

# A3

# Contents

Chapter 1 .....	1
Introduction .....	2
Theory.....	2
Chapter 2 .....	3
Instrumentation .....	4
Light Source.....	4
Burner Assembly .....	5
Optics.....	6
Detector .....	8
Signal Processing .....	8
Chapter 3 .....	9
AAS Techniques .....	10
Flame Analysis.....	10
Graphite Analysis .....	11
Hydride Analysis .....	11
Chapter 4 .....	12
Interferences .....	13
Chemical Interference.....	13
Matrix Interference .....	13
Emission Interference .....	14
Ionisation interference .....	14
Spectral Interference .....	14
Background Interference .....	14
Deuterium Arc(D2) .....	15
Self Reversal (SR).....	15
Zeeman .....	16
Chapter 5 .....	17
Standard Flame Conditions .....	18
Analytical Wavelength .....	18
Bandwidth.....	18
Filter Factor .....	19
Lamp Current .....	19
Integration .....	19
Background .....	20
Flame Type .....	20
Sensitivity.....	20
Detection limit.....	21
Working Range .....	22
Standards Solution .....	23
Interference .....	23
Element Data Sheets.....	23
Aluminium .....	24
Antimony.....	25

Arsenic.....	26
Barium .....	27
Beryllium .....	28
Bismuth .....	29
Boron.....	30
Cadmium .....	31
Calcium .....	32
Chromium .....	33
Cobalt .....	34
Copper .....	35
Dysprosium .....	36
Europium .....	37
Gold.....	38
Indium .....	39
Iron.....	40
Lead .....	41
Lithium .....	42
Magnesium .....	43
Manganese .....	44
Molybdenum .....	45
Nickel.....	46
Palladium.....	47
Phosphorus.....	48
Platinum .....	49
Potassium .....	50
Rhodium .....	51
Rubidium .....	52
Scandium .....	53
Selenium.....	54
Silicon .....	55
Silver.....	56
Sodium .....	57
Strontium.....	58
Tantalum .....	59
Tellurium .....	60
Thallium.....	61
Tin .....	62
Titanium .....	63
Tungsten .....	64
Vanadium .....	65
Zinc.....	66
Chapter 6.....	67
Graphite Furnace Analysis .....	68
Graphite Tube .....	69
Graphite Conditions.....	69
Acidity.....	69
Interferences.....	69

<b>Graphite Element Data Sheets .....</b>	<b>70</b>
<b>Aluminium .....</b>	<b>71</b>
<b>Antimony.....</b>	<b>72</b>
<b>Arsenic.....</b>	<b>73</b>
<b>Barium .....</b>	<b>74</b>
<b>Beryllium .....</b>	<b>75</b>
<b>Bismuth .....</b>	<b>76</b>
<b>Cadmium .....</b>	<b>77</b>
<b>Chromium.....</b>	<b>78</b>
<b>Cobalt .....</b>	<b>79</b>
<b>Copper .....</b>	<b>80</b>
<b>Gold.....</b>	<b>81</b>
<b>Iron.....</b>	<b>82</b>
<b>Lead .....</b>	<b>83</b>
<b>Manganese .....</b>	<b>84</b>
<b>Molybdenum .....</b>	<b>85</b>
<b>Nickel.....</b>	<b>86</b>
<b>Palladium.....</b>	<b>87</b>
<b>Platinum .....</b>	<b>88</b>
<b>Rhodium .....</b>	<b>89</b>
<b>Silver.....</b>	<b>90</b>
<b>Strontium.....</b>	<b>91</b>
<b>Thallium.....</b>	<b>92</b>
<b>Titanium .....</b>	<b>93</b>
<b>Vanadium .....</b>	<b>94</b>



# Chapter 1

- Introduction
- Theory

## Introduction

Atomic Absorption Spectrophotometers (AAS) have become an industry standard for many elemental determinations within specific industries. There are three main techniques for AAS which are flame, graphite and hydride. All of which have their own advantages and disadvantages due to analytical problems. The flame technique, being the most common, will determine trace levels (usually ppm) for most analytical elements and it is also the most cost effective technique. If a determination of a lower level is required (usually ppb) the graphite technique can be used. There are a number of elements that can form volatile hydrides and these can be analysed using the hydride technique.

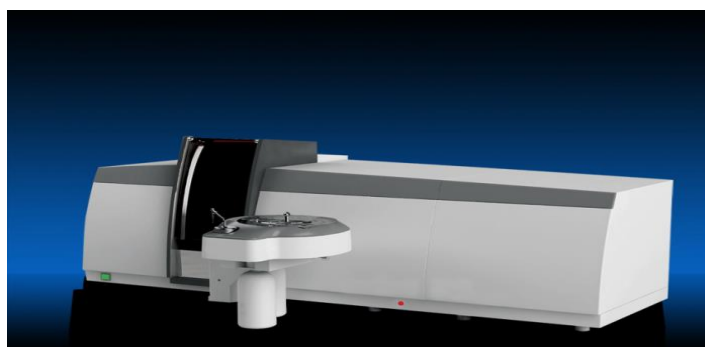
## Theory

### Atomic Absorption Analysis

A hollow cathode lamp containing a coated cathode of the element that is to be analysed is used as a light source. The light source emits a beam of a specific wavelength across the burner and into the monochromator. The sample is aspirated into the flame at the burner which converts the aerosol into an atomic vapour and excites the ground state atoms into an excited state. The atom absorbs light energy at a specific wavelength as it enters the excited state and as the atoms increase the amount of light absorbed will also increase. The amount of light absorbed can be measured and used for a quantitative determination of the amount of analyte in a sample.

### Atomic Emission Analysis

For the determination of some elements, usually high wavelengths, a variation of the standard flame technique can be performed which called atomic emission. There is no need for the hollow cathode lamp to be fitted as a light source as the technique relies on the spectral emission from the flame. The sample is aspirated into the flame which causes the ground state atoms to convert to an excited state. As the excited state is very unstable they return to the ground state and emit an emission spectrum consisting of a number of emission wavelengths. The intensity of an emission line will therefore increase as the number of excited atoms of the specific element increases. The specific wavelength of the emission can be used for a quantitative analysis to determine the element concentration of a solution.



# Chapter 2

- **Instrumentation**
- **Light source**
- **Burner assembly**
- **Optics**
- **Detector**
- **Signal processing**



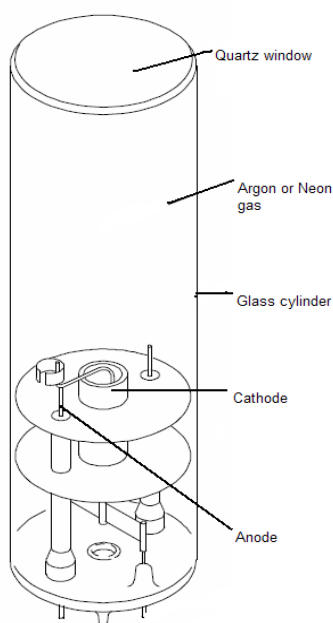
## Instrumentation

The Atomic Absorption Spectrophotometer is made up of five essential components. Light source, burner assembly, optics, detector and signal processing. Each component is designed to produce minimum disruption to the overall system and many design features are installed to keep the signal to noise ratio as low as possible.

### Light Source



The light source used in an AAS is a Hollow Cathode lamp (HCL). The HCL has a cathode which is made up using the element to be analysed and is surrounded by a shield. There is also an anode and both anode and cathode are sealed in a glass cylinder which is filled with the carrier gas of Argon or Neon. A lamp filled with neon will produce a red beam and a lamp filled with argon will produce a blue beam. On the end of the glass cylinder is a quartz glass window which is used for optimum transmittance of the emitted radiation.



The cathode is normally made up from a pure element for a single element lamp and there are up to 60 individual versions available depending on the lamp manufacturer. It is possible to also use a multi-element lamp which is constructed using a cathode made up of a mixture or alloy of several metals. The multi-element lamp can be used to analyse all the metals in the metal combination but they can have inferior performance and a shorter life than that of the single element. Although there are a lot of element combinations available not all elements can be mixed due to metallurgical limitations.

The hollow cathode lamp can produce a stable narrow beam light source which is ideal for Atomic absorption. The intensity of the beam can be increased or decreased by adjusting the lamp current supply to the lamp. Most lamps will operate between 1mA – 12mA but the optimum figure can vary between elements and conditions. As the current is increased the intensity increases and the beam widens causing a less concentrated beam across the burner which will reduce the sensitivity performance. If the current is reduced to low the lamp will become unstable and also adjustments to the amplifier for the photomultiplier tube will have to increase.

Experiments can be carried out to check for the optimum lamp current for each element.

The life expectancy for hollow cathode lamp should be more than 5000mA/hours if used correctly. If the element is of a volatile nature, such as Lead, silver or Cadmium, extra care should be taken to keep the lamp current as low as possible, without any detriment to the performance, especially when using the self reversal background system fitted to the PG Instruments range of instruments.

## Burner Assembly

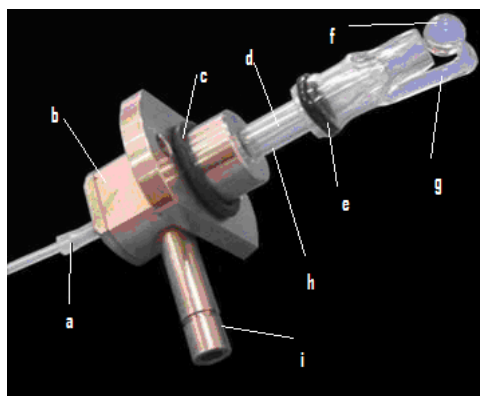
The burner system is made up of a burner, a premix chamber, an end block and a nebuliser.

The burner is made from titanium and has a 100mm or 50mm wide slot in the top for the flame. It fits into the top of the premix chamber and is sealed with o rings. There are two main types of flame available for Atomic Absorption, air acetylene and nitrous oxide acetylene and each is used depending on the element to be analysed. The air acetylene flame uses a 100mm slot burner and burns at approximately 2300C depending how the fuel flow is set at the control of the instrument. The flame can be adjusted by altering the gas flow rate to produce three different types of flame conditions.

- **Oxidising flame** This type of flame is a very weak flame and when observed it has a completely blue line sitting on top of the burner. It is used for elements that are easily atomised like cadmium, lead, nickel etc..
- **Reducing flame** A reducing flame is a fuel rich flame which produces an excess of Carbon and Hydrogen atoms which help to breakdown the oxide bonds which form with some element like chromium, tin etc. The flame can be observed to be bright yellow/white.
- **Stoichiometric flame** This is the final type of flame which falls in the middle of lean to rich and its appearance is blue with a yellow translucent band above. The type of flame is used for elements that are not so easily atomised like iron etc.

There are some elements which are easily atomised in all flame conditions and a good example of this is copper. This element is easy to use, sensitive and not flame dependent which is why it is almost always used for setting up adjustments and optimisation of the AAS instrument.

The premix chamber is made from an inert material (PTFE) and is designed to mix the aerosol from the nebuliser and the gas flow to the burner. The mixture is pushed through the slot in the burner where it is heated by the flame. It is important that the premix is sealed to the other surrounding components so that no air is drawn in and a positive pressure can be maintained



- a: Sipper tube with flexible connection
- b: Metal body
- c: O ring
- d: Capillary tube
- e: O ring
- f: Glass ball
- g: Glass ball support
- h: Nebuliser outer glass
- i: Air inlet connection tube

The nebuliser is attached and sealed to the end block and this in turn is secured and sealed to the pre mix chamber. The standard nebuliser is a cross flow which operates by an airflow being passed across the capillary tube and causes a suction up the sample tube. The sample tube is attached to the capillary tube and is used as a sipper for the sample. The sample travels up the tube into the capillary tube and the aerosol formed hits a glass ball which breaks down the aerosol into a fine mist. At this point only about 10% of the original sample carries on to the premix chamber and the other 90% which are large droplets go to waste. The 10% of the original sample then mixes with the flow

gas and the final sample that will convert to absorbing atoms can be as low as 0.1%. As can be seen the system is extremely inefficient.

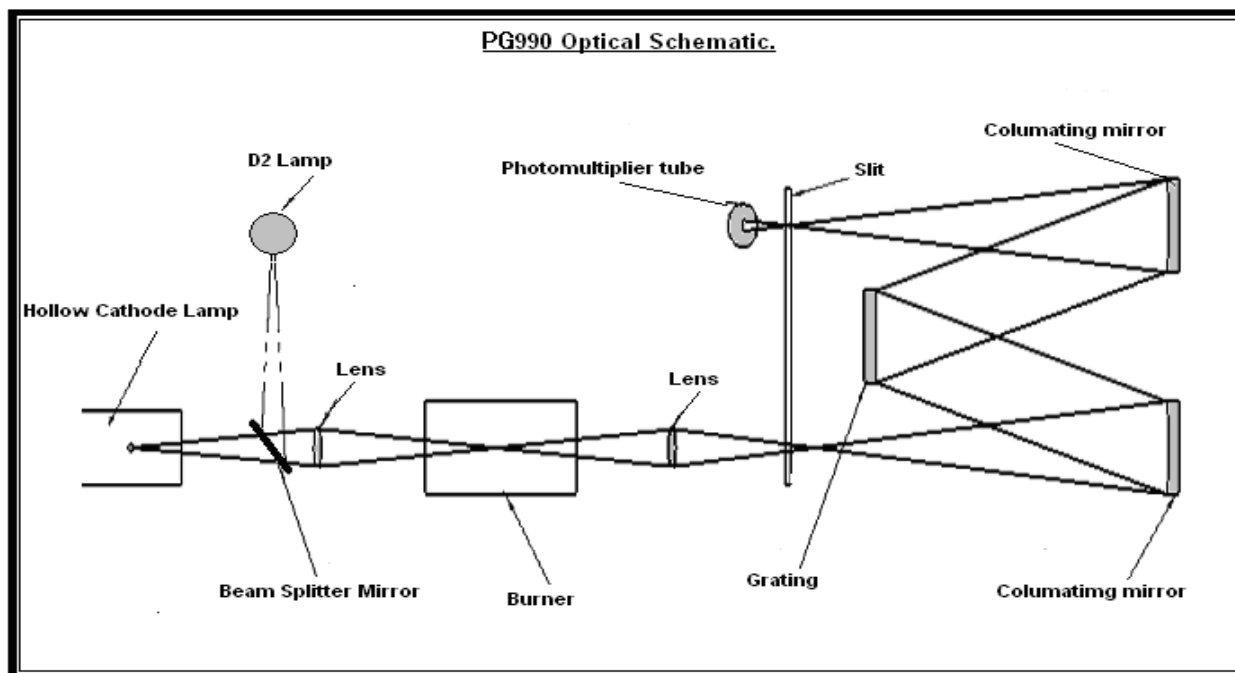
The waste liquid runs away to a drain trap and to a waste container. The waste trap acts as a one way valve so that there is no chance of any air being drawn into the premix system assembly or flame.

A nitrous oxide acetylene flame can be used for analysing elements that require a higher temperature to atomise such as titanium, aluminium, etc. The burner used for this flame has a 50mm width slot and flame can reach temperatures of more than 3000C. It is a more difficult flame to control and great care should be taken in its use as carbon solids can form at the burner slot which can eventually clog up and cause an explosion in the premix chamber. All modern atomic absorption spectrophotometers are now very safe with a number of safety features and all are fitted with a flashback device that will blow out in the event of a pressure build up within the premix assembly.

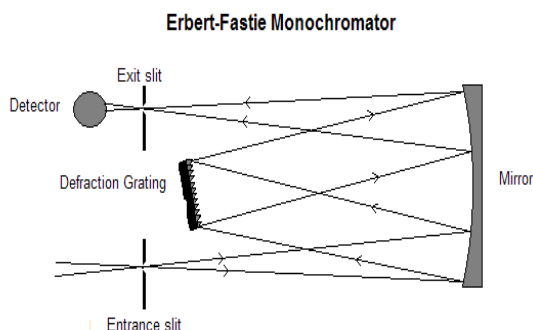
## Optics

The optics of an Atomic Absorption Spectrophotometer needs to be low loss, stable and very accurate to maintain the quality of the measurements and for these reasons the minimum amount of mirrors are used.

The light beam passes through the first lens which focuses it at the middle of the burner slot and then passes through a second lens. This focuses the beam through the entrance slit to the monochromator. The focus positions will vary according to the wavelength to be read due to the refractive index of the lens but this can be minimised by the use of macro lenses used in most instruments today. Lenses are made of silica glass and have good light transmission over a wide wavelength range of 190nm-900nm. They have the optimum refractive index in the Ultra Violet region at approximately 250nm as this is the area for the majority of analytical wavelengths used in the system.

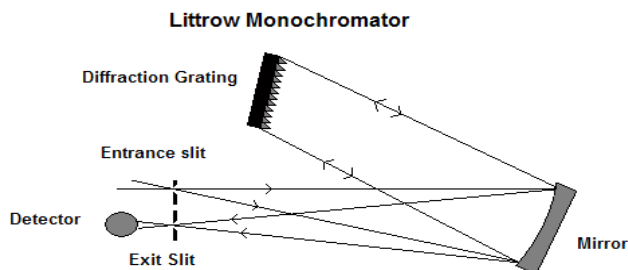


The light enters the entrance slit and into the monochromator where the analytical wavelengths are resolved by the use of a diffraction grating. The monochromator most widely used is a Czerny Turner (CT). It consists of an entrance slit, collimating mirrors, diffraction grating and exit slit. This is the Monochromator that is used in the A3 range of instruments.



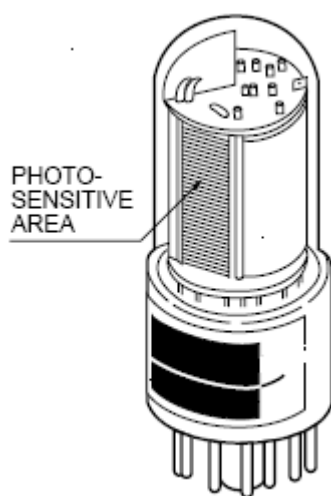
Another design of AAS monochromator is the Erbert-Fastie. This is similar to the Czerny-Turner but it uses only one collimating mirror to focus the light onto the diffraction grating and then focus again onto the exit slit. It is generally cheaper to produce but more difficult to align for resolution.

The third design of monochromator is the Littrow. This is similar to the Erbert-Fastie but it uses the same position of the mirror to focus the light to the grating and then to the detector. This design is not so popular as there can be more optical problems in use.



The Czerny-Turner monochromator used in the A3 has a hollow graphic grating fitted to enable maximum light throughput and excellent resolution of the peaks. The light after entering the entrance slit hits the first collimating mirror which focuses the light onto the diffraction grating. This splits the light into a spectrum and with accurate positioning the wavelength required is seen at the exit slit after being re-focused by the second collimating mirror. The monochromator is extremely accurate device and is capable of resolving peaks within the spectrum which is required for the accuracy of the readings. The movement of the grating is driven from an electrical motor that drives a sign bar attached to the bottom of the grating. Linearity over the whole wavelength range relies on the accurate length of the sign bar. Accuracy is also achieved by performing a full wavelength calibration that reads a number of Mercury lines with a mercury hollow cathode lamp fitted. The instrument calculates a graph which is used when setting the wavelength for a given element to be analysed. The entrance and exit slit work together and are adjustable between 0.1nm and 2nm. They are designed to cut down the spectrum to be resolved within the monochromator and remove unwanted lines that can interfere with the analysis peak. Some elements have wavelengths that are close to interfering lines and for this we can select a smaller slit. Other elements have no lines that can interfere so therefore the slit can be opened to allow more light throughput.

## Detector



The most commonly used type of detector for AAS is the photomultiplier tube (PMT). It is extremely sensitive to light and provides a current output proportional to light intensity. The PMT consists of a photocathode and a series of dynodes in an evacuated glass enclosure. The amplification of the PMT is dependent on the number of dynodes and the accelerating voltage. The supply voltage is varied from -300VDC to -1000VDC which allows a wide range of amplification for different elements and applications. They are also very stable devices and are ideal for low intensity applications like atomic absorption spectroscopy or fluorescence spectroscopy. There are a wide range of devices available which can cover a small dedicated wavelength range for maximum performance or there are devices that cover a wide wavelength range with compromised performance. The wide range device is fitted to the 990 range of instruments and has a wavelength range of 190nm to 900nm.

