TEST QUESTIONS - EXAM I

1. The Motion of an object is described by the Equation

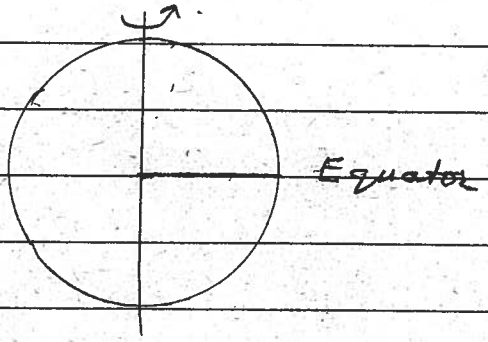
$$\underset{\rightarrow}{x} = (15 - 20t + 5t^2)\,\hat{x}$$

where time is in secs and distances in meters: Calculate: i) position at $t=0$, ii) position at $t=10$sec. (iii) vel. at $t=0$. (iv) acceleration at $t=5$sec. (v) Time when velocity is zero, (vi) Position when velocity is zero. (vii) Times when object is at $x=0$.

2 For Prob. 1 plot $\underset{\rightarrow}{v}$ as a function of time.

3. For Prob 1 plot $\underset{\rightarrow}{x}$ as a function of time

4. As you all know the Earth rotates once on its axis in 24 hrs. The radius of Earth is about 6400 km. What is the speed of an object located at (i) the equator (ii) at the poles and (iii) at a latitude of 45° North.

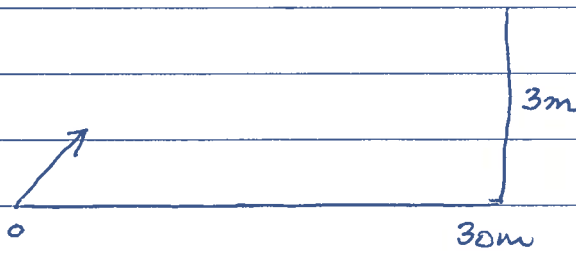


4a The moon goes around the Earth in a Circular orbit of radius 400,000 km and takes about 27 days. What is the orbital speed of the moon

5. A ball is thrown vertically upward ($+\hat{y}$) and reaches a height of 10 meters before returning to ground. (i) What was its initial velocity (ii) why does it stop rising, (iii) what is its acceleration at the highest point? (iv) how long will it be in the air before returning to ground (v) If you wish to double the height to which it should go, by what factor would you change its initial velocity?

6. A player kicks a ball giving it a velocity of 20m/s at an angle of 53° above the horizon (x-axis). a) how long before it reaches the maximum height, b) what is the maximum height? c) what is the velocity vector at the maximum height d) what is the acceleration when it is 10m above the ground e) where will the ball land f) what is the velocity vector just before it lands? g) what is the acceleration just before it lands.

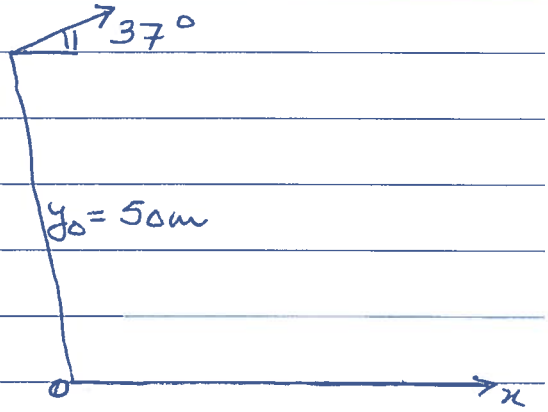
7. In prob. 6 if there were a wall of height 3m at a pt. $x = 30$m,



would the ball clear the wall? If so, what will its velocity and acceleration be at that time?

8. Draw graphs of position, velocity and acceleration as functions of i) x, ii) t for Prob 6.

9. Now the ball is launched from a 50m high tower ~~with~~ at 20m/s ~~to~~ and making an angle of 37° with the horizontal?



i) Write down the x & y components of the velocity at $t=0$. ii) how high will the ball go. (iii) when will it be at $y = 50m$ again (iv) what will be the values of $\vec{x}$, $\vec{v}$ and $\vec{a}$ at that time. (v) how far will the ball be from the origin ($x=0$, $y=0$) at what time

10 Forces are said to come in action-reaction pairs. Near the Earth's surface an object of mass M has a weight of $\vec{W} = -Mg_E\hat{y}$. where does the reaction force to the weight vector act? ($g_E = 9.8m/s^2$).

