



FACULTY OF SCIENCE

DEPARTMENT OF APPLIED CHEMISTRY
NATIONAL DIPLOMA IN ANALYTICAL CHEMISTRY (4 YEARS)

MODULE CHEMISTRY 1B (THEORY) – CETXTA2
CHEMISTRY 2CY1 (THEORY) – CET2CY1

CAMPUS DFC

JUNE EXAMINATION

DATE: 06/06/2018

SESSION: 12:30 – 15:30

ASSESSOR

MR PP MONAMA

INTERNAL MODERATOR

DR J RAMONTJA

DURATION 3 HOURS

MARKS 150

NUMBER OF PAGES: 9 PAGES PLUS 1 ANNEXURE

INSTRUCTIONS: **ANSWER BOTH SECTION A AND SECTION B IN THE SAME ANSWER SCRIPT PROVIDED.**

GIVE ALL NUMERICAL ANSWERS TO THE CORRECT NUMBER OF SIGNIFICANT FIGURES AND WITH APPROPRIATE UNITS.

CONSULT THE PROVIDED DATA AND THE PERIODIC TABLE FOR ALL SUPPLEMENTARY INFORMATION.

CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT).

REQUIREMENTS: **ANSWER SCRIPT**

DATA FOR CONSTANTS

$0^{\circ}\text{C} = 273.15\text{ K}$

Standard pressure = 1 atm = 101.325 kPa = 760 mmHg = 760 torr = 1.01325 bar

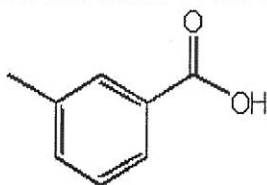
$R = 8.31451\text{ L.kPa.K}^{-1}.\text{mol}^{-1}$
 $= 8.31451\text{ J.K}^{-1}.\text{mol}^{-1}$
 $= 8.31451 \times 10^{-2}\text{ L.bar.K}^{-1}.\text{mol}^{-1}$
 $= 8.20578 \times 10^{-2}\text{ L.atm.K}^{-1}.\text{mol}^{-1}$
 $= 62.364\text{ L.torr.K}^{-1}.\text{mol}^{-1}$

SECTION A

1. Which of the following gases would occupy the largest volume at 26.0°C and 886 torr?
 - A. 325 mg C_4H_{10}
 - B. 325 mg Cl_2
 - C. 325 mg N_2O_4
 - D. 325 mg SO_3
 - E. All the gases would occupy the same volume
2. To what temperature must a sample of neon (Ne) gas be heated in order to double its pressure, if the initial volume of the gas at 35.0°C is decreased by 35.0%?
 - A. 45.5°C
 - B. 237°C
 - C. 127°C
 - D. 26.9°C
 - E. 108°C
3. The temperature at which the liquid phase and the solid phase of a substance are in equilibrium is called the
 - A. critical temperature
 - B. absolute temperature
 - C. freezing point
 - D. triple point
 - E. boiling point
4. Of the following compounds, the one with the lowest vapour pressure is:
 - A. CH_2Cl_2
 - B. CH_3Br
 - C. CH_3Cl
 - D. CHCl_3
 - E. CH_2Br_2

5. A solution contains 46.0 g of ethanol ($\text{C}_2\text{H}_5\text{OH}$) and 64.0 g of methanol (CH_3OH). The mole fraction of ethanol in this solution is:
- 0.418
 - 0.333
 - 0.492
 - 0.500
 - 0.719
6. A colloid in which a liquid is dispersed in a gas is known as a(n):
- sol
 - emulsion
 - gel
 - aerosol
 - foam
7. A system absorbs 140 J of heat from the surroundings and at the same time does 85 J of work on the surroundings. What is the change in the internal energy of the system?
- +225 J
 - 55 J
 - 225 J
 - +55 J
 - 113 J
8. Consider the following reaction:
- $$\text{CH}_3\text{OH}(g) \rightarrow \text{CO}(g) + 2\text{H}_2(g) \quad \Delta H = +90.7 \text{ kJ}$$
- What is the enthalpy change (ΔH) when 952 mg of hydrogen (H_2) gas reacts completely with carbon monoxide (CO) gas to form methanol (CH_3OH) gas at constant pressure?
- 90.7 kJ
 - +41.6 kJ
 - 21.4 kJ
 - 42.8 kJ
 - +45.4 kJ
9. Which compound contains the amide functional group?
- CH_3OH
 - $\text{CH}_3\text{COOCOCH}_3$
 - $\text{CH}_3\text{CH}_2\text{CONH}_2$
 - CH_3NH_2
 - CH_3CN

