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| **Entrance Examination**  **February 2023** |
| **CHEMISTRY**  Time allowed: 1.5 hours (90 minutes)  **Answer TWO questions**  You may use a calculator and a periodic table |

1. This question concerns compounds containing zinc.
   1. A patient is diagnosed with a zinc deficiency and is prescribed zinc sulphate (ZnSO4.xH2O) as a dietary supplement. A 4.38 g sample of this medicine was heated and yielded 2.46 g of anhydrous zinc sulphate. Use these data to calculate the value of the integer x in ZnSO4.xH2O. Show your working. *[2 marks]*
   2. ZnCl2 can be prepared in the laboratory by the reaction between zinc and hydrogen chloride gas.
      1. Write a balanced equation for this reaction. *[1 mark]*
      2. An impure sample of zinc powder with a mass of 2.84 g was reacted with hydrogen chloride gas until the reaction was complete. The zinc chloride produced had a mass of 5.35 g. Calculate the percentage purity of the zinc metal. Show your working and give your answer to 3 significant figures. *[2 marks]*
      3. Describe bonding in zinc chloride *[1 mark]*
   3. Describe the commercial and/or biological uses of zinc. *[4 marks]*
2. In chemistry, what is chirality and why is it important? Give examples to support your answer. *[10 marks]*
3. Look at the four spectra on the next two pages and, using the data, deduce the structure of compound **T16**. Provide evidence for your structure. *[10 marks]*





1. This question is about titrimetric analysis.

Standard potassium hydrogen phthalate solution was used to standardise a solution of sodium hydroxide. This solution of NaOH was then used to titrate the ethanoic acid (acetic acid) in a diluted solution of red rice vinegar.

Potassium hydrogen phthalate (2.04 g) was dissolved in water (50 mL). This solution was placed in a 100 mL volumetric flask, the volume was made up to the mark with water and the contents were mixed thoroughly.

1. How many moles of potassium hydrogen phthalate were in the volumetric flask? The molecular weight (RMM) of potassium hydrogen phthalate is 204. *[1 mark]*
2. What is the molar concentration of the solution of potassium hydrogen phthalate? *[1 mark]*

Ten pellets of sodium hydroxide were dissolved in water (70 mL). This solution was transferred to a 250 mL volumetric flask, the volume was made up to the mark with water and the contents were mixed thoroughly.

An aliquot (10.0 mL) of this sodium hydroxide solution was placed in a conical flask and it was titrated with the standard potassium hydrogen phthalate solution using phenolphthalein indicator until the solution was just colourless. The mean titre volume of potassium hydrogen phthalate solution delivered was 10.20 mL.

1. How many moles of potassium hydrogen phthalate were delivered? *[1 mark]*

The equation for the reaction between sodium hydroxide and potassium hydrogen phthalate is

C8H5KO4 (potassium hydrogen phthalate) + NaOH → C8H4KNaO4 + H2O

1. Therefore, how many moles of sodium hydroxide were in the conical flask? *[1 mark]*
2. Therefore, what is the concentration of the sodium hydroxide solution? *[1 mark]*

Red rice vinegar (19.80 g) was placed in a 100 mL volumetric flask, the volume was made up to the mark with water and the contents were mixed thoroughly. 20.00 mL of this diluted vinegar were taken with a bulb pipette and placed in a conical flask. Phenolphthalein indicator (2 drops) was added and this diluted vinegar was titrated with the sodium hydroxide solution. The mean titre was 16.00 mL.

1. How many moles of sodium hydroxide were delivered? *[1 mark]*

The equation for the reaction between sodium hydroxide and ethanoic acid (acetic acid) is

C2H4O2 (ethanoic acid) + NaOH → C2H3NaO2 + H2O

1. Therefore, how many moles of ethanoic acid (acetic acid) were in the conical flask? [1 mark]
2. Therefore, what was the molarity of the diluted vinegar? [1 mark]
3. Therefore, what was the molarity of the original red rice vinegar? [1 mark]
4. Therefore, what was the number of grams of ethanoic acid (acetic acid) in 100 mL of original red rice vinegar? Assume that the density of red rice vinegar is 1.00 g mL-1. [1 mark]

Period

1

2

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3

4

(1091-01A)

