

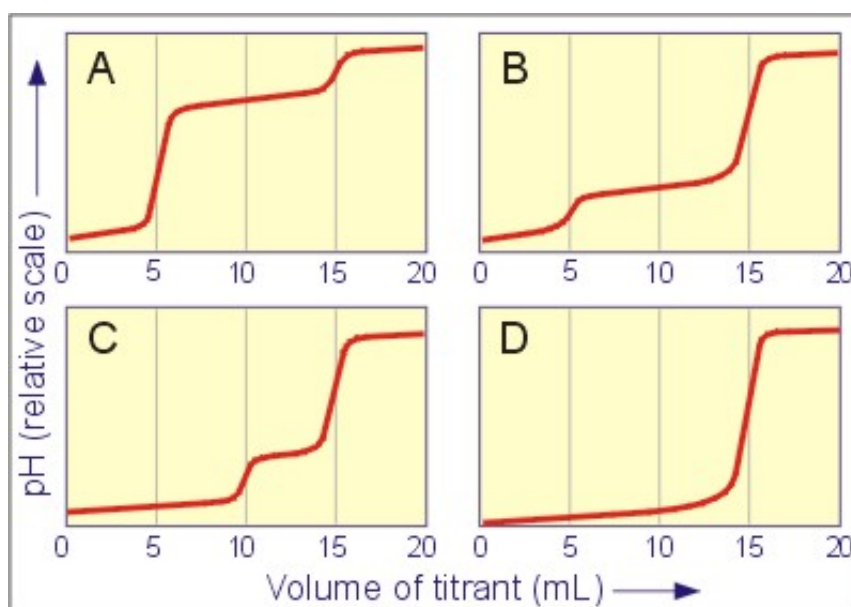
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ECheMTest - Analytical Chemistry 3

Welcome ...

1 of 30

Which one of the titration curves shown in the figure better describes the expected titration curve obtained when 50.0 mL of a solution 0.10 M in HCl and 0.20 M in acetic acid is titrated with a 1.0 M NaOH solution?



- ☐ Curve A
- ☐ Curve B
- ☐ Curve C
- ☐ Curve D

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In the following gravimetric determinations, indicate the type of analytical error (positive, negative, none) that would result from the following analytical procedures:

Fe³⁺ is precipitated with NaOH instead of NH₃ and the precipitate is ignited and weighed as **Fe₂O₃**.

Ca²⁺ is weighed as **CaO**, after precipitation with ammonium oxalate and ignition of the precipitate, but the ignition temperature was lower than recommended.

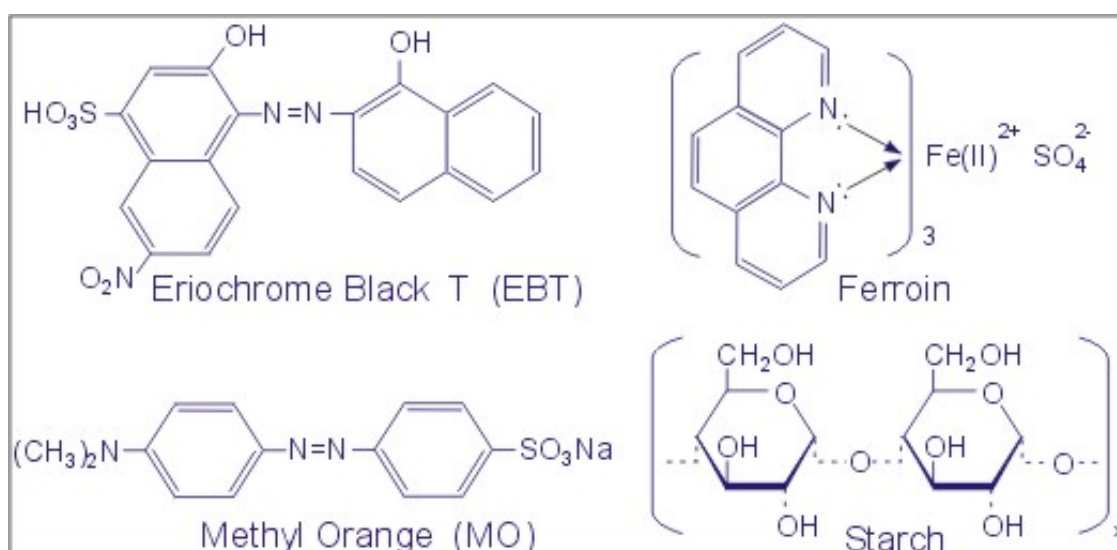
SO₄²⁻ is precipitated as **BaSO₄** but the precipitate was subjected to a digestion period longer than recommended.

Ag⁺ is precipitated as **AgCl** with a solution of HCl of higher concentration than that recommended.

Al³⁺ is precipitated with an excess of NaOH instead of a NH₃ solution and the precipitate is ignited and weighted as **Al₂O₃**.

