UNIVERSITY
OF
JOHANNESBURG

PROGRAM	:	B ENG TECH EXTRACTION METALLURGY
SUBJECT	:	**ANALYTICAL TECHNIQUES 2**
CODE	:	**PSTMTA2**
DATE	:	WINTER EXAMINATION 09 June 2018
DURATION	:	(SESSION 1) 08:30 - 11:30
WEIGHT	:	40: 60
TOTAL MARKS	:	80

EXAMINER	:	MS S.S. LEPHUTHING
MODERATOR	:	MR M DE VILIERS
NUMBER OF PAGES	:	2 PAGES

INSTRUCTIONS	:	ANSWER ALL QUESTIONS. CALCULATORS PERMITTED (ONE PER STUDENT).
REQUIREMENTS	:	2 SCRIPTS PER STUDENT

Question 1 [30]

1.1. Explain what could have happed when an analysis obtains the rejected results [2]

1.2. State two principal errors that occur during analysis and explain their difference [8]

1.3. Analyses of a sample of iron ore gave the following percentage values for the iron content; 7.08, 7.21, 7.21, 7.09, 7.16, 7.14, 7.07, 7.14, 7.18 and 7.11.

1.3.1. Calculate mean, standard deviation and coefficient of variation for the values [10]

1.3.2. State whether or not this results is significant if the true value of the analysis is 7.17 [5]

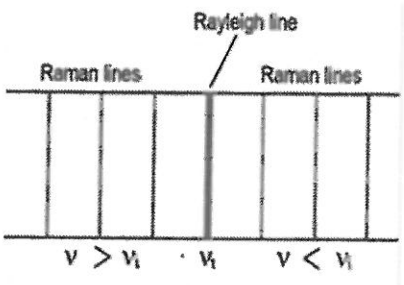
1.3.3. Calculate the 95 % limit for the true value of the above analysis [5]

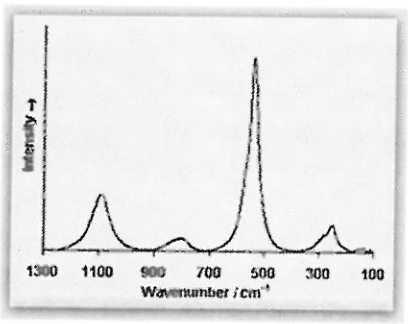
Question 2 [30]

2.1. Explain the advantages and disadvantages of using XRF analysis [10]

2.2. Identify figure below, from which analytical equipment is the spectrum and further explain the application of the equipment [5]

2.3. With the aid of the figures below, explain the principle of the Raman spectroscopy principle [6]





2.4. Transmission electron microscope (TEM) and Scanning electron microscope (SEM) both can yield information about the topography,

morphology, composition and crystallographic information. Explain further the meaning of each information. [9]

Question 3 [20]

3.1. There four flux that are known for fire assaying of silver and gold, name these flux and state each whether is acidic or basic. [5]

3.2. In the crucible fusion, the oxygen present in the flux accomplishes the oxidation. There are components that added at this stage, name these components and their function during crucible fusion [4]

3.3. What is the function of **CUPELLATION** in fire assaying of silver and gold. Breifly, further explain steps involved in cupellation [7]

3.4. A 50 g aliquot of ore was assayed for gold and silver. The bullion mass was found to be 2.1 mg and the mass of the gold after perting was 1.8 mg. Calculate the assay value of the ore in g/t and ppm [4]