## Signal Processing

The final part of the Atomic Absorption instrument is the signal processing. This converts the analogue signal from the photomultiplier tube to a digital signal. This signal is processed by an onboard computer PCB and the data is transferred to the operating software at the PC system. Accurate readings are required to achieve the kind of results needed for analytical analysis and to achieve the specified limit of detection for each element.

# Chapter 3

- **AAS Techniques**
- **Flame Analysis**
- **Graphite Analysis**
- **Hydride Analysis**

## AAS Techniques

There are three main techniques for AAS analysis and each have their strengths and weaknesses depending on the type of analysis required. There are a number of factors to consider when deciding which technique will suit the application. For example:

- Detection limits
- Working range
- Speed of analysis
- Automation
- Sample volume
- Sample matrix
- Equipment cost
- Precision of results
- Element suitability
- Available space required
- Clean area
- Method development
- Running costs

## Flame Analysis

The flame instrument is the standard technique used for general purpose analysis. The readings are normally accepted to be trace levels of ppm and nearly all elements can be analysed to this level. There is a choice of Air/Acetylene flame used for easily ionised elements and Nitrous Oxide/Acetylene flame for the more difficult elements. The flame technique requires a number of extra components to complete the installation. An air compressor is required to produce an oil free air supply, acetylene gas cylinder and line installation is required to produce ultra pure acetylene gas and a suitable fume extraction system with a fume hood over the burner compartment is required. Once the installation is in place the operation of the system would be the simplest technique for the chemist to set up and run routinely. The system can be automated by the use of an auto sampler but care should be taken with unattended operation especially when using Nitrous Oxide/Acetylene. There are a number of advantages and disadvantages for this technique:

Advantages	Disadvantages
Good precision normally less than 1% RSD	Detection limit high only ppm
Good working range about $10^3$	Many chemical and matrix interferences
Good sensitivity	Ionisation can frequently occur
Virtually no spectral interference	High sample volume about 0.5ml/sample
Sample throughput about 10sec/sample	Low dissolved solids only about 3% acceptable
Ease of use is good	Difficult to fully automate for unattended use
Simple method development	Requires combustible gasses
Straightforward optimisation	
Low initial cost	
Low running costs	

## Graphite Analysis

The graphite analysis technique uses an assembly containing a graphite tube to replace the burner. This technique is used to analyse very low levels with small sample volumes. Although the detection limit is very low, the precision is almost always higher than that of the flame technique. The installation requires a supply of pure argon gas and a water circulator for the cooling of the graphite head. The footprint of the system will also increase to include a graphite power supply unit which requires a separate 40Amp power supply. Once installed the graphite technique needs a lot of optimisation and method development which can be time consuming for the chemist. When used routinely it is a much slower technique and can be costly to replace the graphite tubes on a regular basis with only about 300 firings per tube. The system can be automated easily, left unattended with no problem even overnight and will produce better precision and accuracy without human interference. There are however some advantages and disadvantages for this technique.

Advantages	Disadvantages
Low detection limit normally ppb	Poor linear working range about $10^2$
Excellent sensitivity	Poor precision about 2-3%RSD
Virtually no ionisation	Some spectral interference
Low sample volume about 20ul	Chemical and matrix interference
High dissolved solids acceptable up to 20%	Low sample throughput up to 3-4min/sample
System easily automated	Difficult method development
No combustible gasses required	Difficult to optimise
	Difficult routine analysis
	Higher initial cost
	Higher running costs

## Hydride Analysis

The hydride technique requires an additional unit to add to the flame AAS system. The unit is easily installed requiring only argon gas and a mains power supply. It can easily sit in front of the burner compartment and with the installation of the heated quartz glass cell on top of the burner it is easily connected. The technique can be messy with the addition of chemicals and high acid and is not easily automated especially when left unattended. There are two ways to use the hydride, one is with the tube on the top of the burner which is heated used for hydride forming elements and the other is for Hg analysis which is a cold vapour technique with the tube being left cold. The technique is very successful with very low detection limits achievable and a reasonably sample throughput although sample preparation can be a problem. There are some advantages and disadvantages with this system.

Advantages	Disadvantages
Good detection limits usually ppb	Poor precision
Good linear working range	Chemical interference can be a problem
Good sensitivity	Messy with different chemicals
Fairly low sample volume	Sample throughput slow
No combustible gasses	Limited number of elements
Inexpensive unit to add to AAS	Difficult method development
Low running costs	Difficult optimisation
Easily installed	Difficult routine use
	Not easily automated



# Chapter 4

- **Interferences**
- **Chemical**
- **Matrix**
- **Emission**
- **Ionisation**
- **Spectral**
- **Background**

## **Interferences**

Interferences can be a major problem when analysing using an Atomic Absorption Spectrophotometer. If the correct action is not taken then the result will be affected. There are six main types of interferences that can give problems, most of which can be resolved with the correct information. The six types are chemical, matrix, emission, ionisation, spectral and background.

### **Chemical Interference**

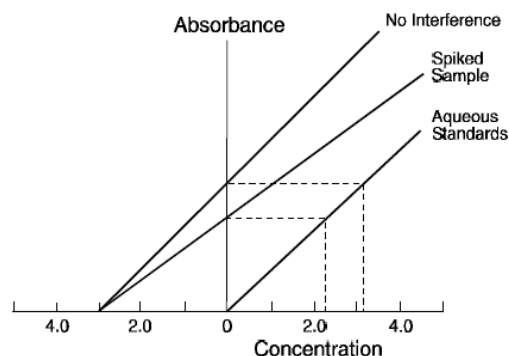
The most common type of interference is the chemical interference. If the analyte is not fully decomposed by the energy of the flame the number of atoms capable of absorbing light is reduced. This is a chemical interference and can be controlled or removed by using a higher temperature flame to add additional energy to breakdown the compound or an addition of a releasing agent to the sample. If a releasing agent is used this will react with the interfering element and release the analyte to be analysed.

A typical example of chemical interference is the analysis of calcium. When analysed using an air acetylene flame and there is a presence of phosphate, the signal is greatly reduced depending on the amount of phosphate. If a large amount of lanthanum is added the calcium is released from the solution irrespective of the amount of phosphate present. If a nitrous oxide acetylene flame is used however there is little or no chemical interference present in the sample and the addition of the releasing agent is not required.

### **Matrix Interference**

Matrix interference occurs when the physical characteristics of the sample, standard or blank solution are considerably different. It could be due to dissolved solids, acid concentrations or solvents which can enhance or suppress the signal. If a solvent is present with the sample the signal will be increased due to the viscosity change causing the nebuliser to become more efficient but if acid is present the signal would reduce due to the opposite change in viscosity. To compensate for matrix interferences it is important to match the matrix components in the sample, standards and blank solutions. If it is not possible to completely match the matrix components then a method of standard addition can be used. The procedure for using the standard addition method is straight forward and can be selected in the AA Win software package.

The standards are made up by spiking aliquots of the sample with varying amounts of the element to be analysed and then diluting to the same matched volume. The standards are measured and plotted against the added analyte. The plotted graph is extrapolated to determine the concentration of the sample.



## Emission Interference

When measuring high concentrations of highly emissive elements and the emissions fall within the spectral band pass selected, poor analytical precision and incorrect signals can be seen. To compensate for this interference

- The slit can be reduced
- Increase in lamp current may help
- Dilution of the sample
- Using a cooler flame

## Ionisation interference

Ionisation interference occurs when the electrons are removed from the atoms which will create an ion. This reduces the ground state atoms and the absorbance reading is reduced.

The ionisation effect can be reduced or eliminated by adding alkali metals to the standards, blank and samples. Sodium or potassium work well as they have very low ionisation potentials. It is also possible to reduce the ionisation effect using a cooler flame but care must be taken in case a chemical interference is to be a problem.

## Spectral Interference

Spectral interference can be a problem when the sample contains a large number of elements. Some of these elements could have wavelengths that are almost the same as the one being analysed and could fall inside the band width selected. The result would be a high signal made up of the measured element and the interfering element. Multi-element lamps can also be a problem if the bandwidth is set to large and more than one line would be seen resulting in enhanced readings. To resolve this problem a smaller bandwidth or an alternative wavelength can be selected.

## Background Interference

The most common type of interference is the background interference. When analysing an element the detector will measure an absorbing peak at the wavelength selected. There is also however a background absorption present caused by molecular species and solid particles present in the flame. The result is the signal absorption is increased as the detection will see the analyte peak plus the background absorption. To overcome this problem all Atomic Absorption Spectrophotometers are fitted with background correction systems. There are three main types of background correction systems available. Deuterium Arc, Self Reversal and Zeeman.

## **Deuterium Arc(D2)**

The D2 system is the most common, fitted to virtually all instruments available and consists of a fitted Deuterium Arc lamp and beam splitter mirror. The lamp is a continuum source which emits a spectrum of radiation covering the ultra violet range of wavelengths but as most of the background absorption occurs in this region it is used for most general purpose analysis. The beam from the D2 lamp is set up to coincide with the beam from the hollow cathode lamp and it is important that these beams are accurately adjusted. The lamps are pulsed out of sequence and when the hollow cathode lamp is on its emission is seen at the detector. When the D2 lamp is on this emission is seen at the detector. The difference between the two readings is the absorption due to the analyte atoms alone and this is the significant figure used for the result. D2 background is used for general purpose and has the following main points to consider when used.

### **Advantages**

- Background correction up to 1.0Abs.
- High frequency good for graphite.
- Good general purpose analysis
- High hollow cathode and D2 lamp life
- Inexpensive to manufacture.

### **Disadvantages**

- Extra lamp fitted
- Accurate alignment of beam required.
- Balancing of beams required.
- Limited use only ultra violet wavelength range.

## **Self Reversal (SR)**

The self reversal background system is not as common as the D2 system with it being fitted by only a small number of manufactures including PG Instruments where it is provided as standard on all the 990 range of instruments. The system uses the same hollow cathode lamp that is fitted for the analysis and relies on the accurate pulsing. There are two different pulses at the HCL, a wide pulse which is the normal pulse used for the elemental analysis and a narrow pulse which is used for the background. The wide pulse can be set between 1mA - 8mA as normal and the narrow pulse is set to 2.5mA for all elements except for the very volatile elements where it is set to 1.5mA. Although the narrow pulse current is low the pulse is very narrow so its intensity is very high. This intense pulse at the hollow cathode lamp causes the beam to broaden and eventually self absorption occurs which produces a double peak that straddles the resonance wavelength.

The detector reads the absorption of the beams from the hollow cathode lamp during the wide beam and the narrow beam switching, As with the D2 system the resultant can be used for the analysis. There are some key point below which should be taken into account when using this system.

### Advantages

- Same lamp used no alignment.
- Can be used for all wavelengths
- Background correction up to 3Abs
- Inexpensive manufacturing cost.

### Disadvantages

- Low frequency. Problems with graphite analysis.
- Loss of sensitivity.
- Reduced lamp life.
- More expensive HCL lamp required for volatile elements.

## Zeeman

This background system is generally used for graphite analysis and is fitted to a number of instruments but it is not used by PG Instruments on any of the range.

The system works by splitting the spectrum beam from the hollow cathode lamp into pi and sigma lines by the presence of a magnetic field. The split produces one pi line which is the line to be measured for the analyte and two sigma lines which are measured for the background. The two sigma lines are wavelength shifted to either side of the pi line. When the magnetic field is not applied the resultant signal at the detector is measured including the background. When the magnetic field is applied the pi line is filtered out and the two sigma lines are measured. The resultant significant reading is the difference between the pi and the sigma absorption signals. Below is some key points to take into consideration when using this background correction system.

### Advantages

- Accurate system uses same optical path.
- High frequency ideal for graphite.
- Can be used at any wavelength.

### Disadvantages

- Loss of sensitivity about 20%
- Expensive manufacturing costs.
- Bulky designs.

## **Chapter 5**

- **Standard Flame Conditions**
- **Analytical Wavelengths**
- **Bandwidth**
- **Filter Factor**
- **Lamp Current**
- **Integration**
- **Background**
- **Flame Type**
- **Sensitivity**
- **Detection Limit**
- **Working range**
- **Standard Solution**
- **Interference**
- **Element Data Sheets**

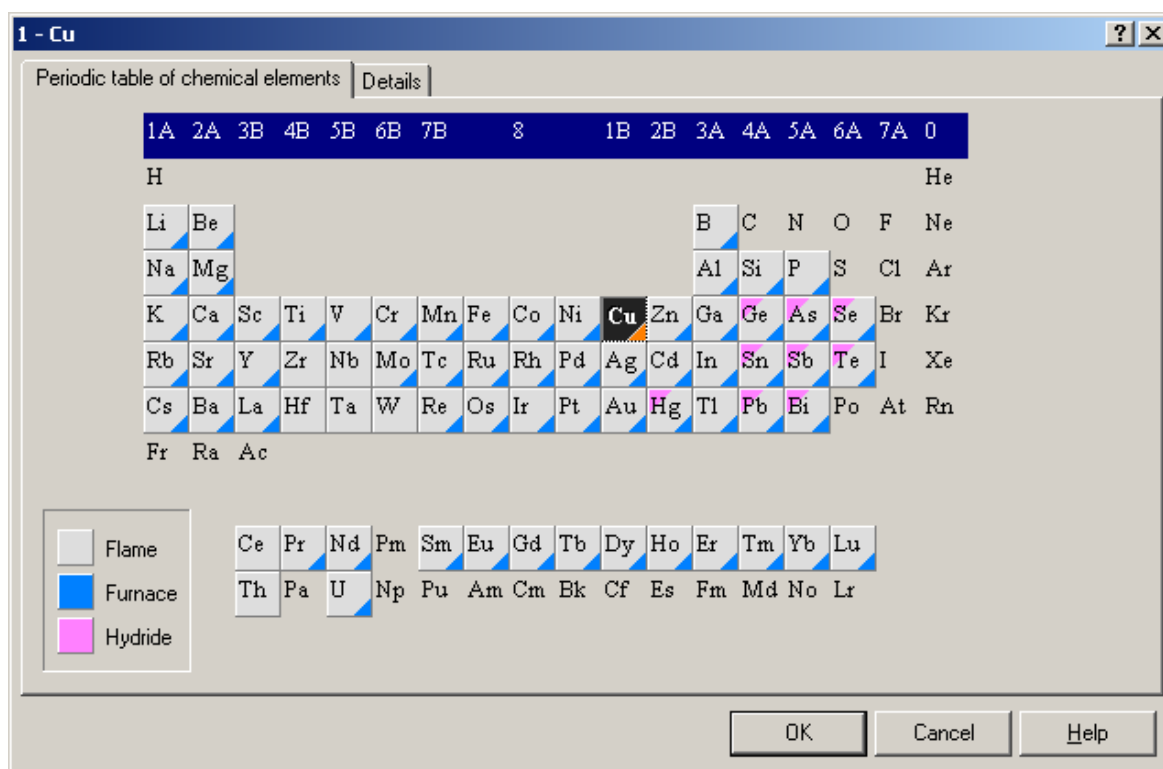
## Standard Flame Conditions

This chapter describes how to use the standard flame conditions to achieve good results. It will explain each section in some detail to give a better understanding of the operation of the atomic absorption instrument.

**Note:** When using the element data sheets please note that the information is there for guidance only and optimum analysis settings may vary slightly due to the different types of samples.

## Analytical Wavelength

The analytical wavelength for each element shown on the data sheets is the most sensitive line in each case. This will give the best performance and achieve the detection limits described. However in some cases, due to high concentration levels, background problems with low wavelength or problems with matrix dilutions, it may be necessary to choose a less sensitive or higher wavelength line. The data sheets show the most useful alternative lines and the detection limit expected when used. The element to be measured can be selected in the software from the periodic table which gives the wavelengths and shows which analysis can be performed.



## Bandwidth

The bandwidth shown on the data sheets are the optimum conditions for the element but it is possible to use alternative settings to overcome problems with the analysis, If there is an interference caused by an alternative element then the bandwidth should be decreased to filter out the problem. One major problem is

with the use of multi element hollow cathode lamps which can cause spectral interference and the lowering of the bandwidth can overcome this.

The bandwidth can be selected from 5 settings and is measured in nm. 0.1, 0.2, 0.4, 1.0 and 2.0.

## Filter Factor

The filter factor is used to smooth out the absorbance reading during an analysis and is selectable from 0.1 to 2.0. When analysing with the flame it is advisable to increase the filter factor to maintain a smooth and more accurate reading. When using the graphite furnace however, the reading is taken in peak height or peak area over a short duration according to the width of the analyte peak so therefore the filter factor should be set to the lowest possible position to obtain maximum readings.

## Lamp Current

The figures shown for the lamp currents are the recommended settings for each analysis. This can be changed to improve performance if required. The lamp current should not exceed 10mA at any time as it will cause damage to the hollow cathode and reduce its warranty. By adjusting the current it will increase or decrease the emission from the hollow cathode lamp which will broaden or narrow the beam through the optics. If the current is low, the beam will be narrow and more intense across the burner slot which will increase the sensitivity of the readings but if it is set to low the readings will become unstable. On the other hand if the current is set high the beam will broaden which will reduce the sensitivity and if set to high will also give noisy unstable readings. The lamp current in general should be set between 3mA and 6mA to give the best results.

## Integration

There are four main types of integration available to choose from. Manual, Auto, peak height and peak area.

### Manual

The operator can select an integration time of 0.1seconds to 99.9seconds, a delay time and number of readings required. When the read is selected the instrument will carry out one integration and then stop until the read is selected again. This type of integration is not used for normal analysis but is used where one quick reading is required.

### Auto

Auto is used for general purpose use including analysis which requires flame auto sampler use. The operator can set the integration time, delay and number of readings at the computer and when the read is selected the instrument will read the number of integrations selected at the specified integration time. The result will be the mean value of all the integrations taken and the standard deviation including the relative standard deviation figure.



## **Peak Height**

Peak height integration will read the maximum signal seen during an integration time which makes it ideal for graphite furnace and hydride analysis. When selected with the graphite furnace analysis the start of integration can be set just before the atomisation process. A peak will be seen on the screen and the height will be measured. There is however a use for peak height integration when in the flame mode and that is when the operator has very small volumes of sample. The integration can be set to a long time, maybe 10 seconds, and after the read is started the sample can be introduced into the flame. At some point during the integration time the absorbance reading will increase to a maximum for a short time and this peak height figure can be used for the result.

## **Peak Area**

This can also be used for graphite furnace and hydride analysis. As with peak height, the integration can be set to cover the width of the peak being analysed but this time the area under the peak will be measured. Peak area is ideal for analysing volatile elements where the integration peak reading is very quick causing the height of the peak to be erratic over a number of readings. In this case the area would still be constant irrespective of the variation of peak height.

## **Background**

The selection of background correction for the 990 instrument can be one of three methods, deuterium arc, self reversal or none. The types and operation of the background systems have been dealt with in chapter 4 so the operator just needs to decide which system is correct for their analysis. If the analysis requirement is to analyse an element whose wavelength is lower than 250nm then almost certainly this will require a background correction system to be used. If the sensitivity is important and the background in the sample is low, then it would be best to choose the D2 system. If however the sample contains a large amount of the element to be analysed and sensitivity is not an issue then it would be best to choose the self reversal system. For higher wavelength elements the background is not so much of a problem so unless there is a high background associated with the samples there is no need to select any background system at all. For samples with high background, the self reversal can be used.

## **Flame Type**

There are only two selections for the flame type, air/acetylene and nitrous oxide/acetylene. The data sheets show which should be used for each individual elements. The flame can be adjusted by selecting the acetylene flow within the software which should be optimised for each element before starting the analysis. Care should be taken when using nitrous oxide/acetylene flame as a carbon build up will form at the jaw of the burner and if left unattended will block causing an explosion within the premix system. There is however a safety blow out at the back of the premix which will stop any damage to the system. If a flashback occurs and the blow out is forced out, please make sure this is resealed before trying to light the flame again.

