TOPIC 2:
ATOMIC STRUCTURE

APPENDICES

Appendix 2.1: Spectral Lines

Element	Wavelength (nm)	Colour
Barium	659.5 614.1 585.4 577.7 553.5 455.4	Red Orange Yellow Yellow Green (strong) Blue (strong)
Calcium	445.4 443.4 442.6 396.8 393.3	Blue Blue-violet Violet (strong) Violet (strong) Violet (strong)
Chromium	520.8 520.6 520.4 428.9 427.4 425.4	Green Green Green Violet (strong) Violet (strong) Violet (strong)
Copper	521.8 515.3 510.5	Green Green Green
Hydrogen	656.2 486.1 434.0 410.1	Red Green Blue-violet Violet
Helium	706.5 667.8 587.5 501.5 471.3 388.8	Red Red Orange (strong) Green Blue Violet (strong)
Potassium	404.7 404.4	Violet (strong) Violet (strong)

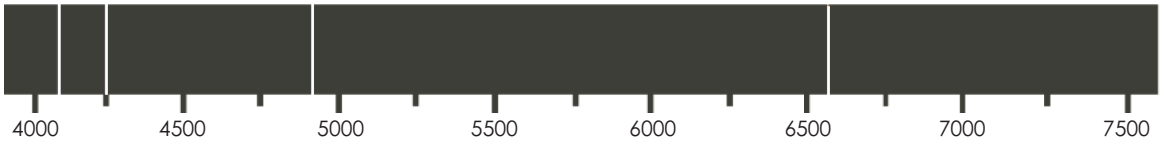
continued

Appendix 2.1: Spectral Lines *(continued)*

Element	Wavelength (nm)	Colour
Mercury	623.4 579.0 576.9 546.0 435.8	Red Yellow (strong) Yellow (strong) Green (strong) Blue-violet
Lithium	670.7 610.3 460.3	Red (strong) Orange Violet
Sodium	589.5 588.9 568.8 568.2	Yellow (strong) Yellow (strong) Green Green
Neon	640.2 585.2 540.0	Orange Yellow Green
Strontium	496.2 487.2 483.2 460.7 430.5 421.5 407.7	Blue-green Blue Blue Blue (strong) Blue-violet Violet Violet

Appendix 2.2: Gas Discharge Tubes (BLM)

Hydrogen



Emission Spectrum of Hydrogen

Element _____

Element _____

Element _____

Element _____

Element _____

Element _____

Appendix 2.3: Flaming Salts (Demonstration)

For this demonstration, ignite a series of salt solutions mixed in methanol and have students observe the colours given off. The demonstration is probably more convincing if all the salts differ only by the metal (e.g., all the salts are chlorides).

Materials

evaporating dishes or crucibles (1 per salt solution)

long matches or a lighter

gloves and goggles

diffraction gratings or spectroscopes

Solutions

Prepare saturated salt solutions (60%) mixed in methanol

lithium chloride (LiCl)

sodium chloride (NaCl)

potassium chloride (KCl)

calcium chloride ($CaCl_2$)

strontium chloride ($SrCl_2$)

barium chloride ($BaCl_2$)

copper(II) sulphate ($CuSO_4$)

borax ($Na_2B_4O_7$)

sodium carbonate (Na_2CO_3)

Procedure

1. Set the evaporating dishes on a heat/flame-resistant surface.
2. Pour about 10 to 20 mL of each salt solution/methanol mix into separate dishes.
3. Light the salt mixture with a long match or lighter. (Do not drop the match into the solution.)
4. Allow the flames to burn for a few seconds until a consistent, single-coloured flame appears.
5. Record the colours of the flames in a data table.
6. Observe the spectral lines of the flames through a diffraction grating or spectroscope.

