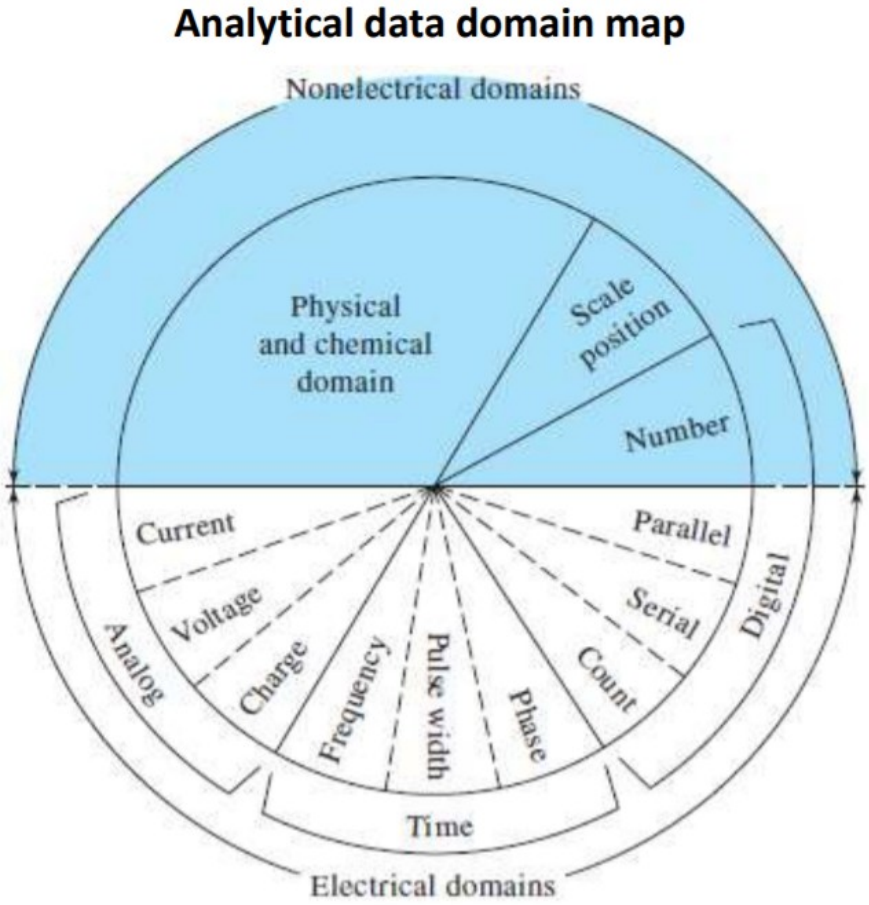
Chapter 1

Textbook questions

Question 1-1

What is a transducer in an analytical instrument?

換能器是一種將化學或物理信息互相轉換成電信號的設備。



https://www.google.com/search?q=pH+meter&tbm=isch&ved=2ahUKEwil1fViZLoAhVTxIsBHSq2AFwQ2cCegQIABAA&oq=pH+meter&gs_l=img.3..0l7j0i30l3.194688.198220..198744...1.0..0.102.468.7j1.....0....1..gwswizimg.....10..35i362i39j35i39.SV24PCPh3c&ei=96poXuX_CdOIr7wPquyC4AU&bih=748&biw=1707&rlz=1C1GCEAenTW850TW850#imgrc=iW-pD6-loEAghM

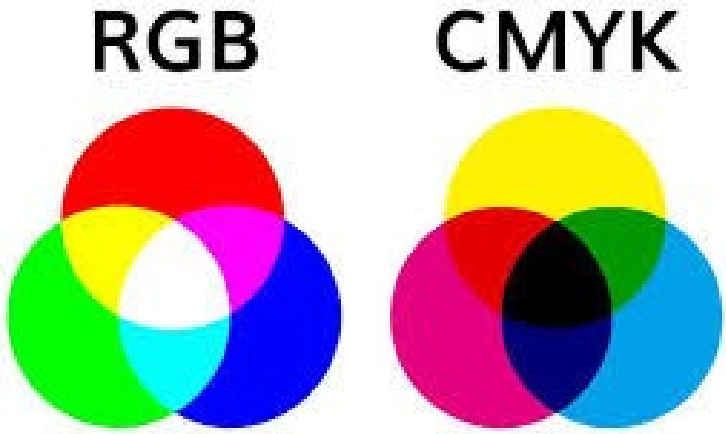
Skoog D.A., Holler F.J., Crouch S.R. 2017, Principles of Instrumental Analysis, 7th Edition. Cengage.

Question 1-2

What is the information processor in an instrument for measuring the colour of a solution visually?

