INSTITUT TEKNOLOGI BANDUNG
FAKULTAS MATEMATIKA DAN ILMU PENGETAHUAN ALAM
PROGRAM STUDI SARJANA FISIKA
Jl. Ganesha No 10 Bandung 40132 Indonesia

2nd STUDENT ASSIGNMENT SHEET ELEMENTARY PHYSICS IA (FI-1101)
Semester 1 Year 2023-2024
TOPIC: WORK-ENERGY – LINEAR MOMENTUM

For all problems air resistance can be ignored; use $g = 9{,}8\ \mathrm{m/s^2}$.

1. Suppose that you lift a 4-kg book from the floor to a shelf 2 m high. (a) What force must you apply to move the book at constant velocity? (b) What work is done by this force? (c) What force must you apply to the book to carry it slowly at constant velocity from one shelf to an adjoining one 3 m away but at the same level? (Assuming no friction between the book and the shelf) (d) How much work is done by this force?

2. Sixteen kg sled is pulled by a rope over a wet snow for a horizontal distance of 3.2 m. The tension in the rope remains constant at 5.8 N and the rope is at 37° from horizontal. Suppose that the sled is moving at a constant velocity. Determine (a) the work done by the rope on the sled, (b) the work done by the frictional force on the sled, and (c) the coefficient of kinetic friction at the snow-sled interface.

3. A 1.5-kg ball attached to a light string is whirled in a circular path of radius 0.75 m. If the path is a horizontal circle, (a) how much work is done by the earth's gravitational force on the ball as it moves halfway around the circle, and (b) how much work is done by the tension force in the string? If the path is a vertical circle, (c) evaluate the work done by the earth's gravitational force as the ball moves from the highest point to the lowest point in the circle, and (d) how much work is done by the tension force in the string?

4. One end of a light string is slipped around a peg fixed in a horizontal tabletop, while the other end is tied to a 0.50-kg puck. The puck is given an initial velocity of magnitude 3.4 m/s so that it moves in a horizontal circle of radius 0.75 m. The object comes to rest after completing 2.5 revolutions. (a) For the entire motion, what work is done by frictional force? (b) Assume that the magnitude of the frictional force is constant, determine the coefficient of kinetic friction at the interface. (c) Determine the tension in the string at the instant that the puck complete the first revolution. (d) How much work is done by the tension force in the string?

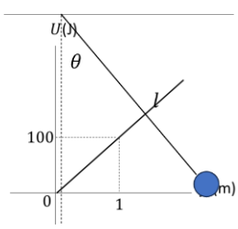
5. Assume that the drag force exerted by the water on a barge is proportional to the speed of the barge to water. A tug delivers 230 hp to the barge when they travel at constant speed of 0.25 m/s. (a) What power is required to move the barge at 0.75 m/s? (b) What force does the tug exert on the barge at the lower speed? (c) at the higher speed? 9 1hp=746 watt)

6. The potential energy of interaction between neutral atoms is sometimes approximated by "12-6" potential energy function.

$$U(x) = V_0\left[\left(\frac{a}{x}\right)^{12} - \left(\frac{a}{x}\right)^{6}\right]$$

where x is the separation between centers of the atoms and V_0 and a are constants. (a) Construct a graph of the function with $a = 0.3$ nm and $V_0 = 3.2 \times 10^{-21}$ J for 0.28 nm$\leq x \leq$0.47 nm. (b) determine from the graph the equilibrium separation where $F_x = 0$. (c) Check the value by using the connection $F_x = -dU/dx$. (d) Suppose one turning point is at $x = 0.40$ nm, locate the other turning point. (e) Determine the mechanical energy for the motion between these turning points.

7. A simple pendulum is formed by attaching a 40-g ball to a one end of a light string; the other end of the string is held fixed, and the ball can swing in a vertical plane. Suppose the ball is released from rest from the position shown in the figure with $l = 500$ mm and $\theta = 60.0°$. Determine (a) the speed of the ball and (b) the tension in the string when the ball passes through its lowest position. (c) Construct a graph of the kinetic energy of the ball as a function of θ.



8. The gravitational-potential-energy- function $U(y)$ is graphed in the figure for a 10.2-kg object close to the earth's surface; $y = 0$ corresponds to ground level. Suppose the mechanical energy of the system is 0.20 kJ. From the graph determine (a) the maximum height of the object, (b) the maximum kinetic energy and the point where the object has that maximum kinetic energy, (c) the location of the object when its kinetic energy equals the potential energy, (d) the force on the object at that instant.

9. Calculate the energy required to raise 1 kg to a height of 100 km. Do the calculation two ways: (a) assume g stays constant; (b) use the exact expression of the potential energy in the earth's field. (c) What is the percentage difference in the two calculations?

10. Compute the work done by the force $\vec{F} = xy\hat{\imath} + (x - y)\hat{\jmath}$ acting on an object when the object moves from point (1,2) to point (2,8) along (a) a linear path and (b) a parabolic path passing through the origin. (c) Is the force conservative? $\vec{F}$ in newton and x and y in meters.

11. On an air hockey table, a floating disk with a speed of 4 m/s strikes another identical disk which is at rest. The first disk glances off at an angle of 30° from its original direction with a speed of v_1. The second disk is knocked at an angle of 60° from that original direction with a speed of v_2. What are the values of v_1 and v_2?

12. A 50 g tennis ball strikes a racquet perpendicular to its surface. Its speed is 10 m/s and it rebounds with the same speed. The force applied to the ball increases linearly to a maximum in 0.01 s and then decreases linearly to zero in the next 0.01 s. (a) what is the change of momentum of the ball? (b) What is the average force exerted by the racquet on the ball? (c) What is the maximum force exerted by the racquet on the ball?

13. A rocket ship emits hot gases at a speed of 2000 m/s with respect to the ship. If it burns and shoots out 100 kg of mass every second, what is the resultant thrust on the rocket?

14. Consider a system of three particles whose masses and positions t are given in the table. Determine (a) the position, (b) velocity, and (c) acceleration of the center of mass of the system.

Particles	Masses (kg)	x (m)	y (m)	z (m)
Particle 1	1	$2t$	$3t^2 - 2$	$4t^2$
Particle 2	3	2	t^2	0
Particle 3	2	-3	$-4t$	$-t$

15. Position particle 1 of mass m at time t is $\vec{r}_1 = 5(\hat{\imath}\cos(at + b) + \hat{\jmath}\sin(at + b))$ while position of particle 2 of mass $5m$ is $\vec{r}_2 = \hat{\imath}\cos(ct + d) + \hat{\jmath}\sin(ct + d)$. a, b, c, d are constants. Determine (a) the position and (b) the velocity of the center of mass of the system. (c) Specify the requirement that the position of the center of mass does not move. (d) Specify the requirements that the position and velocity of the center of mass are perpendicular to each other.