UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF CHEMICAL SCIENCES

NATIONAL DIPLOMA: ANALYTICAL CHEMISTRY (4 Years)

MODULE CET2BAT/CETAAB3
ANALYTICAL CHEMISTRY 3 ANALYTICAL TECHNOLOGY

CAMPUS **DFC**

NOVEMBER EXAMINATION

DATE: 23/11/2019 **SESSION: 8:30 – 10:30**

ASSESSOR **PROF K PILLAY**

EXTERNAL MODERATOR **PROF R McCRINDLE**

DURATION 2 HOURS **MARKS 100**

NUMBER OF PAGES: 4 PAGES AND 1 ANNEXURE

INSTRUCTIONS: CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT).

REQUIREMENTS: ONE ANSWER SCRIPT
1 × GRAPH PAPER

/2…

PHYSICAL CONSTANTS

Avogadro's number:	$N_A = 6{,}023 \times 10^{23}$ objects mol^{-1}
Speed of light:	$c = 3.00 \times 10^{8}$ $m.s^{-1}$
Planck's constant:	$h = 6.63 \times 10^{-34}$ J.s
Energy:	1 J = 6.242×10^{18}ev

QUESTION 1

1.1 Describe the principles of each of the following processes highlighting the differences between each:

1.1.1 Fluorescence (4)
1.1.2 Phosphorescence (3)
1.1.3 Chemiluminescence (3)

1.2 Briefly describe the basic components of a spectrophotometer and the function of each component. (10)

1.3 The silver iodide bond energy is approximately 244 kJ mol^{-1}.

1.3.1 What is the longest wavelength of light capable of breaking the bond in silver iodide? (5)
1.3.2 Name the region of the electromagnetic spectrum that this light could be considered to be part of. (2)

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QUESTION 2

2.1 Briefly discuss the principle on which transition metals are able to be quantitatively measured in UV-Visible Spectroscopy. (6)

2.2 A solution containing only the thiourea complex of Bismuth(III) has a molar absorptivity of 9.35×10^{3} $L.cm^{-1}.mol^{-1}$.

2.2.1 What will be the absorbance of a 2.52×10^{-5} $mol.dm^{-3}$solution of the complex when measured in a 12.5 mm cell? (5)
2.2.2 What will be the percentage transmittance of the solution described in 2.2.1? (3)
2.2.3 What range of concentrations of bismuth could be determined by means of this complex if only 1.00 cm and 1.75 cm cells are to be used, and the absorbance is to be kept between 0.100 and 1.500? (8)

2.4 Describe the differences between real deviations from Beer's Law and those due to instrumental or chemical factors. (3)

QUESTION 2 (CONTINUED)

2.5 A steel sample of mass 1.1555 g was dissolved in a mixture of sulphuric, phosphoric and nitric acids, and then treated with persulphate and periodate to oxidise the manganese to permanganate and the chromium to dichromate. The solution was then diluted to 100 mL in a volumetric flask and the absorbance measured in a 1.00 cm cell at 440 nm (A = 0.125) and at 545 nm (A = 1.498). Calculate the percentages of chromium and manganese in the steel sample given the following molar absorptivities, in $L.mol^{-1}cm^{-1}$

ION	**Molar absorptivity**	
	440 nm	**545 nm**
dichromate	369	11
permanganate	95	2350

(12)
[37]

QUESTION 3

3.1 Identify the two types of interferences encountered in AAS and briefly describe each. (6)

3.2 State five types of atomizers which are commonly used in atomic spectroscopy. (5)

3.3 As part of a study of the presence of lead in ecosystems, some weeds were gathered along a major road, where they had been exposed to emission fumes from petrol engines. A 6.350 g representative sample of the weeds was ashed to destroy organic matter. The inorganic residue was treated in accordance with a standard analytical procedure and was finally diluted to 50.0 cm^3 in a volumetric flask. The absorbance of this solution was measured at 283.31 nm lead line, yielding an absorbance signal of 0.130. A 5.00 cm^3 aliquot of this solution was then mixed with a 5.00 cm^3 aliquot of a 20 ppm lead solution. This mixture gave an absorbance of 0.385 when measured under identical conditions. Calculate the lead content in ppm of the plant material. (7)

3.4 A 3.674 g sample was analysed for its arsenic content. The entire powdered sample was dissolved and diluted to 250 mL in a volumetric flask. Several 5.0 mL aliquots of this solution were pipetted into each of five 50.0 mL volumetric flasks. Various volumes of a standard solution containing 10.3 ppm arsenic were added to the flask, and the solutions diluted to volume.

QUESTION 3 (CONTINUED)

Volume sample (mL)	Volume Arsenic Standard (mL)	Absorbance
5.0	0.0	0.302
5.0	5.0	0.405
5.0	10.0	0.502
5.0	15.0	0.603
5.0	20.0	0.700

Determine the percentage arsenic in the powdered sample. (14)

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QUESTION 4

4.1 State two types of processes on which X-ray techniques are based. (2)

4.2 Discuss two disadvantages which X-ray techniques have over other instrumental techniques. (2)

[4]