



UNIVERSITY OF KARACHI
Department of Chemistry (Evening Program)

MATH 402(S): Mechanics and Geometry II

Course Supervisor: Professor Dr. Syed Arif Kamal

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Time Allowed: 3 hours • Maximum Marks: 100 • Date: Tuesday, May 22, 2007

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

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 **Tuesday, June 5, 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) Which of the following are elastic collisions/inelastic collisions?
 i) Person falling on a thick layer of sand; ii) Golf ball striking the ground; iii) Billiard balls striking together;
 iv) A bullet hitting a person and coming out of the other side
- 1-b) Noting that total mechanical energy is conserved in a simple harmonic oscillator $\frac{1}{2}mv^2 + \frac{1}{2}kx^2$, draw graphs between x (displacement) and p (linear momentum), taking various values of total energy, E_1, E_2, E_3 (phase space). Identify the shape of these curves.
- 1-c) Write down the expression of galilean transformations, when one of the frames is moving with a velocity u along z axis.
- 1-d) Obtain $v_2 = \frac{2m_1u_1 + (m_2 - m_1)u_2}{m_1 + m_2}$ starting from $v_1 = \frac{(m_1 - m_2)u_1 + 2m_2u_2}{m_1 + m_2}$ (you cannot apply energy and momentum conservation equations).
- 2-a) What sort of detector is needed for products in a head-on ICBM-ABM collision? ICBM is "Intercontinental Ballistic Missile". ABM is Anti Ballistic Missile".
- 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) What would be the ratio of escape velocity of a rocket from planet 'X' to that from earth if mass of planet 'X' is 20 times the mass of earth and its radius is three-fourth the radius of earth?
- 3-b) Using the spherical-polar-coordinate formulation show that the surface area of a sphere of radius a comes out to $4\pi a^2$, and volume $\frac{4}{3}\pi a^3$.
- 4) Derive the following equation using geometrical argument and method of integration. What should be conditions on direction of motion and magnitude of acceleration for this equation to be valid (under ordinary circumstances average is never taken by summing up the lowest and highest value and dividing by 2):

$$S = \frac{v_i + v_f}{2} t$$
- 5-a) Starting from the general expression of Newton's second law of motion $F = \frac{dp}{dt}$ derive the expression $F = ma$, when mass of the moving body is constant.
- 5-b) A bullet of mass ' m ' and velocity ' u ', penetrates a wooden block of mass ' M ', initially, at rest. The block, after the impact, moves with a velocity ' v '. Compute ' v '. Is this an elastic collision. If not, compute the fractional loss of kinetic energy, T_f/T_i . What happened to this energy?
- 6-a) Differential between inertial and gravitation mass. Suggest an experiment for determination of each of these masses.
- 6-b) A mass m is suspended from a spring balance in an elevator. When the elevator is at rest, the spring balance reads 30 N. If the elevator starts moving up with acceleration twice the acceleration due to gravity, what would be the reading on the spring balance?
- 7-a) Using Green's theorem in a plane evaluate:

$$\oint_C [(5x + 4y) dx + (4x - 5y) dy]$$
 where C is a circle centered at origin having a radius 5 (cm).
- 7-b) Starting from Gauss' law of electrostatics in the integral form:

$$\iiint_V \mathbf{E} \cdot d\mathbf{a} = q / \epsilon_0$$
 obtain the differential form, $\nabla \cdot \mathbf{E} = \rho_Q / \epsilon_0$, using the divergence theorem.

Web address of this document: http://www.ngds-ku.org/Chemistry/Exams401-2/402-07_Paper.pdf

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