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Which one of the indicators shown is appropriate for the following titrations:

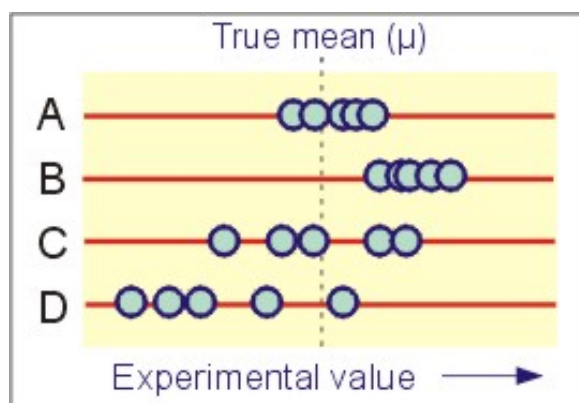


H₂O₂ with a standard KMnO₄ solution.

- Fe^{2+} with a standard Ce(IV) solution.
- H_3AsO_3 with a standard I_2 solution.
- Na_2CO_3 with a standard HCl solution.
- Zn^{2+} with a standard EDTA solution.

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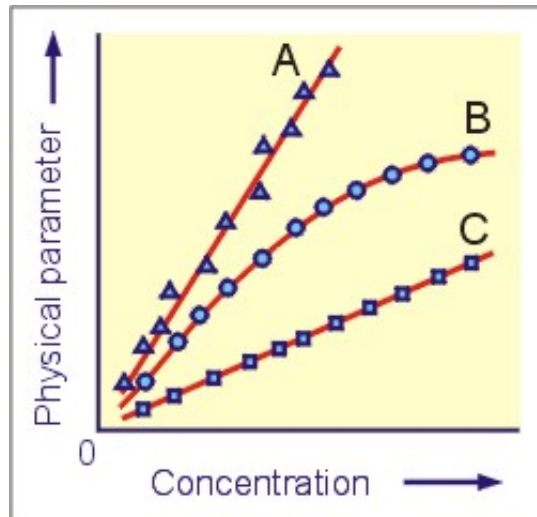
The dot-plots A to D, shown in the figure, represent the experimental values (e.g. analytical results) obtained by replicate measurements. Associate the accuracy and the precision of the applied method with each dot-plot.



- High accuracy - low precision.
- High accuracy - high precision.
- Low accuracy - low precision.
- Low accuracy - high precision.

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A new instrumental method of analysis is tested under the influence of a variety of experimental parameters. Each set (A, B and C) of experimental parameters yielded a different working curve (measured physical parameter vs. analyte concentration) shown in the figure. By visual inspection of the working curves decide which set:



indicates a non-constant instrumental sensitivity.

must finally be recommended.

provides the highest instrumental sensitivity.

provides the lowest detection limit.

excludes the use of standard additions as a quantification technique.

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The technique of **standard known addition** is commonly used in instrumental analysis for the quantification of an analyte. Are the following statements true or false?

P : is the measured physical parameter.

[X]: is the unknown concentration of the target analyte X.

A 50-150% increase of P after the addition of the known amount of X is generally recommended .

The sample matrix components alone should not generate signal P.

The technique can be applied even if instrumental instability (i.e. drift) is encountered.

The sample matrix components should not affect the

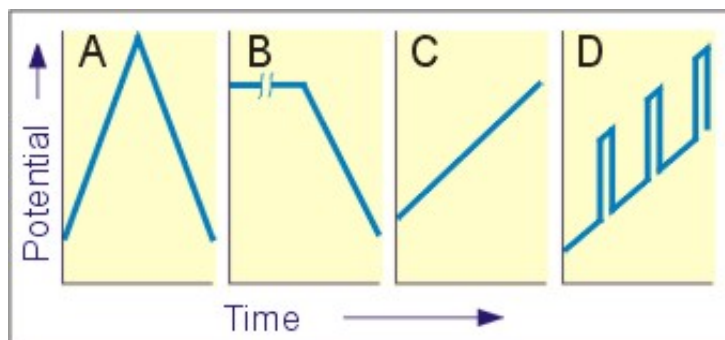
proportionality constant between P and [X].

P must be proportional to [X].



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Associate the potential-time plots (A-D) shown in the figure with the corresponding voltammetric techniques we read below:



Stripping voltammetry.



Cyclic voltammetry.



Differential pulse voltammetry.



Linear scanning voltammetry.



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The most common electroanalytical determination of the fluoride anion (F^-) is based on which one of the following:

- ☐ the voltammetric oxidation of fluoride anion.
- ☐ the use of an ion-selective electrode with a membrane based on a multi-crystalline mixture of various insoluble fluoride salts.
- ☐ the use of an ion-selective electrode with a LaF_3 - crystal membrane.

☐

the amperometric titration of fluoride with a standard Pb(II) solution.

