UNIVERSITY OF SWAZILAND
DIPLOMA IN ENVIRONMENTAL HEALTH SCIENCE
SUPPLEMENTARY EXAMINATION PAPER 2007

TITLE OF PAPER	:	**INTEGRATED BASIC SCIENCES**
COURSE CODE	:	**HSC 103**
TIME	:	**3 HOURS**
TOTAL MARKS	:	**100 MARKS**
INSTRUCTIONS	:	**ANSWER FIVE QUESTIONS ONLY**
	:	**EACH QUESTION IS 20 MARKS**
	:	**AT LEAST TWO QUESTIONS MUST BE ANSWERED FROM EACH SECTION.**
	:	**A PERIODIC TABLE AND DATA SHEETS ARE PROVIDED WITH THIS EXAMINATION PAPER**
	:	**NO FORM OF ANY PAPER SHOULD BE BROUGHT INTO NOR TAKEN OUT OF THE EXAMINATION ROOM**
	:	**BEGIN THE ANSWER TO EACH QUESTION ON A SEPARATE SHEET OF PAPER**
	:	**ALL CALCULATIONS/WORKOUT DETAILS SHOULD BE SUBMITTED WITH YOUR ANSWER SHEET(S)**

DO NOT OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

61

SECTION B

ANSWER AT LEAST TWO QUESTIONS

QUESTION 5 [20 MARKS]

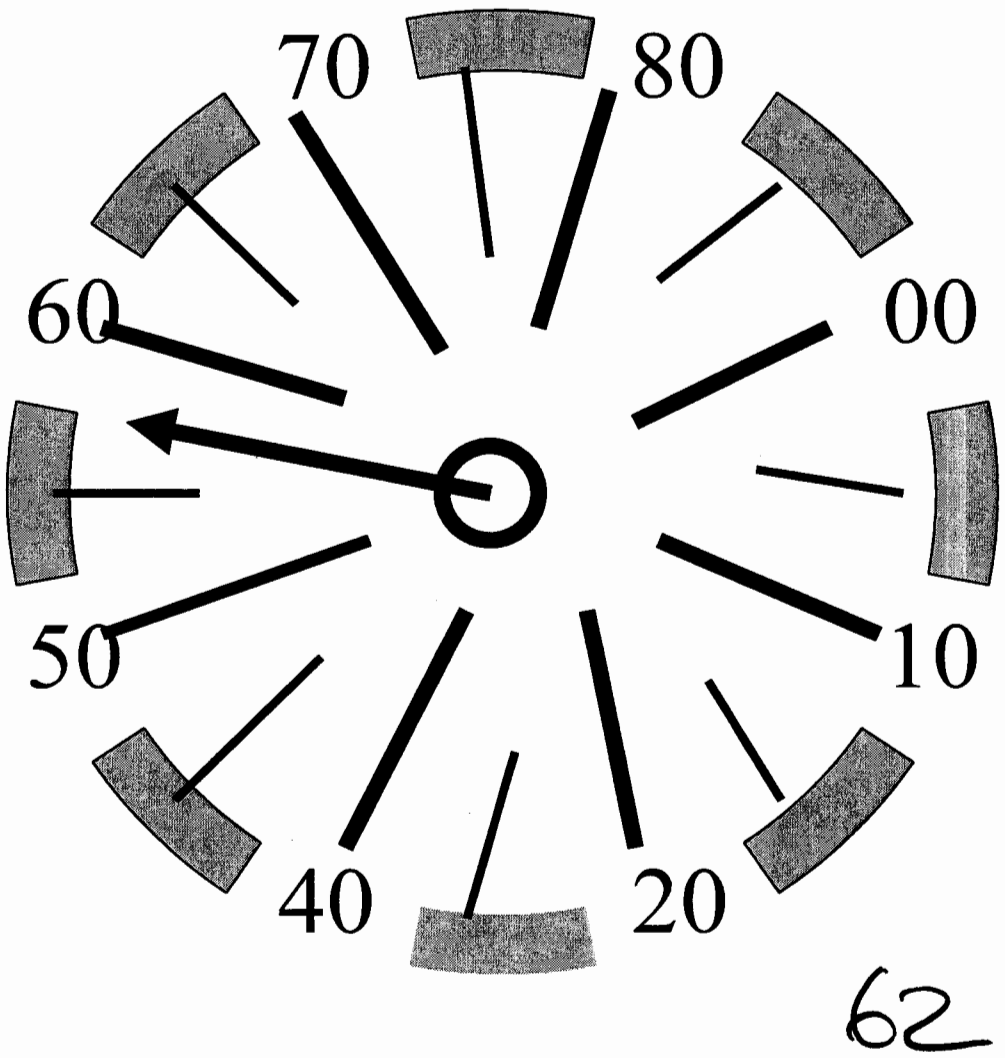
a) Convert the following figures to the units indicated: [4]

