UNIVERSITY OF SWAZILAND

FINAL EXAMINATION – 2017, DECEMBER

TITLE OF PAPER : Chemistry

COURSE NUMBER : CPR 103

TIME : Three Hours

INSTRUCTIONS :

1. **Answer all questions in Section A** (Total 50 marks)
2. **Answer any two questions in Section B** (each question is 25 marks)

NB: Non-programmable electronic calculators may be used

A periodic table and answer sheet (for **Section A**) are attached

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This Examination Paper Contains Twelve Printed Pages Including This Page

You are not supposed to open the paper until permission to do so has been granted by the Chief Invigilator.

Section A

1) What is the physical state in which matter has no specific shape but does have a specific volume?

A) gas   B) solid   C) liquid   D) salts   E) ice

2) Which one of the following has the element name and symbol correctly matched?
A) S, sodium   B) Tn, tin   C) Fe, iron
D) N, neon   E) B, bromine

3) Which one of the following is often easily separated into its components by simple techniques such as filtering or decanting?
A) heterogeneous mixture   B) compounds   C) homogeneous mixture
D) elements   E) solutions

4) Gases and liquids share the property of _____.
A) compressibility   B) definite volume   C) incompressibility
D) indefinite shape   E) definite shape

5) Which one of the following is the highest temperature?
A) 38 °C   B) 96 °F   C) 302 K
D) none of the above   E) the freezing point of water

6) Osmium has a density of 22.6 g/cm^3. What volume (in cm^3) would be occupied by a 21.8 g sample of osmium?

A) 0.965   B) 1.04   C) 493   D) 2.03×10^{-3} E) 2.03×10^3

7) Accuracy refers to _____.
A) how close a measured number is to zero
B) how close a measured number is to the calculated value
C) how close a measured number is to other measured numbers
D) how close a measured number is to the true value
E) how close a measured number is to infinity

8) In which one of the following numbers are _none_ of the zeros significant?
A) 100.0   B) 1065   C) 0.0100   D) 1.003450   E) 0.00001

9) Round the number 0.08535 to two significant figures.
A) 0.09   B) 0.086   C) 0.0854   D) 0.085   E) 0.08535

10) There are _____ electrons, _____ protons, and _____ neutrons in an atom of $^{132}_{54}$Xe .

A) 132, 132, 54   B) 54, 54, 132   C) 78, 78, 54
D) 54, 54, 78   E) 78, 78, 132

11) The nucleus of an atom does not contain _____.
A) protons   B) protons or neutrons   C) neutrons
D) subatomic particles   E) electrons

12) In the symbol shown below, x = _____.

$^{13}_{x}$C

A) 7   B) 13   C) 12   D) 6   E) not enough information to determine

13) The average atomic weight of copper, which has two naturally occurring isotopes, is 63.5. One of the isotopes has an atomic weight of 62.9 amu and constitutes 69.1% of the copper isotopes. The other isotope has an abundance of 30.9%. The atomic weight (amu) of the second isotope is _____ amu.
A) 63.2   B) 63.8   C) 64.1   D) 64.8   E) 28.1

14) Elements _____ exhibit similar physical and chemical properties.
A) with similar chemical symbols   B) with similar atomic masses
C) in the same period of the periodic table   D) on opposite sides of the periodic table
E) in the same group of the periodic table

15) An element that appears in the lower left corner of the periodic table is _____.
A) either a metal or metalloid   B) definitely a metal
C) either a metalloid or a non-metal   D) definitely a non-metal
E) definitely a metalloid

16) A molecular formula always indicates _____.
A) how many of each atom are in a molecule
B) the simplest whole-number ratio of different atoms in a compound
C) which atoms are attached to which in a molecule
D) the isotope of each element in a compound
E) the geometry of a molecule

17) Which one of the following substances is the product of this combination reaction?

$$Al\ (s)\ +\ I_2\ (s)\ \rightarrow\ \underline{\qquad}$$
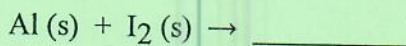
A) AlI_2 B) AlI C) AlI_3 D) Al_2I_3 E) Al_3I_2

18) The formula weight of potassium dichromate ($K_2Cr_2O_7$) is _____ amu.
A) 107.09   B) 255.08   C) 242.18   D) 294.18   E) 333.08

19) The mass % of H in methane (CH_4) is _____.
A) 25.13   B) 4.032   C) 74.87   D) 92.26   E) 7.743

20) Calculate the percentage by mass of lead in $Pb(NO_3)_2$.
A) 38.6   B) 44.5   C) 62.6   D) 65.3   E) 71.2