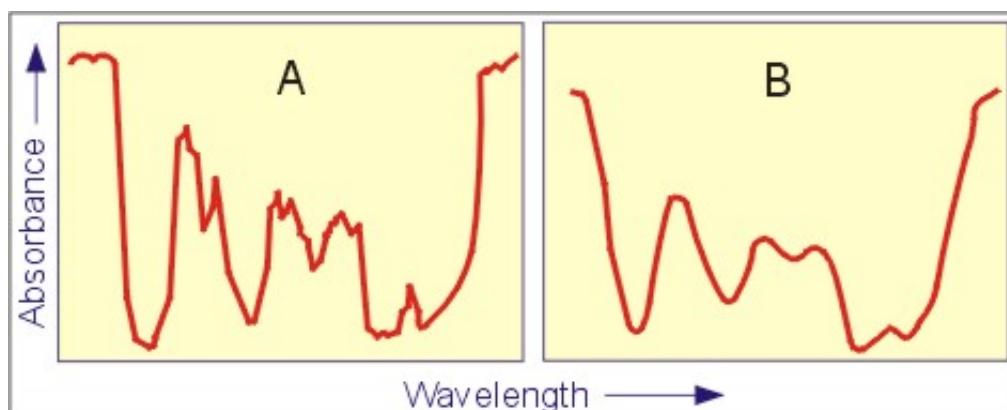
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What is the mathematical relationship, which describes the dependence of the analytical signal from the concentrations in a potentiometric and an amperometric measurement?

- ☐ Logarithmic for potentiometric, linear for amperometric.
- ☐ Linear for both.
- ☐ Logarithmic for both.
- ☐ Linear for potentiometric, logarithmic for amperometric.
- ☐ Logarithmic for potentiometric, exponential for amperometric.

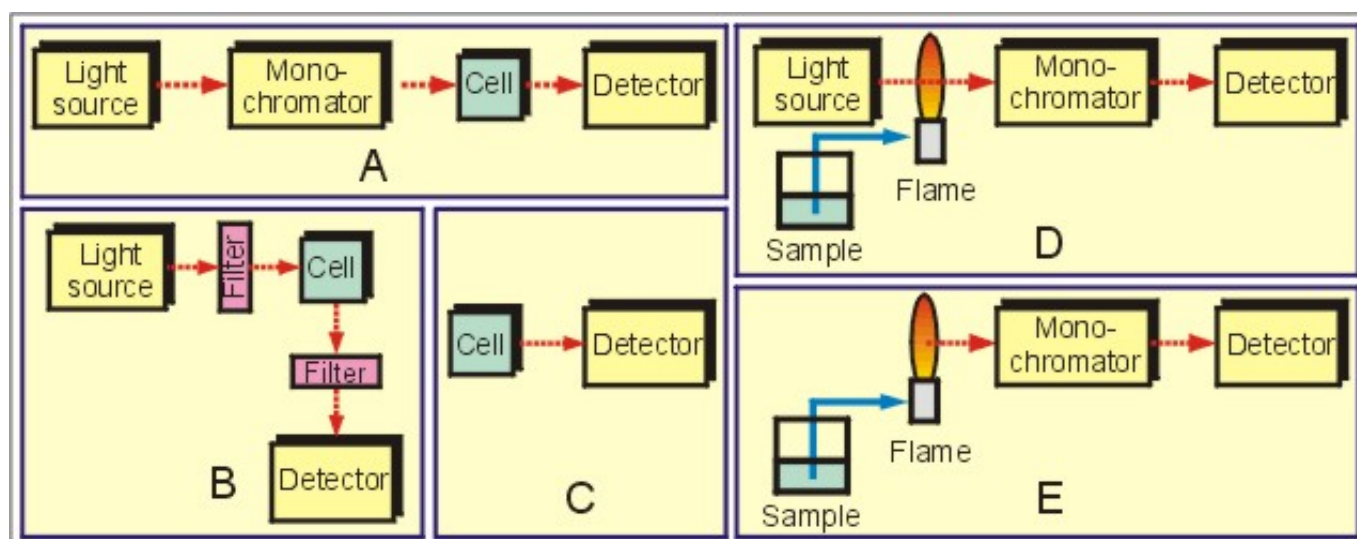
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The real (theoretical) spectrum of an absorbing solution is shown in figure A. The spectrum obtained experimentally is shown in figure B. In order to obtain a spectrum more similar to the real one the following experimental conditions must be applied:



- ☐ Use a less absorbing solvent.
- ☐ Increase the intensity of the light source.
- ☐ Decrease the exit slit width of the monochromator.
- ☐ Use a cell of better quality glass (e.g. quartz).
- ☐ Increase the voltage applied to the photomultiplier tube.

