PRACTICE PAPERS CHEMISTRY OLYMPIADS

STAGE – 2

Paper – 14 Part – C

TIME: 1HR 30MIN MAX MARKS: 180

- Attempt all the Questions.
- All questions carry +3 for right answer and -1 for wrong answer.
- Use of Calculator is allowed.

PERIODIC TABLE OF THE ELEMENTS

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.008	2 2A																2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Name: …….

Correct Questions =…… **Wrong Questions = …..** **Unattempt Questions = ……**

Marks = ……

Lab Problem 1

A box of food coloring, available from a grocery store, contains one small bottle each of the color red, yellow, blue, and green. You have been given two vials, one containing some green food coloring and the other a mixture of the blue and the yellow.

Devise and carry out a procedure to determine:

1) ***Which solvent-paper combination gives the best separation of the dyes present in the mixture of the blue and yellow food coloring, and***
2) ***Which dye(s) is (are) present in both the mixture of the blue and yellow food coloring and in the green food coloring.***

Lab Problem 2

A bottle of acetic acid of unknown molarity is found in a chemical storeroom. The determination of the concentration of this acid has been assigned to you. You find some standardized sodium hydroxide solution, but there are no indicators in the storeroom. Just before giving up, you remember that you brought grape juice to drink with your lunch today. In addition to a number of other organic compounds, red and purple grapes contain multiple anthocyanins, naturally occurring compounds which can act as acid-base indicators.

Devise and carry out a procedure to determine the concentration of the acetic acid. You should keep detailed notes of your data and observations, and show all your calculations.

Laboratory Practical Problem 1

Characteristics of Excellent Student Responses for Lab Practical **Problem 1:**

1. Experimental Plan

   An *average* response indicated that the experiment relied on paper chromatography. It gave a plan for using all six combinations (2 types of paper × 3 eluents) on the mixture of blue and yellow food coloring, then using the most effective combination to analyze the green food coloring. (Using all six combinations on each of the two types of food coloring was also reasonable.)

   An *excellent* response gave more details about the mechanics of paper chromatography, for example by drawing a sketch of the proposed setup.

2. Data and Observations

   An *average* response clearly linked sets of observations with particular conditions (eluent, paper, food coloring sample), usually in the form of a table or tables. The degree of separation was described in qualitative terms, and included the color of the spots ("blue faster than yellow"). A difference in the order of elution, with blue dye eluting faster than yellow on white paper but yellow faster than blue was observed.

   An *excellent* response described the observations both qualitatively and quantitatively (by R_f or by a quantitatively accurate sketch of the chromatogram). The presence of a red spot in the blue/yellow mixture was noted.

3. Best separation

   The white paper/salt water combination worked best.

4. Dyes in common between the samples

   An *average* response noted that blue and yellow dyes were present in both samples. An *excellent* response made the comparison with respect to elution rates (i.e., R_f values) as well as colors. A *poor* response alluded to the presence of a green dye (no green dye was present in any of the samples, but overlap between spots might produce the appearance of a green smear).

4. Changing elution order and its explanation

   An *average* response noted the inversion of order mentioned in (2) and attributed to different affinities of the dyes for the surfaces of the brown vs. white paper. An *excellent* response was concrete in connecting the change in affinity to the difference in elution times, e.g., that the greater affinity of the brown paper for the blue dye made the blue dye run more slowly on the brown paper. It might also have mentioned possible reasons for the change in affinity, e.g. different hydrophilicity of the paper surfaces. A *poor* response attributed differences to factors unrelated to paper chromatographic separation (e.g., the molecular weights of the dyes).

Laboratory Practical Problem 2

Characteristics of Excellent Student Responses for Lab Practical **Problem 2**:

1. Experimental Plan

   a. Statement that this was a titration task.
   b. Plan to use volumes of acetic acid solution, standardized NaOH solution, and grape juice indicator that seem reasonable for a titration analysis.
   c. Specific equipment used is properly described (e.g.: a 10 mL graduated cylinder).

2. Data and Observations

   a. The observation of the color of the grape juice in acidic and basic solution.
   b. At least two titration trials performed, with the final result for the molarity of the acetic acid determined by averaging the results of multiple trials.
   c. If drops were counted as part of the titration analysis, a description of how the drop count was converted into volume (if needed for the calculations) was provided.
   d. A data table, rather than a series of sentences that included data, was created that was easy to read and included units.
   e. All data required for the calculations was neatly and clearly provided. This likely included the volume of acetic acid solution used, the volume of NaOH solution used, the number of drops of grape juice used as indicator.

3. Show all calculations

   a. Student clearly indicates, either in words or by a balanced chemical equation, or as shown in the calculations, that there is a 1:1 mole:mole ratio between the moles of acetic acid and moles of sodium hydroxide reacting.
   b. Calculation of acetic acid concentration from each trial and then averaging, OR calculation of concentration from average volume of titrant used. For example: $M_A V_A = M_B V_B$ (since acetic acid and NaOH react in a 1:1 mole ratio)
   $M_A = M_B V_B / V_A$ (volumes need not be converted to L; just must both be expressed in the same unit, e.g., mL)
   Alternatively, something similar to the following (based on avg. volume; will vary based on volume of acetic acid used):

   $$8.4 \text{ mL NaOH} \times \frac{1 \text{ L NaOH}}{1000 \text{ mL NaOH}} \times \frac{0.501 \text{ mol NaOH}}{1 \text{ L NaOH}} = 4.2 \times 10^{-3} \text{ mol NaOH}$$

   $$4.2 \times 10^{-3} \text{ mol NaOH} \times \frac{1 \text{ mol HOAc}}{1 \text{ mol NaOH}} = 4.2 \times 10^{-3} \text{ mol HOAc}$$ (may not be shown explicitly)

   $$\frac{4.2 \times 10^{-3} \text{ mol HOAc}}{0.00500 \text{ L HOAc used}} = 0.84\ M$$ (steps may be shown & calc. as one sequence)

   c. The calculated value for the molarity of acetic acid fell within an acceptable range that was established by the grading team.

   d. The calculations were neatly done, easy to follow, and included appropriate units.

   e. The student chose to include a statement or statements of likely sources of error in the titration work.