5. Sensors, Types of Sensors

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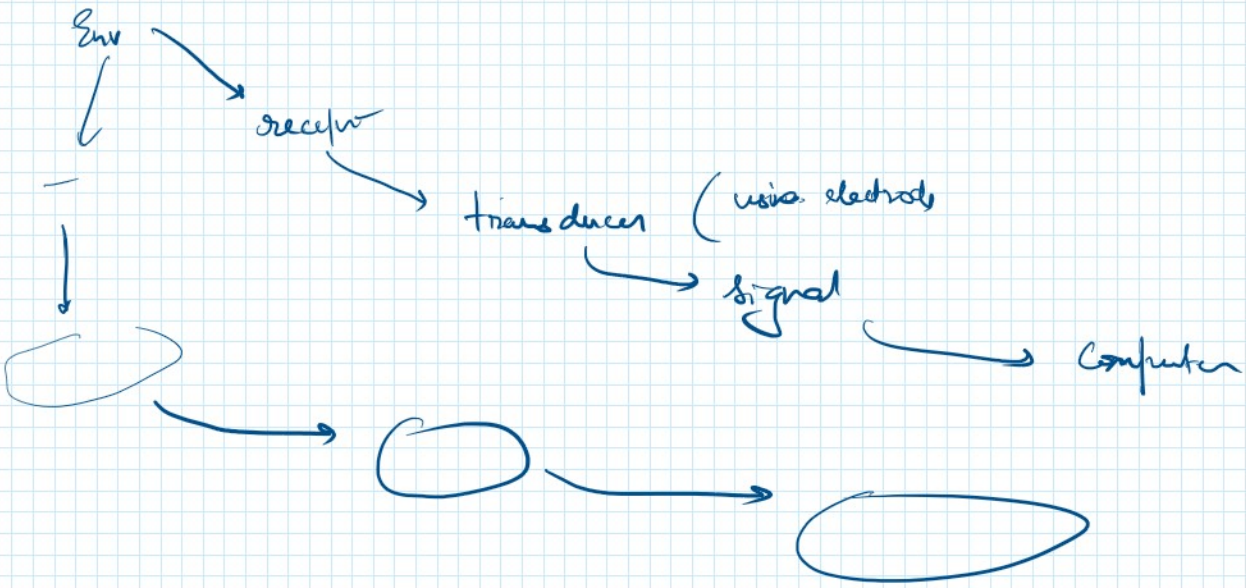
SENSORS

- Detects and responds to some certain types of inputs from the environment

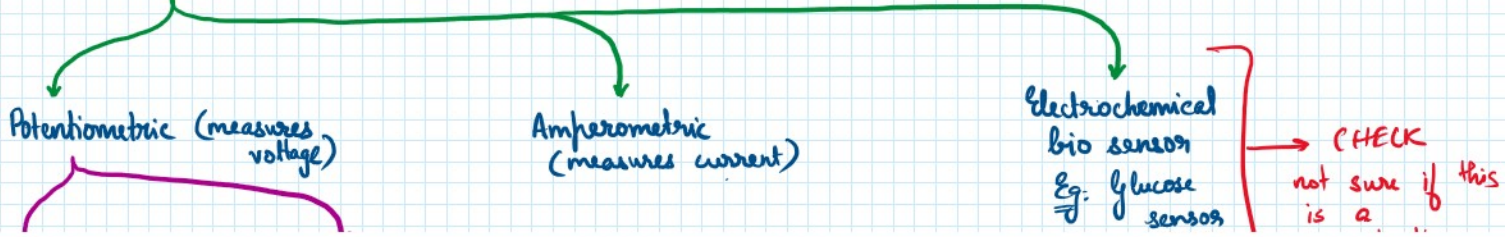
Input examples: Moisture, molecules, light, heat, gas etc.



TYPES OF SENSORS

S:	Semiconductor sensor	Eg: Solar cells
O:	Optical sensor	Eg: Ga-As, Ge-Si, photodetective sensor
M:	Mass-sensitive sensor	Eg: Piezo device
E:	Electrochemical sensor	Eg: O_2 sensor, glucose sensor
C:	Conductivity sensor	Eg: Pt electrode
C:	Capacitive sensor	Eg: Touch screens, polycarbonate, polyester
C:	Calorific sensor	Eg: Bomb calorimeter
T:	Thermosensitive sensor	Eg: Thermostat

ELECTROCHEMICAL SENSORS



voltage)

(measures current)

Bio sensor
Eg: Glucose sensor

not sure if this is a classification

Ion selective
- Glass electrode (H^+, Na^+)
- Solid electrode (AgX)
- Liquid electrode (Ca^{2+})

