UNIVERSITY OF SWAZILAND
DIPLOMA IN ENVIRONMENTAL HEALTH SCIENCE
FINAL 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.

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SECTION A

ANSWER AT LEAST TWO QUESTIONS FROM THIS SECTION

QUESTION 1.

(a) A body initially moving at 4 m/s accelerates to 16 m/s in 4 s, and then moves at constant velocity for 5 s after which it accelerates to a velocity of -20 m/s in 5 s. Sketch

(i) the velocity-time graph, **(5 marks)**
(ii) the acceleration-time graph, and **(6 marks)**
(iii) the distance-time graph for this motion. **(7 marks)**

(b) A body initially at rest free falls over a height $h = 10$ m. What is its velocity when it hits the ground? **(2 marks)**

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QUESTION 2

(a) The system shown in Figure 1 is in equilibrium. Find the tension in each cord. **(8 marks)**

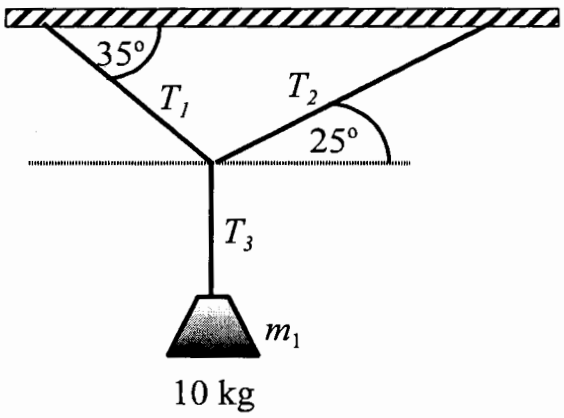

Figure 1.

(b) A body mass m = 15 kg falls from rest from a height *h*. Use energy methods to find its kinetic energy after it falls over a height $s = 10$ m. **(6 marks)**

(c) A bullet of mass $m = 100$ g moving with a velocity of $\upsilon_0 = 300$ m/s strikes and embeds itself in a stationary block of mass $M = 2$ kg resting on a frictionless surface. What is the velocity of the block and bullet after the collision? **(6 marks)**

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QUESTION 3

(a) A steel wire of length $l = 5$ m and cross-sectional area $A = 0.05$ cm^2 suspends a mass of 5 kg. The wire stretches by 0.75 mm under the load.

(i) What is the tensile stress on the wire? **(3 marks)**

(ii) What is the tensile strain on the wire? **(2 marks)**

(iii) What is the Young's modulus for the wire? **(2 marks)**

(b) State Pascal's law and give an example of its application in everyday life. **(5 marks)**

(c) Ice of mass $m_i = 124$ g at -10°C is mixed with a mass of water $m_w = 500$ g at 18°C in a perfectly insulating container to make an ice bath. How much ice is left over after the ice stops melting? **(8 marks)**

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QUESTION 4

(a) An industrial machine produces a sound at an average power of 100 W. At what distance r from the source is the sound level at the threshold of pain? **(6 marks)**

(b) The near point of a person is 5 m. What must be the focal length of the spectacle lenses for the person to read a newspaper at a distance of 25 cm? **(4 marks)**

(c) Discuss with the aid of equations why it is unsafe to connect too many electrical appliances to one wall plug. **(6 marks)**

(d) A person with wet skin is part of the circuit shown in Figure 2. The voltage drop across R is $\Delta v = 49.5$ V, while the resistance of the person $r = 1000\ \Omega$. Determine whether the current through the person is dangerous. **(4 marks)**

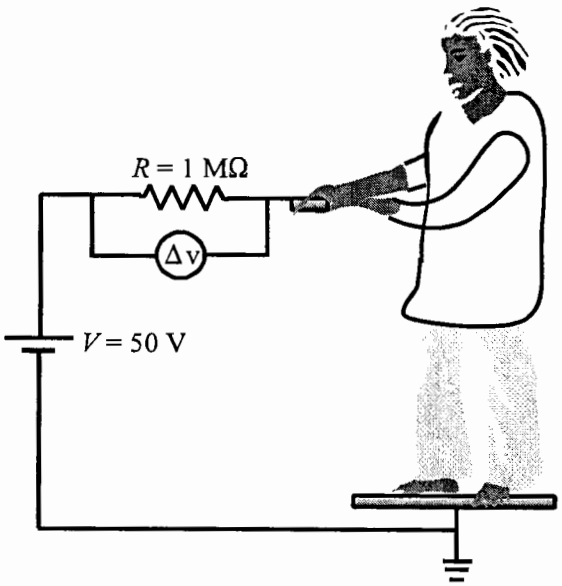

Figure 2.