21) A sample of CH_4O with a mass of 32.0 g contains _____ molecules of CH_4O.
A) 5.32×10^{-23} B) 1.00   C) 1.88×10^{22}
D) 6.02×10^{23} E) 32.0

22) The balanced molecular equation for complete neutralization of H_2SO_4 by KOH in aqueous solution is _____.
A) $2H^+\ (aq)\ +\ 2OH^-\ (aq)\ \rightarrow\ 2\ H_2O\ (l)$
B) $2H^+\ (aq)\ +\ 2KOH\ (aq)\ \rightarrow\ 2\ H_2O\ (l)\ +\ 2K^+\ (aq)$

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C) H_2SO_4 (aq) + $2OH^-$ (aq) → $2 H_2O$ (l) + SO_4^{2-} (aq)

D) H_2SO_4 (aq) + $2KOH$ (aq) → $2 H_2O$ (l) + K_2SO_4 (s)

E) H_2SO_4 (aq) + $2KOH$ (aq) → $2 H_2O$ (l) + K_2SO_4 (aq)

23) Which combination will produce a precipitate?

A) $Pb(NO_3)_2$ (aq) and HCl (aq)   B) $Cu(NO_3)_2$ (aq) and $KC_2H_3O_2$ (aq)

C) KOH (aq) and HNO_3 (aq)   D) $AgC_2H_3O_2$ (aq) and $HC_2H_3O_2$ (aq)

E) $NaOH$ (aq) and $Sr(NO_3)_2$ (aq)

24) The net ionic equation for the reaction between aqueous nitric acid and aqueous sodium hydroxide is _____.

A) H^+ (aq) + HNO_3 (aq) + $2OH^-$ (aq) → $2 H_2O$ (l) + NO_3^- (aq)

B) HNO_3 (aq) + $NaOH$ (aq) → $NaNO_3$ (aq) + H_2O (l)

C) H^+ (aq) + OH^- (aq) → H_2O (l)

D) HNO_3 (aq) + OH^- (aq) → NO_3^- (aq) + H_2O (l)

E) H^+ (aq) + Na^+ (aq) + OH^- (aq) → H_2O (l) + Na^+ (aq)

25) Which hydroxides are weak bases?

A) KOH, $Ba(OH)_2$ B) $Sr(OH)_2$, KOH, $NaOH$, $Ba(OH)_2$

C) KOH, $NaOH$ D) KOH, $NaOH$, $Ba(OH)_2$

E) None of these is a weak base.

26) In which species does nitrogen have the highest oxidation number?

A) N_2 B) NH_3 C) HNO_2 D) NO_2^- E) $NaNO_3$

27) Sodium does not occur in nature as Na (s) because _____.

A) it is easily reduced to Na^- B) it is easily oxidized to Na^+

C) it reacts with water with great difficulty   D) it is easily replaced by silver in its ores

E) it undergoes a disproportionation reaction to Na^- and Na^+

28) Which of the following is an oxidation-reduction reaction?

A) Cu (s) + $2AgNO_3$ (aq) → $2Ag$ (s) + $Cu(NO_3)_2$ (aq)

B) HCl (aq) + $NaOH$ (aq) → H_2O (l) + $NaCl$ (aq)

C) $AgNO_3$ (aq) + HCl (aq) → $AgCl$ (s) + HNO_3 (aq)

D) $Ba(C_2H_3O_2)_2$ (aq) + Na_2SO_4 (aq) → $BaSO_4$ (s) + $2NaC_2H_3O_2$ (aq)

E) H_2CO_3 (aq) + $Ca(NO_3)_2$ (aq) → $2HNO_3$ (aq) + $CaCO_3$ (s)

29) A tenfold dilution of a sample solution can be obtained by taking _____.

A) 1 part sample and 9 parts solvent   B) 1 part sample and 10 parts solvent

C) 9 parts sample and 1 part solvent   D) 10 parts sample and 1 part solvent

E) 99 parts sample and 1 part solvent

30) What mass (g) of potassium chloride is contained in 430.0 mL of a potassium chloride solution that has a chloride ion concentration of 0.193 M?

A) 0.0643   B) 0.0830   C) 12.37   D) 0.386   E) 6.19

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31) The point in a titration at which the indicator changes is called the _____.
A) setpoint   B) indicator point   C) standard point
D) endpoint   E) volumetric point

32) _____ is an oxidation reaction.
A) Ice melting in a soft drink
B) Table salt dissolving in water for cooking vegetables
C) Rusting of iron
D) The reaction of sodium chloride with lead nitrate to form lead chloride and sodium nitrate
E) Neutralization of HCl by NaOH

33) Which one of the following is an incorrect subshell notation?
A) 4f   B) 2d   C) 3s   D) 2p   E) 3d

34) Which electron configuration represents a violation of the Pauli exclusion principle?