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

F-DISTRIBUTION

Probability level	$\emptyset_2$	$\emptyset_2$	(corresponding to greater mean square)										
		1	2	3	4	5	6	7	8	9	10	15	∞
0,10	1	39,9	49,5	53,6	55,8	57,2	58,2	58,9	59,4	59,9	60,2	61,2	63,3
0,05		161,4	199,5	215,7	224,6	230,2	234,0	236,8	238,9	240,5	241,9	246,0	254,3
0,01		4,052	4,999	5,403	5,625	5,764	5,859	5,928	5,981	6,023	6,056	6,157	6,366
0,10	2	8,53	9,00	9,16	9,24	9,29	9,33	9,35	9,37	9,38	9,39	9,42	9,49
0,05		18,5	19,0	19,2	19,2	19,3	19,3	19,4	19,4	19,4	19,4	19,4	19,5
0,01		98,5	99,0	99,2	99,2	99,3	99,3	99,4	99,4	99,4	99,4	99,4	99,5
0,10	3	5,54	5,46	5,39	5,34	5,31	5,28	5,27	5,25	5,24	5,23	5,20	5,13
0,05		10,1	9,55	9,28	9,12	9,01	8,94	8,89	8,85	8,81	8,79	8,70	8,53
0,01		34,1	30,8	29,5	28,7	28,2	27,9	27,7	27,5	27,3	27,2	26,9	26,1
0,10	4	4,54	4,32	4,19	4,11	4,05	4,01	3,98	3,95	3,94	3,92	3,87	3,76
0,05		7,71	6,94	6,59	6,39	6,26	6,16	6,09	6,04	6,00	5,96	5,86	5,63
0,01		21,2	18,0	16,7	16,0	15,5	15,2	15,0	14,8	14,7	14,5	14,2	13,5
0,10	5	4,06	3,78	3,62	3,52	3,45	3,40	3,37	3,34	3,32	3,30	3,24	3,10
0,05		6,61	5,79	5,41	5,19	5,05	4,95	4,88	4,82	4,77	4,74	4,62	4,36
0,01		16,3	13,3	12,1	11,4	11,0	10,7	10,5	10,3	10,2	10,1	9,72	9,02
0,10	6	3,78	3,46	3,29	3,18	3,11	3,05	3,01	2,98	2,96	2,94	2,87	2,72
0,05		5,99	5,14	4,76	4,53	4,39	4,28	4,21	4,15	4,10	4,06	3,94	3,67
0,01		13,7	10,9	9,78	9,15	8,75	8,47	8,26	8,10	7,98	7,87	7,56	6,88
0,10	7	3,59	3,26	3,07	2,96	2,88	2,83	2,78	2,75	2,72	2,70	2,63	2,47
0,05		5,59	4,74	4,35	4,12	3,97	3,87	3,79	3,73	3,68	3,64	3,51	3,23
0,01		12,2	9,55	8,45	7,85	7,46	7,19	6,99	6,84	6,72	6,62	6,31	5,65
0,10	8	3,46	3,11	2,92	2,81	2,73	2,67	2,62	2,59	2,56	2,54	2,46	2,29
0,05		5,32	4,46	4,07	3,84	3,69	3,58	3,50	3,44	3,39	3,35	3,22	2,93
0,01		11,3	8,65	7,59	7,01	6,63	6,37	6,18	6,03	5,91	5,81	5,52	4,86
0,10	9	3,36	3,01	2,81	2,69	2,61	2,55	2,51	2,47	2,44	2,42	2,34	2,16
0,05		5,12	4,26	3,86	3,63	3,48	3,37	3,29	3,23	3,18	3,14	3,01	2,71
0,01		10,6	8,02	6,99	6,42	6,06	5,80	5,61	5,47	5,35	5,26	4,96	4,31
0,10	10	3,29	2,92	2,73	2,61	2,52	2,46	2,41	2,38	2,35	2,32	2,24	2,06
0,05		4,96	4,10	3,71	3,48	3,33	3,22	3,14	3,07	3,02	2,98	2,85	2,54
0,01		10,0	7,56	6,55	5,99	5,64	5,39	5,20	5,06	4,94	4,85	4,56	3,91
0,10	12	3,18	2,81	2,61	2,48	2,39	2,33	2,28	2,24	2,21	2,19	2,10	1,90
0,05		4,75	3,89	3,49	3,26	3,11	3,00	2,91	2,85	2,80	2,75	2,62	2,30
0,01		9,33	6,93	5,95	5,41	5,06	4,82	4,64	4,50	4,39	4,30	4,01	3,36
0,10	15	3,07	2,70	2,49	2,36	2,27	2,21	2,16	2,12	2,09	2,06	1,97	1,76
0,05		4,54	3,68	3,29	3,06	2,90	2,79	2,71	2,64	2,59	2,54	2,40	2,07
0,01		8,68	6,36	5,42	4,89	4,56	4,32	4,14	4,00	3,89	3,80	3,52	2,87
0,10	16	3,05	2,67	2,46	2,33	2,24	2,18	2,13	2,09	2,06	2,03	1,94	1,72
0,05		4,49	3,63	3,24	3,01	2,85	2,74	2,66	2,59	2,54	2,49	2,35	2,01
0,01		8,53	6,23	5,29	4,77	4,44	4,20	4,03	3,89	3,78	3,69	3,41	2,75
0,10	24	2,93	2,54	2,33	2,19	2,10	2,04	1,98	1,94	1,91	1,88	1,78	1,53
0,05		4,26	3,40	3,01	2,78	2,62	2,51	2,42	2,36	2,30	2,25	2,11	1,73
0,01		7,82	5,61	4,72	4,22	3,90	3,67	3,50	3,36	3,26	3,17	2,89	2,21
0,10	60	2,79	2,39	2,18	2,04	1,95	1,87	1,82	1,77	1,74	1,71	1,60	1,29
0,05		4,00	3,15	2,76	2,53	2,37	2,25	2,17	2,10	2,04	1,99	1,84	1,39
0,01		7,08	4,98	4,13	3,65	3,34	3,12	2,95	2,82	2,72	2,63	2,35	1,60
0,10	∞	2,71	2,30	2,08	1,94	1,85	1,77	1,72	1,67	1,63	1,60	1,49	1,00
0,05		3,84	3,00	2,60	2,37	2,21	2,10	2,01	1,94	1,88	1,83	1,67	1,00
0,01		6,63	4,61	3,78	3,32	3,02	2,80	2,64	2,51	2,41	2,32	2,04	1,00