Appendix 2.3: Flaming Salts (Demonstration) *(continued)*

Data Table

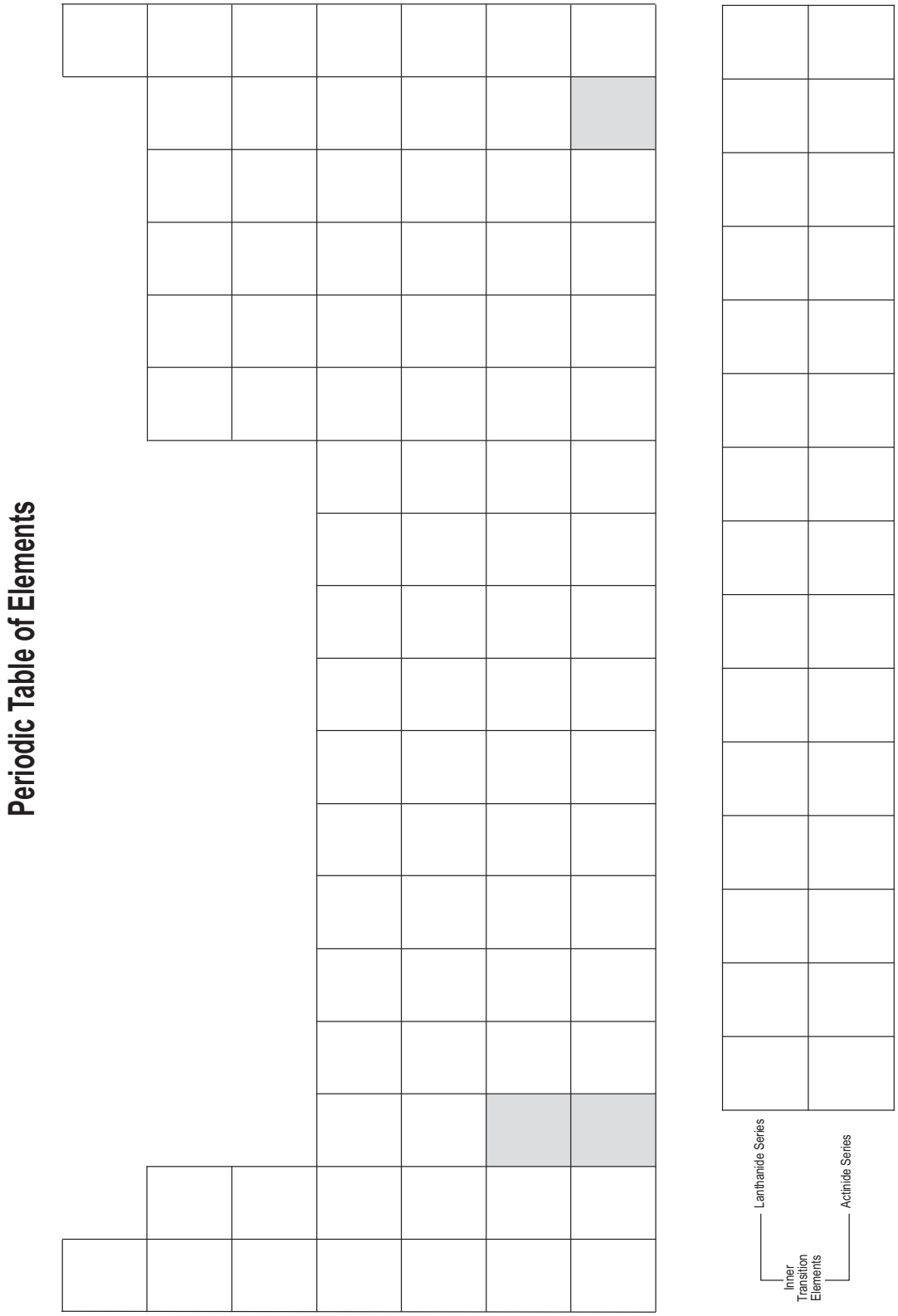
Salt Solutions	Flame Colour
Lithium chloride (LiCl)	Red
Sodium chloride (NaCl)	Yellow
Potassiulm chloride (KCl)	Lilac
Calcium chloride ($CaCl_2$)	Bright orange
Strontium chloride ($SrCl_2$)	Red-orange
Barium chloride ($BaCl_2$)	Green
Copper(II) sulphate ($CuSO_4$)	Green
Borax ($Na_2B_4O_7$)	Green
Sodium carbonate (Na_2CO_3)	Yellow

Appendix 2.4: Observing Continuous Spectra and Line Spectra

Questions

1. Draw the spectra of an incandescent light bulb and of a fluorescent light bulb.
2. What is the difference between a line spectrum and a continuous spectrum? Draw one of each.
3. Based on your observations in the lab activities, what types of materials produce continuous spectra? What types of materials produce line spectra?
4. Give an example of a light source with
   a) a continuous spectrum
   b) a line spectrum
   c) both a continuous spectrum and a line spectrum
5. Based on your observations, what would you say are some things that all light-emitting sources have in common? How can they differ?
6. Explain why a rainbow is considered to be an example of a continuous spectrum.
7. What do the different colours in a line spectrum represent?
8. Why do different substances show different spectra?
9. Sodium vapour lamps emit a characteristic yellow light. What can you assume about sodium atoms, based on this observation?
10. Explain how atoms produce their characteristic spectral lines. Why are different lines produced instead of just a single line?
11. Which elements produce the largest number of spectral lines? What does this suggest about electron transitions?
12. Spectral lines are fingerprints of elements. Explain what is meant by this statement.

