UNIVERSITY OF SWAZILAND
FACULTY OF HEALTH SCIENCES

INTEGRATTED BASIC SCIENCES (HSC-103)
FINAL EXAM
2005/2006

MARKS 100

DURATION 3:

INSTRUCTIONS

1. READ THROUGH ALL QUESTIONS CAREFULLY BEFORE ANSWERING
2. EACH QUESTION CARRIES 20 MARKS
3. ANSWER ONLY FIVE QUESTIONS
4. ATTEMPT AT LEAST TWO QUESTIONS FROM EACH SECTION AND ANY ONE FROM EITHER OF THE SECTIONS
5. NO QUESTION PAPER SHOULD BE BROUGHT INTO NOT OUT OF THE EXAMINATION ROOM
6 BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER
7. A PRRIODIC TABLE AND DATA SHEETS ARE PROVIDED
8. ALL CALCULATIONS / WORK OUTDETAILS SHOULD BE SUBMITTED WITH YOUR ANSWER SHEET(S)

SECTION A

QUESTION 1.

(a) A particle starting at the origin moves according to the velocity-time graph shown in Figure 1.

(i) Find the accelerations $a_{0,4}$ for 0 - 4 s, $a_{4,8}$ for 4 - 8 s and $a_{8,14}$ for 8 - 14 s. **(3 marks)**

(ii) Sketch the acceleration-time graph. **(2 marks)**

(iii) Calculate the distance traveled at t = 4 s, t = 8 s and t = 14 s. **(3 marks)**

(iv) Sketch a clear distance-time graph for this motion. **(3 marks)**

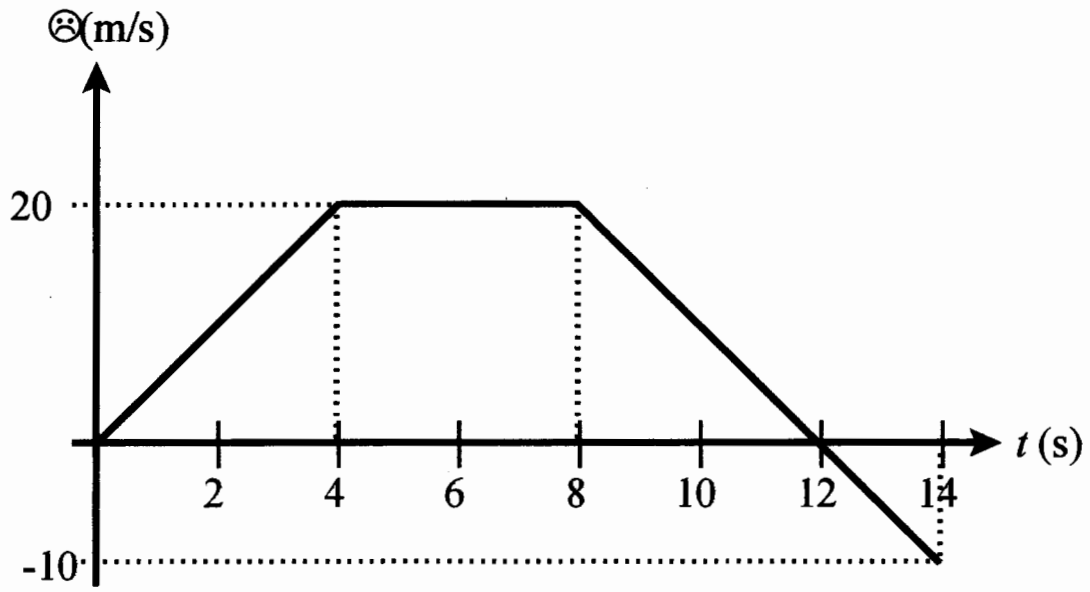

Figure 1.

(b) A student pulls her 20 kg suitcase with a strap that makes an angle of 45° with the horizontal at constant velocity. The coefficient of kinetic friction between the ground and the wheels of the suitcase is 0.1.

(i) Make a complete resolved force diagram for the suitcase. **(2 marks)**

(ii) Write down the force equations for the suitcase. **(2 marks)**

(iii) Find the force F applied by the student. **(4 marks)**

(iv) What is the normal force on the suitcase? **(1 mark)**

QUESTION 2

(a) A tow truck pulls a 1000 kg car at constant speed by a tow bar which makes an angle of 35° above the horizontal. The coefficient of kinetic friction between the towed car and the road is 0.9. The car is pulled for a distance of 5 km.