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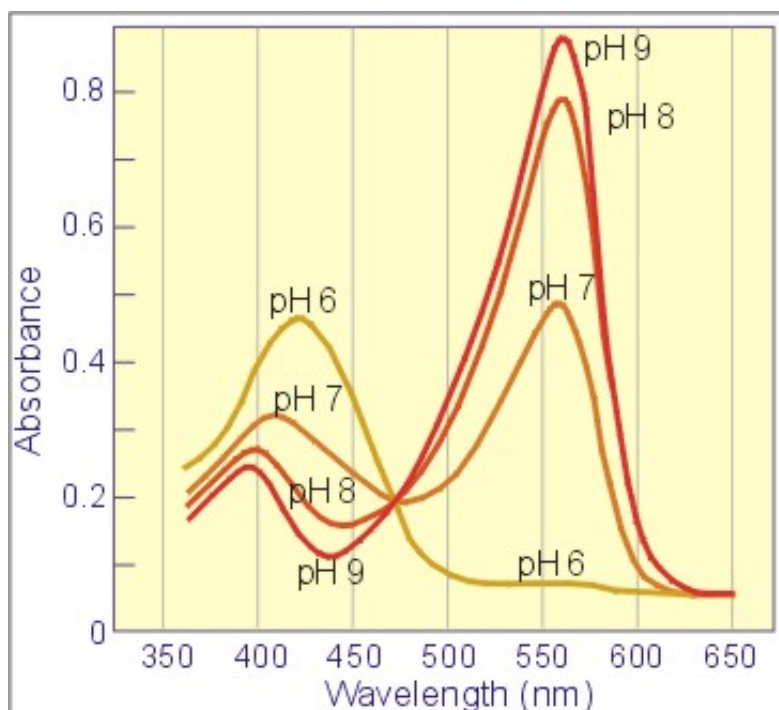


Which of the instrumental configurations A-E shown in the figure is more appropriate for measuring:

- Chemiluminescence
- Atomic emission
- Molecular absorbance
- Atomic absorption
- Fluorescence

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The absorption spectra of an aqueous solution of the acid/base indicator "phenol red" (PR), obtained at various pH are shown in figure. The analytical concentration of the indicator is the same in all cases.



Which is the optimal wavelength for the photometric determination of the indicator if:

All PR solutions are strongly acidic ($\text{pH} < 4$).

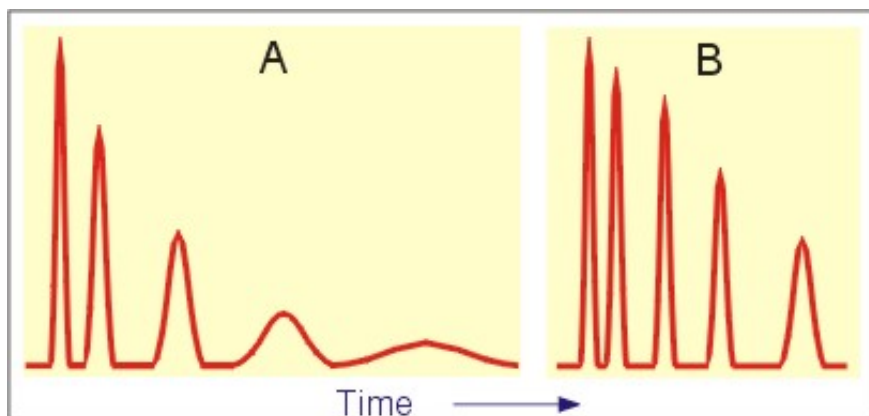
All PR solutions are strongly basic ($\text{pH} > 10$).

The pH of all PR solutions have been adjusted at 7.0.

The pH of all PR solutions has not been adjusted.

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The quality of the gas chromatogram A (of a mixture of 5 aliphatic hydrocarbons) can be improved to that of B:



- ☐ By increasing the column temperature and the flow rate of the carrier gas.
- ☐ By increasing gradually the column temperature during elution.
- ☐ By increasing the flow rate of the carrier gas.
- ☐ By increasing the column temperature.

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In gas chromatography, the retention index (Kovats' index) of a normal (straight-chain) alkane $n-C_mH_{2m+2}$ depends:

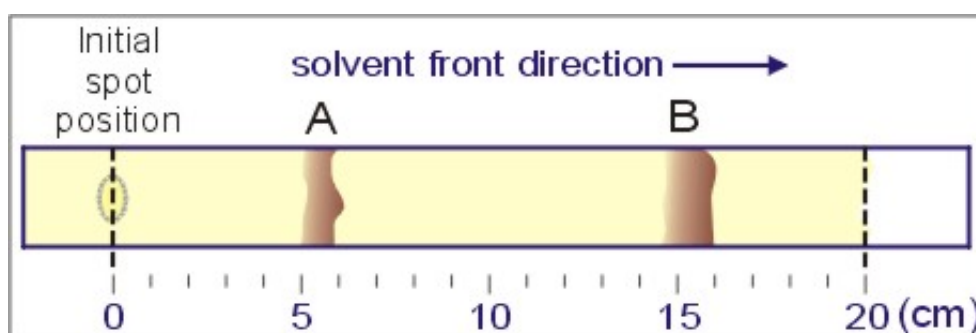
- ☐ On the number of carbon atoms (m) of its molecule.
- ☐ On all instrumental parameters (static phase, column temperature, flow rate of the mobile phase).
- ☐ On the temperature and the flow rate of the mobile phase.
- ☐ On the nature of the static phase of the chromatographic column.