5

6

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**THE PERIODIC TABLE**

**1 2 Group 3 4 5 6 7 0**

s Block

Key

relative atomic

4.00

He

Helium

2

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| --- |
|  |
| 1.01  H  Hydrogen  1 |

p Block

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| --- | --- | --- |
| *A*r |  |  |
| Symbol Name  Z | |  |
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| 6.94  Li  Lithium  3 | 9.01  Be  Beryllium 4 | mass  atomic number  d Block | | | | | | | | | | 10.8  B  Boron  5 | 12.0  C  Carbon  6 | 14.0  N  Nitrogen  7 | 16.0  O  Oxygen  8 | 19.0  F  Fluorine  9 | 20.2  Ne  Neon  10 |
| 23.0  Na  Sodium  11 | 24.3  Mg  Magnesium  12 | 27.0  Al  Aluminium  13 | 28.1  Si  Silicon  14 | 31.0  P  Phosphorus  15 | 32.1  S  Sulfur  16 | 35.5  Cl  Chlorine  17 | 40.0  Ar  Argon  18 |
| 39.1  K  Potassium  19 | 40.1  Ca  Calcium  20 | 45.0  Sc  Scandium  21 | 47.9  Ti  Titanium  22 | 50.9  V  Vanadium  23 | 52.0  Cr  Chromium  24 | 54.9  Mn  Manganese  25 | 55.8  Fe  Iron  26 | 58.9  Co  Cobalt  27 | 58.7  Ni  Nickel  28 | 63.5  Cu  Copper  29 | 65.4  Zn  Zinc  30 | 69.7  Ga  Gallium  31 | 72.6  Ge  Germanium  32 | 74.9  As  Arsenic  33 | 79.0  Se  Selenium  34 | 79.9  Br  Bromine  35 | 83.8  Kr  Krypton  36 |
| 85.5  Rb  Rubidium  37 | 87.6  Sr  Strontium  38 | 88.9  Y  Yttrium  39 | 91.2  Zr  Zirconium  40 | 92.9  Nb  Niobium  41 | 95.9  Mo  Molybdenum  42 | 98.9  Tc  Technetium  43 | 101  Ru  Ruthenium  44 | 103  Rh  Rhodium  45 | 106  Pd  Palladium  46 | 108  Ag  Silver  47 | 112  Cd  Cadmium  48 | 115  In  Indium  49 | 119  Sn  Tin  50 | 122  Sb  Antimony  51 | 128  Te  Tellurium  52 | 127  I  Iodine  53 | 131  Xe  Xenon  54 |
| 133  Cs  Caesium  55 | 137  Ba  Barium  56 | 139 ‣  La  Lanthanum  57 | 179  Hf  Hafnium  72 | 181  Ta  Tantalum  73 | 184  W  Tungsten  74 | 186  Re  Rhenium  75 | 190  Os  Osmium  76 | 192  Ir  Iridium  77 | 195  Pt  Platinum  78 | 197  Au  Gold  79 | 201  Hg  Mercury  80 | 204  Tl  Thallium  81 | 207  Pb  Lead  82 | 209  Bi  Bismuth  83 | (210)  Po  Polonium  84 | (210)  At  Astatine  85 | (222)  Rn  Radon  86 |
| (223)  Fr  Francium  87 | (226)  Ra  Radium  88 | (227)  Ac ‣‣  Actinium  89 | f Block | | | | | | | | | | | | | | |

* Lanthanoid elements

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 140  Ce  Cerium 58 | 141  Pr  Praseodymium  59 | 144  Nd  Neodymium  60 | (147)  Pm  Promethium  61 | 150  Sm  Samarium  62 | (153)  Eu  Europium  63 | 157  Gd  Gadolinium  64 | 159  Tb  Terbium 65 | 163  Dy  Dysprosium  66 | 165  Ho  Holmium 67 | 167  Er  Erbium 68 | 169  Tm  Thulium 69 | 173  Yb  Ytterbium 70 | 175  Lu  Lutetium 71 |

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elements

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| 232  Th  Thorium 90 | (231)  Pa  Protactinium  91 | 238  U  Uranium 92 | (237)  Np  Neptunium  93 | (242)  Pu  Plutonium  94 | (243)  Am  Americium  95 | (247)  Cm  Curium 96 | (245)  Bk  Berkelium 97 | (251)  Cf  Californium  98 | (254)  Es  Einsteinium  99 | (253)  Fm  Fermium 100 | (256)  Md  Mendelevium  101 | (254)  No  Nobelium 102 | (257)  Lr  Lawrencium  103 |

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