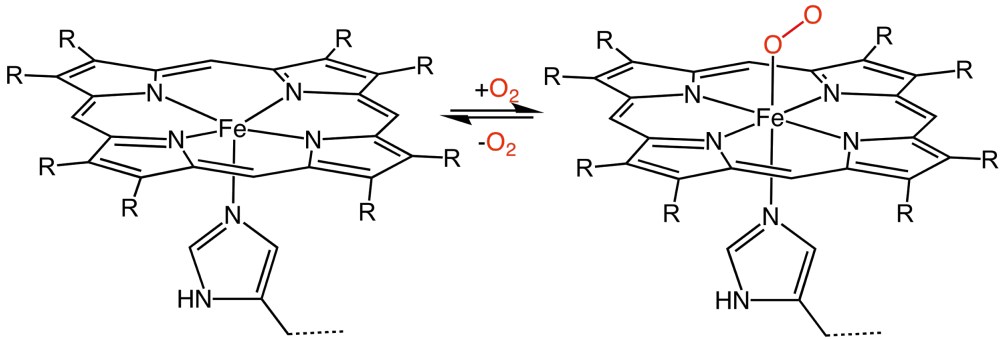
Single-ended



Differential



Colorimetric Array Detector

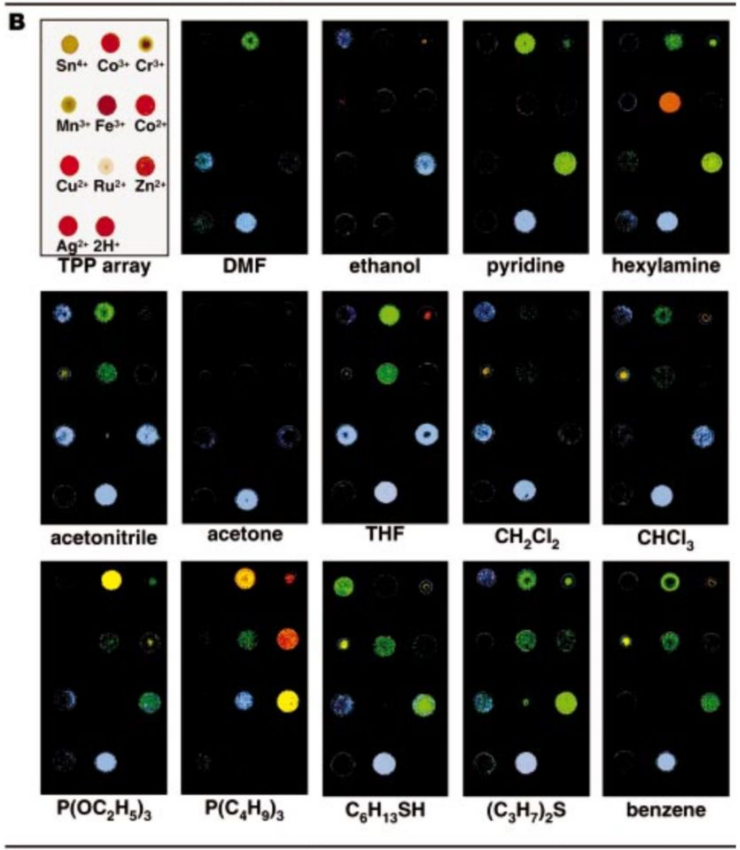


Deoxyhemoglobin

- Dark red
- Fe^{2+} oxidation state

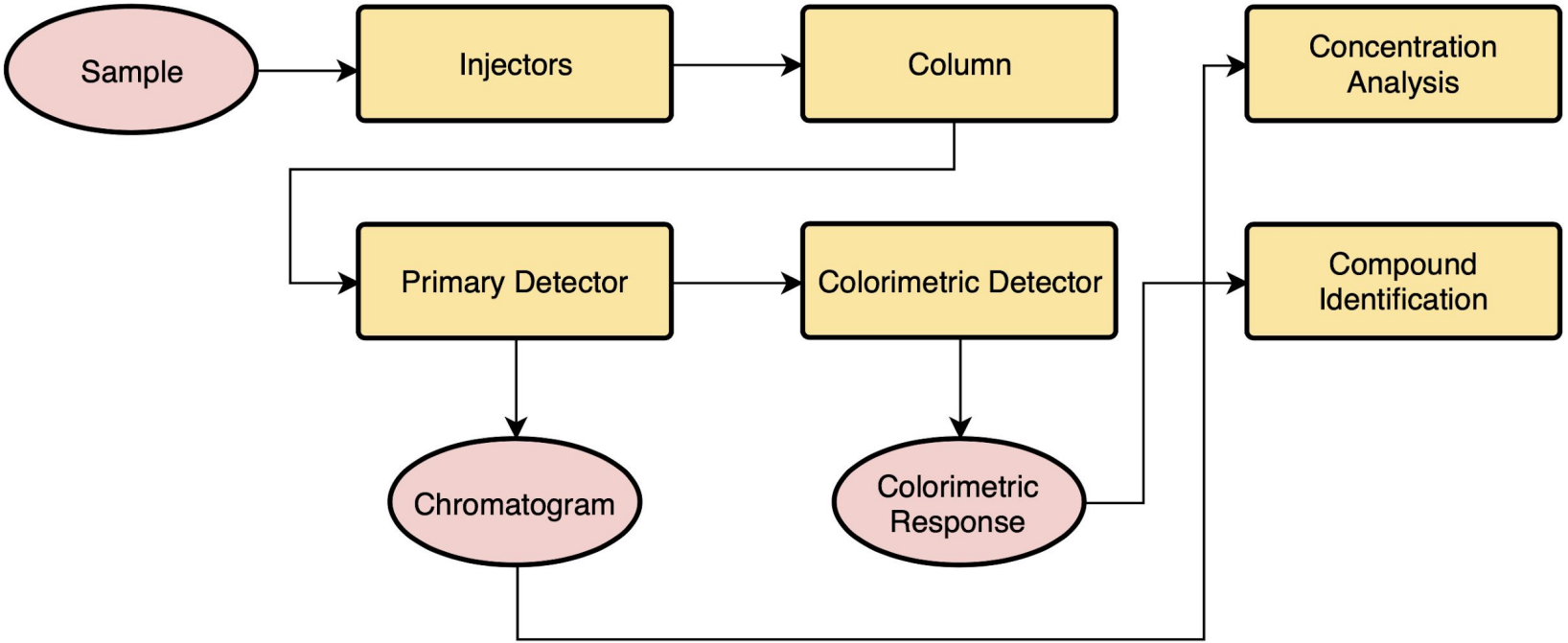