Appendix 2.5: Blank Periodic Table of the Elements



Appendix 2.6: Table of Electronegativity Values

Period	Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 2.20																	2 **He** —
2	3 **Li** 0.97	4 **Be** 1.47											5 **B** 2.01	6 **C** 2.50	7 **N** 3.07	8 **O** 3.50	9 **F** 4.10	10 **Ne** —
3	11 **Na** 1.01	12 **Mg** 1.23											13 **Al** 1.47	14 **Si** 1.74	15 **P** 2.06	16 **S** 2.44	17 **Cl** 2.83	18 **Ar** —
4	19 **K** 0.91	20 **Ca** 1.04	21 **Sc** 1.20	22 **Ti** 1.32	23 **V** 1.45	24 **Cr** 1.56	25 **Mn** 1.60	26 **Fe** 1.64	27 **Co** 1.70	28 **Ni** 1.75	29 **Cu** 1.75	30 **Zn** 1.66	31 **Ga** 1.82	32 **Ge** 2.02	33 **As** 2.20	34 **Se** 2.48	35 **Br** 2.74	36 **Kr** —
5	37 **Rb** 0.89	38 **Sr** 0.99	39 **Y** 1.11	40 **Zr** 1.22	41 **Nb** 1.23	42 **Mo** 1.30	43 **Tc** 1.36	44 **Ru** 1.42	45 **Rh** 1.45	46 **Pd** 1.35	47 **Ag** 1.42	48 **Cd** 1.46	49 **In** 1.49	50 **Sn** 1.72	51 **Sb** 1.82	52 **Te** 2.01	53 **I** 2.21	54 **Xe** —
6	55 **Cs** 0.86	56 **Ba** 0.97	57–71 **Lanthanide Series**	72 **Hf** 1.23	73 **Ta** 1.33	74 **W** 1.40	75 **Re** 1.46	76 **Os** 1.52	77 **Ir** 1.55	78 **Pt** 1.44	79 **Au** 1.42	80 **Hg** 1.44	81 **Tl** 1.44	82 **Pb** 1.55	83 **Bi** 1.67	84 **Po** 1.76	85 **At** 1.90	86 **Rn** —
7	87 **Fr** 0.86	88 **Ra** 0.97	89–103 **Actinide Series**	104 **Rf** —	105 **Db** —	106 **Sg** —	107 **Bh** —	108 **Hs** —	109 **Mt** —	110 **Ds** —	111 **Rg** —	112 **Cn** —	113 **Uut** —	114 **Uuq** —	115 **Uup** —	116 **Uuh** —		118 **Uuo** —

Inner Transition Elements

Lanthanide Series	57 **La** 1.08	58 **Ce** 1.08	59 **Pr** 1.07	60 **Nd** 1.07	61 **Pm** 1.07	62 **Sm** 1.07	63 **Eu** 1.01	64 **Gd** 1.11	65 **Tb** 1.10	66 **Dy** 1.10	67 **Ho** 1.10	68 **Er** 1.11	69 **Tm** 1.11	70 **Yb** 1.06	71 **Lu** 1.14
Actinide Series	89 **Ac** 1.00	90 **Th** 1.11	91 **Pa** 1.14	92 **U** 1.30	93 **Np** 1.29	94 **Pu** 1.25	95 **Am** —	96 **Cm** —	97 **Bk** —	98 **Cf** —	99 **Es** —	100 **Fm** —	101 **Md** —	102 **No** —	103 **Lr** —

Appendix 2.7A: Electronegativities (BLM)

Use the Table of Electronegativity Values to determine the bond type (ionic, polar covalent, non-polar covalent) that would be formed between each of the following elements. Provide the electronegativity difference for each pair.

Elements	Bond Type	Electronegativity Difference
1. Na, Cl		
2. Al, Cl		
3. H, S		
4. K, F		
5. O, O		
6. Mg, S		
7. Li, Br		
8. F, F		

Appendix 2.7B: Electronegativities (Teacher Key)

Use the Table of Electronegativity Values to determine the bond type (ionic, polar covalent, non-polar covalent) that would be formed between each of the following elements. Provide the electronegativity difference for each pair. Answers are based on the Allred-Rochow scale.

Elements	Bond Type	Electronegativity Difference
1. Na, Cl	Very polar covalent	2.83 – 1.01 = 1.82
2. Al, Cl	Very polar covalent	2.83 – 1.47 = 1.36
3. H, S	Non-polar covalent	2.44 – 2.20 = 0.24
4. K, F	Ionic	4.10 – 0.91 = 3.19
5. O, O	Non-polar covalent	3.50 – 3.50 = 0
6. Mg, S	Very polar covalent	2.44 – 1.23 = 1.21
7. Li, Br	Very polar covalent	2.74 – 0.97 = 1.77
8. F, F	Non-polar covalent	4.10 – 4.10 = 0