視覺色彩測量系統中的信息處理器是人的頭腦。

https://www.google.com/search?q=%E6%BB%B4%E5%AE%9A&tbm=isch&ved=2ahUKEwi7pOzLkJLoAhWVAKYKHS3UAYQ2cCegQIABAA&oq=%E6%BB%B4%E5%AE%9A&gs_l=img.3..0l10.167700.170799..171620...1.0..0.50.368.9.....0....1..gwswizimg.....10..35i39j35i362i39.FokjuVdqELk&ei=ObJoXvujE5WBmAWtqIwDg&bih=748&biw=1707&rlz=1C1GCEA_enTW850TW850#imgrc=Onj3FUmmENSVHM

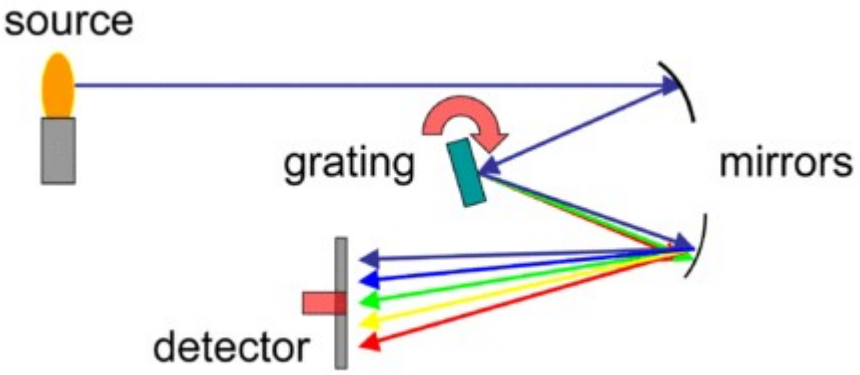


https://www.google.com/search?q=RGB&tbm=isch&ved=2ahUKEwin9om1ipLoAhUGdJQKHRAhBaoQ2cCegQIABAA&oq=RGB&gs_l=img.3..0l10.1100950.1102203..1103282...1.0..0.43.122.3.....0....1..gwswizimg.....10..35i362i39.QzCXpeZM9Rs&ei=vqtoXqefOobo0QSQwpTQCg&bih=748&biw=1707&rlz=1C1GCEA_enTW850TW850#imgrc=VNgqUSXVSNMSjM

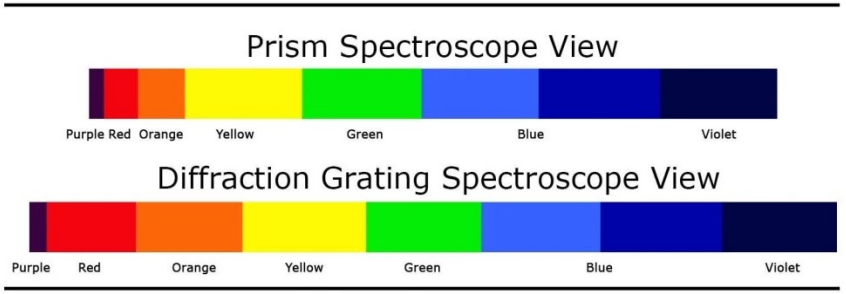
Question 1-3

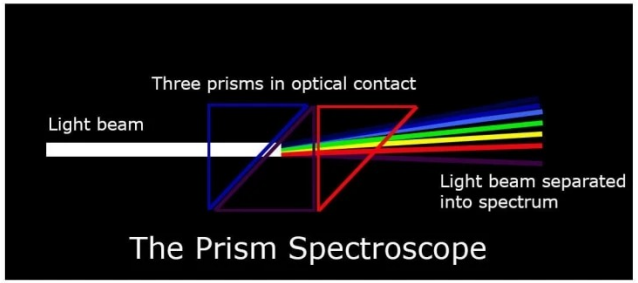
What is the detector in a spectrograph in which spectral lines are recorded photographically?