A) 1s $\uparrow$ 2s $\uparrow\downarrow$ 2p [ ][ ]

B) 1s $\uparrow\uparrow$ 2s $\uparrow\downarrow$ 2p [ ][ ]

C) 1s $\uparrow\downarrow$ 2s $\uparrow\downarrow$ 2p $\uparrow\downarrow$ [ ]

D) 1s $\uparrow\downarrow$ 2s $\uparrow\downarrow$ 2p $\uparrow$ [ ] $\uparrow$

E) 1s $\uparrow$ 2s $\uparrow$ 2p $\uparrow$ $\uparrow$ $\uparrow$

35) Which one of the following configurations depicts an excited oxygen atom?
A) $1s^2 2s^2 2p^2$ B) $1s^2 2s^2 2p^2 3s^2$ C) $1s^2 2s^2 2p^1$
D) $1s^2 2s^2 2p^4$ E) $[He]2s^2 2p^4$

36) Which two elements have the same ground-state electron configuration?
A) Pd and Pt   B) Cu and Ag   C) Fe and Cu
D) Cl and Ar   E) No two elements have the same ground-state electron configuration.

37) Atomic radius generally increases as we move _____.
A) down a group and from right to left across a period
B) up a group and from left to right across a period
C) down a group and from left to right across a period
D) up a group and from right to left across a period
E) down a group; the period position has no effect

38) Which equation correctly represents the first ionization of calcium?
A) $Ca (g) \rightarrow Ca^+ (g) + e^-$ B) $Ca (g) \rightarrow Ca^- (g) + e^-$
C) $Ca (g) + e^- \rightarrow Ca^- (g)$ D) $Ca^- (g) \rightarrow Ca (g) + e^-$
E) $Ca^+ (g) + e^- \rightarrow Ca (g)$

39) Chlorine is much more apt to exist as an anion than is sodium. This is because _____.

A) chlorine is bigger than sodium
B) chlorine has a greater ionization energy than sodium does

C) chlorine has a greater electron affinity than sodium does
D) chlorine is a gas and sodium is a solid
E) chlorine is more metallic than sodium

40) Of the ions below, only _____ has a noble gas electron configuration.
A) S^{3-} B) O^{2+} C) I^+ D) K^- E) Cl^-

41) Pentane has _____ structural isomers.
A) 0   B) 1   C) 2   D) 3   E) 4

42) The structure of 2,3-dimethylheptane is _____.

A)
$$CH_3 \quad\quad CH_3$$
$$\mid \quad\quad\quad \mid$$
$$CH_2 - CH_2 - CH_2 - CH_2$$

B)
$$H_3C \quad CH_3$$
$$\mid \quad\quad \mid$$
$$CH_3CH_2 - C - CH - CH_3$$
$$\mid$$
$$CH_3$$

C)
$$H_3C \quad CH_3 \quad CH_3$$
$$\mid \quad\quad \mid \quad\quad \mid$$
$$CH_2 - C - CH - CH_2$$
$$\mid \quad \mid$$
$$H_3C \quad CH_3$$

D)
$$CH_3$$
$$\mid$$
$$CH_3CH_2CH_2CH_2 - CH - CH - CH_3$$
$$\mid$$
$$CH_3$$

E)
$$CH_3$$
$$\mid$$
$$H_3C - C - CH_3$$
$$\mid$$
$$CH_3$$

43) Alcohols are hydrocarbon derivatives in which one or more hydrogens have been replaced by a hydroxyl functional group. _____ is the general formula of an alcohol.
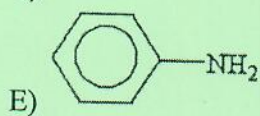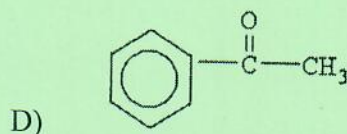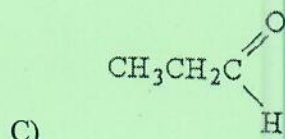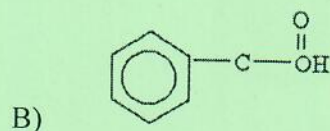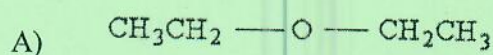A) R-O-R   B) R-CO-R   C) R-CO-OH
D) R-OH   E) R-CO-H

44) Which one of the following compounds is an isomer of $CH_3CH_2CH_2CH_2OH$?

