Exam 1-932

Problem 1 (10 points)

Assuming the density of nitrogen gas , **r**, in a container that measures **1.0m x 2.0m x 4.0m** is **1/800** that of water, and **r** (water) = **1.0 g/cm3.**

a) What is the mass of nitrogen gas in the above container?

b) Find the number of nitrogen molecules in this container given that the molecular weight of nitrogen **M** = **28 g NA** = **6.02x1023** molecules/mole.

Problem 2 (10 points)

Energy is a physical quantity with dimensions equal to the dimension of mass multiplied by the dimensions of the square of velocity. Suppose the energy, **E**, of an object is given by:
E = c mj v2 + m gk yn
where **m**, **v**, and **y** are mass, velocity, and relative position of the object, **g** is the acceleration due to gravity, **c** is a dimensionless constant, and **j**, **k**, and **n** are constant numbers.

a) Use dimensional analysis to find numerical values for the constants **j**, **k,** and **n**.

b) What are the units of energy in **SI** system?

Problem 3 (10 points)

Two displacement vectors, **a** has a length of **20 m** and makes an angle of **qa = 60o** with respect to the **negative y-axis** (**counterclockwise**) and **b =** (**40 i - 32 j**) **m.**
a) What are the magnitude and direction of the vector (**2 a - b)**?

b) What is the angle between the two vectors **a** and **b**?

Problem 4 (10 points)
An object is released from rest from an unknown height **h** above the ground. It requires **2.0 s** to travel the last **50 m** just before hitting the ground.

a) Find the speed when the object is **50 m** above the ground.

b) Calculate the height **h** above the ground.

c) What are the magnitudes of the average velocity and the average acceleration of the object during the last **50 m** of the trip just before hitting the ground ?

Problem 5 (10 points)

A projectile is fired at an angle of **30°** to a horizontal ground. The total flight time is **10 s** as it returns to the ground.

a) Find the initial speed, **v0** , of the projectile.

b) Find the maximum height, **H**, reached by the projectile.

c) Find the range (the maximum horizontal distance), **R**, traveled by the projectile.

Problem 6 (10 points)

A ball is thrown from the ground at an angle of **45°** to the horizontal with an initial speed, **v0** , of **15.5 m/s.** At the same moment a man runs from the opposite side to catch the ball in the air. He catches the ball at a height of **1.0 m** above the ground as it descends.

a) Find the speed of the man if he runs at a constant speed for a distance of **6.0 m** before catching the ball.

b) Find the speed of the ball at the highest point.

c) What is the relative speed of the ball relative to the running man when the ball is at the highest point ?

Problem 7 (10 points)

A boat can move at **8.0 m/s** in still water. The boat takes **4 minutes** to complete a round trip of distance **2 d** along a river where the speed of the current is **2 m/s**.

a) Find the distance **d**.

b) How long does it take to complete the same round trip if the river is calm (still)?

Problem 8 (10 points)

A block of mass **m** is kicked up a **30° rough** inclined plane with an initial speed of **6.0 m/s**. The block slides a distance of **2.0 m** up the incline before coming to rest.

a) Draw a free body diagram showing all the forces applied on the object as it is moving up the inclined plane.

b) Find the acceleration of the block.

c) Find the coefficient of kinetic friction between the block and the plane.

Problem 9 (10 points)

string and hung vertically over a light, frictionless pulley. Assume the two masses, **m1 = 1.00 kg** and **m2 = 1.11 kg**.

a) Draw free body diagrams of the two masses, **m1** and **m2**.

b) Find the acceleration of the masses.

c) Find the tension in the string.