Oxyhemoglobin

- Bright red
- Fe^{3+} oxidation state
- Oxygen ligand



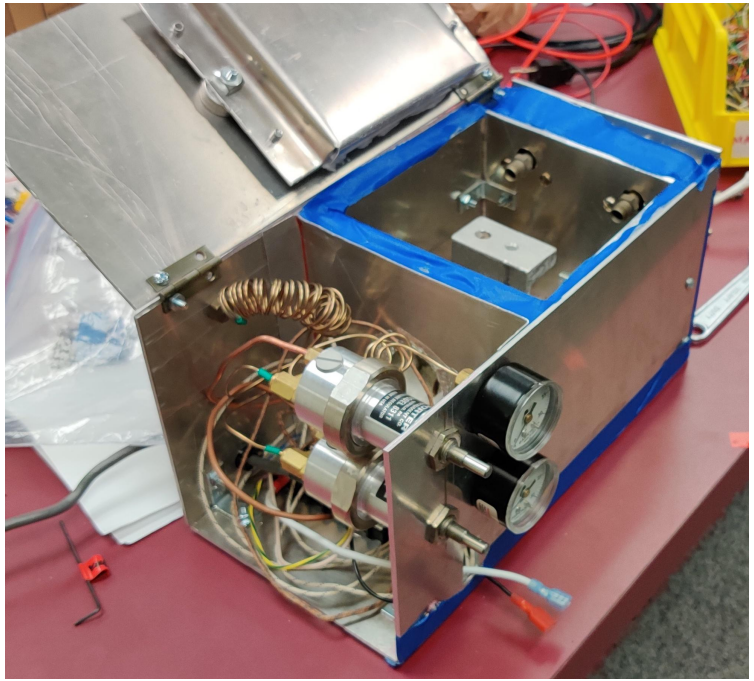
K. Rakow, N. & Suslick. A colorimetric sensor array for odour visualization. Nature, 406:710–713, August 2000.