## **Sensitivity**

Sensitivity (characteristic concentration) can be defined as the concentration of an element required to produce a signal of 1% absorption or 0.0044 absorption units. A concentration can be measured and the sensitivity can be calculated by using the equation:

$$\text{Sensitivity (characteristic concentration)} = \frac{\text{concentration of standard} \times 0.0044}{\text{Absorption}}$$

The figure for each individual elements are shown on the data sheets and can be used to predict the range to be analysed.

The sensitivity or characteristic concentration for each element wavelength is an industry standard and quoted by all atomic absorption spectrophotometer manufacturers.

## **Detection limit**

This is the lowest concentration which can be differentiated from a blank solution taking into account the signal amplitude and the baseline noise. A number of blank readings can be taken and the result would be calculated as:

$$\text{Detection limit} = 3 \times \text{standard deviation.}$$

It can also be calculated by using a low standard between 3 and 5 times the expected detection limit. A number of readings can be measured and the result can be calculated by the equation:

$$\text{Detection limit} = \frac{\text{standard concentration} \times 3(\text{standard deviation})}{\text{mean value}}$$

The detection limit is not an area that can be used for analysis and a factor should be used to give a realistic level. This factor can vary between industries but it would be between 2 and 4.65.

Below is a quick guide to detection limits:

Element	Wavelength (nm)	Flame mg/l(ppm)	Graphite* µg/l(ppb)	Vapour µg/l(ppb)
Aluminium (Al)	309.3	0.028**	0.13	n/a
Antimony (Sb)	217.6	0.092	0.29	0.26
Arsenic (As)	193.7	0.12	0.33	0.05
Barium (Ba)	553.6	0.031**	0.23	n/a
Beryllium (Be)	234.9	0.0036**	0.02	n/a
Bismuth (Bi)	223.1	0.0049	0.26	0.19
Cadmium (Cd)	228.8	0.0028	0.01	n/a
Calcium (Ca)	422.7	0.0037**	0.60	n/a
Chromium (Cr)	357.9	0.0054	0.025	n/a
Cobalt (Co)	240.7	0.01	2.00	n/a
Copper (Cu)	324.8	0.0045	0.065	n/a
Gold (Au)	242.8	0.013	3.00	n/a
Iron (Fe)	248.3	0.0043	0.06	n/a
Lead (Pb)	217.0	0.013	0.03	n/a
Lead (Pb)	283.3	0.016	0.08	n/a
Lithium (Li)	670.8	0.0021	0.70	n/a
Magnesium (Mn)	285.2	0.0022	0.09	n/a
Manganese (Mn)	279.5	0.0016	0.03	n/a
Mercury (Hg)	253.7	n/a	40.0	0.15
Molybdenum(Mo)	313.3	0.021**	0.14	n/a
Nickel (Ni)	232.0	0.008	0.065	n/a
Potassium (K)	766.5	0.0009	0.40	n/a
Selenium (Se)	196.0	0.23	0.32	0.27
Silicon (Si)	251.6	0.30**	17.0	n/a
Silver (Ag)	328.1	0.0032	0.04	n/a
Sodium (Na)	589.0	0.0037	n/a	n/a
Tellurium (Te)	214.3	0.054	3.20	0.43
Thallium (Tl)	276.8	0.014	0.15	n/a
Tin (Sn)	224.6	0.21**	15.0	1.39
Titanium (Ti)	365.4	0.05**	4.0	n/a
Vanadium (V)	318.5	0.11**	0.7	n/a
Zinc (Zn)	213.9	0.0033	0.15	n/a

Note \*\* = Nitrous Oxide/ Acetylene flame.

## Working Range

The working range on the data sheets are a suggested range for each element and may vary depending on how the instrument is set up and the type of samples used. The operator should try and produce a standard curve using at least 3 points but preferably 5 that falls within the linear range for that element. If readings are taken outside this linear range they will become noisy and inaccurate as the response curves more and more. As a guideline it is usually safe for the highest standard to read a maximum of 0.500Abs. Some elements will naturally curve anyway and for these there is no large area of linearity that can be used so it can be a compromise. Calibration curve or quantitative analysis is based on Beers Law which stated that the concentration is proportional to the absorbance  $C = KA$ . If the analysis is carried out using a linear curve where it passes through the origin the equation for calculating the curve would be:

$$C=K_0(K_1A)$$

C= Concentration  
K<sub>1</sub>= coefficient of standards  
K<sub>0</sub>= reslope coefficient

For a linier calibration where the intercept is not fixed at zero. The equation would be:

$$A= K_1+K_2C$$

K<sub>1</sub> and K<sub>2</sub>= standard coefficients

For a non linier curve the rational equation would be:

$$C=K_0 \frac{K_1A+K_3A^2}{K_2A-1}$$

C= Concentration  
A= Absorption  
K<sub>1</sub> +K<sub>2</sub> +K<sub>3</sub>= Coefficients calculated from the standards

## Standards Solution

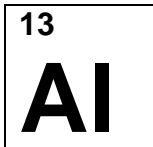
Bulk standards are usually available in 1000mg/l concentrations and have a shelf life of at least 1 year. These standards should be high purity with their own certificate supplied and traceable to NIST( National Institute of Standards and Technology). The working standards can be prepared in the laboratory by diluting the 1000ppm standard. It is good laboratory practice to first make up a low standard (maybe 10ppm) then dilute all the working standards from there to try and reduce error. Water is used for dilution in most cases and this should be de ionised for flame analysis and ultra pure if using the graphite furnace. It is also good practice to matrix match blanks and standards and prepare them the same as the samples. There are a number of reasons for this, viscosity, density, surface tension and solvent vapour pressure, which will all effect the aspiration rate of the nebuliser and give inaccurate results.

## Interference

The interference information on the element data sheets is there as a guide to try and solve problems associated with the individual elements. It gives suggestions of chemical additions to the samples and flame condition changes. Experiments should be carried out by the operating chemist to try and resolve chemical problems for their own individual samples. For more help with interference problems please contact your local agent or PG Instruments Ltd.

## Element Data Sheets

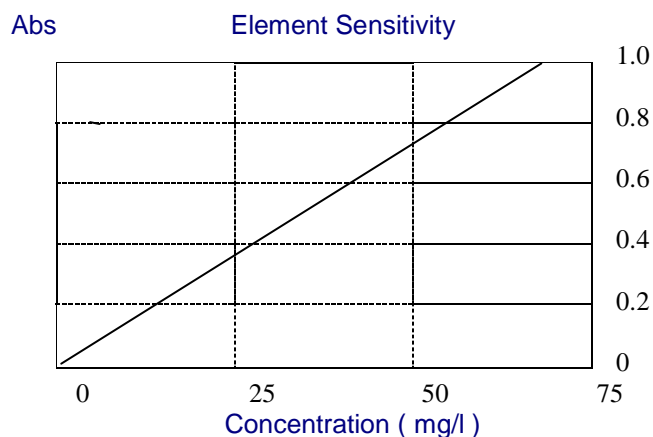
The following element data sheets will show the operating conditions for each element in alphabetical order. Please refer to the appropriate section in this chapter for the relevant explanation or information.



# Aluminium

## Analysis Parameters

<b>Analytical Line:</b>	309.3nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.6
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing red feather
<b>Sensitivity:</b>	0.30mg/l
<b>Detection Limit:</b>	0.03mg/l
<b>Working Range:</b>	0.14– 50.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	396.2nm	0.4nm	0.35mg/l	0.05mg/l	0.24 – 70mg/l
(3)	308.2nm	0.4nm	0.60mg/l	0.12mg/l	0.50 – 110mg/l
(4)	394.4nm	0.4nm	0.85mg/l	0.22mg/l	0.90 – 150mg/l

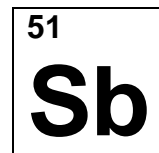
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

## Interferences

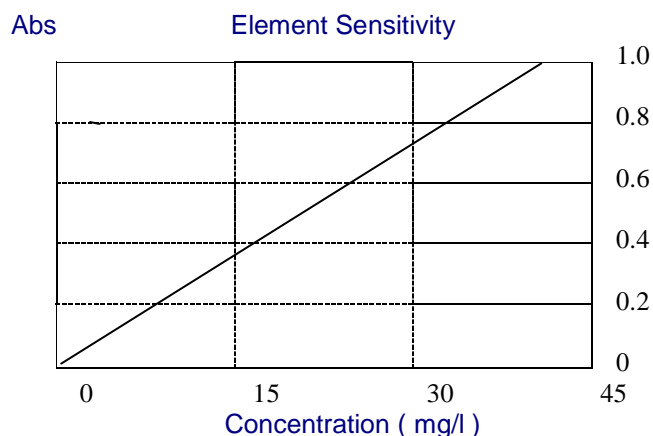
Element is ionised in N2O/Acetylene flame. Add K or La at 0.15% to reduce the interference. Signal is depressed when Ca, P or Si are present in solution.



# Antimony

## Analysis Parameters

<b>Analytical Line:</b>	217.6nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.15mg/l
<b>Detection Limit:</b>	0.06mg/l
<b>Working Range:</b>	0.07– 30.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

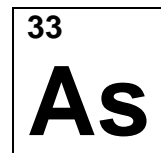
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	206.8nm	0.2nm	0.28mg/l	0.10mg/l	0.20 – 50mg/l
(3)	231.2nm	0.4nm	0.42mg/l	0.22mg/l	0.40 – 70mg/l
(4)	212.7nm	0.4nm	4.80mg/l	2.10mg/l	5.00 – 300mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

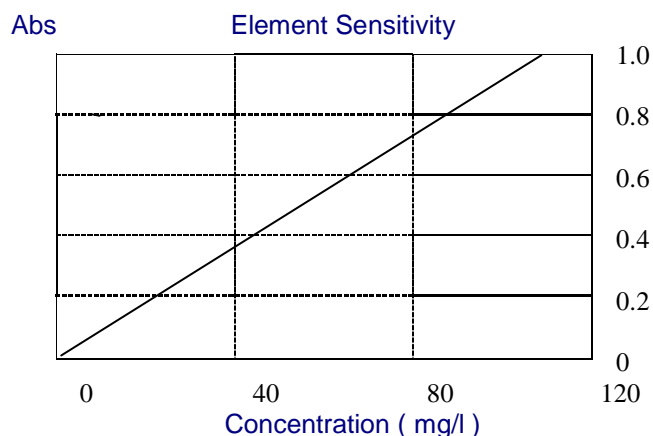
Signal can be depressed when solution made up in high acid. Significant levels of Cu and Ni Present in solution can reduce the absorbance reading.



## Arsenic

### Analysis Parameters

<b>Analytical Line:</b>	193.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.40mg/l
<b>Detection Limit:</b>	0.16mg/l
<b>Working Range:</b>	0.80– 75.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

### Alternative wavelengths

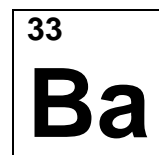
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 189.0nm	0.4nm	0.35mg/l	0.18mg/l	1.00 – 85mg/l
(3) 197.2nm	0.4nm	0.90mg/l	0.35mg/l	2.40 – 180mg/l

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

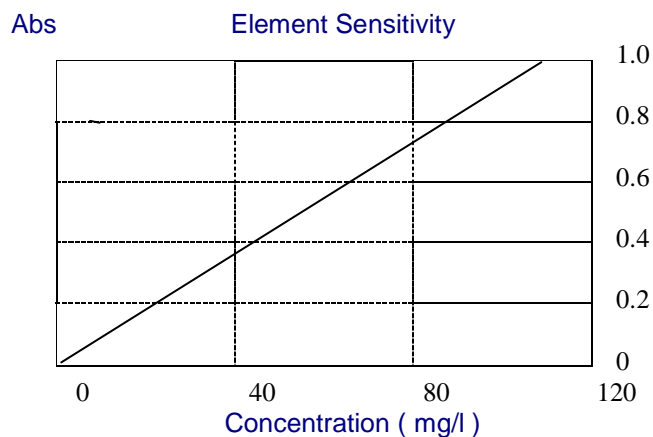
Background correction is recommended to reduce absorption by flame.



## Barium

### Analysis Parameters

<b>Analytical Line:</b>	536.6nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.40mg/l
<b>Detection Limit:</b>	0.09mg/l
<b>Working Range:</b>	0.60– 75.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

### Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	553.6nm	0.2nm	0.46mg/l	0.12mg/l	0.80 – 85mg/l
(3)	350.1nm	0.2nm	5.60mg/l	1.80mg/l	8.50 – 600mg/l

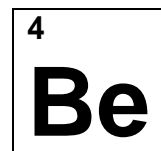
### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

Element is partially ionised in N2O/Acetylene flame. This can be reduced by adding 0.1% KCL To all solutions.

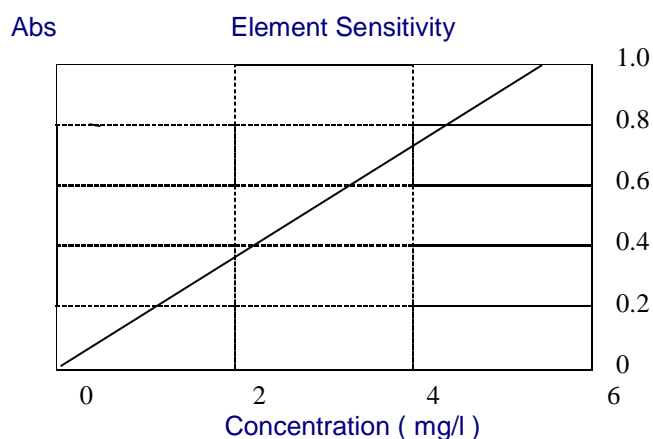




# Beryllium

## Analysis Parameters

<b>Analytical Line:</b>	234.9nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing red Feather
<b>Sensitivity:</b>	0.01mg/l
<b>Detection Limit:</b>	0.005mg/l
<b>Working Range:</b>	0.03– 4.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
------------	-----------	-------------	-----------------	---------------

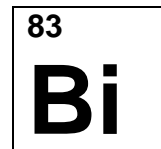
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

## Interferences

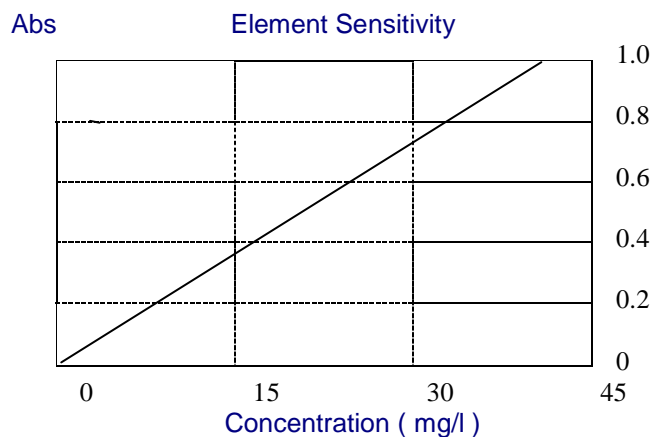
Signal can be reduced when Al, Mg, Na, Si at high levels are present in samples. Samples made up with 1% HF added can reduce the interference of Al. Adding Oxine will reduce the interference with MG and Si



# Bismuth

## Analysis Parameters

<b>Analytical Line:</b>	223.1nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.20mg/l
<b>Detection Limit:</b>	0.06mg/l
<b>Working Range:</b>	0.30– 30.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

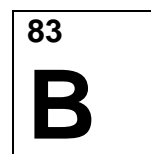
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	306.8nm	0.4nm	0.65mg/l	0.12mg/l	0.90 – 75mg/l
(3)	206.2nm	0.4nm	1.82mg/l	0.42mg/l	2.50 – 200mg/l
(4)	227.7nm	0.4nm	3.40mg/l	1.20mg/l	5.00 – 400mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

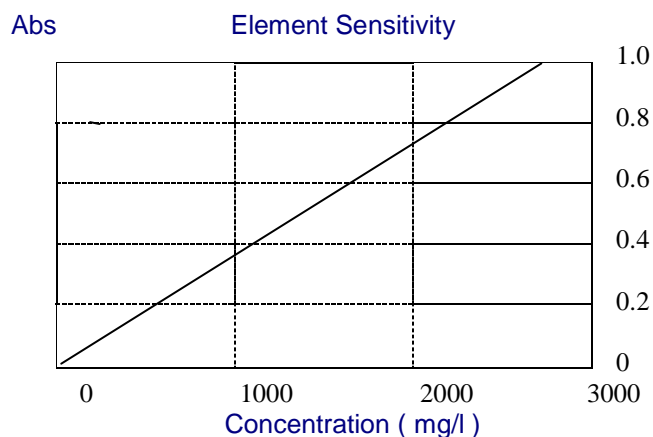
There are no major interferences with this element



# Boron

## Analysis Parameters

<b>Analytical Line:</b>	249.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	10.00mg/l
<b>Detection Limit:</b>	3.50mg/l
<b>Working Range:</b>	16.0– 1800mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 208.9nm	0.2nm	22.0mg/l	7.40mg/l	40.0 – 2500mg/l

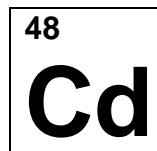
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

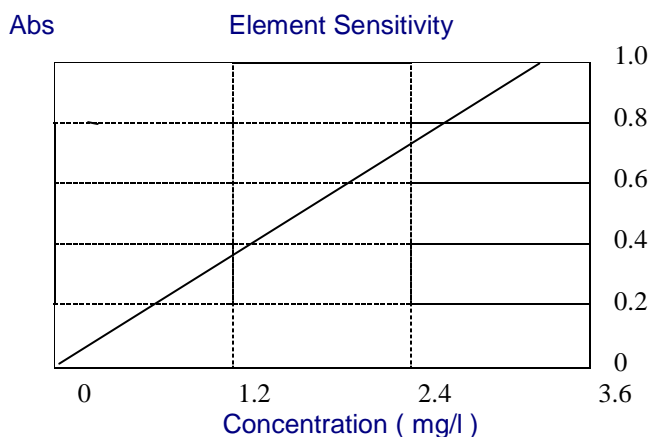
This is one of the lowest sensitive elements. High levels of Sodium can cause interference. This can be reduced by using a richer flame

# Cadmium



## Analysis Parameters

<b>Analytical Line:</b>	228.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.012mg/l
<b>Detection Limit:</b>	0.0028mg/l
<b>Working Range:</b>	0.02– 2.20mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

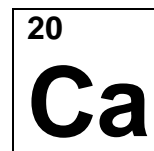
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 326.1nm	0.4nm	11.0mg/l	2.80mg/l	15.0 – 200mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

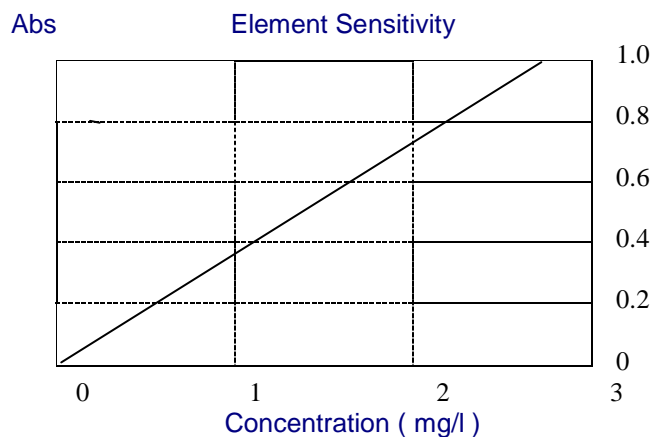
There are no major interferences with this element.