i) 92 pulse/min.....pulses/sec
ii) 35 mL.....L
iii) 30 μg.....mg
iv) 3.2×10^{24} atoms.....moles

Recall: *1 minute = 60 secs* *1 oz = 28.4 g*
1 in. = 2.54 cm 1 gal = 3.8 L 6.023×10^{23} = 1mole

b) Write short notes explaining the differences between Systematic and random errors. [8]

c) Give the correct reading of the following measurement in the form $x \pm S_x$. [2]



d)

i) Calculate the degree of precision as a percentage coefficient of variation (or percentage relative standard deviation, %RSD) in your reading. [1]

ii) Calculate the percentage relative error (% RE) in the reading by using the difference between the reading without any correction and the reading after correction. [1]

iii) Based on the % RSD and the % RE would you consider readings from this instrument reliable, explain. [2]

iv) What are the two sources of error in this device ? [2]

Useful Formulae:

$$standard\ deviation\ S_x = \sqrt{\frac{\sum_{i=1}^{N}(\bar{x} - x_i)^2}{N-1}};\quad mean\quad \bar{x} = \frac{\sum_{i=1}^{N} x_i}{N}$$

QUESTION 6 [20 MARKS]

a). Explain the difference between the following pairs of terms. Give examples for each pair.

i). Ionic bonding and Covalent bond [4]

ii) Hunds rule and Agfbau builing up principle [4]

b). Draw Lewis structures or diagrams to show and name the type of bonding for each of the following:

(i) calcium chloride [2]

(ii) NH_4^+ [2]

c) i) Using Hunds rule, Agfbau builing up principle and the periodic table write the electronic configurations of **any Two** of the following elements. [4]

ii) Also indicate the role in health and the most likely dietary sources of the **Two** you have chosen in c(i): [4]

Iodine Iron Calcium

QUESTION 7 [20 MARKS]

a) Define the term "Empirical formula". [4]

b) Give three ways by which the empirical formula may be obtained. [3]

c) 6.853 mg of a sex hormone containing C, H and O was burned to determine its molecular formula. On burning 20.08 mg CO_2 and 5.023 mg of H_2O were obtained. The formula weight of the substance was found to be 270 g/mol.

i) Calculate the Empirical formula for the hormone [8]

ii) Calculate the molecular formula for the hormone [5]

63

[note that the unit 1 mg = 0.001 g = $1x10^{-3}$g]

QUESTION 8 [20 MARKS]

a) Briefly discuss any one of the following: [10]
   i) Respiratory Alkalosis
   ii) Metabolic Alkalosis

   In your discussion include the cause, the symptoms and the treatment.

b) A 30 year old woman is admitted to Mbabane Clinic. On admission her arterial blood results were as follows:

HCO3-	28 mEq/L	pH	7.21
Barbiturates	160 mEq/lL	PCO_2	52 mm Hg
Heroin	30 Meq/L	Blood ketones	positive

   i) Using the data given diagnose the condition of the patient, giving specific reasons for your diagnoses. [6]
   ii) What treatment would you prescribe for this patient. [4]

