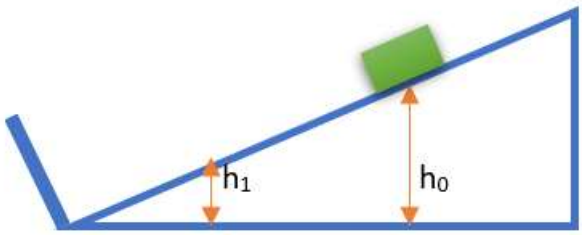
Physics I

Set no. 6

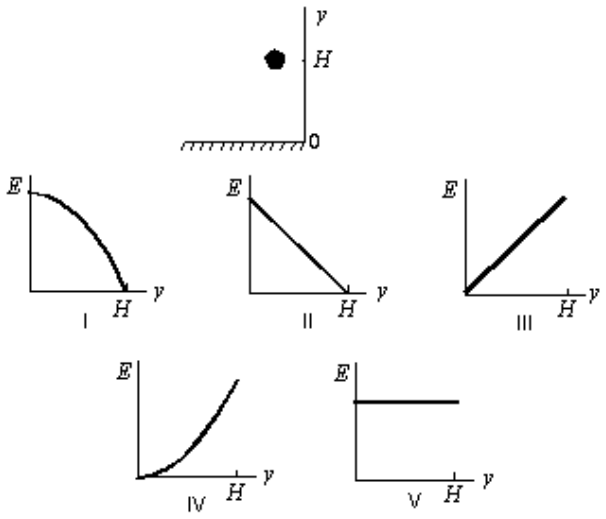
Please assume that g = 10 m/s^2 (magnitude the acceleration due to gravity) unless otherwise stated

1. Using the principle of energy conservation, please find the formula to the maximum height in the diagonal projection (assume that we know the initial speed and angle). At the moment t=0 the body is at the height H

E 2. On a slope with an angle of inclination α, the body slides down from the height h_0. At the end of the slope, the body bounces back elastically from the wall. Please calculate height the body will rise after the bounce (h_1). The coefficient of friction has a constant value of f. Use the principle of energy conservation.



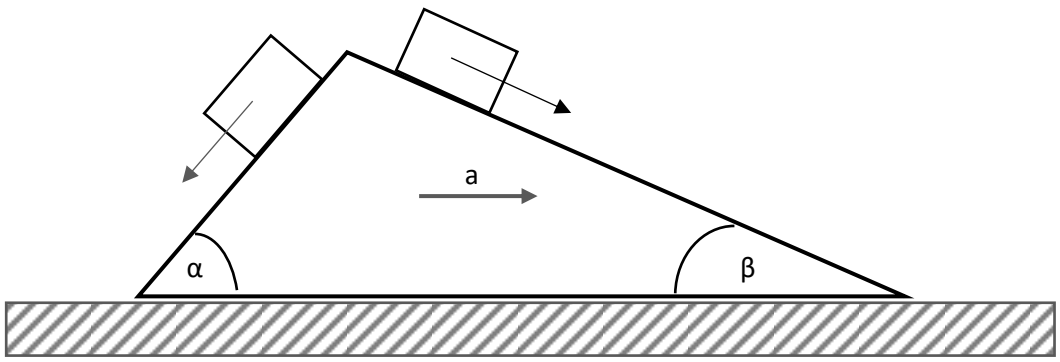
E 3. A ball is held at a height H above the floor. It is then released and falls to the floor. If air resistance can be ignored, which of the five graphs below correctly gives the mechanical energy E of the Earth-ball system as a function of the altitude y of the ball?



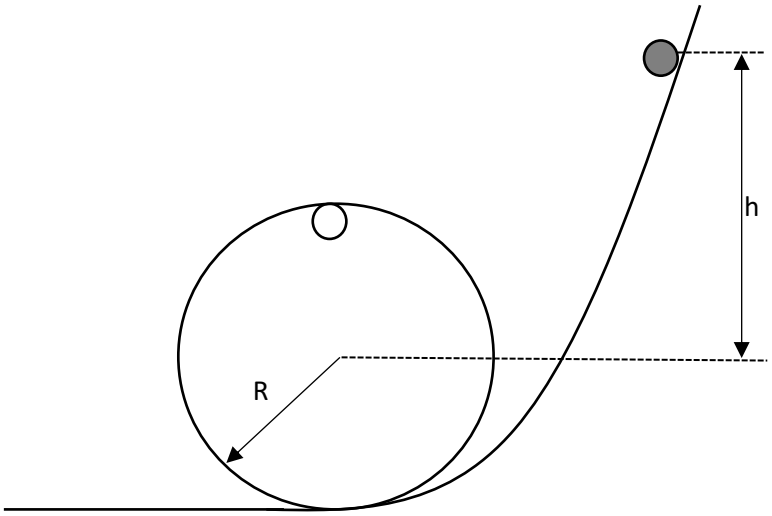
4. A m = 2-kg block is thrown upward from a point h = 20 m above the Earth's surface. At what height above Earth's surface will the gravitational potential energy of the Earth-block system have increased by Ep = 500 J?