10. What is the correct name of the following compound?



- A. 5-methylbenzoic acid
B. *m*-methylbenzoate
C. tolyl-carboxylate
D. methylbenzoate
E. *m*-methylbenzoic acid
11. Isopentyl is the common name for which alkyl group?
- A. $\text{CH}_3\text{CH}_2\text{CH}_2(\text{CH}_3)\text{CH}-$
B. $\text{CH}_3\text{CH}_2(\text{CH}_3)\text{CHCH}_2-$
C. $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2-$
D. $(\text{CH}_3\text{CH}_2)_2\text{CH}-$
E. $(\text{CH}_3)_3\text{CCH}_2-$
12. What is the general formula for a tertiary alcohol?
- A. $\text{R}-\text{CH}_2\text{OH}$
B. $\text{R}-\text{CH}(\text{OH})_2$
C. $\text{R}-\text{C}(\text{OH})_3$
D. R_2-CHOH
E. R_3-COH
13. How many primary carbons are present in 5-ethyl-3,3,4-trimethylheptane?
- A. 1
B. 4
C. 3
D. 6
E. 2
14. Which compound has the highest melting point?
- A. 2,3-dimethylpentane
B. 3-methylhexane
C. 2,2,3-trimethylbutane
D. 2-methylhexane
E. heptane

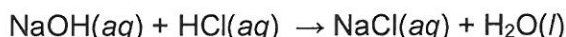
[14 x 3 = 42]

SECTION B**QUESTION 1**

- 1.1 Three rigid flasks are connected by narrow tubes (of negligible volume) and a common valve. When the valve is closed, Flask 1 (volume of 700 cm^3) is at a pressure of 464 mmHg, Flask 2 (volume of 400 cm^3) is at a pressure of 685 mmHg, and Flask 3 (unknown volume) is at a pressure of 593 mm Hg. After the valve is opened and the gases are allowed to mix, it is found that the total pressure is 560 mmHg. Calculate the volume of Flask 3. (6)
- 1.2 A balloon is filled with a mixture of 16.0 g of nitrogen (N_2) gas and an unknown quantity of argon (Ar) gas at constant temperature and pressure. If 24.0 g of nitrogen (N_2) gas is added to the mixture, the volume of the gas is increased by 65.2%. Assuming that the mixture is kept under the same conditions (**constant temperature and pressure**), calculate the mass of argon (Ar) gas in the mixture. (9)
- 1.3 It takes 6 minutes and 55 seconds for 333 cm^3 of helium (He) gas to pass through a small hole.
- 1.3.1 Calculate the volume of sulphur hexafluoride (SF_6) gas that will pass through the same hole in 8 minutes and 12 seconds. (4)
- 1.3.2 Calculate the time taken for 848 cm^3 of hexane (C_6H_{14}) gas to pass through the same hole. (4)
- 1.4 Write brief notes to explain the meniscus of liquid mercury in a thin glass tube. (6)

[29]**QUESTION 2**

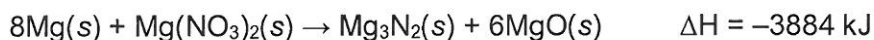
- 2.1 Camphor ($\text{C}_{10}\text{H}_{16}\text{O}$) melts at 178.4°C and has a large freezing point depression constant, $K_f = 37.50^\circ\text{C} \cdot m^{-1}$. When 126.8 mg of an unknown non-volatile, non-electrolyte compound is dissolved in 10.50 g of liquid camphor, the freezing point of the mixture was found to be 177.3°C . What is the molar mass of the unknown compound? (6)
- 2.2 When 50.0 cm^3 of $1.00 \text{ mol} \cdot \text{dm}^{-3}$ sodium hydroxide and 50.0 cm^3 of $1.00 \text{ mol} \cdot \text{dm}^{-3}$ hydrochloric acid are mixed in a constant-pressure calorimeter, the temperature of the mixture rises from 25.5°C to 32.2°C . The temperature increase is caused by the following reaction:



Calculate the enthalpy change for the reaction, assuming that the mixture has a specific heat capacity close to that of water, $4.18 \text{ J} \cdot \text{g}^{-1} \cdot \text{K}^{-1}$. The density of $1.00 \text{ mol} \cdot \text{dm}^{-3}$ sodium hydroxide solution is $1.04 \text{ g} \cdot \text{cm}^{-3}$ and that of $1.00 \text{ mol} \cdot \text{dm}^{-3}$ hydrochloric acid is $1.02 \text{ g} \cdot \text{cm}^{-3}$. (8)