NORMAL LABORATORY VALUES FOR BLOOD TESTS

	USUAL REFERENCE RANGE	
Specific Gravity		1.056
Hemoglobin Count Hb		Men: 14 - 18g /dL Women: 12 -16 g/dL
HCO^-_3 Bicarbonate	24 - 28 mmol/L	24 - 28 mEq/L
Glucose	(3.6-6.1 mmol/L)	65 - 110 mg/dL
BUN (Blood Urea Nitrogen)	2.9 - 7.1 mmol/L	8 - 20 mg/dL
Ca^{+2}	(2.1-2.6 mmol/L)	8.5 - 10.3 mg/dL
Cl^-	(96-106 mmol/L)	96 - 106 mEq/L
Cholesterol		150 - 220 mg/dL
CO_2	24-29 mmol/L	24-29 mEq/L
PCO_2		35-45 mmHg
PO_2		80 - 100 mm Hg
pH		7.35 - 7.45
Fatty acids	0.3-0.8 mmol/L	0.3-2 mg/dL
Protein		6-8 µg/dL
Phosphate	1 - 1.5 mmol/L	3-4.5 mg/dL
ketone bodies		0.3-2 mg/dL
K^+	3.5-5 mmol/L	3.5 - 5 mEq/L
Na^+	136-145 mmol/L	136 - 145 mEq/L
Uric Acid	Men: 0.18 - 0.54 Women: 0.15 - 0.46 mmol/L	Men: 3 - 9 mg/dL Women: 2.5 - 7.5 mg/dL Children: 1.5 g/L (150mg/dL)

SECTION A

ANSWER AT LEAST TWO QUESTIONS FROM THIS SECTION

QUESTION 1

(a) A body with an initial velocity of 5 m/s is accelerated at 3 m/s^2 for 5 s. It then moves at constant velocity for 4 s after which it is accelerated at -2 m/s^2 for 5 s. Sketch

(i) the acceleration-time graph, **(3 marks)**

(ii) the velocity-time graph, and **(5 marks)**

(iii) the distance-time graph for this motion. **(6 marks)**

(b) A body is shot vertically with a speed of 100 m/s.

(i) What is its velocity at t = 5 s. **(2 marks)**

(ii) What is its velocity at t = 15 s. **(2 marks)**

(iii) Specify the direction of motion in (i) and (ii), and justify your reasoning. **(2 marks)**

65

QUESTION 2

(a) The system shown in Figure 1 is in equilibrium. Find the tension in each cord, and the mass m_2. The pulley is frictionless. **(8 marks)**

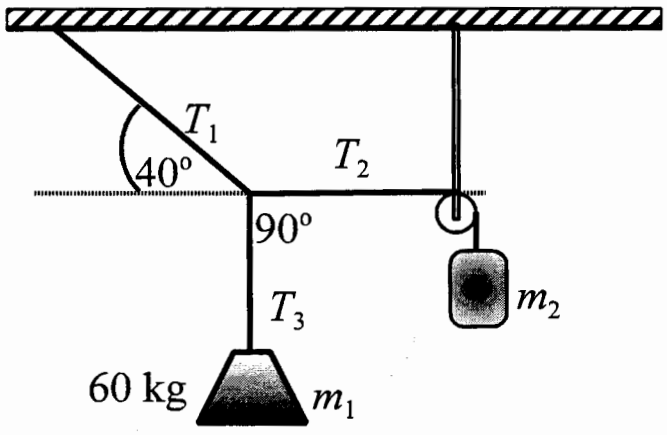


Figure 1.

(b) A body is projected upward with a velocity of 60 m/s. Use energy methods to determine

(i) its maximum height, and **(4 marks)**

(ii) its velocity at a height of 10 m. **(2 marks)**

(c) A bullet of mass m = 200 g moving with an initial speed u_0 = 450 m/s strikes a stationary block of mass M = 5 kg. The block acquires a velocity of 2 m/s after the impact. What is the final velocity of the bullet u_f? **(6 marks)**

66

QUESTION 3

(a) In a certain day the height h of the mercury column in the barometer is 76.1 cm. What is the atmospheric pressure on such a day? The density of mercury is 13.6×10^3 kg/m^3. **(4 marks)**

(b) State Archimedes Principle. **(3 marks)**

(c) A block of wood has sides of length a = 30 cm, b = 20 cm and c = 10 cm and a density of 650 kg/m^3. It floats in sea water of density 1025 kg/m^3. What is the upward force (upthrust) on the block due to the water? **(5 marks)**

(d) A metal block of mass 200 g at 140 °C is placed into 150 g copper cylinder containing 200 g of water at 20 °C. The final temperature of the system is 30 °C. The specific heat capacity of copper is 385 J/(kgK). What is the specific heat capacity of the metal block? **(8 marks)**