## Calcium

### Analysis Parameters

<b>Analytical Line:</b>	422.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.01mg/l
<b>Detection Limit:</b>	0.0042mg/l
<b>Working Range:</b>	0.02– 2.00mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

### Alternative wavelengths

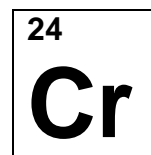
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 239.9nm	0.4nm	5.60mg/l	1.80mg/l	10.0 – 800mg/l

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

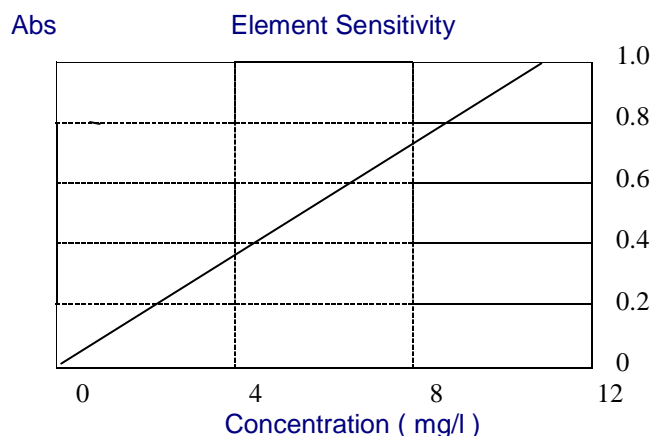
The element is partially ionised with N2O/Acetylene flame and can be improved by adding 1% Alkali salt to solutions. Sensitivity can be reduced by the presence Al, Be, P, Si, Ti. This can be resolved by adding 15 la to solutions.



# Chromium

## Analysis Parameters

<b>Analytical Line:</b>	357.9nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.05mg/l
<b>Detection Limit:</b>	0.005mg/l
<b>Working Range:</b>	0.04– 8.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	359.4nm	0.4nm	0.08mg/l	0.012mg/l	0.06 – 10mg/l
(3)	360.5nm	0.4nm	0.12mg/l	0.018mg/l	0.10 – 15mg/l
(4)	425.4nm	0.4nm	0.16mg/l	0.034mg/l	0.15 – 25mg/l

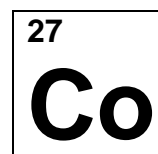
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

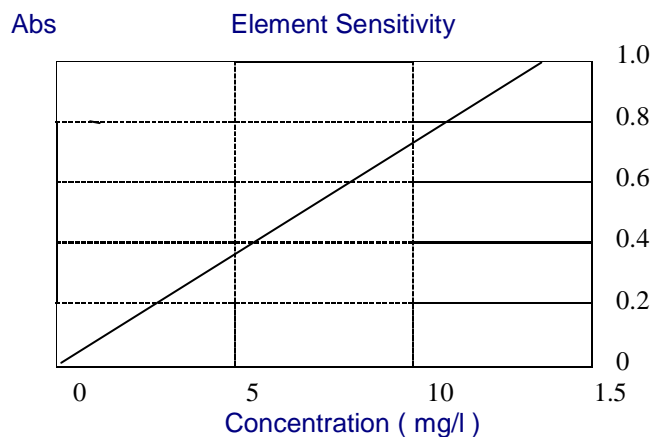
There are no major interferences when using N2O/Acetylene flame.

# Cobalt



## Analysis Parameters

<b>Analytical Line:</b>	240.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.05mg/l
<b>Detection Limit:</b>	0.01mg/l
<b>Working Range:</b>	0.04– 8.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	242.5nm	0.2nm	0.07mg/l	0.02mg/l	0.10 – 10.0mg/l
(3)	241.2nm	0.4nm	0.12mg/l	0.04mg/l	0.10 – 20mg/l
(4)	252.1nm	0.2nm	0.16mg/l	0.06mg/l	0.30 – 25mg/l

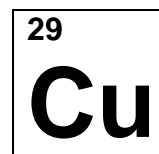
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

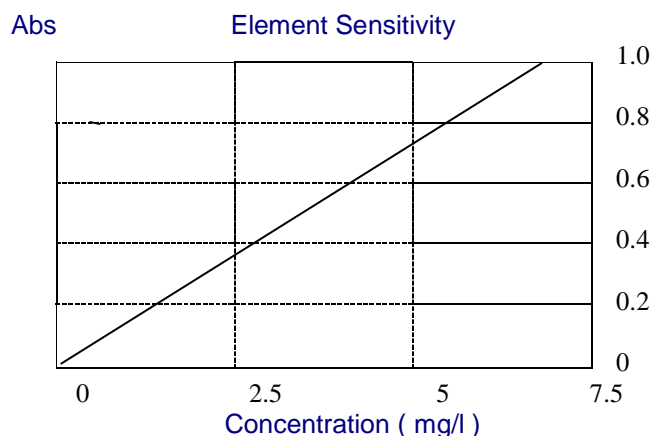
There are no major interferences with this element. High levels of Ni can reduce sensitivity.

# Copper



## Analysis Parameters

<b>Analytical Line:</b>	324.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.03mg/l
<b>Detection Limit:</b>	0.004mg/l
<b>Working Range:</b>	0.018– 4.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	327.4nm	0.4nm	0.06mg/l	0.01mg/l	0.05 – 8.0mg/l
(3)	216.5nm	0.2nm	0.07mg/l	0.02mg/l	0.10 – 15mg/l
(4)	222.6nm	0.4nm	0.75mg/l	0.24mg/l	1.30 – 120mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

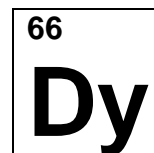
1000mg/l Standard solution: Part no.

## Interferences

There are no major interferences with this element.

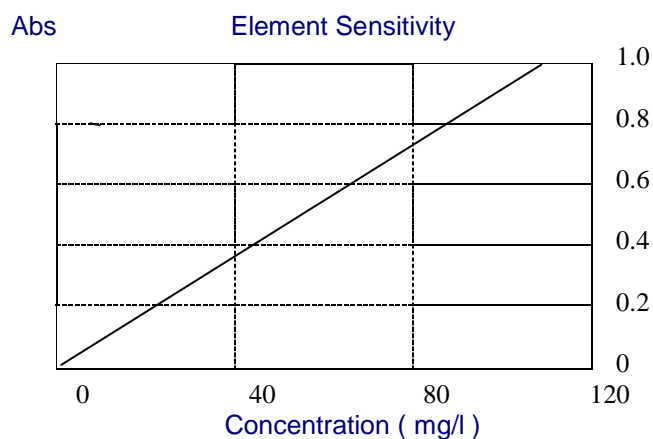


# Dysprosium



## Analysis Parameters

<b>Analytical Line:</b>	421.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.035mg/l
<b>Detection Limit:</b>	0.20mg/l
<b>Working Range:</b>	1.20– 70.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	404.6nm	0.2nm	0.55mg/l	0.36mg/l	1.65 – 100mg/l
(3)	418.7nm	0.4nm	0.60mg/l	0.40mg/l	2.00 – 120mg/l

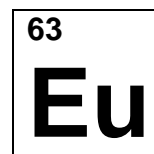
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

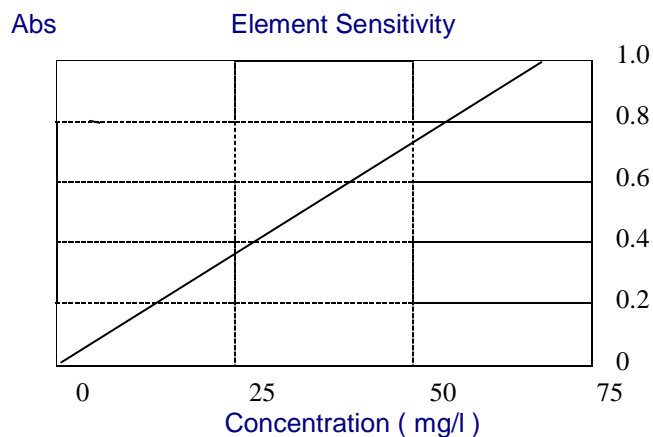
This element is ionised in the N2O/Acetylene flame. This can be reduced by adding 0.1% Alkali salt to the solutions.

# Europium



## Analysis Parameters

<b>Analytical Line:</b>	459.4nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.15mg/l
<b>Detection Limit:</b>	0.04mg/l
<b>Working Range:</b>	0.30– 45mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

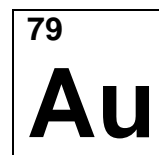
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 462.7nm	0.4nm	0.24mg/l	0.06mg/l	0.36 – 60mg/l
(3) 466.2nm	0.4nm	0.32mg/l	0.08mg/l	0.45 – 75mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

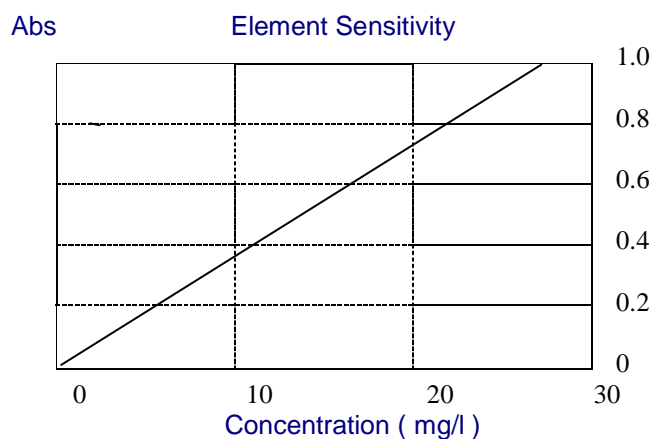
This element is ionised in the N2O/Acetylene flame. This can be reduced by adding 0.1% Alkali salt to the solution



# Gold

## Analysis Parameters

<b>Analytical Line:</b>	242.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.085mg/l
<b>Detection Limit:</b>	0.011mg/l
<b>Working Range:</b>	0.07– 15.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

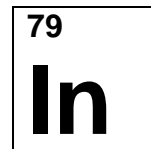
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 267.6nm	0.4nm	0.15mg/l	0.04mg/l	0.18 – 30 mg/l
(3) 312.3nm	0.4nm	210.0mg/l	40 mg/l	180 – 1000mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

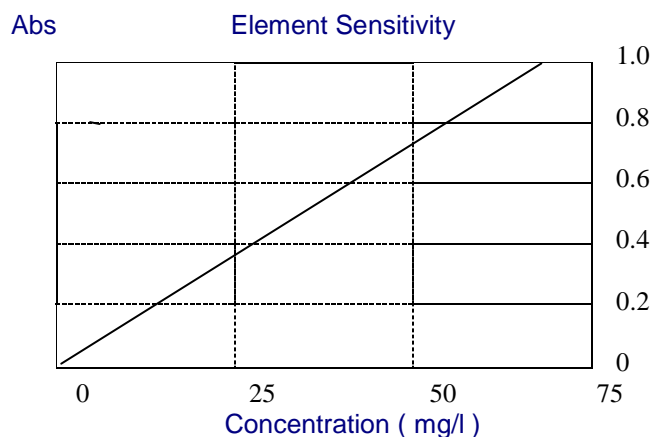
The signal can be depressed by the presence of large quantities of Fe, Cu, Co, Sn, Ca. The effect can be reduced by adding 1% U to the solutions.



# Indium

## Analysis Parameters

<b>Analytical Line:</b>	303.9nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.25mg/l
<b>Detection Limit:</b>	0.07mg/l
<b>Working Range:</b>	0.30– 40.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

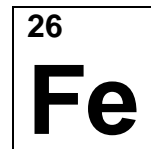
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	325.6nm	0.2nm	0.30mg/l	0.09mg/l	0.40 – 50mg/l
(3)	410.2nm	0.4nm	1.00mg/l	0.30mg/l	1.30 – 150mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

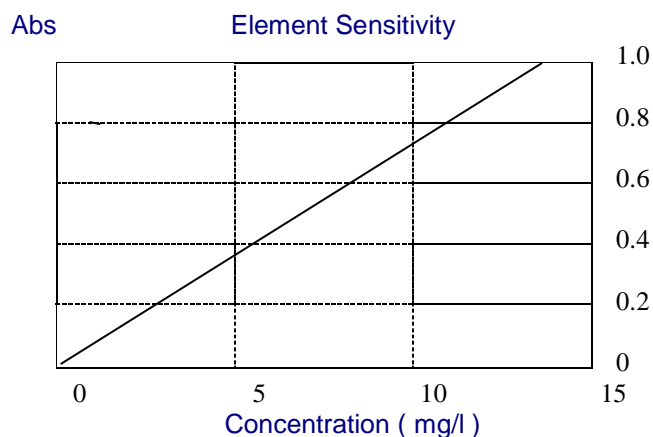
The signal can be depressed by the presence Phosphate in solution.



# Iron

## Analysis Parameters

<b>Analytical Line:</b>	248.3nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.05mg/l
<b>Detection Limit:</b>	0.0046mg/l
<b>Working Range:</b>	0.03– 8.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

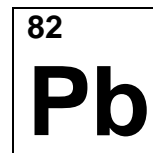
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	252.3nm	0.2nm	0.09mg/l	0.01mg/l	0.05 – 10mg/l
(3)	248.8nm	0.2nm	0.10mg/l	0.02mg/l	0.10 – 15mg/l
(4)	302.1nm	0.2nm	0.20mg/l	0.03mg/l	0.15 –20mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

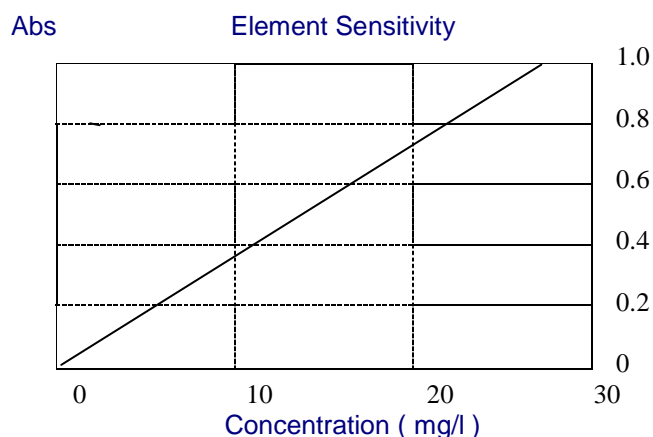
The signal can be depressed by the presence Al, Mg, Si in solution. This can be partially rectified by a cooler flame and a lower burner height. This element can have to oxidising states when used with reducing flame.



# Lead

## Analysis Parameters

<b>Analytical Line:</b>	217.0nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.08mg/l
<b>Detection Limit:</b>	0.012mg/l
<b>Working Range:</b>	0.08– 14.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

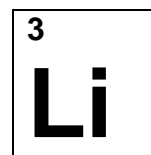
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 283.3nm	0.4nm	0.18mg/l	0.03mg/l	0.15 – 20mg/l
(3) 205.3nm	0.4nm	2.20mg/l	0.35mg/l	1.70 – 150mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

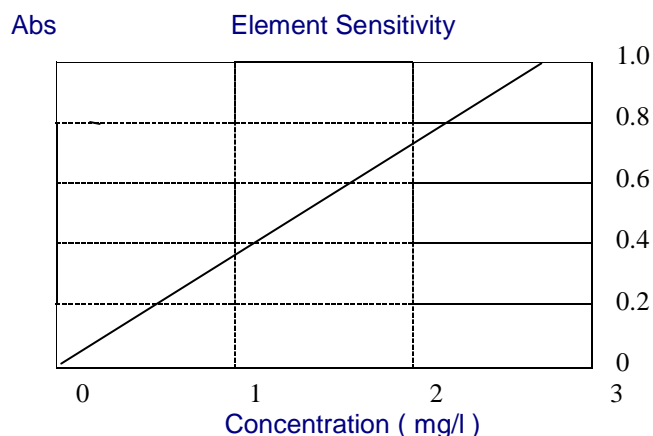
Several different Anions can reduce the sensitivity of the element. The effect can be reduced by adding 0.5% EDTA.



# Lithium

## Analysis Parameters

<b>Analytical Line:</b>	670.8nm
<b>Bandwidth:</b>	0.8nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.01mg/l
<b>Detection Limit:</b>	0.003mg/l
<b>Working Range:</b>	0.02– 2.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

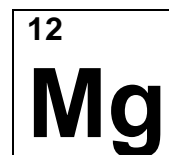
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 323.3nm	0.4nm	4.00mg/l	1.10mg/l	5.0 – 400mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

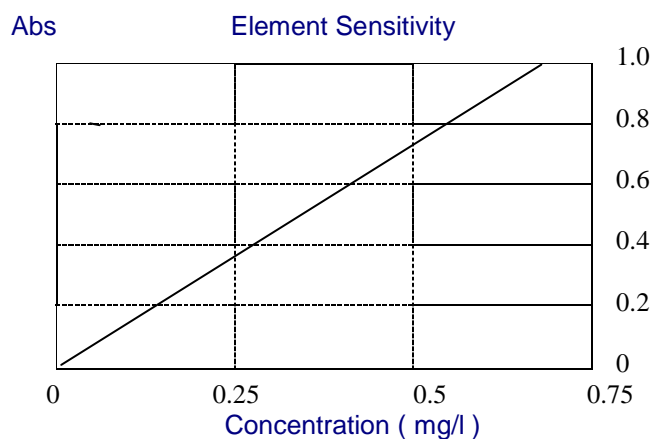
Ionisation can be reduced by adding K to the solutions. Any other interference can be eliminated by using N<sub>2</sub>O/Acetylene flame.



# Magnesium

## Analysis Parameters

<b>Analytical Line:</b>	285.2nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.003mg/l
<b>Detection Limit:</b>	0.0018mg/l
<b>Working Range:</b>	0.007– 0.4mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 202.6nm	0.4nm	0.10mg/l	0.07mg/l	0.32 – 25 mg/l

## Standard Solution

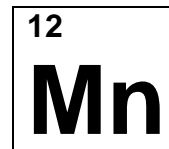
Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

## Interferences

The presence of Al, P, Si, Ti in large quantity can reduce the sensitivity. This can be eliminated by adding 1% lanthanum chloride.

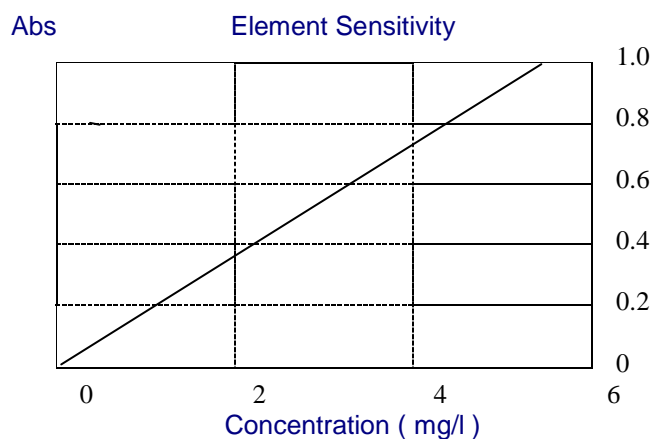




# Manganese

## Analysis Parameters

<b>Analytical Line:</b>	279.5nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.02mg/l
<b>Detection Limit:</b>	0.002mg/l
<b>Working Range:</b>	0.01– 3.5mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 279.8nm	0.2nm	0.03mg/l	0.004mg/l	0.02 – 7.0mg/l
(3) 280.1nm	0.4nm	0.07mg/l	0.020mg/l	0.10 – 15mg/l

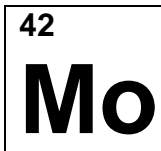
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

## Interferences

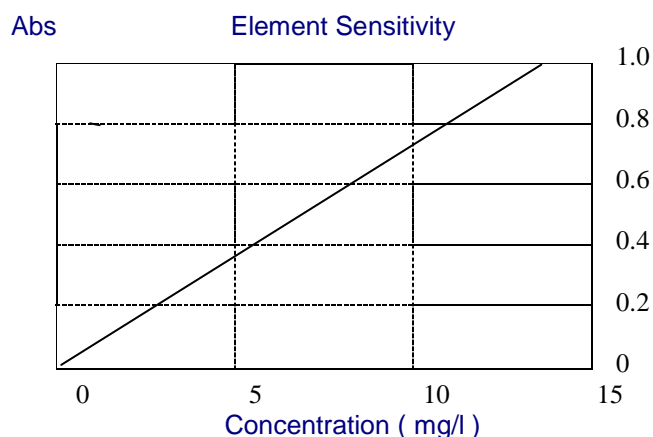
The presence of Silicon, Borate, Tungstate, Dichromate, Cyanide, Silicate can reduce the sensitivity. This can be improved by adding EDTA.