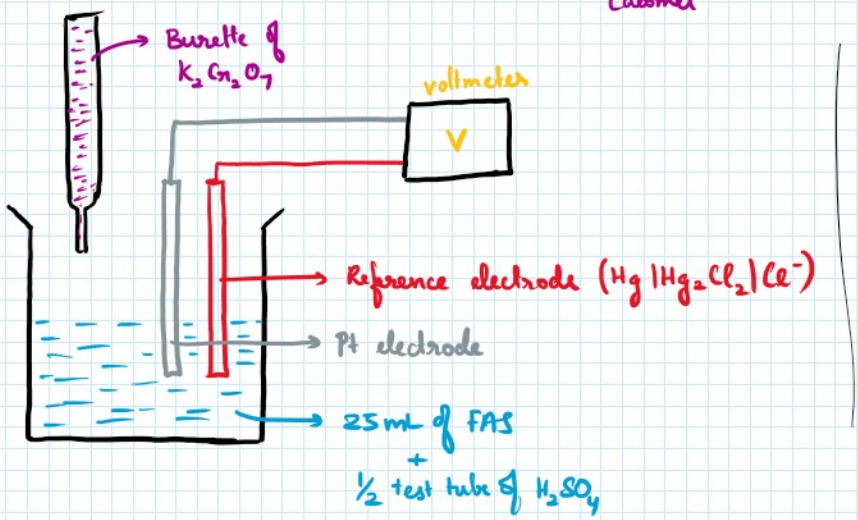
Gas
Eg: O_2 sensor (or) λ - sensor

POTENTIOMETRIC SENSOR

- Measures voltage
- 2 electrode system

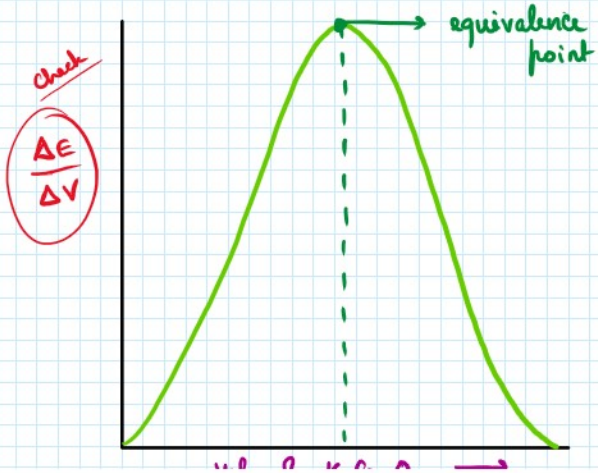
Analyte → Receptor → Transduces → Signal → Computer

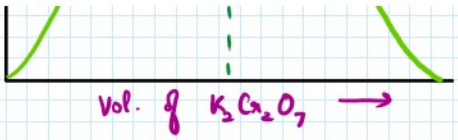
Transduces:
- Pt electrode
- Reference electrode
  Eg: Ag-AgCl
  Calomel



Oxid.

Red.





Advantages

- Accurately measure voltage
- Simple
- Qualitative and quantitative measurements

Disadvantages

- Calibration
- Variation in temperature causes change in value of voltage measured

O_2 SENSOR (solid oxide sensor) (potentiometric sensor) → check classification

Applications

- I.C. engines
- Medical applications → respiration, anaesthesia
- Deep sea divers

Anode: Pt

Cathode: Pt

Electrolyte: Ceramic material : YSZ → releases O^{2-} ions

Yitria Stabilised Zirconia

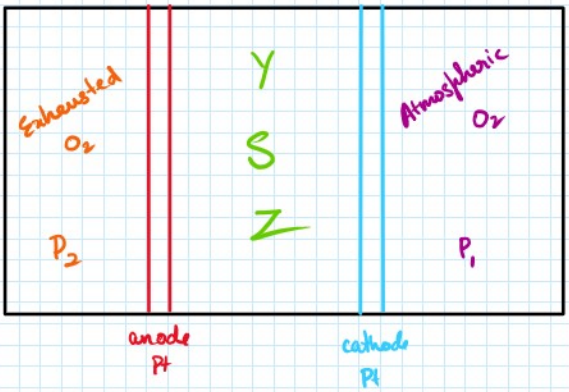
ZrO_2 doped with Y_2O_3

Operating temp.: 360°C

- Air : fuel = 14.7 : 1
- Ideal voltage = 0.45 V

→ For ideal engine

- Using lead-free gasoline



$$E_{cell} = \frac{2.303RT}{nF} \log \frac{P_1}{P_2}$$ → P_1: atmospheric O_2, P_2: exhausted O_2

At 25°C,

$$E_{cell} = \frac{0.0591}{n} \log \frac{P_1}{P_2}$$ → P_1: atmospheric O_2, P_2: exhausted O_2

Equations

Anode: $2O^{2-} \longrightarrow O_2 + 4e^-$

Cathode: $O_2 + 4e^- \longrightarrow 2O^{2-}$

Rich mixture (less O_2) ⟶ 0.8 V (emission of CO_2, unburnt C)

Lean mixture (more O_2) ⟶ 0.2 V (emission of NO_x gases)