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Paper chromatography using as mobile phase n-butanol saturated with an aqueous 3 M HCl solution can effectively separate a mixture of Cu^{2+} , Pb^{2+} , Bi^{3+} , Cd^{2+} and Hg^{2+} . Dithizone or rhodizonic acid can be used for the development of the chromatogram.

The following R_F values were obtained with a standard solution containing the following metal cations:

Cu^{2+} : 0.20; Pb^{2+} : 0.27; Bi^{3+} : 0.59; Cd^{2+} : 0.77; Hg^{2+} : 0.81



Identify the metal ions contained in an unknown sample, which give bands A and B in the paper chromatogram shown in the figure.

Band A

Band B

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The (metal) ion A is to be titrated with EDTA in the presence of (metal) ion B. What reagent must be added in excess to eliminate co-titration of B and avoid interference?

A = Ca^{2+} , B = Mg^{2+}

A = Zn^{2+} , B = Fe^{3+}

A = Bi^{3+} , B = Mg^{2+}

A = Mg^{2+} , B = Zn^{2+}

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The mean iron content in a sample of a tap water was determined by a spectrophotometric method and was found 1.25 mg/L. The standard deviation of this determination is known to be 0.10 mg/L. Calculate the percent probability (P%) that a single measurement will give a result within the 1.20-1.30 mg/L range.

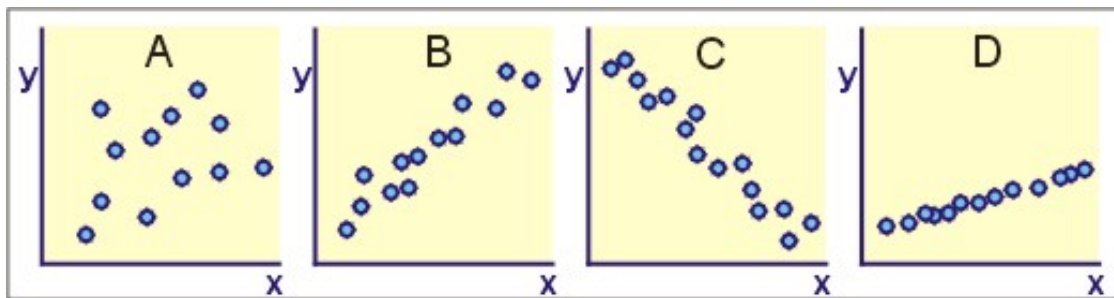
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Gauss integral (GI) values					
Z	GI	Z	GI	Z	GI
0.1	0.0797	1.1	0.7287	2.1	0.9643
0.2	0.1585	1.2	0.7699	2.2	0.9722
0.3	0.2358	1.3	0.8064	2.3	0.9786
0.4	0.3108	1.4	0.8385	2.4	0.9836
0.5	0.3829	1.5	0.8664	2.5	0.9876
0.6	0.4515	1.6	0.8904	2.6	0.9907
0.7	0.5161	1.7	0.9109	2.7	0.9931
0.8	0.5763	1.8	0.9281	2.8	0.9949
0.9	0.6319	1.9	0.9426	2.9	0.9963
1.0	0.6827	2.0	0.9545	3.0	0.9973

P% =

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In the following figure 4 data sets (A-D) are shown. If the equation $y = Bx + A$ is to be used to fit the data, associate (by visual inspection) the following values of the correlation coefficients (r) to each set.



$r = -0.97$

$r = 0.95$

$r = 0.993$

$r = 0.30$

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The polarographic waves of thallium(I) and lead(II) in a non-complexing carrier electrolyte solution (e.g. KNO_3) almost overlap at $E_{1/2} = -0.4$ (vs. SCE).

It is known that lead(II) but not thallium(I) forms a very stable complex with EDTA. In which of the following media are one (indicate which) or both of these metals present?

In a KNO_3 -EDTA medium a **single wave** is observed at -1.3 V.

In a KNO_3 medium a **single wave** is observed at -0.4 V.