A) $CH_3CH_2CH_2OH$

B)
$$CH_3 \ CHCH_3$$
$$\mid$$
$$OH$$

C)
$$O$$
$$\parallel$$
$$CH_3CH_2CH_2C$$
$$\diagdown$$
$$H$$

D)
$$CH_3CH_2CHCH_3$$
$$\mid$$
$$OH$$

E) CH_3OH

45) Which of the following compounds do not contain an sp^3 hybridized oxygen atom?
A) ketones   B) alcohols   C) ethers
D) esters   E) water

46) Which structure below represents an amine?

6

A) $CH_3CH_2 \text{---} O \text{---} CH_2CH_3$

B)
$$\bigcirc\!\!\!\!\bigcirc\text{---}C\overset{O}{\underset{}{\|}}\text{---}OH$$
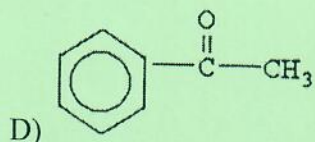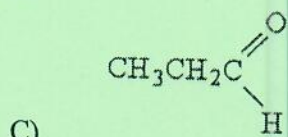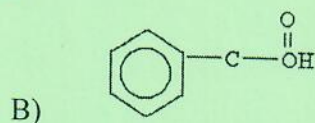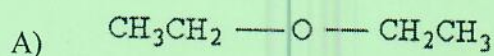
C)
$$CH_3CH_2C\overset{\overset{O}{\|}}{\underset{H}{\diagdown}}$$

D)
$$\bigcirc\!\!\!\!\bigcirc\text{---}C\overset{O}{\underset{}{\|}}\text{---}CH_3$$

E)
$$\bigcirc\!\!\!\!\bigcirc\text{---}NH_2$$

47) Which structure below represents an ether?

A) $CH_3CH_2 \text{---} O \text{---} CH_2CH_3$

B)
$$\bigcirc\!\!\!\!\bigcirc\text{---}C\overset{O}{\underset{}{\|}}\text{---}OH$$

C)
$$CH_3CH_2C\overset{\overset{O}{\|}}{\underset{H}{\diagdown}}$$

D)
$$\bigcirc\!\!\!\!\bigcirc\text{---}C\overset{O}{\underset{}{\|}}\text{---}CH_3$$

E)
$$\bigcirc\!\!\!\!\bigcirc\text{---}NH_2$$
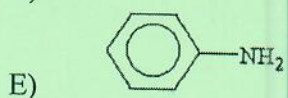
48) The compound below is an _____.

$H\text{-}C\text{=}CH\text{-}CH_3$

A) alkyne   B) alkene   C) alkane
D) aromatic compound   E) olefin

49) _____ could be the formula of an alkene.
A) C_3H_8 B) C_3H_6 C) C_6H_6
D) $C_{17}H_{36}$ E) CH_8

50) The general formula of a carboxylic acid is _____.
A) R-O-R'   B) R-CO-R'   C) R-COOH
D) R-H   E) R-CO-OR'

Section B

Question 1

a)   What mass (g) ofAgBr is formed when 35.5 mL of 0.184 M AgNO3is treated with an

excess of aqueous hydrobromic acid? [5]   (15)

b)   What is the empirical formula of a compound that contains 29% Na, 41 % S, and 30% O

by mass?

[10]

Question 2

a) Write the molecular and the net ionic equation for the formation of an aqueous
solution of $Al(NO_3)_3$ when solid $Al(OH)3$ is mixed with aqueous nitric acid. [10]

b) Determine the molar mass of $CO(NO_3)_2 \cdot 6H_2O$ (5)

c) Name the following compounds

     i) $NiF_2 \cdot 4H_2O$

     ii) Hg_2Cl_2

     iii)   HCl

     iv)   KOH

     v)   HIO(aq) (10)

Question 3

a)   Name any six classes of organic compounds. (6)

b)   Give the functional group and a named example for each of the classes of compounds
named above in (a). (12)

c)   Draw all the structural isomers of pentene, C_4H_{10}, that have an hydrocarbon chain. (4)

d)   Draw the structure of 5-chloro-3-methyl-octanoic acid (3)

UNIVERSITY OF SWAZILAND
Department of Chemistry

Atomic Number

2	He
	4.0026

Atomic Weight

1 H 1.0079																	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.179
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.69	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac 227.03															

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 146.92	62 Sm 150.36	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (234)	96 Cm (247)	97 Bk 247	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)