QUESTION 2 (continued)

2.3 Given the following thermochemical equations:



Calculate the standard enthalpy of formation (in $\text{kJ}\cdot\text{mol}^{-1}$) of $\text{Mg}(\text{NO}_3)_2(s)$. Show all steps. (7)

2.4 List four physical properties of a solution which depend on the concentration of the solution but not on the type(s) of particle(s) present as a solute. Write the mathematical expression (equation) which describes how each one of these properties depends on concentration. (8)

[29]**QUESTION 3**

3.1 The following names are incorrect. For each compound, draw the condensed structural formula from the given name, explain why the name is wrong and give the correct IUPAC name:

3.1.1 2-ethyl-2-methyl-4-pentanone (6)

3.1.2 3-propyl-6-heptanol (6)

3.2 Draw the **bond line** structure for each of the following organic compounds:

3.2.1 N-(3-Bromobutyl)-hexanamide (3)

3.2.2 2,4-Dimethyl-3-hexanethiol (3)

3.3 Provide the common name for each of the following compounds:

3.3.1 Ethanoic acid (2)

3.3.2 1,2,3-propantriol (2)

[22]

QUESTION 4

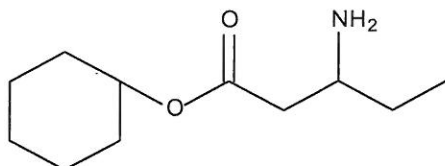
- 4.1 Drawing all resonance structures associated with **chlorobenzene**. Use arrows to show the movement of electrons. (5)
- 4.2 Draw the **Newman projections** for the least **and** most stable conformations that results from the rotation of the C1–C2 bond of 1,2-dichloroethane. (4)
- 4.3 Draw the **Newman projections** of the chair **and** boat conformations of cyclohexane. Which of these conformations is the more stable? (5)
- 4.4 Consider the three isomeric alkanes:
Hexane, 2,3-dimethylbutane, and 2-methylpentane
List these compounds in order of **increasing** boiling points. Give reasons for your answer. (6)

[20]

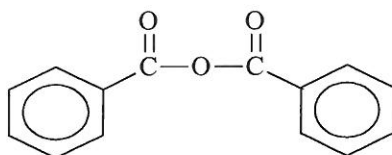
QUESTION 5

Give the IUPAC name of each of the following organic compounds:

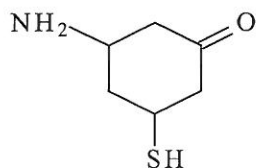
- 5.1 (3)



- 5.2 (2)



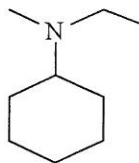
- 5.3 (3)



QUESTION 5 (continued)

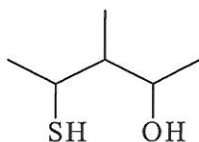
5.4

(3)



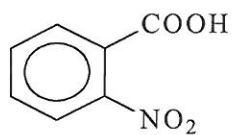
5.5

(3)



5.6

(2)



[16]

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Atomic Number		Atomic Weight	
1	H 1.0079	2	He 4.0026
3	Li 6.941	4	Be 9.0122
11	Na 22.990	12	Mg 24.305
19	K 39.098	20	Ca 40.078
37	Rb 85.47	38	Sr 87.62
55	Cs 132.91	56	Ba 137.33
87	Fr (223)	88	Ra 226.03

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
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
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
89	Ac 227.03																		

5	B 10.811	6	C 12.011	7	N 14.007	8	O 15.999	9	F 18.998	10	Ne 20.179
13	Al 26.982	14	Si 28.086	15	P 30.974	16	S 32.064	17	Cl 35.453	18	Ar 39.948
31	Ga 69.723	32	Ge 72.61	33	As 74.922	34	Se 78.96	35	Br 79.904	36	Kr 83.80
49	In 114.82	50	Sn 118.71	51	Sb 121.75	52	Te 127.60	53	I 126.90	54	Xe 131.29
81	Tl 204.38	82	Pb 207.2	83	Bi 208.98	84	Po (209)	85	At (210)	86	Rn (222)

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 (243)	96	Cm (247)	97	Bk 247	98	Cf (251)	99	Es (252)	100	Fm (257)	101	Md (258)	102	No (259)	103	Lr (260)