PERIODIC TABLE OF ELEMENTS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.008																	2 He Helium 4.0026
2	3 Li Lithium 6.94	4 Be Beryllium 9.0122											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
3	11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminium 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
4	19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
5	37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
6	55 Cs Caesium 132.91	56 Ba Barium 137.33	57–71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89–103	104 Rf Rutherfordium (267)	105 Db Dubnium (268)	106 Sg Seaborgium (269)	107 Bh Bohrium (270)	108 Hs Hassium (277)	109 Mt Meitnerium (278)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (282)	112 Cn Copernicium (285)	113 Nh Nihonium (286)	114 Fl Flerovium (289)	115 Mc Moscovium (290)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)
6				57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.97
7				89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (266)

Atomic # / Symbol / Name / Weight

C Solid
Hg Liquid
H Gas
Rf Unknown

Metals
- Alkali metals
- Alkaline earth metals
- Lanthanoids (Lanthanides)
- Actinoids (Actinides)
- Transition metals
- Post-transition metals

Metalloids

Nonmetals
- Other nonmetals
- Noble gases

Pnictogens | Chalcogens | Halogens

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

Ptable.com

Statistics formulas

Standard deviation / the root mean square deviation-

- For the infinite number of measurements, symbol σ

1. $\sigma = \sqrt{\frac{(X_1-\ddot{x})2+(X_2-\ddot{x})2+\cdots\ldots\ldots\ldots(X_n-\ddot{x})2}{N}}$ or $\sigma = \sqrt{\frac{(X_1-\ddot{x})2}{N}}$
   - For the small number of measurement (N), symbol S

2. $S= \sqrt{\frac{(X_1-\ddot{x})2+(X_2-\ddot{x})2+\cdots\ldots\ldots\ldots(X_n-\ddot{x})2}{N-1}}$ or $S= \sqrt{\frac{(X_1-\ddot{x})2}{N-1}}$
3. The confidence limits for population means by
   $\ddot{x} \pm tc\frac{s}{\sqrt{N-1}}$
   - Tc is critical value or confidence coefficient
4. Variance

$$Cv = \frac{S\,X\,100}{X}$$

5. $t = \frac{(\ddot{x}-\mu)\sqrt{N}}{S}$
6. $\ddot{x} \pm tc\frac{s}{\sqrt{N-1}}$
7. $t = \frac{\ddot{x}-\mu}{\frac{s}{\sqrt{N}}}$
8. $t = \frac{\ddot{x}1-\ddot{x}2}{r\sqrt{\frac{1}{N1}+\frac{1}{N2}}}$ where $r = \sqrt{\frac{(N_1-1)S_1^2+(N_2-1)S_2^2}{N_1+N_2-2}}$
9. $F = \frac{S_1^2}{S_2^2}$