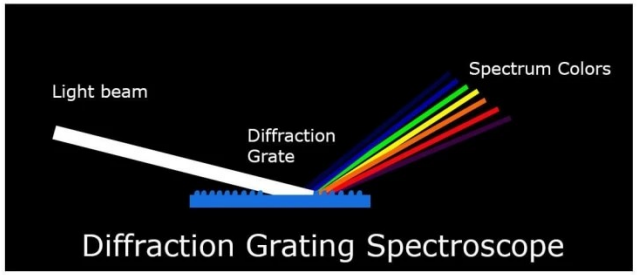
光譜儀中的檢測器是攝影膠片或板。



https://zh.wikipedia.org/wiki/%E5%85%89%E8%B0%B1%E4%BB%AA







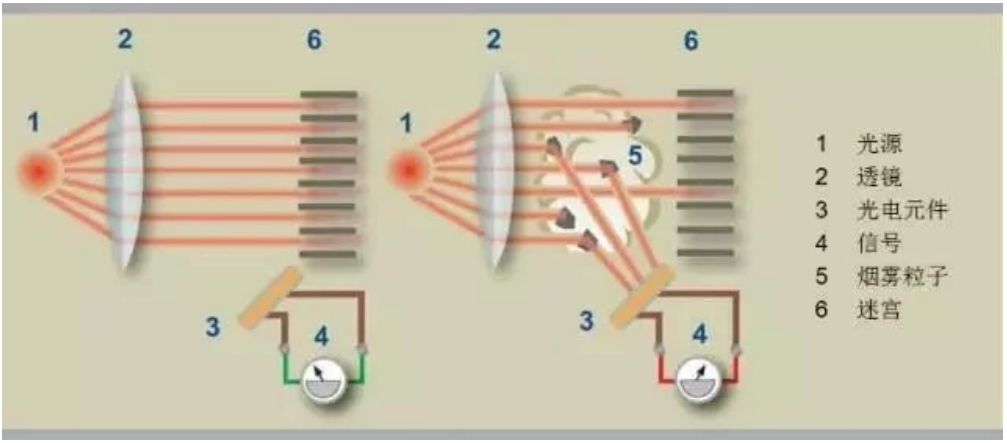
https://www.google.com/search?q=Spectroscope&tbm=isch&ved=2ahUKEwic1I_OupLoAhXNxGEKHVUNCj8Q2cCegQIABAA&oq=Spectroscope&gs_l=img.3..35i39l2j0i30l8.97281.98320..98626...0.0..0.51.267.6.....0....1..gwswiz-img.....0i19j0i8i30i19.ZlC79oL2sI8&ei=SN5oXpyQF82JhwPVmqj4Aw&bih=748&biw=1707&rlz=1C1GCEA_enTW850T

Question 1-4

What is the transducer in a smoke detector?