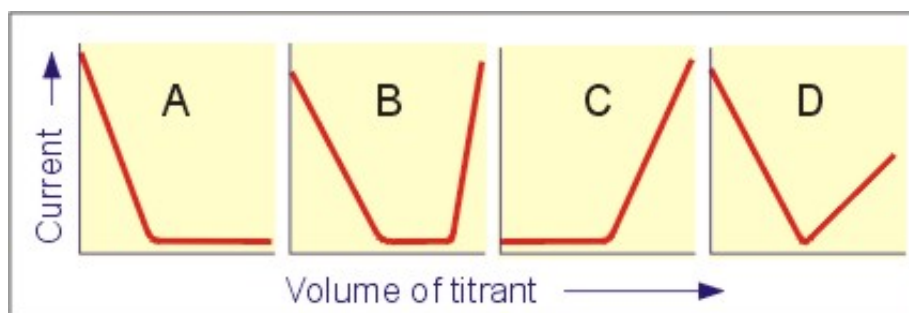
In a KNO_3 -EDTA medium a **single wave** is observed at -0.4 V.

In a KNO_3 -EDTA medium **two waves** are observed at -0.4 V and -1.3 V.

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Associate the amperometric titration graphs (A-D) shown in the figure with the following titration experiments (all potentials are measured

vs. saturated calomel electrode):



A mixture of Ba^{2+} and Pb^{2+} is titrated with K_2CrO_4 , and monitored at -1.0 V , where Pb^{2+} is reduced in a $2e^-$ step and CrO_4^{2-} in a $3e^-$ step.



Cu^{2+} , titrated with complexing titrant L, is monitored at -1.5 V , where Cu^{2+} is reduced in a $2e^-$ step and L in a $1e^-$ step.



SO_4^{2-} , titrated with $\text{Pb}(\text{NO}_3)_2$, is monitored at -1.0 V , where Pb^{2+} is reduced in a $2e^-$ step.



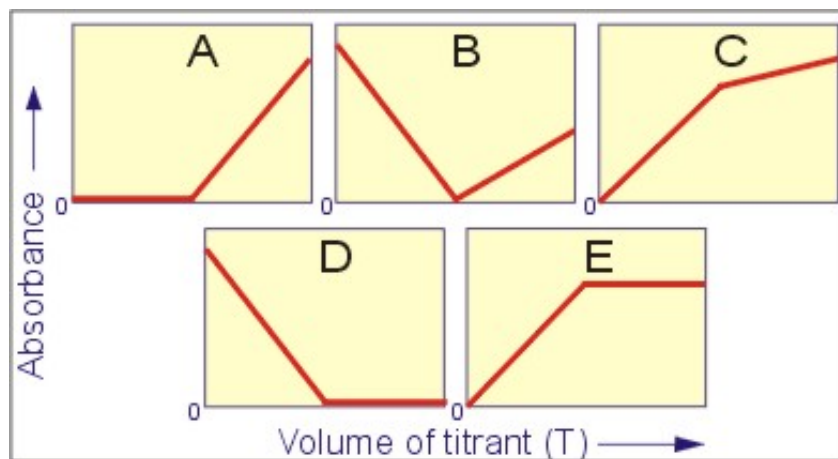
Cu^{2+} , titrated with EDTA, is monitored at -0.2 V , where only Cu^{2+} is reduced, in a $2e^-$ step.



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A photometric titration is described by the reaction:





Associate the photometric titration curves shown in the figure, with the combinations of absorbing properties of AN, TI and PR given below (dilution effects are not considered):

Only PR absorbs.

Only TI absorbs.

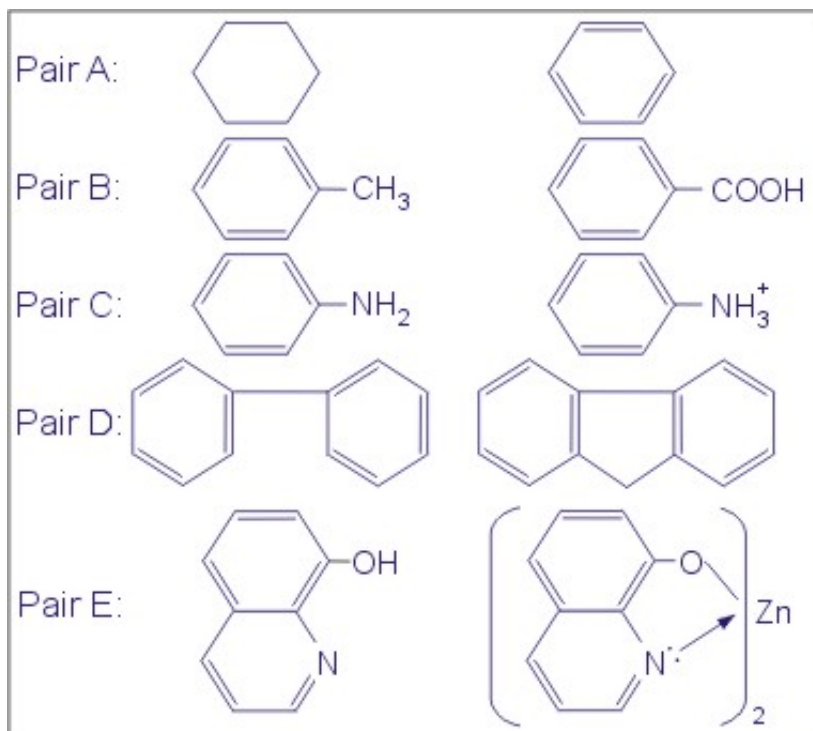
TI and PR absorb, AN does not absorb.