System and Components



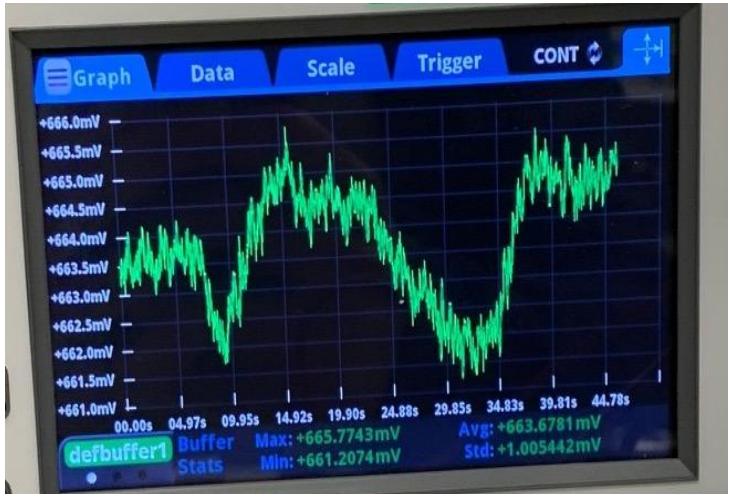
Current Prototype

- Original design and fabrication
- Functional
  - Heating
  - Insulation
  - Gas flow control
  - Configurable detector