5. Please calculate using its definition the potential energy of (1D cases):
   - an apple of mass m at low altitude h over Earth surface (the force of gravitational field is equal **F** = m**g**)
   - elastic Energy, where **F** = -k**r**

6. A wedge is lying on a flat surface. From top of it, two blocks (m_1 and m_2) are sliding down the sides, where one is inclined to the surface at angle α and the other β. What horizontal acceleration a should the wedge have so that both blocks use the same energy to overcome the force of friction?

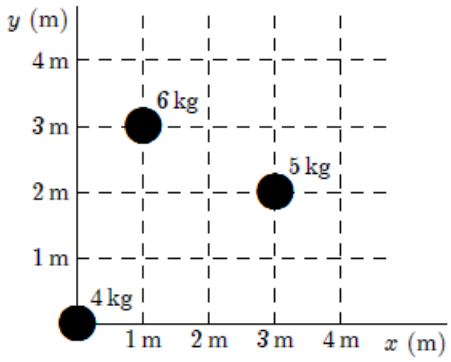


E 7. A ball goes through a death loop (with radius R) without slipping. What is the smallest possible distance (h) between centre of the ball and the level of the centre of the loop?



E 8. A system of three material points of masses m_A=1kg, m_B = 2 kg i m_C= 3kg is given. The masses are initially (t=0) at points in space m_A: A= (1,2,1) m_B B=(3,2,1) m_C: C = (0,0,1). Please calculate the position of the centre of mass of this system.

E 9. The x and y coordinates of the centre of mass of the three-particle system shown below are:



Please calculate the position of the centre of mass of this system.

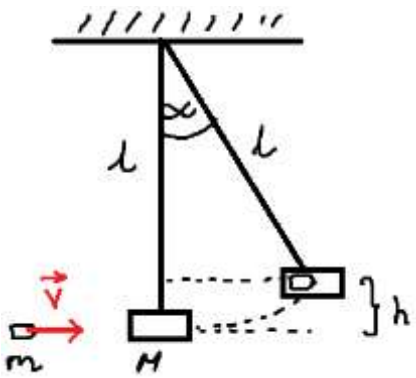
10. Train cars are coupled together by being bumped into one another. Suppose two loaded train cars are moving toward one another, the first having a mass of m_1 = 150 000 kg and a velocity of v_1 = 0.300 m/s, and the second having a mass of m_2 = 110 000 kg and a velocity of v_2 = 0.120 m/s (opposite directed to $\boldsymbol{v_1}$). What is their final velocity?

11. What is the velocity of a M = 900-kg car initially moving at v_1 = 30.0 m/s, just after it hits a m = 150-kg deer initially running at v_2 = 12.0 m/s in the same direction? Assume the deer remains on the car.

E

12. A bullet (with mass m) is fired horizontally into a block of wood (with mass M) suspended by a rope. The block swings in an arc, rising h above its lowest position.

a) Please find the initial velocity v of the bullet.
b) Please calculate the loss of the energy during this process.
c) Assuming that the length of the rope is l, please find an angle α through which the block will deflect.



13. A bullet is accelerated down the barrel of a gun by hot gases produced in the combustion of gun powder. What is the average force exerted on a m = 0.03 kg bullet to accelerate it to a speed of v = 600 m/s in a time of t = 2 ms (milliseconds)?

E

14. A m = 3-kg ball moves towards a wall with velocity v_1 = 4 m/s and reflects from the wall with v_2 = 0.5 m/s ($\mathbf{v_2}$ has an opposite direction to the $\mathbf{v}_1$). Please:

a) find the magnitude of the change in the momentum vector.
b) calculate the percentage loss of the ball energy during this reflection.