AN and TI absorb, PR does not absorb.

Only AN absorbs.

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For each pair (A-E) of chemical species given below, indicate which species (left / right) is expected to exhibit more intense fluorescence.



Pair A.

Pair B.

Pair C.

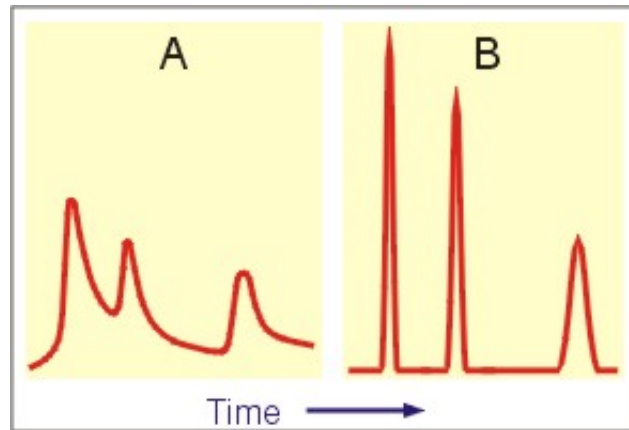
Pair D.

Pair E.

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The gas chromatogram A, obtained with a mixture of methanol, ethanol and n-propanol using a capillary glass column, gave 'highly-tailed' peaks.

What action might be the most appropriate in order to improve the quality of the chromatogram to a B type chromatogram?



- ☐ Use a different type of detector.
- ☐ Use a capillary column with silanized walls.
- ☐ Use a longer glass capillary column.
- ☐ Use a different carrier gas.
- ☐ Increase the column temperature.

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How many consecutive extractions of a 500 mL aqueous iodine (I_2) solution 0.0010 M in I_2 with 25 mL of CCl_4 (each time) is needed to remove at least 99% of I_2 from the aqueous to the organic phase? The distribution ratio (D) of I_2 in the CCl_4/H_2O system is 90.

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Minimum number of extractions =

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Beta-emitting isotopes A and B have half-lives of 10 and 20 hours, respectively. The decay products of both isotopes are not radioactive. In a mixture of A and B prepared with quantities of equal radioactivity, calculate which one of the following percentages represents the remaining radioactivity of this mixture after 40 hours?

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☐ 12.5%

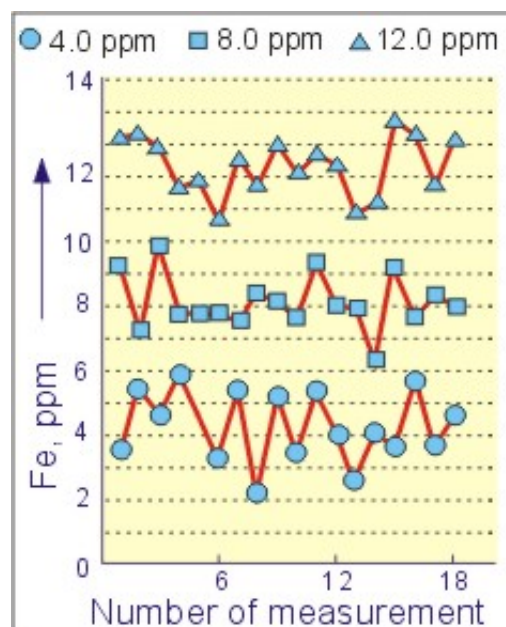
☐ 31.2%

☐ 25.0%

☐ 15.6%

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Successive analytical results for standard samples containing 4.0, 8.0 and 12.0 ppm Fe are shown in the following figure. By visual inspection of these plots, estimate which one of the following values is closest to the limit of detection (LOD) for the particular method used.