# Molybdenum

## Analysis Parameters

<b>Analytical Line:</b>	313.3
<b>Bandwidth:</b>	0.8nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red feather
<b>Sensitivity:</b>	0.20mg/l
<b>Detection Limit:</b>	0.04mg/l
<b>Working Range:</b>	0.20– 7.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

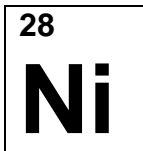
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	317.0nm	0.8nm	0.50mg/l	0.10mg/l	0.50 – 20mg/l
(3)	319.4nm	0.4nm	0.70mg/l	0.14mg/l	0.80 – 25mg/l
(4)	390.3nm	0.4nm	1.40mg/l	0.30mg/l	1.60 – 100mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

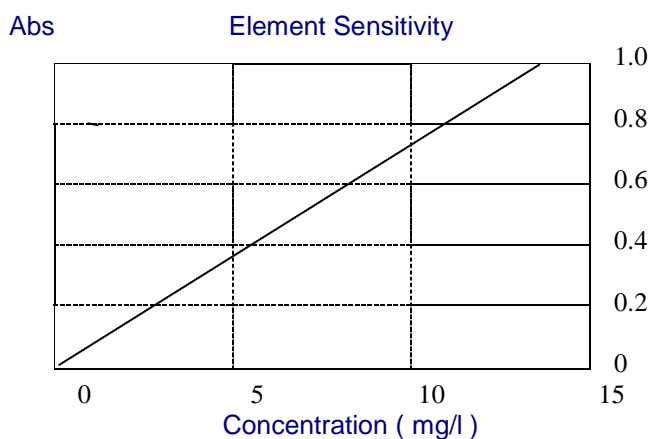
The sensitivity can be depressed when there is Ca, Fe, or Sr in the solution. The effect can be reduced by adding 2ppm Al to all the solutions.



# Nickel

## Analysis Parameters

<b>Analytical Line:</b>	232.0nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.05mg/l
<b>Detection Limit:</b>	0.008mg/l
<b>Working Range:</b>	0.04– 8.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

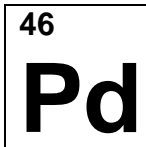
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	231.1nm	0.2nm	0.08mg/l	0.015mg/l	0.06 – 12mg/l
(3)	252.3nm	0.4nm	0.15mg/l	0.03mg/l	0.15 – 20mg/l
(4)	241.5nm	0.4nm	0.16mg/l	0.035mg/l	0.17 – 20mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

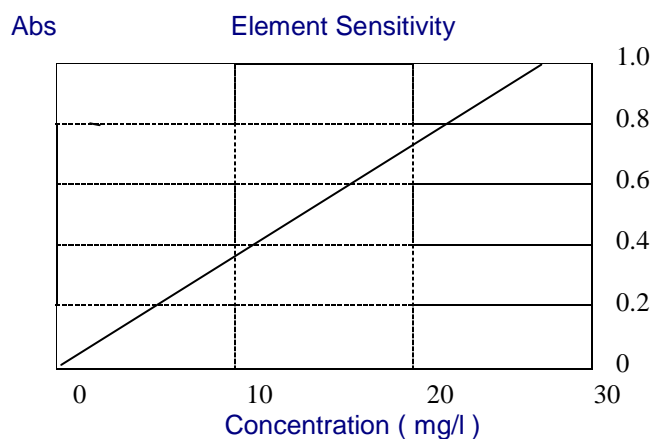
The sensitivity can be increased when there is high level of Cr or Fe in the solution. The effect can be reduced by using N<sub>2</sub>O/Acetylene flame but the sensitivity will be reduced.



# Palladium

## Analysis Parameters

<b>Analytical Line:</b>	244.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.08mg/l
<b>Detection Limit:</b>	0.03mg/l
<b>Working Range:</b>	0.20– 14.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

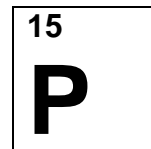
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 247.6nm	0.4nm	0.10mg/l	0.05mg/l	0.30 – 20mg/l
(3) 276.3nm	0.4nm	0.30mg/l	0.15mg/l	1.00 – 75mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

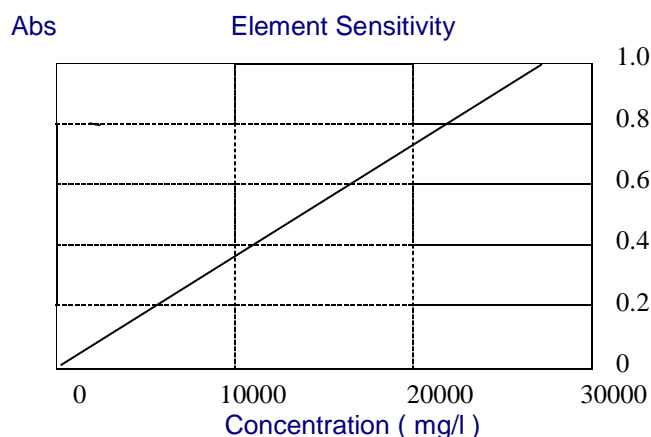
The sensitivity can be decreased when there is high level of Co, Ni or Al in the solution. The effect can be reduced by adding 0.5% EDTA to the solutions.



# Phosphorus

## Analysis Parameters

<b>Analytical Line:</b>	213.6nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	120.0mg/l
<b>Detection Limit:</b>	10.0mg/l
<b>Working Range:</b>	50.0– 18000mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

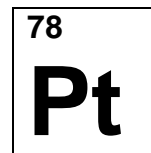
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 214.9nm	0.4nm	200.0mg/l	18.0mg/l	80.0 – 25000mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

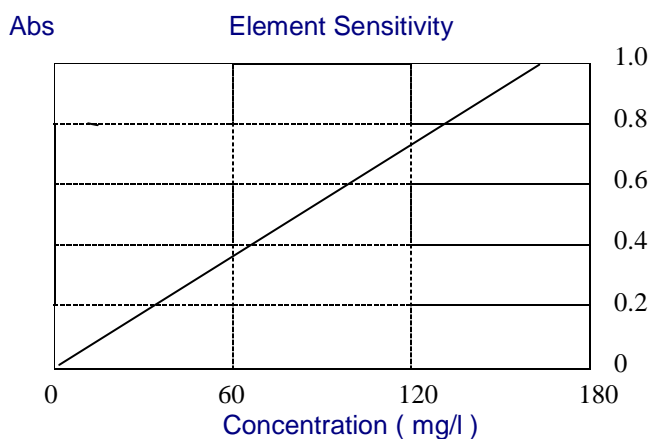
There are no major interferences for this element.



# Platinum

## Analysis Parameters

<b>Analytical Line:</b>	265.9nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.80mg/l
<b>Detection Limit:</b>	0.12mg/l
<b>Working Range:</b>	0.50– 100mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

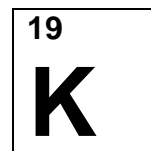
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	306.5nm	0.4nm	1.20mg/l	0.20mg/l	0.80 – 120mg/l
(3)	262.8nm	0.4nm	1.60mg/l	0.27mg/l	1.10 – 150mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

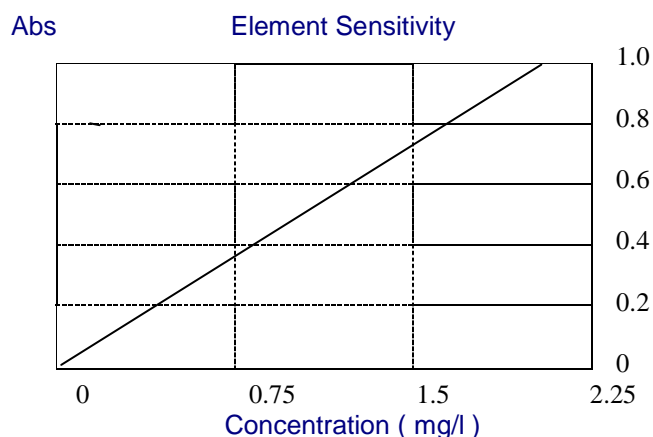
Most high level elements will affect the sensitivity. This can be reduced by adding 0.2% Lanthanum chloride in 1% HCL.



# Potassium

## Analysis Parameters

<b>Analytical Line:</b>	766.5nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.008mg/l
<b>Detection Limit:</b>	0.001mg/l
<b>Working Range:</b>	0.008– 1.2mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

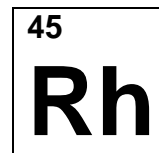
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	769.9nm	0.4nm	0.02mg/l	0.003mg/l	0.02 – 3.0mg/l
(3)	404.4nm	0.4nm	2.50mg/l	0.35mg/l	2.50 – 250mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

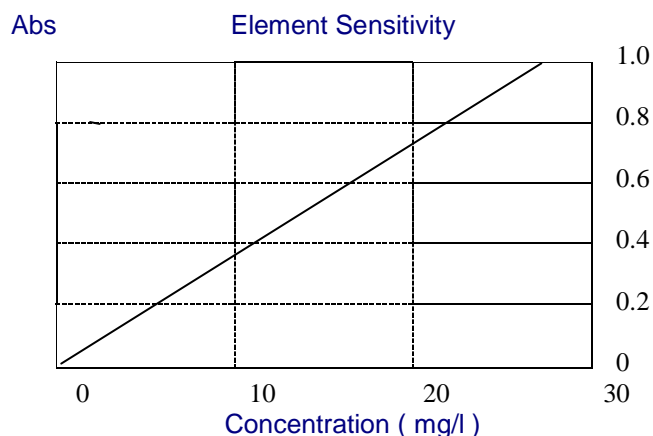
This element is partially ionised in the flame. This can be eliminated by the addition of La or Cs Salts.



# Rhodium

## Analysis Parameters

<b>Analytical Line:</b>	343.5nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.09mg/l
<b>Detection Limit:</b>	0.009mg/l
<b>Working Range:</b>	0.05– 15.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 369.2nm	0.4nm	0.16mg/l	0.02mg/l	0.09 – 20mg/l
(3) 339.7nm	0.4nm	0.20mg/l	0.03mg/l	0.15 – 25mg/l

## Standard Solution

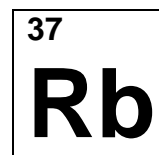
Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

Alkali metals can interfere with this element and reduce the sensitivity. Phosphoric and sulphuric acids can increase the sensitivity. The effect can be reduced by adding Na<sub>2</sub> So<sub>4</sub> to the solutions.

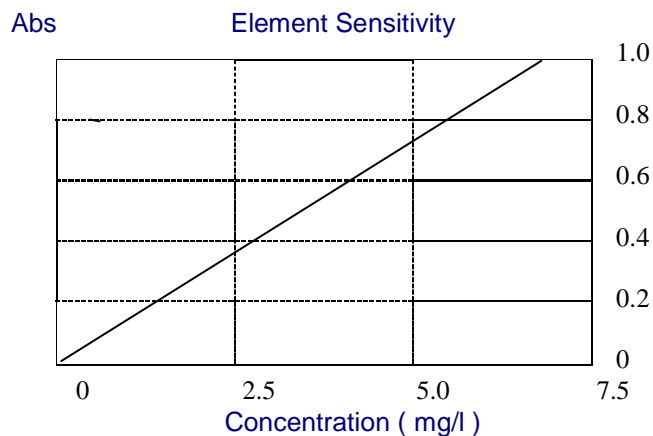


# Rubidium



## Analysis Parameters

<b>Analytical Line:</b>	780.0nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.02mg/l
<b>Detection Limit:</b>	0.003mg/l
<b>Working Range:</b>	0.015– 4.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

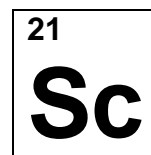
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 794.8nm	0.4nm	0.04mg/l	0.008mg/l	0.04 – 10mg/l
(3) 420.2nm	0.4nm	6.40mg/l	0.75mg/l	4.50 -150mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

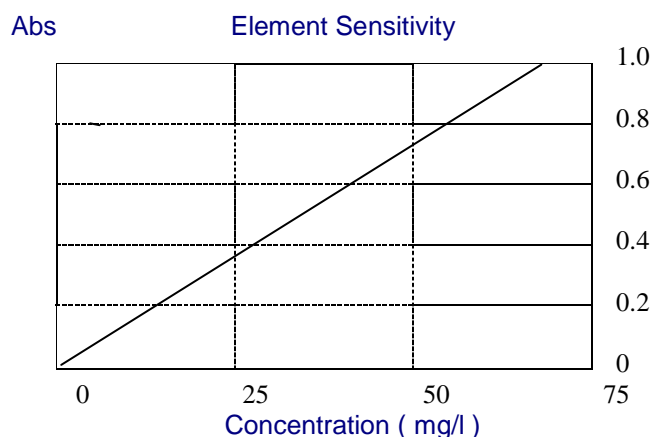
This element is ionised in the flame. By adding 0.1% Alkali salt to the solutions the effect can be reduced.



# Scandium

## Analysis Parameters

<b>Analytical Line:</b>	391.2nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.20mg/l
<b>Detection Limit:</b>	0.02mg/l
<b>Working Range:</b>	0.40– 40 mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	390.8nm	0.4nm	0.30mg/l	0.03mg/l	0.60 – 70mg/l
(3)	402.4nm	0.4nm	0.30mg/l	0.03mg/l	0.70 – 80mg/l

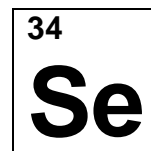
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

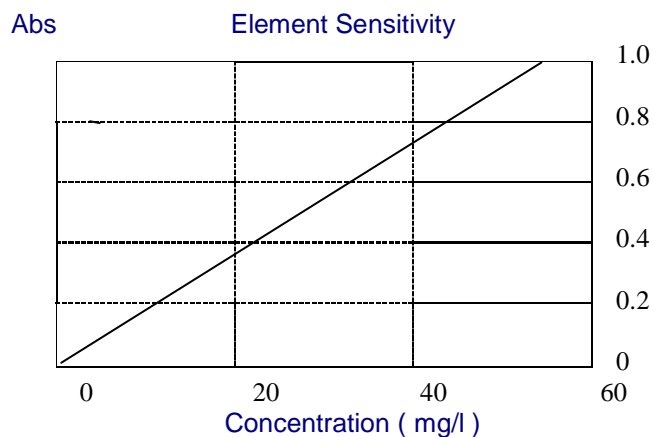
This element is ionised in the flame. By adding 0.5% Potassium Chloride to the solutions the effect can be reduced.

# Selenium



## Analysis Parameters

<b>Analytical Line:</b>	196.0nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.20mg/l
<b>Detection Limit:</b>	0.15mg/l
<b>Working Range:</b>	0.50– 30mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

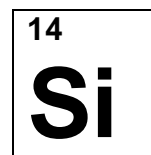
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 204.0nm	0.4nm	1.20mg/l	0.90mg/l	3.0 – 100mg/l
(3) 206.3nm	0.4nm	5.10mg/l	3.90mg/l	12.0 – 200mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

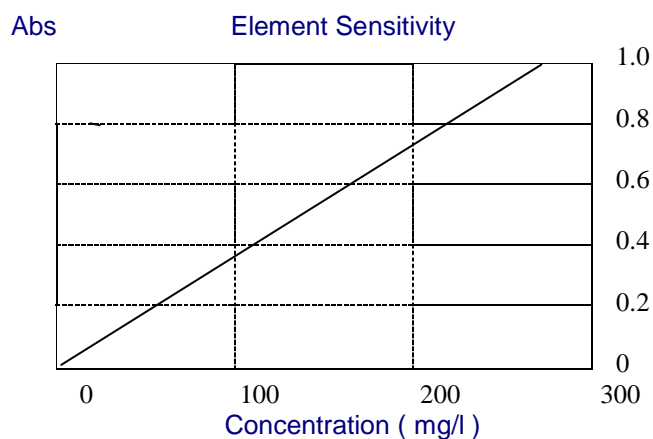
There are no major interferences for this element.



# Silicon

## Analysis Parameters

<b>Analytical Line:</b>	251.6nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	1.00mg/l
<b>Detection Limit:</b>	0.70mg/l
<b>Working Range:</b>	2.5– 150mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

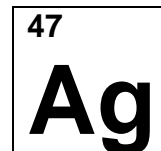
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 251.9nm	0.2nm	1.50mg/l	1.10mg/l	4.0 – 250mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

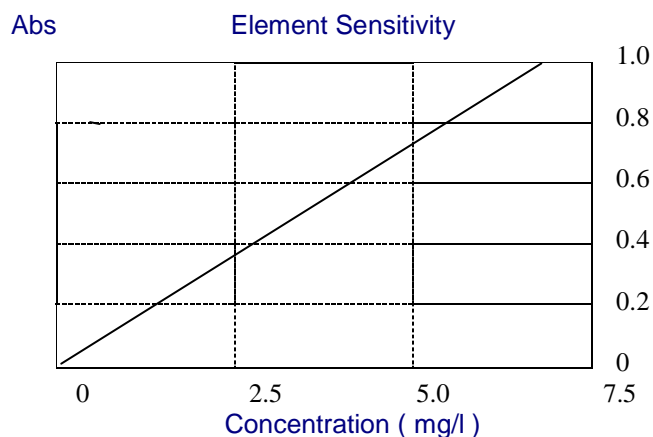
By adding 1% HF acid to the standards and samples will avoid precipitation. High levels of aluminium or Alkali solution can cause increase in signal.



# Silver

## Analysis Parameters

<b>Analytical Line:</b>	328.1nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.02mg/l
<b>Detection Limit:</b>	0.003mg/l
<b>Working Range:</b>	0.02– 4.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

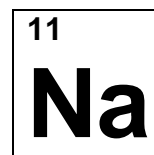
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 338.3nm	0.4nm	0.05mg/l	0.008mg/l	0.05 – 8.0mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

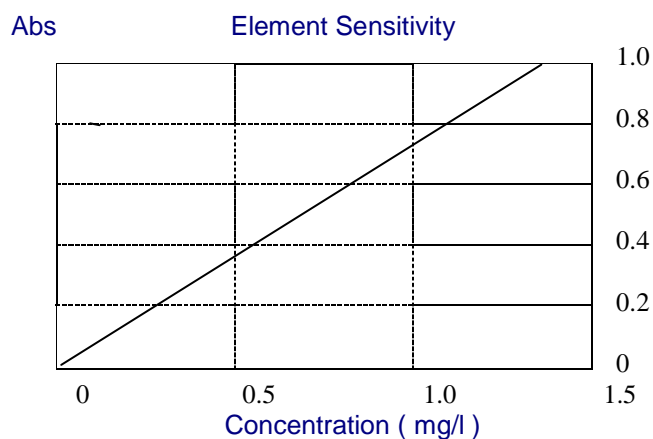
The signal can be reduced when the sample contains Al or mineral acid. Silver is easily precipitated especially when Cr, Br, Cl, I or W is present in the solution.



# Sodium

## Analysis Parameters

<b>Analytical Line:</b>	589.0nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.003mg/l
<b>Detection Limit:</b>	0.002mg/l
<b>Working Range:</b>	0.02– 1.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

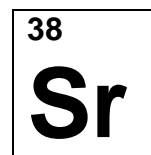
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 330.2nm	0.4nm	0.70mg/l	0.30mg/l	2.50 – 150mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

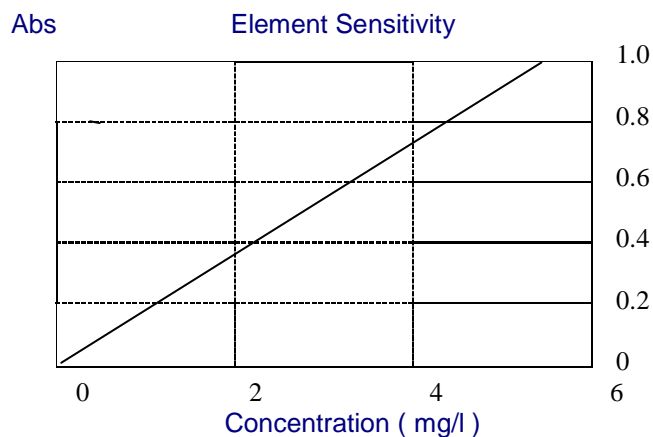
Na can easily be ionised in the flame therefore an Ionization suppressant must be added at approximately 1000ppm of Cs or K salts.