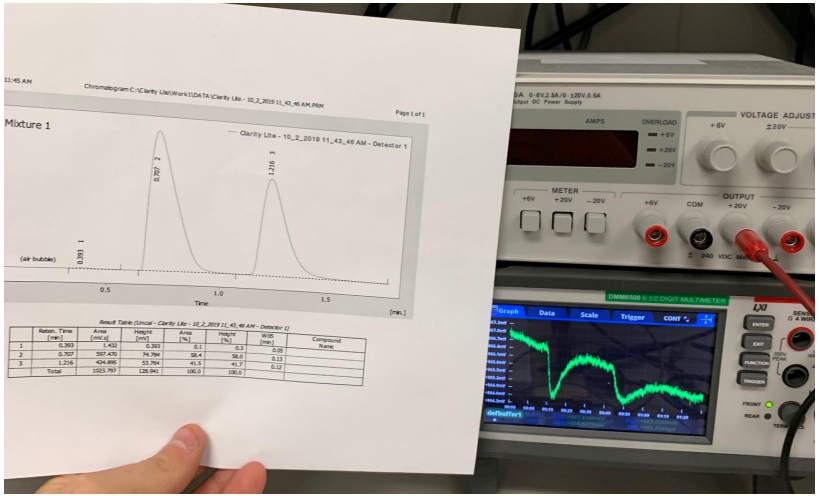


Current Chromatograms

Single Diode and Nitrogen



Single Diode and Helium

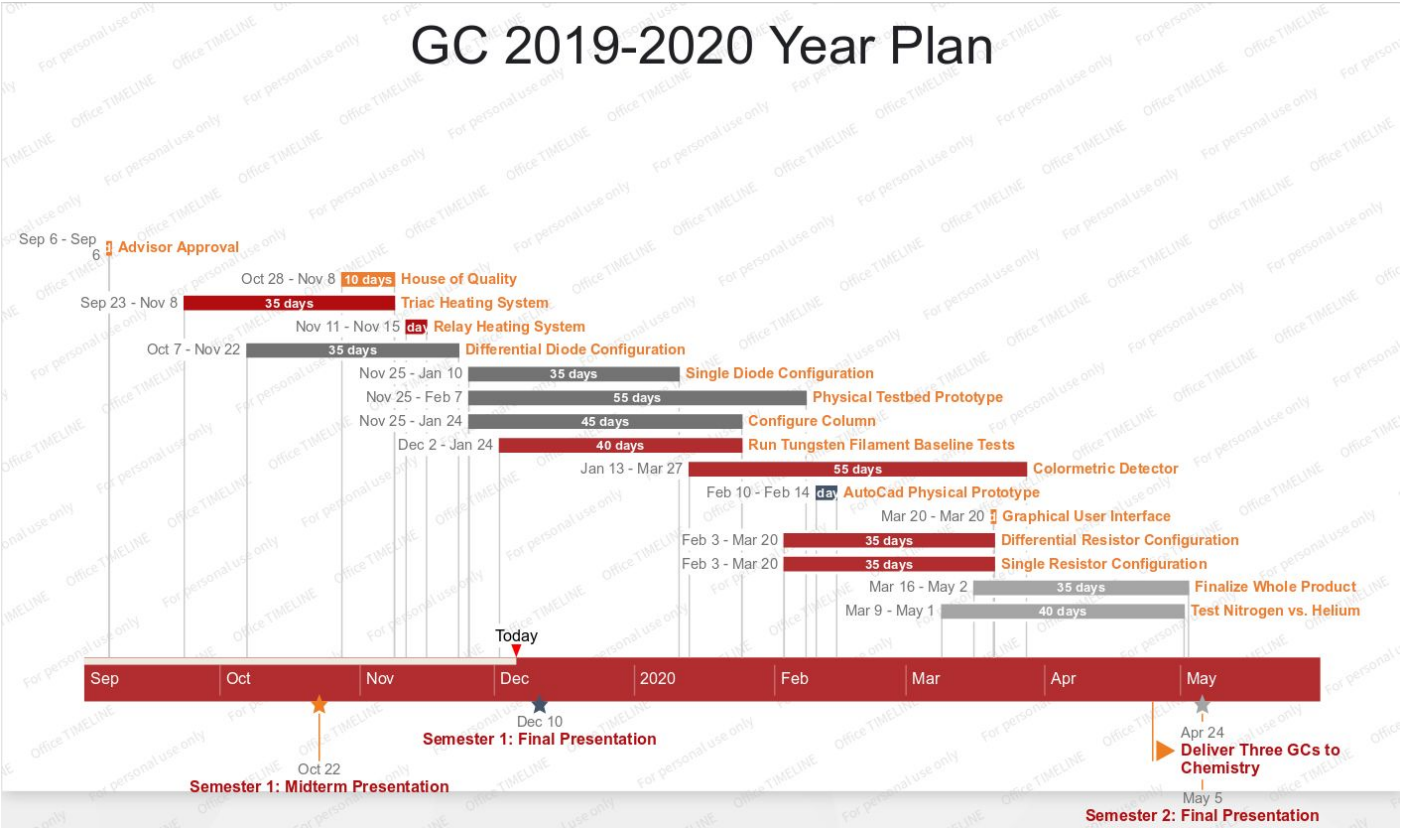


User Interface and GUI

		*Scores are out of 5																	
		C				**Java**				**Python**									
Design Criteria	**Weight (%)**	C#		Visual Basic		AWT		Swing		Qt		TkInter		Pygame		PyGtk		wxPython	
Cross-platform compatability	40	1	0.4	1	0.4	3	1.2	3	1.2	5	2	5	2	1	0.4	4	1.6	5	2
Compilable	5	5	0.25	5	0.25	5	0.25	5	0.25	2	0.1	2	0.1	1	0.05	5	0.25	3	0.15
Speed	20	5	1	4	0.8	1	0.2	1	0.2	2	0.4	2	0.4	2	0.4	3	0.6	3	0.6
Codability	10	3	0.3	3	0.3	2	0.2	2	0.2	4	0.4	4	0.4	5	0.5	3	0.3	3	0.3
Range of abilities	25	5	1.25	5	1.25	4	1	4	1	4	1	4	1	3	0.75	5	1.25	5	1.25
	Total:		3.2		3		2.85		2.85		3.9		3.9		2.1		4		4.3

- wxPython
- Raspberry Pi
- Interface with Arduino Pro Micro via GPIO for analog voltage measurements

Development Plan



References

K. Rakow, N. & Suslick. A colorimetric sensor array for odour visualization. Nature, 406:710–713, August 2000.

M. Jones. A simple-to-build thermal-conductivity gc detector. Journal of Chemical Education, 71:995–996, November 1994.