☐ 1 ppm

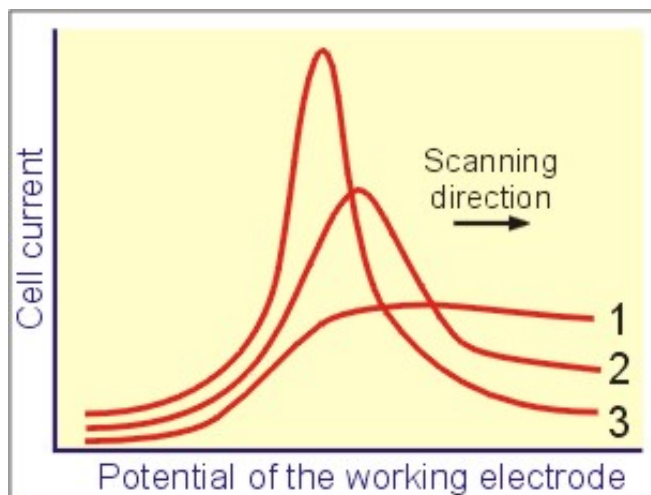
☐ 2 ppm

☐ 3 ppm

☐ 6 ppm

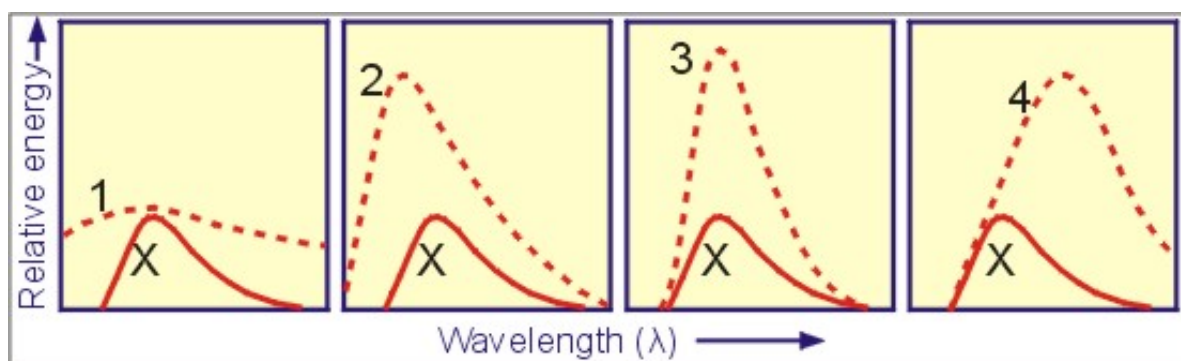
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The figure below shows three voltammographic scans obtained with aqueous samples containing a certain electroactive compound. Which one of the following parameters was altered and resulted in the change of the shape of the obtained voltammograms from 1 to 3?



- ☐ The scanning rate of the potential was increased.
- ☐ The active surface of the working electrode was increased.
- ☐ The concentration of the electroactive compound was increased.
- ☐ The pH of the tested solutions was increased.

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An electrically heated tungsten wire is a common source of continuous radiation. Its radiation spectrum approximates that of the ideal **blackbody** and it is shown in the figure as curve X. Upon increasing its temperature (e.g. by increasing the electric current passing through it), which one of the following changes of its emission spectrum takes place?

- ☐ The peak relative energy remains almost the same but the peak is getting wider spreading toward both directions, so that an almost perfect white light spectrum is obtained (curve 1).
- ☐ The relative radiation energy increases. The wavelength of the peak maximum is shifted towards higher wavelengths (curve 4), a phenomenon known as 'red shift'.
- ☐ The relative radiation energy increases. The wavelength of the peak maximum is shifted toward smaller wavelengths (curve 2).
- ☐ The relative radiation energy increases. The wavelength of the peak maximum does not change, being exclusively dependent on the wire material (curve 3).

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Characterize the following pairs of features or terms as either related exclusively to **Gas Chromatography** (GC), to **High Performance Liquid Chromatography** (HPLC), or to **both** (GC+HPLC):

Polarity of mobile phase, post-column reactor.

Size exclusion, isocratic elution.

Analyte derivatization, theoretical plate.

Packed column, silanization process.

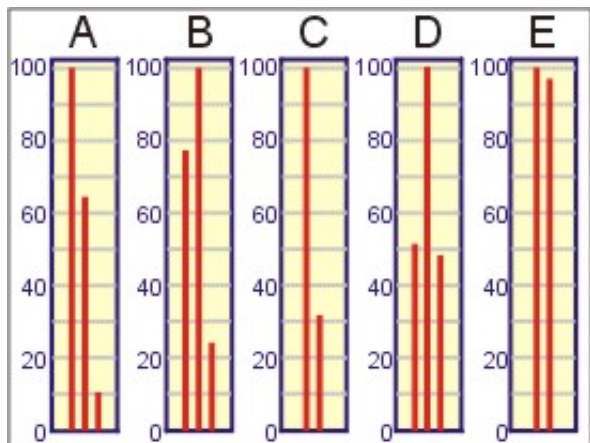
Temperature programming, Kovats' number.

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Associate the ionic fragments listed below with the isotopic lines (A-E)

shown in the figure. The natural isotopic abundances of the elements involved are:

^{35}Cl : 75.8%; ^{37}Cl : 24.2%; ^{79}Br : 50.7%; ^{81}Br : 49.3%



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Cl_2^+

Br_2^+

ClBr^+

Cl^+

Br^+

Submit

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