Disadvantages

- Tailpipe emission
- Hesitation on acceleration

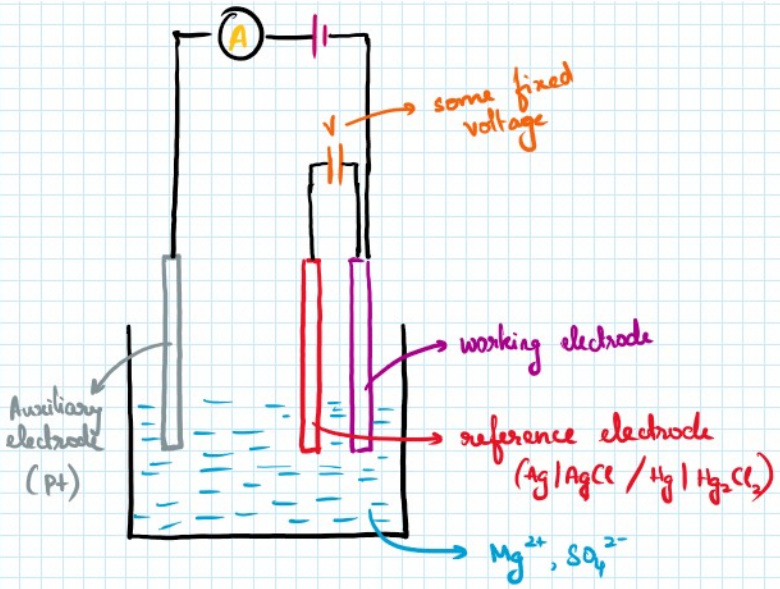
AMPEROMETRIC SENSOR

- Measures current
- 3 electrode system

Analyte ⟶ Receptor ⟶ Transducer ⟶ Signal ⟶ Electronic display

Transducer:
- Working electrode
- Reference electrode [Ag|AgCl, calomel]
- Auxiliary electrode

Ammeter



Advantages

- Simple to construct
- Qualitatively and quantitatively measure

Disadvantages

- -ve voltage leads to errors due to liberation of H_2

BIOSENSOR

Analyte → Bioreceptor → Transducer → Signals → Electronic display

Blood
RNA
DNA
cells

Transducer:
- electrodes
- pH
- piezo electric device

GLUCOSE SENSOR

- Amperometric sensor

Analyte → Biosensor → Transducer → Signals → Electronic display

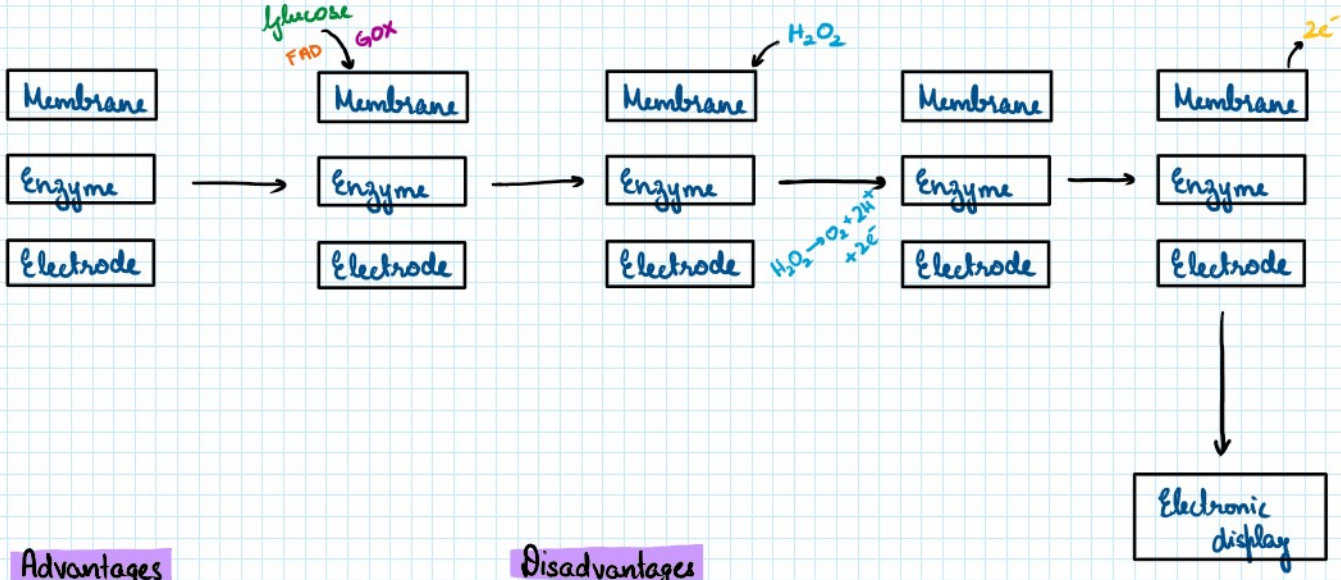
Blood

Transducer:
- membrane
- enzyme
- electrode

Blood → HIGH glucose → hyperglycemia
LOW glucose → hypoglycemia

Glucose —GOX, oxidation→ [Glucofactone] − H_2O_2 → CHECK
FAD → Flavin Adenine Dinucleotide
Glucose Oxidase Enzyme

$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$
More electrons → 250
less electrons → 100



Advantages
- Simple method
- Checking blood sugar

Disadvantages
- Treatment errors (glucose levels)