# Strontium

## Analysis Parameters

<b>Analytical Line:</b>	460.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.02mg/l
<b>Detection Limit:</b>	0.005mg/l
<b>Working Range:</b>	0.015– 3.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 407.8nm	0.4nm	0.40mg/l	0.09mg/l	0.30-60mg/l

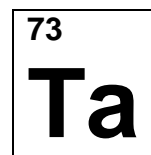
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

## Interferences

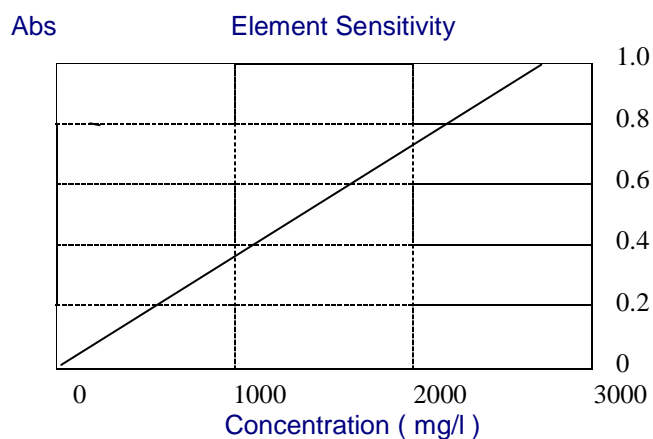
The element is partially ionised in the flame. Adding 2g/L of potassium Chloride will reduce the effect.



# Tantalum

## Analysis Parameters

<b>Analytical Line:</b>	271.5nm
<b>Bandwidth:</b>	0.4m
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	10.0mg/l
<b>Detection Limit:</b>	2.20mg/l
<b>Working Range:</b>	10.0-1500mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 260.9nm	0.4nm	21.0mg/l	5.1mg/l	24-3000mg/l
(3) 277.6nm	0.4nm	22.0mg/l	6.2mg/l	28-3500mg/l

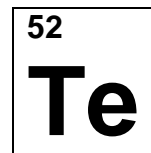
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

Add 1% HF acid and 0.2% Al to solutions to avoid oxidising in the flame at high concentrations. It is recommended that matrix matching is carried out on all solutions.

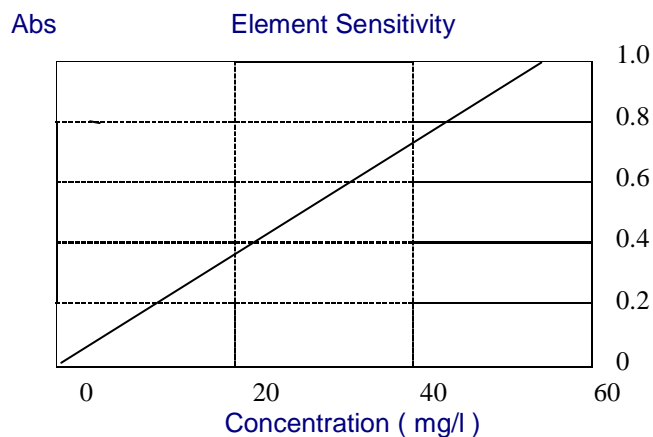




# Tellurium

## Analysis Parameters

<b>Analytical Line:</b>	214.3nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.2mg/l
<b>Detection Limit:</b>	0.05mg/l
<b>Working Range:</b>	0.25-30mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3X the Standard Deviation of a blank Solution.

## Alternative wavelengths

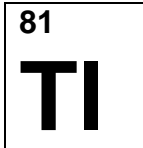
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 225.9nm	0.4nm	2.3mg/l	0.5mg/l	2.5-200mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

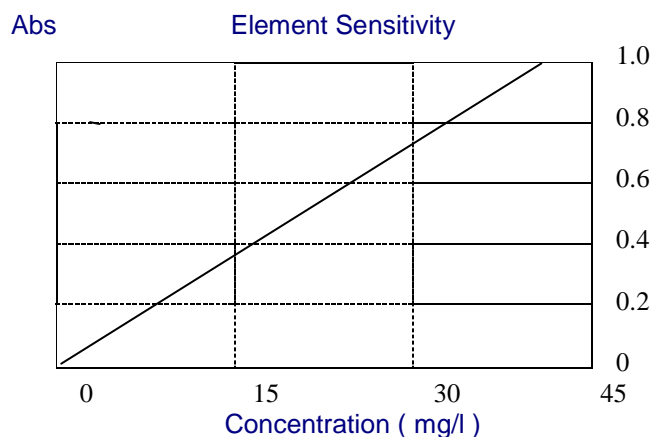
Matrix modifying is recommended to avoid interferences from other elements.



# Thallium

## Analysis Parameters

<b>Analytical Line:</b>	276.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.15mg/l
<b>Detection Limit:</b>	0.05mg/l
<b>Working Range:</b>	0.10-20mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

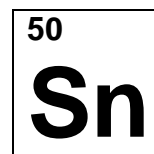
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 377.6nm	0.4nm	0.40mg/l	0.15mg/l	0.30 – 50mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

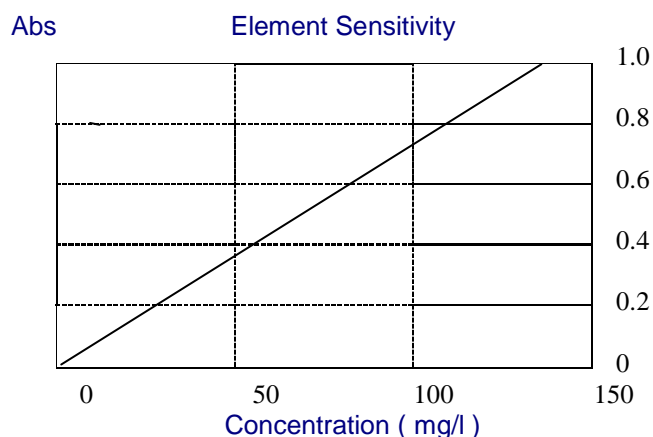
Matrix matching of standards and samples is recommended to avoid interference.



## Tin

### Analysis Parameters

<b>Analytical Line:</b>	224.6nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.50mg/l
<b>Detection Limit:</b>	0.10mg/l
<b>Working Range:</b>	0.70– 75mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

### Alternative wavelengths

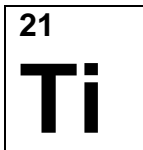
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 286.3nm	0.8nm	1.10mg/l	0.25mg/l	1.70 – 150mg/l

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

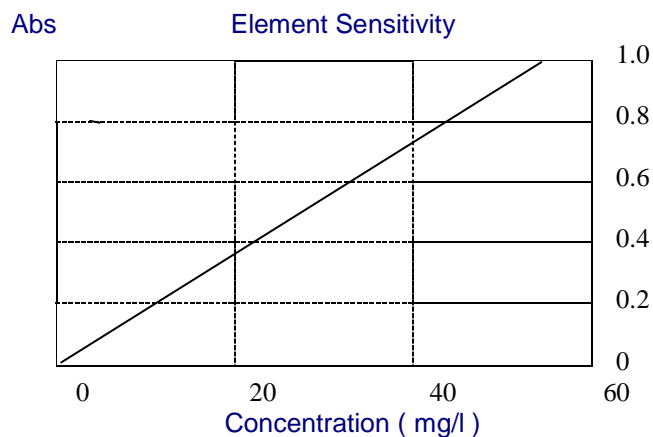
This element can be partially ionized in the flame. 0.5% Potassium Chloride can be added to reduce the effect.



# Titanium

## Analysis Parameters

<b>Analytical Line:</b>	365.4nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.50mg/l
<b>Detection Limit:</b>	0.05mg/l
<b>Working Range:</b>	0.40– 30mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

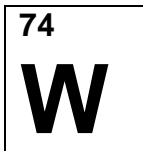
	Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2)	264.3nm	0.2nm	0.50mg/l	0.05mg/l	0.40 – 30mg/l
(3)	320.0nm	0.4nm	0.60mg/l	0.07mg/l	0.60 – 40mg/l
(4)	363.5nm	0.4nm	0.75mg/l	0.09mg/l	0.80 – 50mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

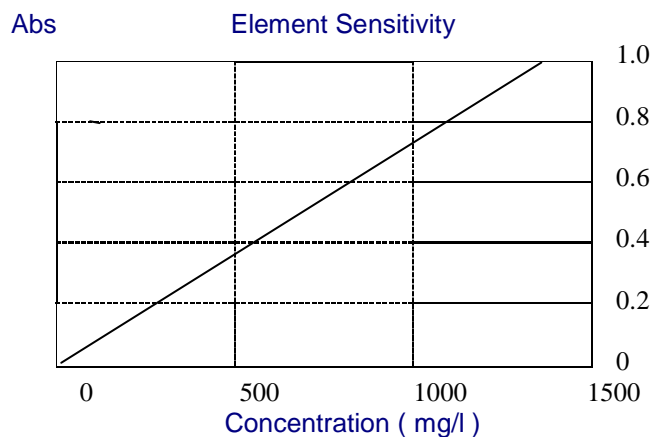
Adding alkali salt to the solution will reduce any problems with ionization in the flame.



# Tungsten

## Analysis Parameters

<b>Analytical Line:</b>	255.1nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	6.0mg/l
<b>Detection Limit:</b>	1.2mg/l
<b>Working Range:</b>	5.0– 800mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

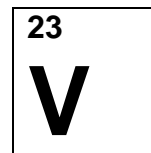
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 268.1nm	0.2nm	7.50mg/l	1.50mg/l	7.0 – 1000mg/l
(3) 294.4nm	0.4nm	9.00mg/l	2.00mg/l	10.0 – 1000mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

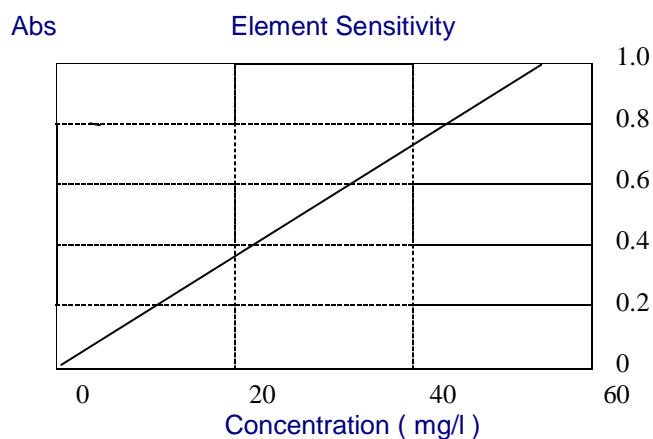
Co, Fe, K or Cu can cause interference therefore it is advised to matrix match all solutions.



# Vanadium

## Analysis Parameters

<b>Analytical Line:</b>	318.4nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None/ SR
<b>Flame Type:</b>	N2O/Acetylene
<b>Flame Setting:</b>	Reducing Red Feather
<b>Sensitivity:</b>	0.35mg/l
<b>Detection Limit:</b>	0.12mg/l
<b>Working Range:</b>	0.40– 30mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

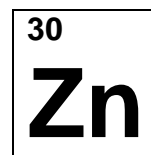
Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 306.6nm	0.2nm	0.80mg/l	0.30mg/l	0.90 –50mg/l
(3) 306.0nm	0.2nm	0.85mg/l	0.35mg/l	1.00 –50mg/l
(4) 305.6nm	0.4nm	1.20mg/l	0.55mg/l	1.60 –70mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

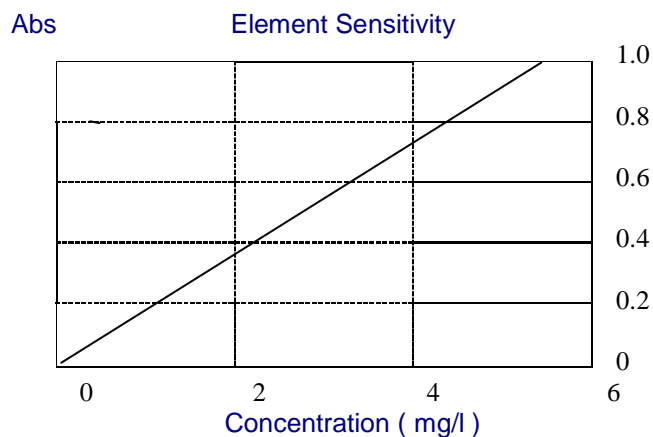
Vanadium is ionized in the flame. This affect can be reduced by adding Potassium Chloride to the solutions. High levels of Al, Fe, Ti or H2SO4 can increase the signal.



# Zinc

## Analysis Parameters

<b>Analytical Line:</b>	213.9nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	1.0
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2/ SR
<b>Flame Type:</b>	Air/Acetylene
<b>Flame Setting:</b>	Oxidising Blue
<b>Sensitivity:</b>	0.01mg/l
<b>Detection Limit:</b>	0.003mg/l
<b>Working Range:</b>	0.01– 3.0mg/l



**Note:** The Sensitivity or Characteristic Concentration is the analyte concentration that gives a signal of 0.0044 Absorbance units.

The detection limit is the concentration equivalent to 3 X the Standard Deviation of a blank Solution.

## Alternative wavelengths

Wavelength	Bandwidth	Sensitivity	Detection Limit	Working Range
(2) 307.9nm	0.8nm	40.0mg/l	12.5mg/l	40 –3000mg/l

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

There are no major interferences for this element.

## **Chapter 6**

- **Graphite Furnace Analysis**
- **Graphite Tube**
- **Graphite Conditions**
- **Acidity**
- **Interferences**
- **Graphite Element Data Sheets**

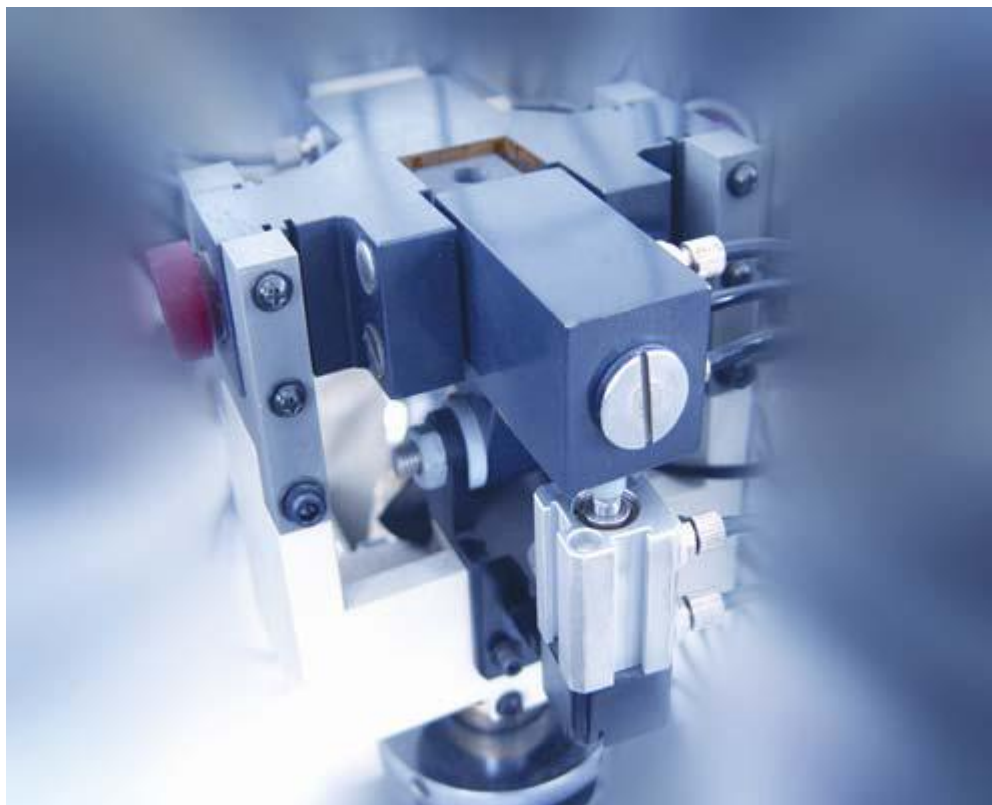


## Graphite Furnace Analysis

The graphite furnace consists of a power supply unit and a furnace head which contains the graphite tube. When graphite analysis is selected at the software the head is motorised into position to replace the burner system. Care needs to be taken to align the head so that the light beam from the hollow cathode lamp can pass through the centre of the graphite tube without touching the walls. The sample is injected into the tube by using a hand pipette or graphite auto sampler with a maximum volume of 20ul. The precision expectation will be up to 3% RSD for the hand pipette or 1.5% RSD with the graphite auto sampler.

To analyse the sample there are three main operations within the heating program, drying, ashing and atomising. First of all the sample needs to be dried and this is carried out slowly using one or two drying stages depending on the element to be analysed. The next operation is to ash the sample in the tube which again can be carried out in one or two stages. The temperature at this point should be low enough so that the sample does not start to atomise but it should be high enough for the sample to ash so it may require experiments to set this correctly. The third stage is atomising. The temperature at this stage is much hotter, up to 2650°C, and the analyte atoms are vaporised and disassociated for the absorbance. Due to the high percentage of ground state atoms, smaller volumes and lower concentrations can be analysed.

Other requirements for the graphite system are water recirculation for cooling the head after an analysis (firing) and an argon gas supply which is used as a flow across the graphite tube so that the tube heats up in an inert environment.



## Graphite Tube

The graphite tube fitted to the 990GF instrument is coated and has a platform fitted as standard. The design is transverse which means that the tube heating connections are on a different axes to the analytical light beam which passes through it. There is a small hole in the top which is used for sample introduction.

As well as coated tubes there are uncoated tubes and plain tubes without a platform fitted for use with varying type of analysis shown on the data sheets.



## Graphite Conditions

The following analysis data sheets show the conditions required for each individual element. The temperature in each program has up to six stages with ramping and hold for each step.

Integration should start at the atomisation stage and should be set to either peak height or peak area depending on the shape of the resultant peak. If the peak has a slow rise and fall then the peak height would be the best to use but if the peak has a fast rise and fall, generally found when analysing volatile elements, peak area would be favourable.

## Acidity

Acid concentration should be kept to a minimum when using the graphite furnace, approximately 0.1%, and nitric acid is more preferable. The combination of the acid concentration in the sample used and the atomisation temperature will affect the overall life of the graphite tube so it is important to keep the acid concentration as low as possible and the atomisation temperature as low as possible but making sure that all the sample has been atomised otherwise there will be a memory effect added to the next sample.

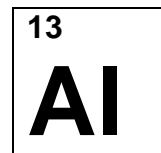
## Interferences

Interferences when using the graphite furnace are a major problem for the analyst. In most cases a matrix modifier should be used and there are suggestions on each of the data sheets showing this and solutions to other possible problems. It is advisable also to use the D2 background system for the lower wavelengths where possible to avoid spectral interference which is also common for this type of analysis.

## Graphite Element Data Sheets

Following is a number of data sheets giving information on how to set up the instrument for the individual elements. It also suggests the expected detection limit and working range. The data sheets are presented in alphabetical order.

