UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS (APK)

MODULE: PHYL03E

PHYSICS FOR LIFE SCIENCES

MID-YEAR EXAM

DATE: JUNE 2016
120 Minutes

	Student's Mark	Question's Mark
Q 1		10
Q 2		26
Q 3		17
Q 4		24
Q 5		23
Total		100

EXAMINER/SECOND EXAMINER/MODERATOR — **Dr. B. Sondezi**, **Dr. E. Carleschi**

TIME — 120 MINUTES
MARKS — **100**

INSTRUCTIONS: ANSWER ALL THE QUESTIONS IN THE SPACES PROVIDED

NUMBER OF PAGES: 12 (BACK-TO-BACK, INCLUDING COVER PAGE)
REQUIREMENTS: SCIENTIFIC CALCULATOR, NO PROGRAMMABLE CALCULATORS ARE ALLOWED

Student Number									

ID Number													

Surname and Initials: _____

Contact Number: _____

Venue: _____

1.1	**A**	**B**	**C**	**D**
1.2	**A**	**B**	**C**	**D**
1.3	**A**	**B**	**C**	**D**
1.4	**A**	**B**	**C**	**D**
1.5	**A**	**B**	**C**	**D**

QUESTION 1 [10]

1.1 An object is pulled with a force $\vec{F}$ of magnitude 10 N upward by a distance of 3 m along an inclined plane that forms an angle of 30^o with the horizontal. Which of the following choices comes closest to the result for the work done on the object by the force $\vec{F}$, if $\vec{F}$ is directed parallel to the surface of the inclined plane?

(a) $W = -15J$, (b) $W = 15J$, (c) $W = -30J$, (d) $W = 30J$

1.2 A basketball player passes the ball to another player such that it bounces once before reaching the second player's hands. At what instant is the kinetic energy of the ball the greatest?

(a) it is always the same, kinetic energy is conserved,
(b) it is greatest just after leaving the hands of the first player,
(c) just before touching the ground,
(d) just before being caught by the second player.

1.3 The entropy of a system describes the

(a) increase of particle number, (b) increase of internal energy,
(c) isothermal expansion, (d) dissociation of molecules

1.4 The equation $W = - P(V_2-V_1)$ is used to calculate the work done on the system at

(a) constant pressure
(b) constant temperature
(c) constant volume
(d) constant number of moles

1.5 A process is called adibatic if

(a) The tempeature remains constant,
(b) No work is done,
(c) No heat is exchanged with the environment,
(d) The internal energy remains constant.

CONSTANTS

Body temperature of a healthy human being = 37^0C;
1 atm = 1.013×10^5 Pa; 1 atm = 760 mmHg
Equation for translational energy (Internal energy) U = 3/2 nRT
R = 8.314 J/mol.K or 0.08206 atm.L/mol.K;
k = 1.38×10^{-23} J/mol.K
$\lambda - \lambda' = h/(m_0 c)[1-\cos\theta]$
h = 6.6×10^{-34} J
c = 3×10^8 m/s

QUESTION 2 [26]

2.1 A 51 kg woman runs up a flight of stairs in 5.0 s. Her net upward displacement is 5.0 m. Approximately, what average power did the woman exert while she was running? (4)

2.2 Two objects are connected by a light string that passes over a frictionless pulley, as shown in the figure below. If the incline has a kinetic friction between mass m_2 and the table, and if m_1 = 2 kg, m_2 = 7 kg, and θ = 55°, draw free-body diagrams of both objects and

(a) Derive the equation for acceleration of this motion. (3)

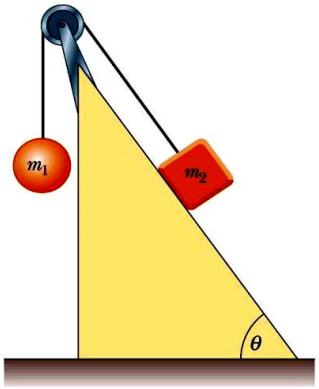
Calculate:-

(b) the accelerations of the objects, (2)

(c) the tension in the string, (2)

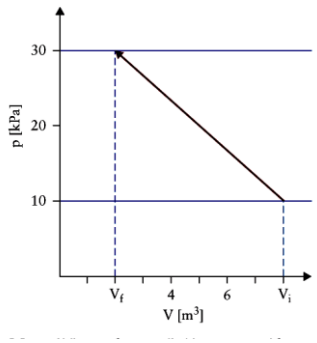
(d) the speed of each object 4 s after being released from rest. (2)

(e) the kinetic energy of the system after 4 s. (4)



2.3 State 2 conditions that must be satisfied for a collision to be classified as elastic. (2)

2.4 The diagram below applies to an ideal gas enclosed in a cylinder. Study the diagram carefully and answer the following questions.



