

ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)

ELEMENTARY MECHANICS

Valid from January 1, 2026 to December 31, 2026

**It is compulsory to submit the Assignment before filling in the
Term-End Examination Form.**

Please Note

- You can take electives (56 to 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.
- You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.
- At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits should be from lab courses.
- You cannot appear in the Term-End Examination of any course without registering for the course. Otherwise, your result will not be declared and the onus will be on you.



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Dear Student,

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments in the Programme Guide for Elective Courses that we sent you after your enrolment. A weightage of 30 per cent, as you are aware, has been earmarked for continuous evaluation which would consist of **one** tutor-marked assignment for this course.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully.

- 1) On top of the first page of your TMA answer sheet, please write the details exactly in the following format:

ENROLMENT NO. :

NAME :

ADDRESS :

.....

.....

COURSE CODE :

COURSE TITLE :

ASSIGNMENT NO. :

STUDY CENTRE : DATE :

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

- 2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.
- 3) Leave 4 cm margin on the left, top and bottom of your answer sheet.
- 4) Your answers should be precise.
- 5) While solving problems, clearly indicate the question number along with the part being solved. Be precise. Write units at each step of your calculations as done in the text because marks will be deducted for such mistakes. Take care of significant digits in your work. Recheck your work before submitting it.
- 6) **This assignment will remain valid from January 1, 2026 to December 31, 2026.** However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response.

We wish you good luck.

Tutor Marked Assignment Elementary Mechanics

Course Code: BPHE-101/PHE-01

Assignment Code: PHE-01/TMA/2026

Max. Marks: 100

Note: Attempt all questions. Symbols have their usual meanings. The marks for each question are indicated against it.

1. a) A massless rope is stretched horizontally between two supports that are 3.0 m apart. When an object of weight 3200 N is hung at the center of the rope, the rope is observed to sag by 50 cm. Calculate the tension in the rope. (5)
- b) A ball of mass 5.0×10^{-2} kg, starting from rest, falls a height of 4.0 m and then collides with the ground. The ball bounces up to a height of 2.0 m. The collision with the ground takes place over a time 4.0×10^{-3} s. Determine (i) the momentum of the ball immediately before the collision, (ii) the momentum of the ball immediately after the collision and (iii) the average force of the ground on the ball. (5)
2. a) The speed of an aeroplane is 1200 ms^{-1} . The engines take in 80 kg of air per second and mix it with 40 kg of fuel. This mixture is expelled after it ignites and it moves at a velocity of 3000 ms^{-1} relative to the aeroplane. Calculate the thrust of the engine. (5)
- b) A 2400 W engine pulls a 200 kg block at constant speed up a 12.0 m long, 25.0° incline. Determine long does it takes to cover this distance. (5)
3. a) A ball has an angular velocity of 5.0 rads^{-1} counterclockwise. Some time later, after rotating through a total angle of 4.5 radians, the ball has an angular velocity of 1.5 rads^{-1} clockwise. Determine the angular acceleration, the average angular velocity and how much time it takes for the ball to attain this velocity. (5)
- b) When a high diver wants to execute a flip in midair, she draws her legs up against her chest. Why does this make her rotate faster? What should she do when she wants to come out of her flip? (5)
4. a) What is the maximum torque exerted by a 60 kg person riding a bike, if the rider puts all his weight on each pedal when climbing a hill? The pedals rotate in a circle of radius 17 cm. (5)
- b) A ball of mass 1.5 kg rolling to the right with a speed of 3.6 ms^{-1} , collides head-on with a spring with a spring constant of 2.0 Nm^{-2} . Determine the maximum compression of the spring and the speed of the ball when the compression of the spring is 0.10 m. (5)
5. a) A force $F = A\left(\frac{x}{a} - 1\right)$ is acting on a particle along the x -axis. Determine the work done by the force in moving the particle from $x = 0$ to $x = 2a$. (5)
- b) A block of mass 6.0 kg slides from rest at a height of 2.0 m down to a horizontal surface where it passes over a 1.5 m rough patch. After crossing this patch it climbs up another incline which is at an angle of 30° to the ground. The rough patch has a coefficient of kinetic friction $\mu_k = 0.25$. What height does the block reach on the incline before it comes to rest? (5)

6. a) The distance between the oxygen molecule and each of the hydrogen atoms in a water (H_2O) molecule is 0.96 \AA and the angle between the two oxygen-hydrogen bonds is 105° . Treating the atoms as particles, find the centre of mass of the system. (5)
- b) A stationary ball, with a mass of 0.2 kg , is struck by an identical ball moving at 4.0 ms^{-1} . After the collision, the second ball moves 60° to the left of its original direction. The stationary ball moves 30° to the right of the moving ball's original direction. What is the velocity of each ball after the collision? (5)
7. a) An L-shaped object of uniform density is hung over a nail so that it is free to rotate. Determine the angle that the long side of the object makes with the vertical. The long side of the L-shaped object is given to be twice as long as the short side. (5)
- b) A solid cylinder rolls up an inclined plane without slipping. If the incline makes an angle of 30° to the horizontal and the coefficient of static friction is $\mu_s = 0.40$, find its acceleration. Also determine the angle of the inclined plane at which the object will start to slip. (5)
8. a) A particle of mass 4.0 kg , initially moving with a velocity of 5.0 ms^{-1} collides elastically with a particle of mass 6.0 kg , initially moving with a velocity of -8.0 ms^{-1} . What are the velocities of the two particles before and after the collision in the centre of mass frame of reference? What are the velocities of the two particles after the collision in the laboratory frame? (5)
- b) A 30.0 kg girl stands at the rim of a merry-go-round that has a moment of inertia of 500 kg m^2 and a radius of 3.00 m . The merry-go-round is initially at rest. The woman then starts walking around the rim clockwise at a constant speed of 2.0 ms^{-1} .
- i) In what direction and with what angular speed does the merry-go-round rotate?
- ii) How much work does the girl do to set herself and the merry-go-round into motion? (5)
9. a) The comet Encke has an aphelion distance of $6.1 \times 10^{11} \text{ m}$ and perihelion distance of $5.1 \times 10^{11} \text{ m}$. The mass of the sun is $2.0 \times 10^{30} \text{ kg}$. Find the speed of the comet at the perihelion and the aphelion. (5)
- b) The planet earth is $1.5 \times 10^{11} \text{ m}$ from the sun and orbits the sun in one year. The planet Pluto takes 248 years to orbit the sun. How far is Pluto from the sun? (5)
10. a) Consider a simple pendulum of mass m mounted inside a railroad car that is accelerating to the right with constant acceleration a . Analyse this problem in the non inertial frame of reference to find the angle ϕ with the vertical direction at which the pendulum will remain at rest relative to the moving car. (5)
- b) On Jupiter a day lasts for 9.9 earth hours and the circumference at the equator is 448600 km . If the measured value of gravitational acceleration at the equator is 24.6 ms^{-2} , what is the true gravitational acceleration and the centrifugal acceleration. (5)