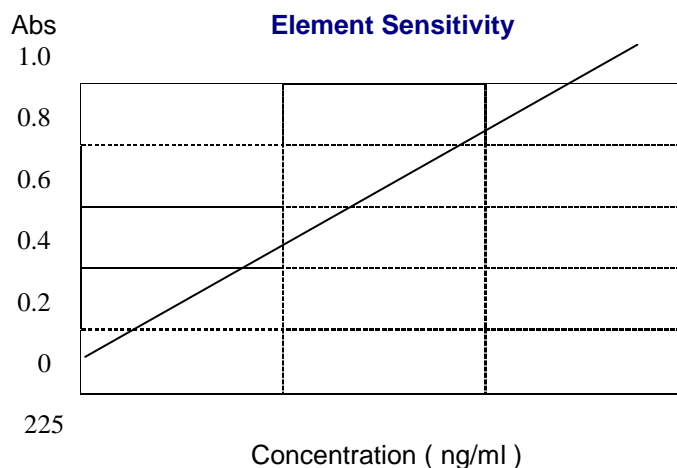
**Note:** The information supplied on these data sheets should be used as a guide only and further optimisation and changes may be required for different types of analysis. If you require more information please contact your local agent or PG Instruments Ltd direct.



# Aluminium

## Analysis Parameters

**Analytical Line:** 309.3nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 5.0ma  
**Integration Time:** 3.0sec  
**Background:** None  
 0 75 150  
**Graphite Type:** Platform coated  
**Sample size:** 20ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 12.36pg/ml  
**Detection Limit:** 11.80pg/ml  
**Working Range:** 2.00– 150.0ng/ml



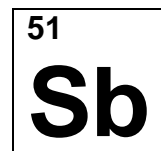
Stage	Temp	Ramp	Hold	Int	Gas
1	90	10	10		high
2	150	10	10		high
3	500	5	10		high
4	1500	5	10		high
5	2400	0	3	yes	off
6	2600	1	3		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid < 0.5% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

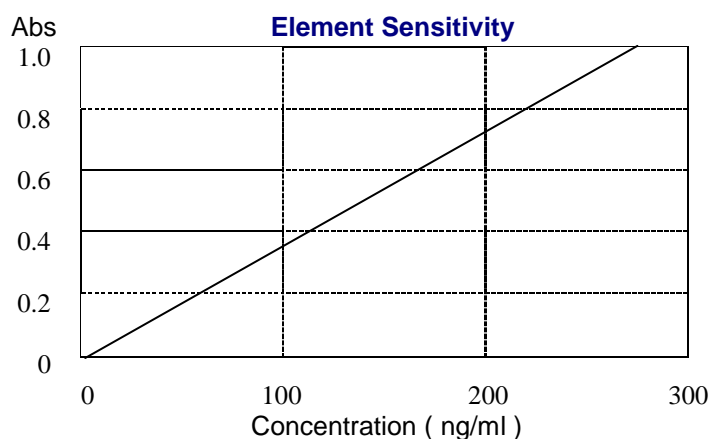
The signal can be stabilised by adding 0.5ug/ml Mg to all the solutions. Care should be taken with the surrounding environment as aluminium pollution is possible.



## Antimony

### Analysis Parameters

<b>Analytical Line:</b>	217.6nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	20ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	38.6pg/ml
<b>Detection Limit:</b>	22.4pg/ml
<b>Working Range:</b>	5.00– 200ng/ml



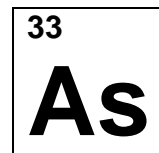
Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	500	20	10		high
3	1100	10	10		high
4	2200	0	3	yes	off
5	2300	1	3		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

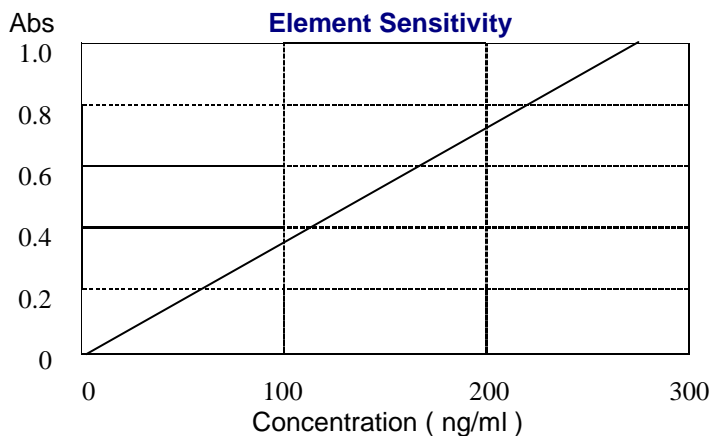
A matrix modifier should be added to the solutions to act as releasing agent. 35ug/ml of Nickel Nitrate can be made up as the matrix modifier.



## Arsenic

### Analysis Parameters

<b>Analytical Line:</b>	193.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	22.92pg/ml
<b>Detection Limit:</b>	17.19pg/ml
<b>Working Range:</b>	3.00– 200ng/ml



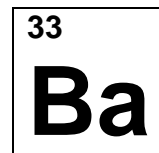
Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	110	10	10		high
3	1200	10	15		high
4	2000	0	3	yes	off
5	2200	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

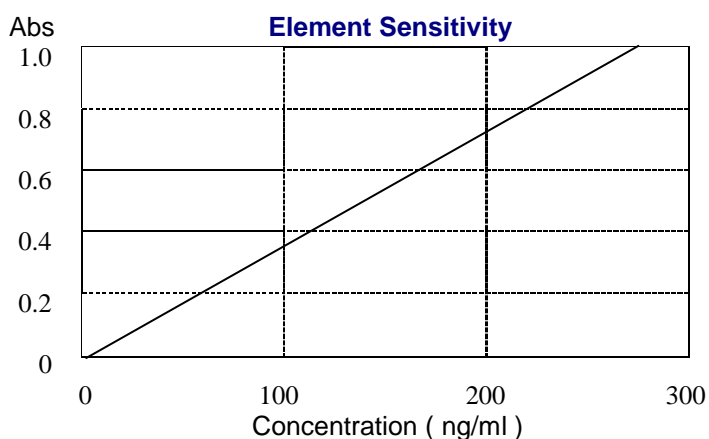
A matrix modifier should be added to the solutions to act as releasing agent. 35ug/ml of Nickel Nitrate can be made up as the matrix modifier. Palladium can be also used as a modifier but the ashing temperature should be increased by approximately 250°C



## Barium

### Analysis Parameters

<b>Analytical Line:</b>	553.6nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	12.5pg/ml
<b>Detection Limit:</b>	11.08pg/ml
<b>Working Range:</b>	2.00– 200ng/ml



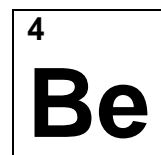
Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	100	10	10		high
3	1000	10	15		high
4	2200	0	3	yes	off
5	2300	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

### Interferences

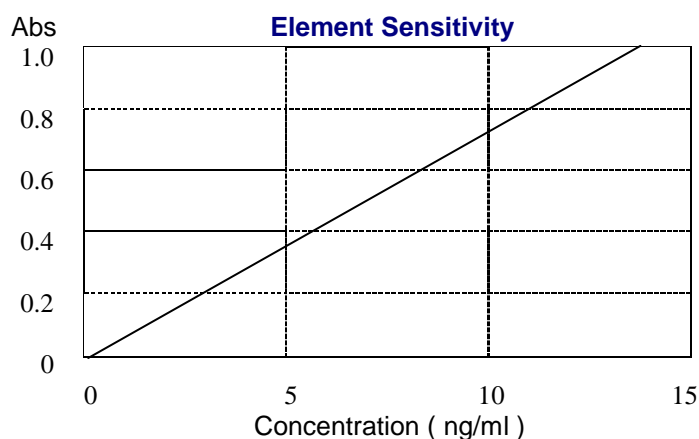
Spectral interference can be a problem due to the visible wavelength of this element. It is advised to keep the bandwidth to 0.2nm to reduce the effect.



## Beryllium

### Analysis Parameters

**Analytical Line:** 234.9nm  
**Bandwidth:** 0.2nm  
**Filter Factor:** 0.1  
**Lamp Current:** 5.0ma  
**Integration Time:** 3.0sec  
**Background:** D2  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 0.18pg/ml  
**Detection Limit:** 0.13pg/ml  
**Working Range:** 0.02– 10ng/ml



Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	120	10	15		high
3	1200	10	10		high
4	2400	0	3	yes	off
5	2500	1	2		high

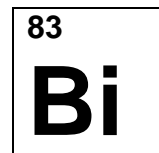
### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

### Interferences

Adding Magnesium oxide to the solutions will improve the sensitivity if required.

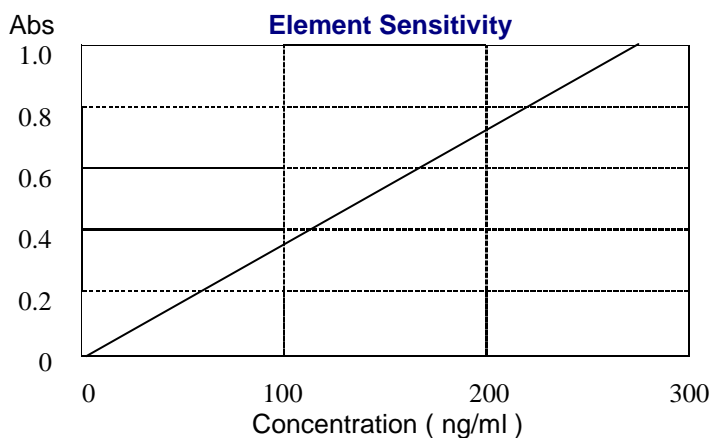




## Bismuth

### Analysis Parameters

<b>Analytical Line:</b>	193.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	26.5pg/ml
<b>Detection Limit:</b>	18.2pg/ml
<b>Working Range:</b>	4.00– 200ng/ml



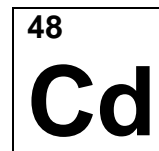
Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	800	10	10		high
3	1400	10	15		high
4	2200	0	3	yes	off
5	2300	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

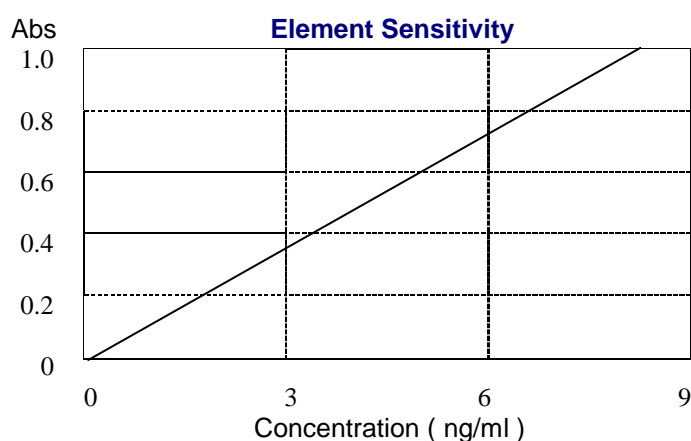
A matrix modifier consisting of 35ug/ml of Nickel Nitrate can be added to the solutions.



## Cadmium

### Analysis Parameters

<b>Analytical Line:</b>	228.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	0.4pg/ml
<b>Detection Limit:</b>	0.25pg/ml
<b>Working Range:</b>	0.10– 6.0ng/ml



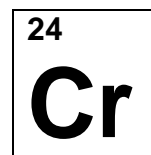
Stage	Temp	Ramp	Hold	Int	Gas
1	90	5	10		high
2	120	5	10		high
3	500	5	10		high
4	1800	0	3	yes	off
5	1900	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

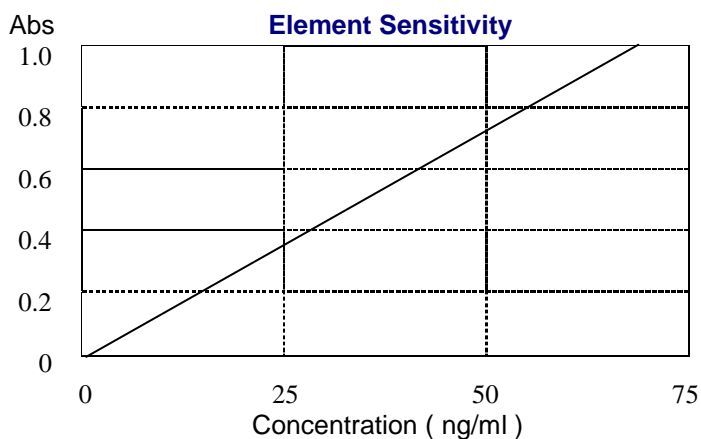
It is advisable to use D2 background correction when analysing this element. A matrix modifier of 100ug/ml Ammonium Phosphate can be used to stop the element from releasing prior to the atomisation stage due to it being very volatile.



# Chromium

## Analysis Parameters

**Analytical Line:** 357.9nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 5.0ma  
**Integration Time:** 3.0sec  
**Background:** None  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 3.55pg/ml  
**Detection Limit:** 2.42pg/ml  
**Working Range:** 0.50– 50ng/ml



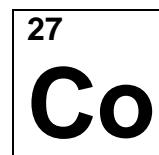
Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	100	10	10		high
3	800	10	15		high
4	2100	0	3	yes	off
5	2200	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

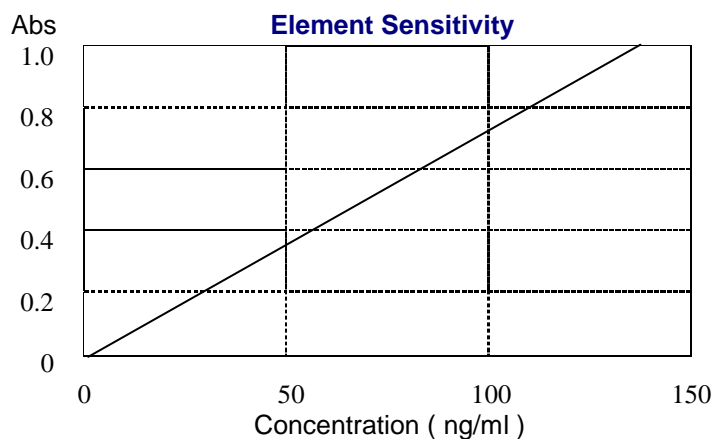
A matrix modifier can be added to the solutions of 50ug/ml Magnesium Nitrate if required.



## Cobalt

### Analysis Parameters

<b>Analytical Line:</b>	240.7nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	7.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	5.18pg/ml
<b>Detection Limit:</b>	4.23pg/ml
<b>Working Range:</b>	1.00– 100.0ng/ml



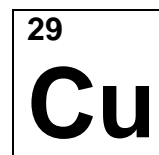
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	100	10	10		high
3	800	10	10		high
4	2000	0	3	yes	off
5	2100	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

### Interferences

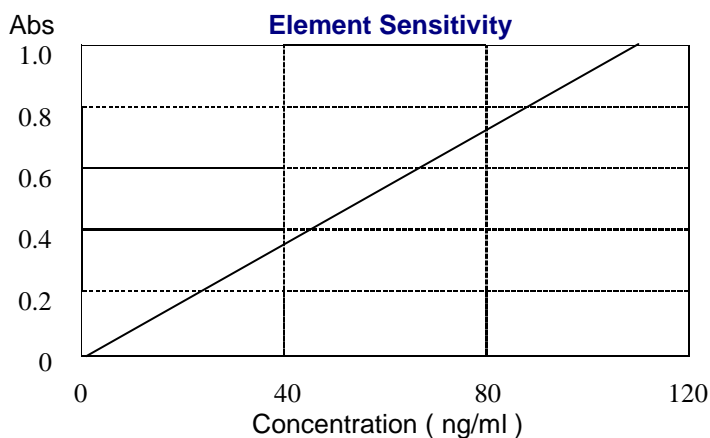
A matrix modifier .containing 50ug/ml can be used if required.



## Copper

### Analysis Parameters

<b>Analytical Line:</b>	324.7nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	3.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	none
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	6.28pg/ml
<b>Detection Limit:</b>	3.43pg/ml
<b>Working Range:</b>	0.50– 70.0ng/ml



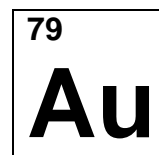
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	10	10		high
3	600	10	15		high
4	2100	0	3	yes	off
5	2200	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

### Interferences

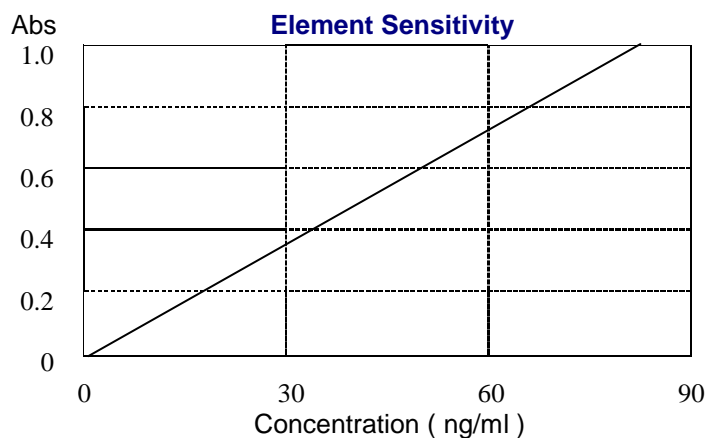
Interferences are small with this element but if required a matrix modifier of 50ug/ml + 10ug/ml magnesium nitrate can be used.



## Gold

### Analysis Parameters

<b>Analytical Line:</b>	242.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	4.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Hcl
<b>Sensitivity:</b>	4.15pg/ml
<b>Detection Limit:</b>	2.55pg/ml
<b>Working Range:</b>	0.50– 50.0ng/ml



Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	10	10		high
3	600	10	15		high
4	1800	0	3	yes	off
5	1900	1	2		high

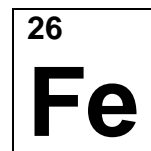
### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

### Interferences

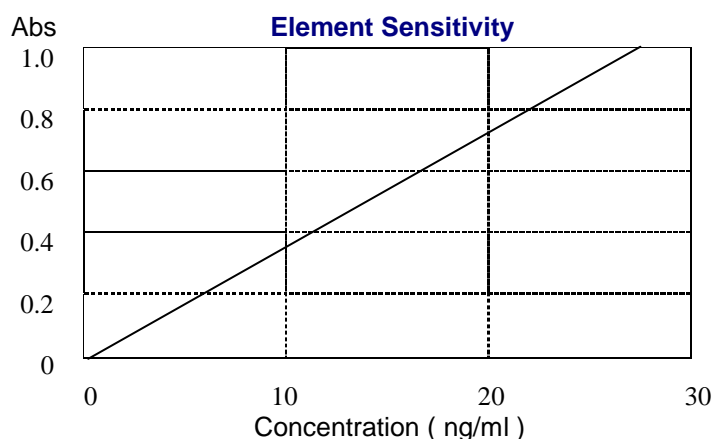
A matrix modifier of 15ug/ml pd + 10ug/ml mg can be added to the samples and standards.



# Iron

## Analysis Parameters

<b>Analytical Line:</b>	248.3nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	5.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	1.1pg/ml
<b>Detection Limit:</b>	0.59pg/ml
<b>Working Range:</b>	0.10– 18.0ng/ml



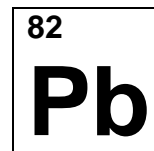
Stage	Temp	Ramp	Hold	Int	Gas
1	90	5	10		high
2	120	10	10		high
3	800	10	15		high
4	2200	0	3	yes	off
5	2300	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

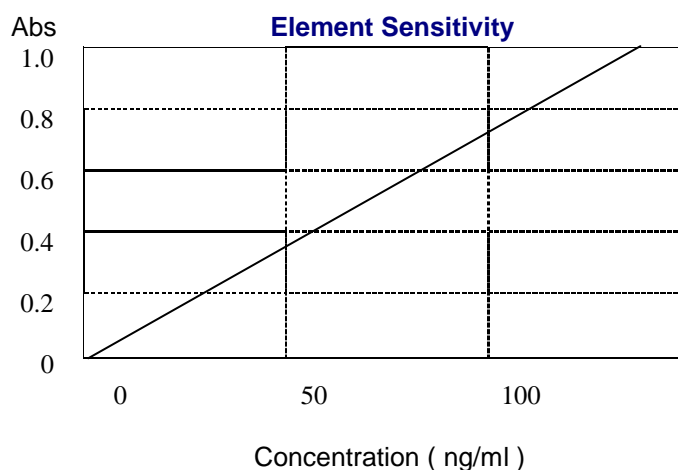
Interference from silicon can be a problem which can be suppressed by adding a matrix modifier containing ammonium fluoride or adding sulphuric acid to the solutions. Addition of EDTA to the solutions will suppress the interference caused by cobalt.