(i) What is the force F applied on the car? **(4 marks)**
(ii) Find the work done by the truck on the car. **(2 marks)**
(iii) What is the work done by friction? **(2 marks)**

(b) Show with the aid of equations why for the same change in momentum, fast collisions result in higher possibilities of damage than slow collisions. **(6 marks)**

(c) A hiker of mass 70 kg gets a ride from a furniture flat bed pick-up truck. He holds on to the roll bar so that he cannot fall. The truck takes a 200 m radius turn at 120 km/hr. How much force must he use to grab the roll bar so that he does not get thrown off? **(6 marks)**

QUESTION 3

(a) A hypodermic syringe contains medicine with the density of water. The barrel of the syringe has a cross-sectional area $A = 2.50 \times 10^{-5}$ m^2 and the needle has a cross-sectional area of $a = 1 \times 10^{-8}$ m^2. The blood pressure of the patient is120/80. In injecting a patient, a force of 4 N is applied to the barrel. Use Bernoulli's equation to determine the speed with which the medicine enter the blood vessel under the two pressures? **(10 marks)**

(b) A spinal tap is inserted into the spinal column of a patient. The cerebrospinal fluid in the tap rises to a height of 160 mm. The upper end of the tap is exposed to atmospheric pressure. The density of the fluid is the same as that of water. What is the

(i) absolute pressure in Pascals, **(2 marks)**
(ii) the gauge pressure in millimetres of mercury. **(2 marks)**

(c) An ice-bath is to be made from 500 g of ice at -10° C and water of mass m at 25° C. What is the minimum amount of water that must be added to the ice to make the ice-bath. Assume that no heat is lost to the surroundings. **(6 marks)**

QUESTION 4

(a) An industrial machine produces a sound at an average power of 100 W.

(i) At what distance r from the source is the sound level at the threshold of pain? **(6 marks)**
(ii) What should be the power of the source if the sound level is to be at 60 dB at the distance obtained from (i)? **(3 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? **(3 marks)**

(c) Show with the aid of fully labeled diagrams how both real and virtual images can be formed by a converging lens. **(8 marks)**

QUESTION 5

(a) What are the effects of electrical shocks above 10 mA on the human body? **(2 marks)**

(b) An electric kettle is rated at 1000 W at 220 V(rms).

(i) How much current is drawn by the kettle? **(2 marks)**

(ii) What is the resistance of the filament? **(2 marks)**

(iii) If the kettle is kept on for 10 minutes what is the cost of the electricity consumed assuming that electrical energy cost 35 cents per kilowatt-hour. **(4 marks)**

(c) Consider the network shown in Figure 2.

(i) What is the effective resistance of the network? **(4 marks)**

(ii) Comment on the effective resistance of resistors in parallel? **(2 marks)**

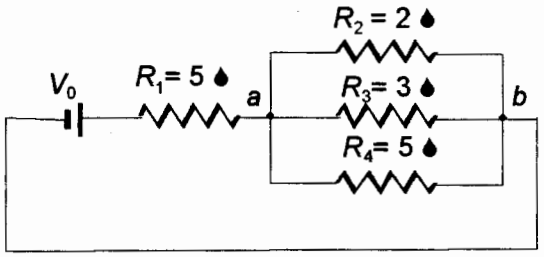

Figure 2.

(d) A step-down transformer is used for recharging a cell phone battery. The turns ratio in the transformer are 26:1 and is used with a 240 V (rms) household service. The transformer draws a current of 0.350 A from the house outlet.

(i) What is the voltage supplied to the battery? **(2 marks)**

(ii) What is the current supplied to the battery? **(1 mark)**

(iii) How much power is delivered to the battery? **(1 mark)**

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
iv) 72 pulse/min.....pulses/sec
v) 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) i) A 2.027 mL drug weighing 5.13g was given to a patient. Calculate both the density and specific gravity of the drug given that the density of water is 1.0 g/mL. [2]

ii) A nurse recorded the temperature of a patient as 96.8 °F. What is the temperature in °C given that : [2]

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

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:

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

QUESTION 6 [20 MARKS]

a). Explain Any Two of the following terms giving an example for each.

i). Ionic bonding [2]
ii) Covalent bond [2]
iv). Co-ordinate bond [2]
iv) Metallic bonding [2]

b). Using Hunds rule, Agfbau builing up principle and the periodic table give the electronic configurations using atomic orbitals of the following elements:
i) Calcium, Ca [2]
ii) Iodine, I [2]
iii) Also describe the role of the above ions in the body. In your description mention the function, the associated deficiency disorder and its most common dietary source. [4]

b) Write short notes on any **Two** the following
i). Ionisation energy [2]
ii). Electropositivity [2]
iii) Electronegativity [2]
iv) Electron Affinity [2]
v) Atomic radii [2]

c) Explain **any Two** of the following trends:

(i) Atomic Radii in Angstrom units [2]

H	Li	Na	K	Rb	Cs
0.30	1.23	1.57	2.03	2.16	2.35

(ii) ionisation energies in kJ/mol [2]

Na	Mg	Al	Si	P	S	Cl	Ar
496	737	577	786	1012	999	1255	1521

(iii) Pauling's Electronegativity coefficients (Unitless) [2]

Li	Be	B	C	N	O	F
1.0	1.5	2.0	2.5	3.0	3.5	4.0

QUESTION 7 [20 MARKS]

a) Adenosine triphosphate (ATP) is an important substance in all living cells. A sample with mass of 0.8138 g was analysed and found to contain 0.1927 g of Carbon C, 0.02590 g of hydrogen H, 0.1124 g of Nitrogen N and 0.1491 g of phosphorus P. The remainder was oxygen. Its formula weight was determined to be 507 g/mol.

