

Physics 111N Final Exam
Dec 10 2007

Constants:

$$g = 9.81 \text{ m/s}^2$$

$$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

$$\text{mass of Earth} = 5.97 \times 10^{24} \text{ kg}$$

$$\text{radius of Earth} = 6.37 \times 10^3 \text{ km}$$

PROBLEM 1 (10pt)

A projectile was launched from a 60m high building at an angle 45° with initial velocity 22 m/s .

- a) Find the time it takes to reach highest point in trajectory

- b) What is the maximum height (from the ground level) that projectile reaches.

- c) Find the total time of flight.

- d) Find the velocity after 1.5 sec (V_x , V_y and V_{tot}).

- e) How far does the ball fall from the building.

- f) Find the velocity (V_x , V_y and V_{tot}) just before it hits the ground.

- g) What angle does the projectile make with horizon just before it hits the ground.

PROBLEM 2 (10pt)

Two boxes with attached to each other with a string are sitting on a table top with kinetic friction coefficient $\mu = 0.2$ ($m_1 = 1.2 \text{ kg}$ and $m_2 = 3.2 \text{ kg}$). The third mass, $m_3 = 2.5 \text{ kg}$ is attached with a string to masses going over the pulley and is hanging freely.

- a) Find the acceleration of the system.
- b) Find the tension in the string connecting m_3 and m_2
- c) find the tension in the string connecting m_2 and m_1 .

PROBLEM 3(10pt)

A spring with constant $k = 125 \text{ N/m}$ is compressed ($x = 0.5 \text{ m}$) with a block which has a mass of $m_1 = 3.2 \text{ kg}$. When the block is released it travels to the right and hits another block with mass $m_2 = 1.2 \text{ kg}$. Then the blocks go on the incline.

- a) find the velocity of the first block before it hits the second block.
- b) find the velocity of the blocks m_1 and m_2 after the collision (assume the blocks are moving together).
- c) find the kinetic energy of the system before it starts going to incline plane.
- d) how high will the system go ?

PROBLEM 4(10pt)

A man exerts a horizontal push of 20 N in the positive x-direction on a box of mass 1.8 kg on a level floor. The coefficient of kinetic friction between the box and the floor is 0.3. The box is initially at rest. Ignore the initial static friction between the box and floor.

- a) What is the acceleration of the box?

b) What is the change in kinetic energy of the box after it has been pushed for 5 m?

c) What is the velocity of the box after it has been pushed for 5 m?

PROBLEM 5(5pt)

Three identical balls are arranged in a line. A at $x = 0$, B at $x = 1m$ and C at $x = 5m$.

a) What is the direction of the gravitational force on ball B, assuming the right is positive x direction (circle one)?

- i) right
- ii) left

b) What is the magnitude of the force on the ball B (in terms of G).?

PROBLEM 6(10pt)

A satellite ($m = 100 kg$) is circling around the earth at the height of $H = 800 km$.

a) Find the velocity of the satellite.

b) Find the period of rotation.

c) what is the angular velocity of the satellite ?

d) what is the frequency of rotation ?

e) What is the force on the satellite ?

PROBLEM 7(10pt)

A system of 4 balls ($m = 1 \text{ kg}$) with identical mass are located along a straight line with coordinates $x_1 = 0 \text{ cm}$, $x_2 = 15 \text{ cm}$, $x_3 = 20 \text{ cm}$ and $x_4 = 35 \text{ cm}$.

find the moment of inertia for given axis:

a) rotation axis passes through ball 1 ?

b) rotation axis passes through ball 2 ?

c) rotation axis passes through ball 3 ?

If a force of 5 N is applied perpendicular to the system at the position of ball 4 and system is fixed at the point of ball 3.

d) what is the magnitude of the torque ?

e) what is the angular acceleration that the system will experience ?