# Lead

## Analysis Parameters

**Analytical Line:** 283.3nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 3.0ma  
**Integration Time:** 3.0sec  
**Background:** None  
 150  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 5.18pg/ml  
**Detection Limit:** 3.88pg/ml  
**Working Range:** 1.00– 100.0ng/ml



Stage	Temp	Ramp	Hold	Int	Gas
1	70	10	10		high
2	110	10	10		high
3	450	10	15		high
4	1800	0	3	yes	off
5	1900	1	2		high

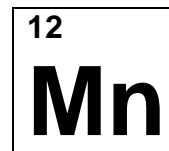
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

Lead is a difficult element to analyse as it requires an accurate ashing temperature which should be optimised for the individual analysis. Adding 0.01% Lanthanum nitrate will improve the problem.

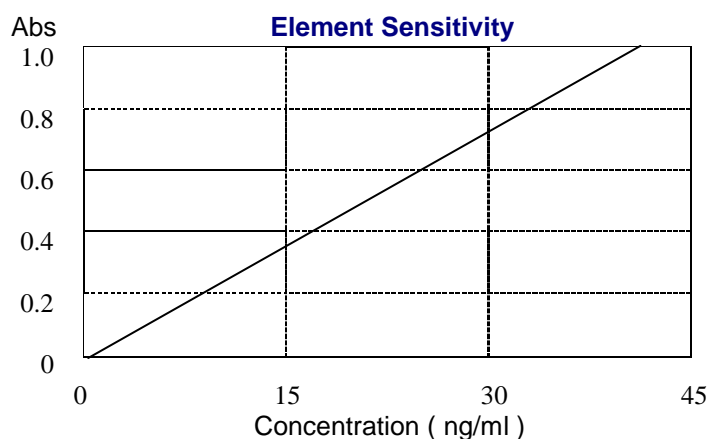




# Manganese

## Analysis Parameters

**Analytical Line:** 279.5nm  
**Bandwidth:** 0.2m  
**Filter Factor:** 0.1  
**Lamp Current:** 30ma  
**Integration Time:** 3.0sec  
**Background:** None  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 1.38pg/ml  
**Detection Limit:** 1.03pg/ml  
**Working Range:** 0.25- 25.0ng/ml



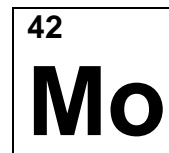
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	5	10		high
3	600	10	10		high
4	2200	0	3	yes	off
5	2300	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

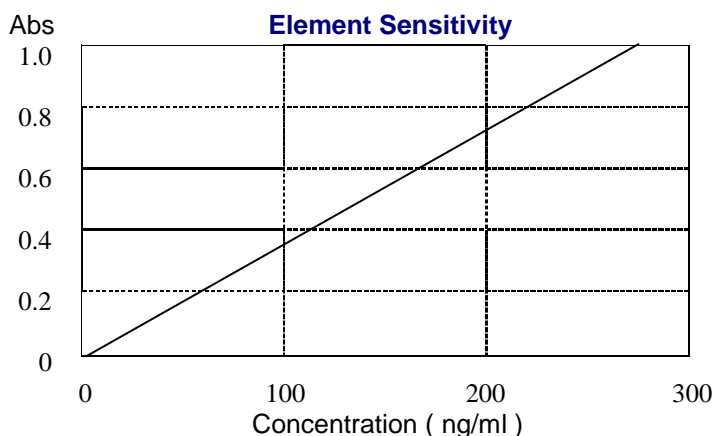
A matrix modifier of 50ug/ml can be added to all the solutions



# Molybdenum

## Analysis Parameters

**Analytical Line:** 313.3nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 5.0ma  
**Integration Time:** 3.0sec  
**Background:** None  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 12.29pg/ml  
**Detection Limit:** 7.54pg/ml  
**Working Range:** 1.00– 200.0ng/ml



Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	5	10		high
3	800	15	15		high
4	2400	0	4	yes	off
5	2500	1	3		high

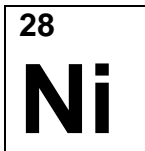
## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.

1000mg/l Standard solution: Part no.

## Interferences

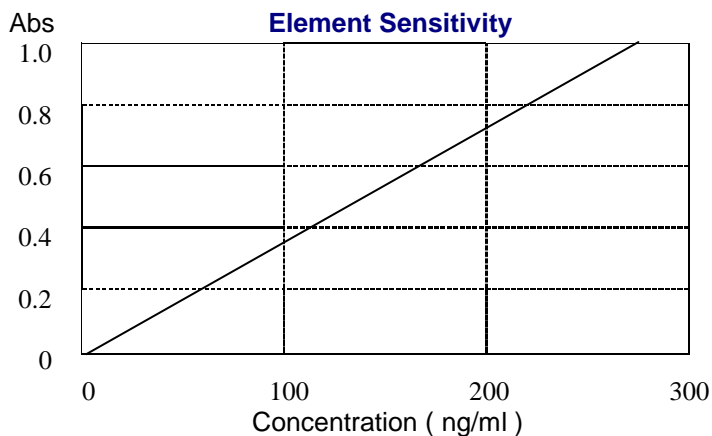
There are no major problems with interference but care should be taken as this element could have a problem with memory effect. Holding the clean position for a longer period may help.



# Nickel

## Analysis Parameters

<b>Analytical Line:</b>	232.0nm
<b>Bandwidth:</b>	0.2nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	4.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	D2
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	8.97pg/ml
<b>Detection Limit:</b>	8.57pg/ml
<b>Working Range:</b>	1.00– 150.0ng/ml



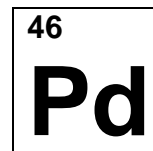
Stage	Temp	Ramp	Hold	Int	Gas
1	80	5	10		high
2	110	10	15		high
3	800	15	10		high
4	2000	0	3	yes	off
5	2100	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

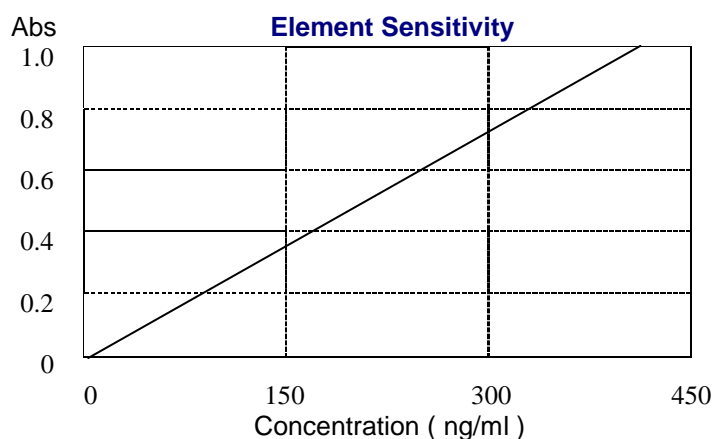
There are no major interferences with this element.



# Palladium

## Analysis Parameters

**Analytical Line:** 247.6nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 3.0ma  
**Integration Time:** 3.0sec  
**Background:** D2  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 18.33pg/ml  
**Detection Limit:** 16.25pg/ml  
**Working Range:** 2.00– 250.0ng/ml



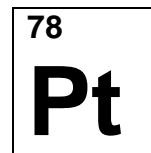
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	10	10		high
3	800	10	15		high
4	1800	0	3	yes	off
5	1900	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

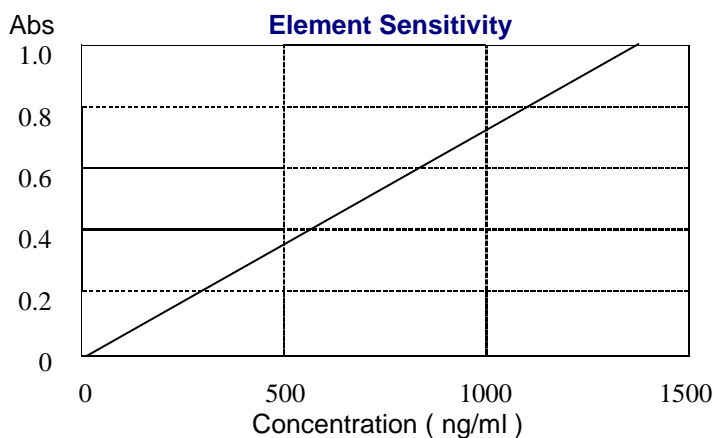
There are no major interferences for this element



# Platinum

## Analysis Parameters

<b>Analytical Line:</b>	265.9nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	3.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	20ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	125.71pg/ml
<b>Detection Limit:</b>	34.29pg/ml
<b>Working Range:</b>	10.0– 1000ng/ml



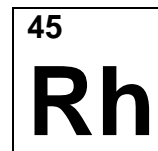
Stage	Temp	Ramp	Hold	Int	Gas
1	110	10	10		high
2	500	10	15		high
3	1200	10	10		high
4	2400	0	3	yes	off
5	2500	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

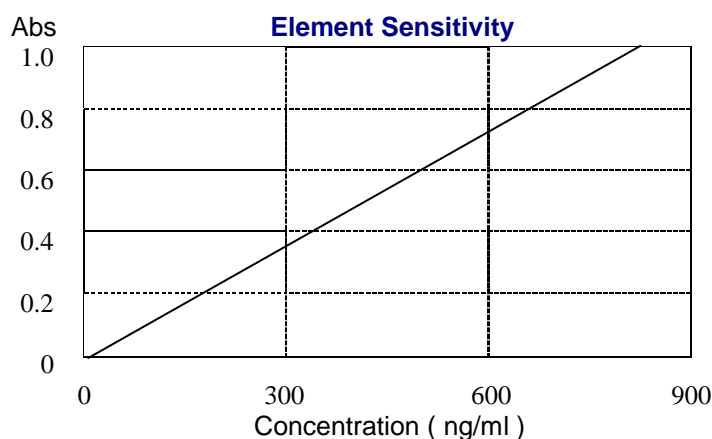
There are no major interferences with this element



# Rhodium

## Analysis Parameters

**Analytical Line:** 243.5nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 3.0ma  
**Integration Time:** 3.0sec  
**Background:** D2  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 47.83pg/ml  
**Detection Limit:** 13.04pg/ml  
**Working Range:** 5.0– 500ng/ml



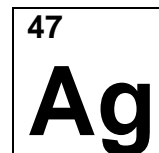
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	10	10		high
3	1000	5	10		high
4	2200	0	3	yes	off
5	2300	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

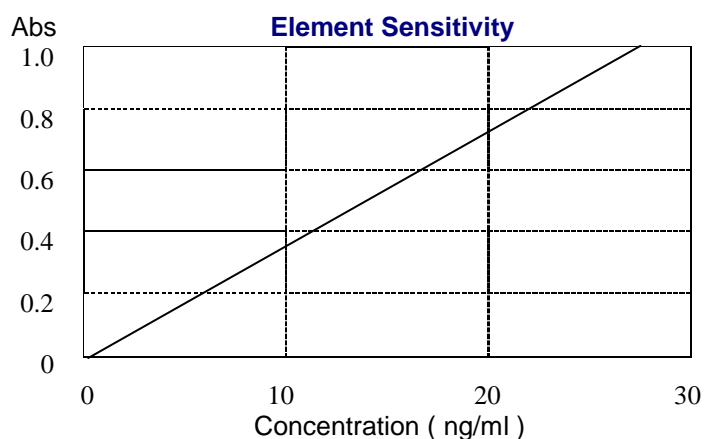
There are no major interferences with this element.



## Silver

### Analysis Parameters

<b>Analytical Line:</b>	328.1nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	3.0ma
<b>Integration Time:</b>	3.0sec
<b>Background:</b>	None
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	0.98pg/ml
<b>Detection Limit:</b>	0.4pg/ml
<b>Working Range:</b>	0.4– 20.0ng/ml



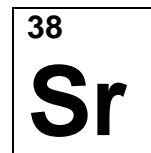
Stage	Temp	Ramp	Hold	Int	Gas
1	90	5	10		high
2	120	10	10		high
3	600	10	5		high
4	1800	0	3	yes	off
5	1900	1	2		high

### Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

### Interferences

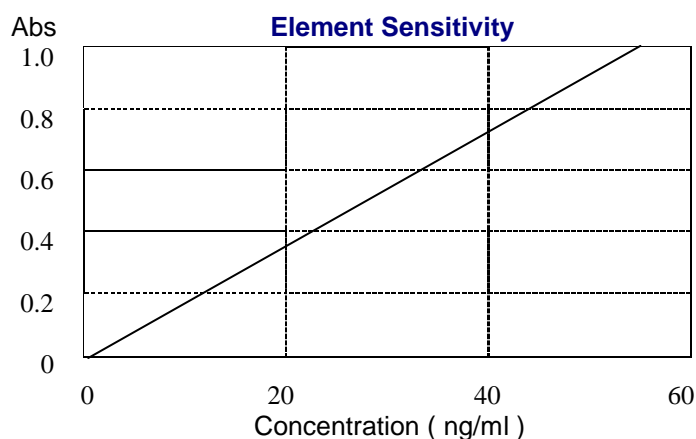
It is best to use Nitric acid in all the solutions to help remove memory effects created by this element.



# Strontium

## Analysis Parameters

**Analytical Line:** 460.7nm  
**Bandwidth:** 0.4nm  
**Filter Factor:** 0.1  
**Lamp Current:** 3.0ma  
**Integration Time:** 5.0sec  
**Background:** None  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 1.93pg/ml  
**Detection Limit:** 1.05pg/ml  
**Working Range:** 0.2– 30.0ng/ml



Stage	Temp	Ramp	Hold	Int	Gas
1	90	5	10		high
2	110	10	10		high
3	800	10	15		high
4	2400	0	3	yes	off
5	2500	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

Risk of memory effect. No major problems with interference..



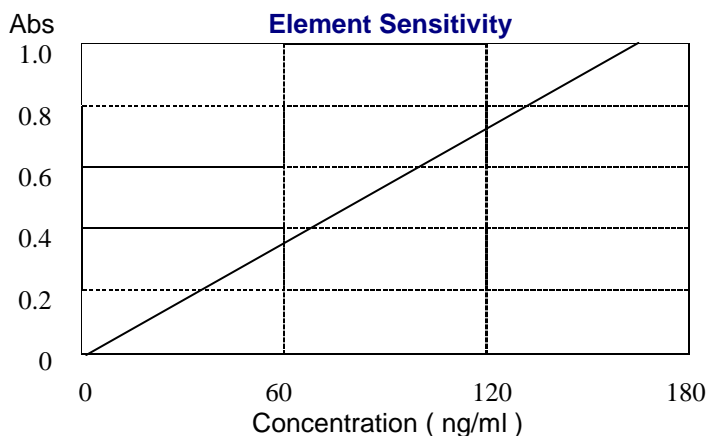
81

TI

# Thallium

## Analysis Parameters

<b>Analytical Line:</b>	367.8nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	3.0ma
<b>Integration Time:</b>	5.0sec
<b>Background:</b>	None
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	7.10pg/ml
<b>Detection Limit:</b>	2.42pg/ml
<b>Working Range:</b>	1.0– 100.0ng/ml



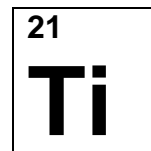
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	110	10	10		high
3	600	10	15		high
4	1700	0	3	yes	off
5	1800	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

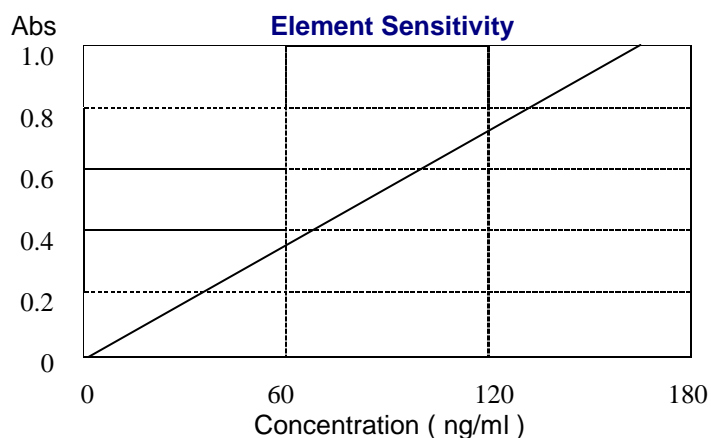
A matrix modifier of 15ug/ml Pd+10ug/ml Mg Nitrate could be used with all solutions.



# Titanium

## Analysis Parameters

**Analytical Line:** 364.3nm  
**Bandwidth:** 0.2nm  
**Filter Factor:** 0.1  
**Lamp Current:** 3.0ma  
**Integration Time:** 6.0sec  
**Background:** None  
**Graphite Type:** Platform coated  
**Sample size:** 10ul  
**Acidity:** 0.1% Nitric  
**Sensitivity:** 55.70pg/ml  
**Detection Limit:** 53.16pg/ml  
**Working Range:** 10– 1000ng/ml



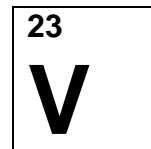
Stage	Temp	Ramp	Hold	Int	Gas
1	70	5	10		high
2	120	10	10		high
3	1200	15	15		high
4	2500	0	3	yes	off
5	2500	1	4		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
 1000mg/l Standard solution: Part no.

## Interferences

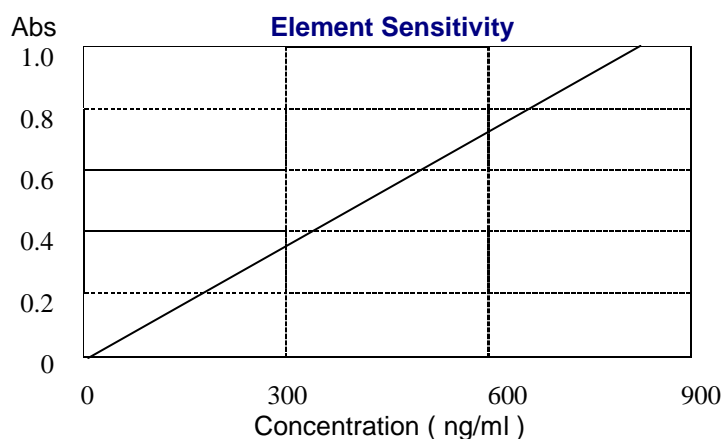
There is a high memory effect when using this element. Using a longer clean at the end of the analysis may help.



# Vanadium

## Analysis Parameters

<b>Analytical Line:</b>	318.4nm
<b>Bandwidth:</b>	0.4nm
<b>Filter Factor:</b>	0.1
<b>Lamp Current:</b>	6.0ma
<b>Integration Time:</b>	6.0sec
<b>Background:</b>	None
<b>Graphite Type:</b>	Platform coated
<b>Sample size:</b>	10ul
<b>Acidity:</b>	0.1% Nitric
<b>Sensitivity:</b>	34.38pg/ml
<b>Detection Limit:</b>	25.78pg/ml
<b>Working Range:</b>	5.0– 500ng/ml



Stage	Temp	Ramp	Hold	Int	Gas
1	110	10	10		high
2	600	10	15		high
3	1000	10	15		high
4	2400	0	3	yes	off
5	2500	1	2		high

## Standard Solution

Standard Solutions should be made up from stock solution of 1000mg/l. Dilutions should be Carried out in stages and acidified using Nitric Acid > 1% to avoid precipitation.  
1000mg/l Standard solution: Part no.

## Interferences

There are no major interferences with this element.