UNIVERSITY OF KARACHI

Department of Chemistry (Evening Program)

MATH 402(S): Mechanics and Geometry II

Course Supervisor: Professor Dr. Syed Arif Kamal

Homepage: http://ngds.-ku.org/kamal • *e-mail*: kamal(at the rate of)ngds-ku.org

Time Allowed: 3 hours • *Maximum Marks*: 100 • *Date*: Tuesday, May 24, 2008

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*Student's Name*_____ (in CAPITAL LETTERS using a "**marker**") • *Paper Format* A

Attempt ***Question*** **1** *and* **5** *other questions. Each part of* ***Question*** **1** *is of* 4 *marks & of* ***Questions*** **2-7** *is of* 8 *marks. Note down the time spent on solving each part of question and time spent on revision by making the following "Time Chart" on the answerbook front page* **(2 marks)**. *Time spent on revision must be at least 10% of the total time*

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Question No.	1a	1b	1c	1d	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b	Revision
Time (minutes)																	

a) DO NOT TURN PAPER AROUND unless the invigilator says: *Start* now

b) This is a closed book examination. Deposit all BOOKS, NOTES, MOBILE PHONES (switched off), DIGITAL DIARIES and LAPTOPS in the designated area. Remove everything from your desk except markers, pens, pencils, stapler and calculator.

c) If you want to use a calculator, **it must bear a "*sticker*"** displaying your NAME and your SEAT NUMBER large enough so that it is visible from a distance of 5 meters. **Absolutely, NO sharing of calculators.**

d) Use your own material. **Nothing can be borrowed from or given to** a friend.

e) The papers may be of different formats. Therefore, work on your own ***without consulting anyone*** (We have a record of your seating arrangement).

f) Write your "**NAME**" on all pages of ***your question paper*** (5 marks shall be deducted for failing to comply) [NOTHING ELSE SHOULD BE WRITTEN ON THE QUESTION PAPER] and "**PAPER FORMAT**" on the front page of ***your answerbook*** (the upper right-hand corner) and ***the Yellow Sheet*** using a "**marker**". Start your work from **Page 2** of your answerbook. The only thing that could be written on the front page is the "*Time Chart*" (see above) and the "*Honor Statement*" (see below).

g) The following statement must be copied on the front page of your answerbook and signed **(2 marks)**: "*My signatures below testify that I am the person whose name and photograph appear on the Admit Card. Upon my honor, I declare that the following work is my own, completed without giving or receiving unacknowledged help, without copying, or the use of any unfair means*." Signatures_____

h) This paper contains TWO PAGES (This page and the back page). On invigilator's signal (*Start now*) turn paper around, check if you have the back page printed correctly. Last line of the second page is: <**END**>. Start working on the paper immediately.

i) Put your pens down and your papers turned (so that this page is facing you) and the FRONT PAGE of your answerbook should be facing you as soon as you hear "**ALL PENS DOWN**". Failure to do as directed shall result in "deduction of 5 marks" from your score.

j) If you use extra copies, it is "your responsibility" to write YOUR NAME, COPY NUMBER and all OTHER INFORMATION on each copy used. All the extra copies must be stapled with the main copy before turning in your paper (you may wish to bring in a stapler with you for this purpose).

k) If you have a question of "Fill in the blanks" in your paper you must write the complete sentence with the filled word underlined.

l) Nobody is allowed to leave the examination hall, **for whatsoever reason**, once the examination has started. Bring your own DRINKING WATER.

m) Students are not allowed to LEAVE THEIR SEATS or STAND UP during the examination. If you have a query, "raise your hand" and someone will help you.

n) All work, including rough work, must be on the official answerbook. No extra sheet may be used.

o) Students are *not* allowed to use RED anywhere. All work (except figures) must be in pen or ballpoint.

p) The result shall be displayed on my homepage on **Monday, June 2, 2007** at **0900h**. DO NOT contact the Course Supervisor. Students are not permitted to see the answerbooks.

q) Anyone found cheating in the examination should be facing disciplinary action, which may result in **EXPLUSION** or **SUSPENSION** for 2 or more years. **Absolutely, no conversation among students. DON'T TURN THE PAPER, YET.** *Wait for "signal" from the invigilator.*

*Student's Name*_____ (in CAPITAL LETTERS using a "**marker**")

1-*a)* An astronaut in a spaceship and in a "weightless" condition wants to know which of the two identical containers used to store equipment is empty. How can the astronaut tell which container is empty without opening it?

1-*b)* List the names of 5 types of coördinate transformations discussed in class.

1-*c)* Which conservation law is, mainly, responsible for:
I. A bicycle not falling when paddled by the rider.
II. No success in constructing a perpetual-motion machine.
III. Motion of Ghauri missile
IV. Einstein's photoelectric equation

1-*d)* A scientific balance is used to measure mass by _____ (*comparison, rationalization, collimation*) with a standard mass. Spring balance is used to measure weight using _____'s law (*Boyle, Hooke, Avogadro*). A/An _____ (*comoving, rotating, inertial*) frame is that frame in which Newton's first and second laws hold good. _____ (*Synchronization, Calibration, Manipulation*) of a scientific instrument means someone is converting the output given in terms of variable A (which is not of interest to us) to variable B (which is required by us).

2-*a)* The US Space Shuttle "Columbia" blew up while re-entering the atmosphere. Do you think the total mechanical energy (kinetic + potential) was conserved during the process?

2-*b)* Prove that the track of outgoing electron in the Compton effect must lie in the plane containing the incident and the scattered photons.

3-*a)* Obtain the expression of unit vectors in cylindrical coördinates in terms of unit vectors in cartesian coördinates, using the method of rotation matrices.

3-*b)* Using the result in Q. 3-*a)*, obtain the expression of unit vectors in spherical-polar coördinates, first in terms of cylindrical coördinates, and then in terms of cartesian coördinates.

4-*a)* Obtain the transformation matrix representing rotation about z axis through an angle q. Using this matrix (and without deriving again) write down the transformation matrices for rotation about y axis through angle φ, as well as about x axis through angle ψ.

4-b) Obtain inverse transformations corresponding to each of the above transformations.

5-*a)* Write down postulates of relativity. Who gave the conceptual framework of relativity? Who obtained Lorentz transformations for the first time? What was the role of Albert Einstein in special theory of relativity? Write down expression of Lorentz transformations, when one of the frames is moving with a velocity V along z axis.

5-*b)* Obtain galilean transformations as limiting case of Lorentz transformations, staring from the expression in Q. 5-*a)*.

6-*a)* An electron collides elastically with a hydrogen atom initially at rest (all motions are along the same straight line). What percentage of electron's initial kinetic energy is transferred to the hydrogen atom? Mass of the hydrogen atom is 1840 times the mass of electron.

6-*b)* Prove the following for relativistic particles: $E^2 = p^2c^2 + m_0^2c^4$

7-*a)* A light mass 'm' and an infinitely heavy mass 'M' are separated by a distance 'r_0' at time $t = 0$. They are allowed to move towards each other under the influence of gravity. Find the velocity of 'm' as a function of 'r', where 'r' is the separation between the two masses at time 't'?

7-*b)* A car starts from rest and its velocity increases linearly to 30 m/s during the first 5 s. It travels at constant velocity for the next 10 s. It, then, uniformly accelerates to 60 m/s during the next 5 s. Afterwards, it uniformly decelerates to rest during the last 10 s. Draw a velocity-time graph and compute (*a*) average acceleration during the first 5 s, (*b*) distance traveled during the last 10 s.

Web address of this document: http://www.ngds-ku.org/Chemistry/Exams401-2/402-08_Paper.pdf

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