67

QUESTION 4

(a) An industrial machine produces a sound at 80 dB at a distance of 5 m. What is the average power of the sound produced by the source? **(6 marks)**

(b) The far point of a person is 60 m. The person wants to be able to watch sports. What is the focal length of the spectacle lenses required to increase the vision up to 2.5 km? **(4 marks)**

12. Consider the network shown in Figure 2.
    (i) What is the effective resistance of the network? **(4 marks)**
    (ii) What is the total current through network? **(2 marks)**

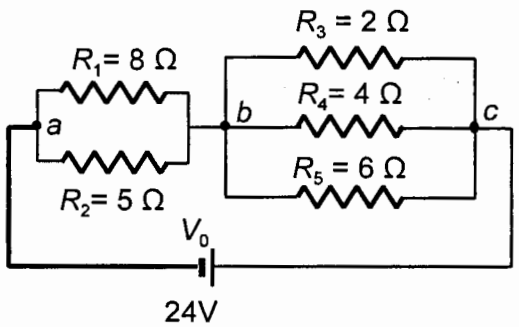


Figure 2.

(d) On a cold Mbabane day, a Faculty of Health student turns on an electric heater rated at 1200 W for 5 hours.
    (i) How much energy in joules is consumed by the heater in 5 hours? **(2 marks)**
    (ii) How much energy in kilowatt-hours is consumed by the heater is 5 hours? **(2 marks)**

68

GENERAL DATA SHEET

Speed of light in vacuum $c = 2.9978 \times 10^8$ m/s
Speed of sound in air = 343 m/s
Gravitational acceleration = 9.80 m/s^2
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N m^2/kg^2
Density of mercury = 1.36×10^4 kg/m^3
Density of water = 1000 kg/m^3
Standard atmospheric pressure = 1.013×10^5 Pa
Gas constant $R = 8.314$ J/(K mol)
Avogadro's number $N_A = 6.022 \times 10^{23}$ mol^{-1}
$I_0 = 10^{-12}$ W/m^2
1 calorie = 1 c = 4.186 J
1 food calorie = 1 Calorie = 1C = 10^3 calories = 4.186×10^3 J

c(*water*) = 4186 J/(kg K) c(*ice*) = 2090 J/(kg K) c(*steam*) = 2079 J/(kg K)
L_f(*ice*) = 3.33×10^5 J/kg L_v(*water*) = 2.260×10^6 J/kg

$$k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$$

Charge of an electron = -1.6×10^{-19} C
Charge of a proton = $+1.6 \times 10^{-19}$ C
1 atomic mass unit = 1 amu = 1 u = 1.66×10^{-27} kg
Electron mass, $m_e = 9.109 \times 10^{-31}$ kg
Proton mass, $m_p = 1.673 \times 10^{-27}$ kg
Neutron mass $m_n = 1.675 \times 10^{-27}$ kg

69

THE PERIODIC TABLE OF ELEMENTS

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
Period 1	1 H 1.008																	2 He 4.003
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.9	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.01	25 Mn 54.9	26 Fe 55.85	27 Co 58.71	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.7	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 91.22	42 Mo 95.94	43 Tc 98.9	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
6	55 Cs 132.9	56 Ba 137.3	71 Lu 174.9	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 196.9	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 208.9	84 Po 210	85 At 210	86 Rn 222
7	87 Fr 223	88 Ra 226.0	103 Lr 257	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une									

NON-METALS

METALLOIDS

METALS

Lanthanides	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 146.9	62 Sm 150.9	63 Eu 151.3	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
Actinides	89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.1	94 Pu 239.1	95 Am 241.1	96 Cm 247.1	97 Bk 249.1	98 Cf 251.1	99 Es 254.1	100 Fm 257.1	101 Md 258.1	102 No 255

*Numbers **below** the symbol indicates the **atomic masses**; and the numbers above the symbol indicates the atomic numbers.*

SOURCE: International Union of Pure and Applied Chemistry, I mills, ed., Quantities, Units, and symbols in Physical Chemistry, Blackwell Scientific publications, Boston, 1988, pp 86-98.