i) Calculate the Empirical formula (in the form $C_vH_wN_xP_yO_z$) of Adenosine triphosphate (ATP). [8]

ii) Calculate the Molecular formula of Adenosine triphosphate (ATP) [2]

b) Name the following compounds [5]

i) H_2CrO_4

ii) H_2SO_4

iii) Na_2SO_4

iv) $KClO_4$

v) $NaHCO_3$

c) Write formulas for each of the compounds [5]

i) Calcium carbonate

ii) Hypochlorous acid

iii) Iodine pentafluoride

iv) Iron (III) oxide

v) Sodium thiosulphate

QUESTION 8 [20 MARKS]

a) i) Define a buffer solution. Give one example. [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 patient with a severe fever of 38.9 °C, a respiratory rate of 60/min. X-ray evaluation shows that pneumonia has developed on his left lung. The patient was given morphine and diazepam (valium) and ventillatory therapy. The laboratory values:

Pulse	60/min	Sodium	145mmol/L
CO_2	43 mmol/L	Potassium	3.5mmol/L
HCO_3^-	41 mEq/L	pH	7.43
Cl^-(mEq/L)	90	PCO_2	63 mm Hg

(i) What is the mechanism of this acid-base imbalance [2]

(ii) What treatment would you prescribe [2]

d) If 4.09 g H_3PO_4 is dissolved in 250 mL solution calculate:
   i) Number of equivalents of H_3PO_4. [3]
   ii) The Normality of the Solution. [1]
   iii) The molar concentration of the solution. [1]

Question 9 [20 Marks]

a) Define water solvency in terms of bonding to form electrolyte solutions [2].

b) Define water pollution. [3]

c) List and describe three major sources of water pollution. [5]

d) Explain any three methods of purification. [5]

e) Explain the difference between permanent and temporary water hardness. [5]

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

Useful Relations

$(RT)_{298.15K}$=2.4789 kJ/mol

$(RT/F)_{298.15K}$=0.025 693 V

T/K:	100.15	298.15	500.15	1000.15
T/Cm^{-1}:	69.61	207.22	347.62	695.13

1mmHg=133.222 N m^{-2}

hc/k=1.438 78x10^{-2} m K

1atm	1 cal	1 eV	1cm^{-1}
=1.01325x10^{5} Nm^{-2}	=4.184 J	=1.602 189x10^{-19} J	=0.124x10^{-3} eV
=760torr		=96.485 kJ/mol	=1.9864x10^{-23}J
=1 bar		= 8065.5 cm^{-1}	

SI-units:

1 L = 1000 ml = 1000cm^3 = 1 dm^3

1 dm = 0.1 m

1 cal (thermochemical) = 4.184 J

dipole moment: 1 Debye = 3.335 64x10^{-30} C m

force: ***1N=1J m^{-1}= 1kgms^{-2}***=10^5 dyne pressure: ***1Pa=1Nm^{-2}***=1Jm^{-3}

1J = 1 Nm

power: 1W = 1J s^{-1} potential: 1V =1 J C^{-1}

magnetic flux: 1T=1Vsm^{-2}=1JCsm^{-2} current: 1A=1Cs^{-1}

Prefixes:

p	n	m	m	c	d	k	M	G
pico	nano	micro	milli	centi	deci	kilo	mega	giga
10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^{3}	10^{6}	10^{9}

General Data

speed of light	**c**	**2.997 925x10^{8} ms^{-1}**
charge of proton	*e*	1.602 19x10^{-19} C
Faraday constant	F=L*e*	9.648 46x10^{4} C mol^{-1}
Boltzmann constant	**k**	**1.380 66x10^{-23} J K^{-1}**
Gas constant	**R=Lk**	**8.314 41 J K^{-1} mol^{-1}**
		8.205 75x10^{-2} dm^3 atm K^{-1} mol^{-1}
Planck constant	**h**	**6.626 18x10^{-34} Js**
	$\hbar = \frac{h}{2\pi}$	1.054 59x10^{-34} Js
Avogadro constant	**L or N_{av}**	**6.022 14x10^{23} mol^{-1}**
Atomis mass unit	u	1.660 54x10^{-27} kg
Electron mass	**m_e**	**9.109 39x10^{-31} kg**
Proton mass	m_p	1.672 62x10^{-27} kg
Neutron mass	m_n	1.674 93x10^{-27} kg
Vacuum permittivity	$\varepsilon_o = \mu_o^{-1}c^{-2}$	8.854 188x10^{-12} J^{-1} C^2 m^{-1}
Vacuum permeability	μ_o	4πx10^{-7} Js^{2}C^{-2} m^{-1}
Bohr magneton	$\mu_B = e\hbar/2m_e$	9.274 02x10^{-24} JT^{-1}
Nuclear magneton	$\mu_N = e\hbar/2m_p$	5.05079x10^{-27} JT^{-1}
Gravitational constant	G	6.67259x10^{-11} Nm^{2}kg^{-2}
Gravitational acceleration	**g**	**9.80665 ms^{-2}**
Bohr radius	a_o	5.291 77x10^{-11} m

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.*

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