a) Briefly describe what is happening in this system. (3)

2.5 Using the data from the P-V diagram calculate the work done on/by the system. (4)

NB. Use the diagram for calculations

QUESTION 3 [17]

3.1 Use the proper diagram and physics explanations to derive the equation $W = -P\Delta V$. (6)

3.2 Four mol of an ideal gas are sealed in a 20 litre container at pressure P = 10 atm. Calculate the internal energy U of the gas. (5)

3.3 An aluminium calorimeter of mass 100 g contains 250 g of water. The system is in thermal equilibrium at 10^0C. We place two blocks of metal in the water, one is a 50 g piece of copper with initial temperature of 80^0C, and the second has a mass of 70 g and an initial temperature of 100^0C. The combined system reaches the final equilibrium temperature of 20^0C. Calculate the specific heat of the unknown second piece of metal. Given:

C_{water}= 4182 J/K.^{0}C, C_{copper} = 400 J/kg.^{0}C and C_{Al} = 900 J/kg.^{0}C (6)

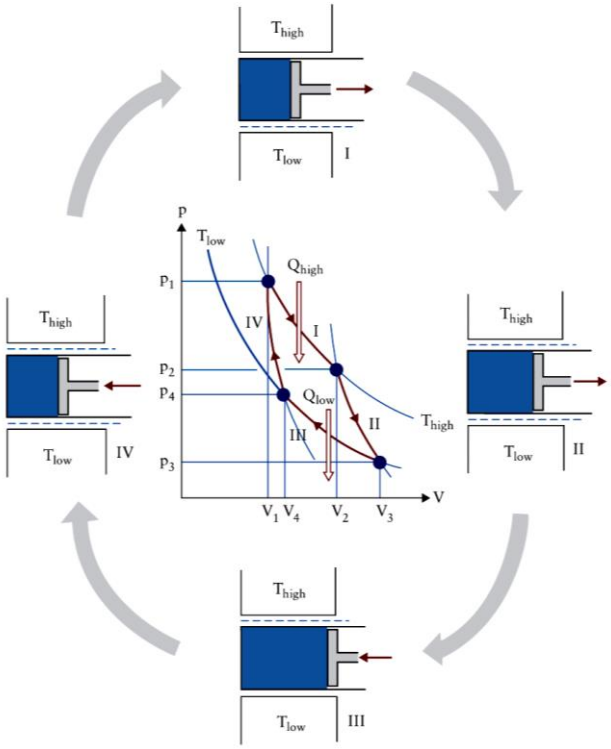
QUESTION 4 [24]

4.1 A 4.0 mol ideal gas expands under conditions where there is no observable temperature changes. After certain time *t* has passed, it is observed that there is a significant change in the volume of a gas as it expands from 2.48 m^3 to 5.1 m^3. Considering that the temperature remains at 21^0C

(a) Calculate the work done by the gas during expansion. (5)

(b) Is there any change in internal energy in this system? Support your answer. (3)

4.2 The diagram at the top of the next page shows a Carnot cycle of an enclosed system. There are consecutive processes represented in the figure. Thoroughly explain what is happening in each and every process starting from process **I** to process **IV**. **Hint: Start by drawing a relevant (*P, V, T*) graph for respective processes**. (16)


T_high
T_low
I
p
T_low
Q_high
P_1
IV
I
T_high
T_high
P_2
P_4
Q_low
II
T_high
III
T_high
T_low
IV
P_3
T_low
II
V
V_1 V_4 V_2 V_3
T_high
T_low
III

QUESTION 4 [23]

4.1 The minimum energy of an X-ray photon is 10 keV.

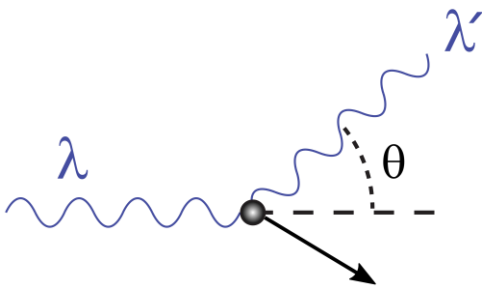
(a) Calculate the corresponding lowest frequency of this X-ray. (3)

(b) Calculate the longest wavelength of an X-ray. (4)

4.2 Jane felt a lump in one of her breasts and immediately suspected the growth might be cancerous. To ease her conscience she decided to go for an X-ray check-up. (10)

Briefly explain to her son who is doing grade 12 physical science, what are the processes involved during the X-ray diagnosis. NB. Start from explaining how X-rays are generated.

4.3 In one of the techniques used in X-ray diagnosis, Compton Effect is one of the important one. Considering that the change in wavelengths between the incident photon and the scattered beam is 1.54 angstroms. Calculate the scattering angle of the electron. (6)



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