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GENERAL DATA SHEET

Speed of light in vacuum $c = 2.9978 \times 10^8$ m/s
Speed of sound in air = 334 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

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SECTION B

ANSWER AT LEAST TWO QUESTIONS

QUESTION 5 [20 MARKS]

a) Convert the following figures to the units indicated: [6]

i) 1.02 kg ..... g
ii) 25 mL.....L
iii) 50 μg.....mg
iv) $1.2x10^{24}$ atoms.....moles
v) 72 pulse/min.....pulses/sec
vi) 20 oz/gal.....g/L

Recall: *1 minute = 60 secs* *1 oz = 28.4 g*
1 in. = 2.54 cm *1 gal = 3.8 L* $6.023x10^{23}$ = *1mole*

b) An order for medication reads: "Give 1.49 mg per kilogram of body weight." How much medication should be given to a patients of 165 lb. [2]

1 lb = 0.4536 kg

c) A nurse by the name of Nontobeko recorded the temperature of a patient as 98.8 °F. Another nurse "Velaphi" recorded the temperature of another patient as 38.2 °C. Which patient has fever ? [2]

Useful equation:

$$^{o}F = \frac{9}{5}{}^{o}C + 32^{o}$$

c) Write short notes explaining the differences between **any one** of the following **pairs**:
i) Accuracy and precision [2]
ii) Systematic and random errors [2]

d) The following weights of tablets were given to pregnant women to use as Iron supplements: 5.8 g, 6.2 g, 5.6 g and 5.9 g.
Calculate:
i) The mean [2]
ii) Standard deviation [2]
iii) Coefficient of variation [1]
iv) % Relative error given that the right weight for iron supplementation as recommended by the WHO is 5.5 g.[1]

Useful Formulae:

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

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QUESTION 6 [20 MARKS]

a). Draw Lewis structures or diagrams to show and name the type of bonding for each of the following: [8]

(i) calcium chloride

(ii) NH_4^+

(iii) H_2O

$$NH_3 + BF_3 \rightarrow NH_3BF_3$$

(iv) CH_2CH_2

b). i) Using Hunds rule, Agfbau builing up principle and the periodic table write the electronic configurations of **any Two** of the following elements. [6]

ii) Also indicate their environmental hazards and most likely source of the **Two** you have chosen in c(i): [6]

Arsenic Lead Cadmium Mercury

c) An antacid tablet was given to a patient to relieve stomach discomfort. Given that the antacid was magnesium hydroxide, $Mg(OH)_2$ which reacts with hydrochloric acid. How many grams acid in the stomach will 1.50 g antacid tablet neutralize ?[2]

QUESTION 7 [20 MARKS]

A sample suspected to be a dangerous drug was confiscated by police for forensic analysis. The sample was suspected to be the dangerous drug, phencyclidine, known as angel dust, whose molecular formula is $C_{17}H_{25}N$. The sample was found to have a percentage composition of 83.71%C, 10.42% H, and 5.61% N.

i). Define the difference between empirical and molecular formular [5]

i). From the formula $C_{17}H_{25}N$ find the percentage composition of C, H and N [12]

ii). From a(i) above, Is this sample the suspected drug ? [2]. Give a reason. [1]

QUESTION 8 [20 MARKS]

a) i) Define a buffer solution [2]

ii) Name three kinds of buffers found in the body. [3]

b) Briefly discuss **any one** of the following: [6]

i) Respiratory Acidosis

ii) Metabolic Acidosis

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

c) A 19 year old man is admitted to hospital.. On admission his laboratory results were as follows:

Blood pressure	90/20 mm Hg	Sodium	132mmol/L
Deep respirations	35/min	Potassium	6.5mmol/L
Pulse	120/min	pH	6.75
glucose	20 mmol/l	PCO_2	11 mm Hg
protein	100 µg/dl	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. [3]

Question 9 [20 Marks]

a) Write short notes on the following terms: [12]

i) isotonic solutions

ii) hypotonic solutions

iii) hypertonic solutions

Give examples for each and define the use or dangers of each in the body.

b) Balance each of the following chemical equations.

i) $C_3H_8+O_2 \rightarrow CO_2 + H_2O$ [2]

ii) $SO_2 + HNO_3 \rightarrow H_2SO_4 + NO$ [2]

iii) $Fe_2(SO4)_3+NH_3+H_2O \rightarrow Fe(OH)_3+(NH_4)_2SO_4$ [2]

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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)

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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.