煙霧探測器有兩種類型：光電探測（photodetectors）和電離探測器（ionization detector）。

光電探測器



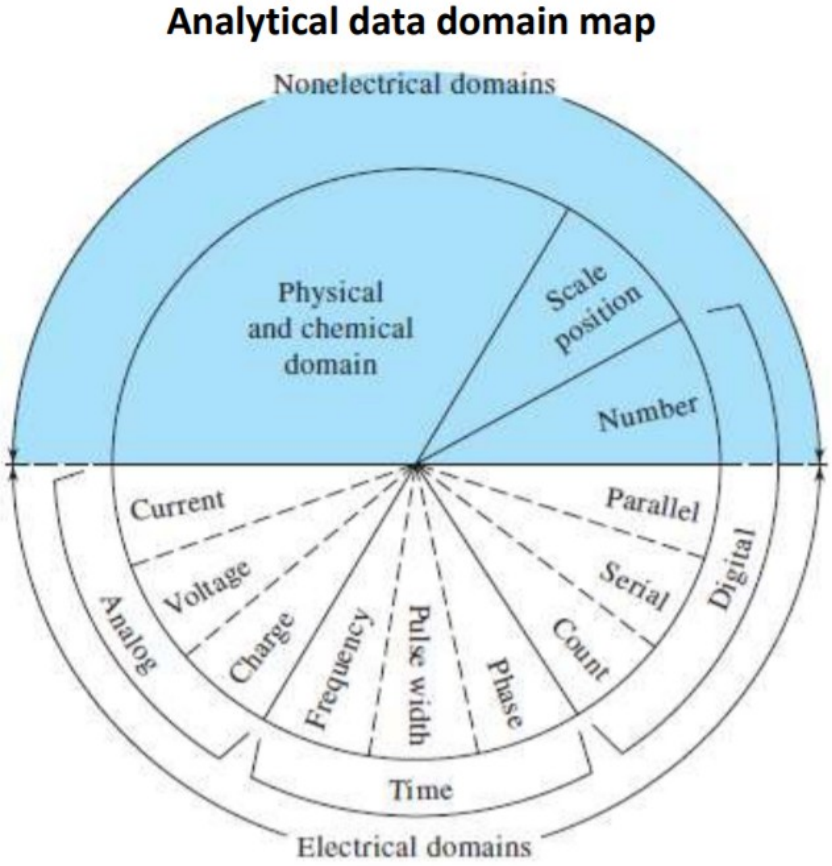
電離探測器

https://kknews.cc/zh-tw/science/6l883p.html

Question 1-5

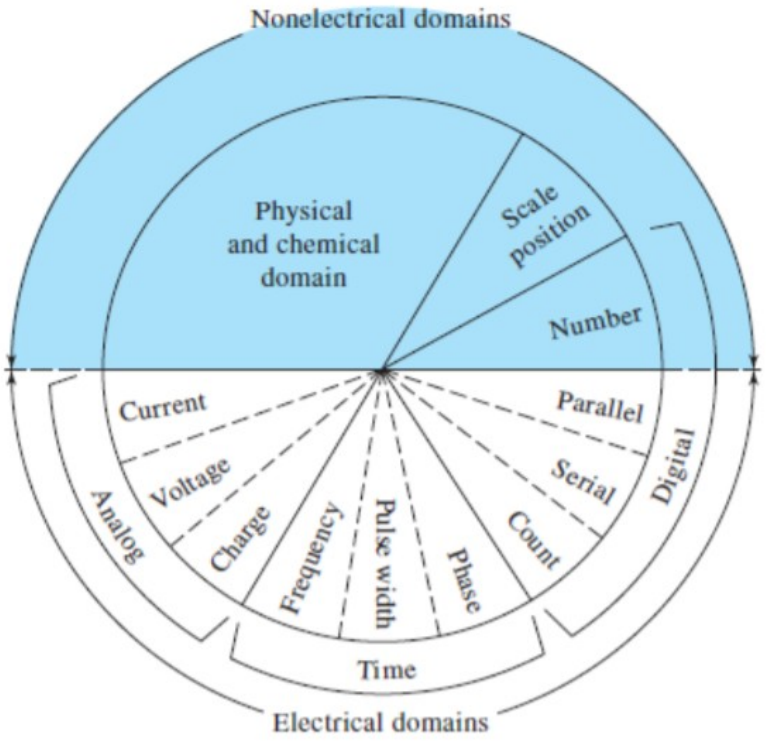
What is a data domain?

數據域，將訊息密碼化的各種方式稱為數據域，是一種包含數據的形式，可將訊息解碼為另一種訊息，其可分為電性域 (electrical domain) 和非電性域 (nonelectricaldomain)，其方法有電流、電壓、數位數字、長度、密度、光強度等。



Question 1-6

Name electrical signals that are considered time-domain signals? How is the information encoded in a time-domain signal?



Skoog D.A., Holler F.J., Crouch S.R. 2017, *Principles of Instrumental Analysis, 7th Edition*. Cengage.

Time-domain signals include **period, frequency, and pulse width**.
時間域包含週期、頻率、脈衝寬。

The information is encoded in the **time relationship of signal fluctuations.**
這類訊息以訊號波動對時間來編碼。

Question 1-7

List four input transducers and describe how they are used?

Input Transducer	Use
Phototube	Convert light intensity to an analog current
Glass electrode	Convert electrode potential to a voltage related to pH
Electron multiplier	Convert ion intensity to a corresponding electric current
Thermal conductivity	Converts sample thermal conductivity to related voltage

https://kids.britannica.com/students/assembly/view/53788

Question 1-8

What is a figure of merit?

A figure of merit(品質因數)is **a number that provides quantitative information** about some **performance criterion** for an instrument or method.

品質因數是用於表示儀器或方法的性能的數量

Example: Resolution of the image sensor in a digital camera

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

Question 1-9

A 25.0mL sample containing Cu^{2+} gave an instrument signal of 25.2 units (corrected for a blank). When exactly 0.500mL of 0.0275 M $Cu(NO_3)_2$ was added to the solution, the signal increased to 45.1 units. Calculate the molar concentration of Cu^{2+} assuming that the signal was directly proportional to the analyte concentration?

6.66×10^{-4} M

Let c_s= molar concentration of Cu^{2+} in standard = 0.0275 M

c_x = unknown Cu^{2+} concentration

V_s = volume of standard = 0.500 mL

V_x = volume of unknown = 25.0 mL

S_1 = signal for unknown = 25.2

S_2 = signal for unknown plus standard = 45.1

Assuming the signal is proportional to c_x and c_s , we can write

$$S_1 = Kc_x \quad \text{or} \quad K = S_1/c_x$$

After adding the standard

$$S_2 = K\left(\frac{V_x c_x + V_s c_s}{V_x + V_s}\right)$$

Substituting for K and rearranging gives,

$$c_x = \frac{S_1 V_s c_s}{S_2(V_x + V_s) - S_1 V_x}$$

$$c_x = \frac{25.2 \times 0.500\ \text{mL} \times 0.0275\ \text{M}}{45.1(0.500\ \text{mL} + 25.0\ \text{mL}) - (25.2 \times 25.0\ \text{mL})} = 6.66 \times 10^{-4}\ \text{M}$$