11. Your mass on Earth is 100kg. If you go to the moon a) what is your mass there? b) What is your weight there if $g_{moon} = \frac{g_E}{6}$?

12. The position of an object is described by the Equation

$$\vec{x} = (3 + 5t - 4t^2)\hat{x}$$

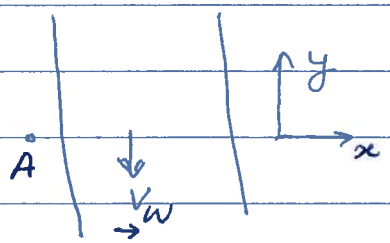
What are the dimensions (NOT UNITS) OF THE Constants on the right hand side of this Equation.

13 We are told that an object is at 100m at $t=0$, has a velocity of $-50\text{m/s}\,\hat{x}$ and an acceleration of $20\text{m/s}^2\,\hat{x}$. Write down the equation which relates $\vec{x}$ to time.

14. You are travelling by a boat in a river where the water flows at $(5\text{m/hr})\,\hat{x}$. If your velocity with respect to the water is 10m/hr at an angle of 60° to $\hat{x}$, what is your velocity with respect to the shore

15. As shown, velocity of water in a river is

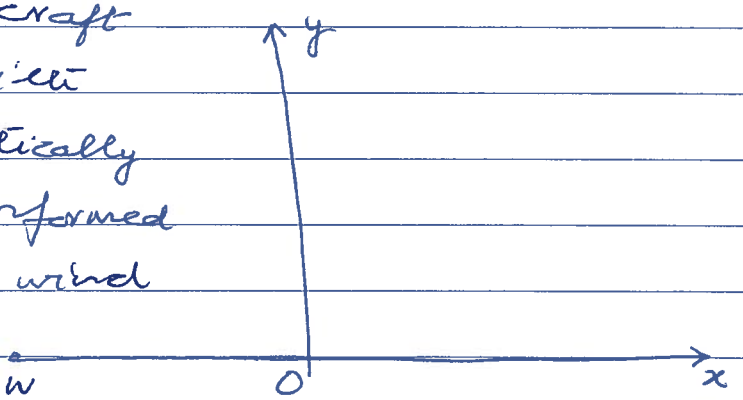
$\vec{v}_W = -0.3\text{m/s}\,\hat{y}$ [Here $\hat{y}$ is not vertical].



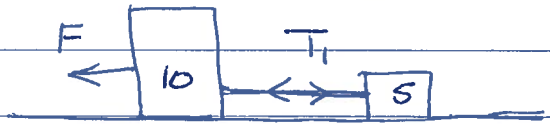
If you were in a boat whose

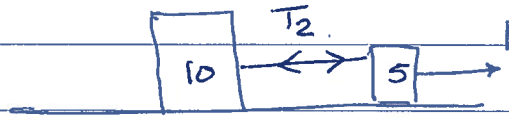
speed with respect to the water is 0.5m/s (no matter what the direction) what direction would you go so as to land directly opposite to the point A? What would your velocity be with respect to the shore.

16 A pilot whose aircraft flies at 100 km/hr with respect to air is vertically above O when he is informed that there is a 50km/hr wind blowing along $-\hat{y}$. He wants to get to W where OW = 86.6 km. What direction should he choose and how long will it be before he reaches above W.

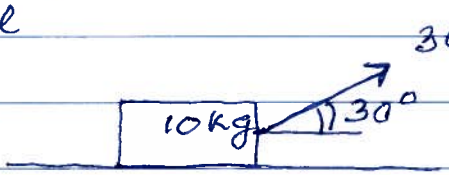


17 Masses of 5kg and 10kg are connected by a string and placed on a smooth horizontal table. In i) a force of $-150N\hat{x}$ is used to pull on the 10kg mass. What is the acceleration of the masses and the tension in the string. In ii) a force of $+150N\hat{x}$ is used to pull on the 5kg mass. What is the acceleration and the tension now?

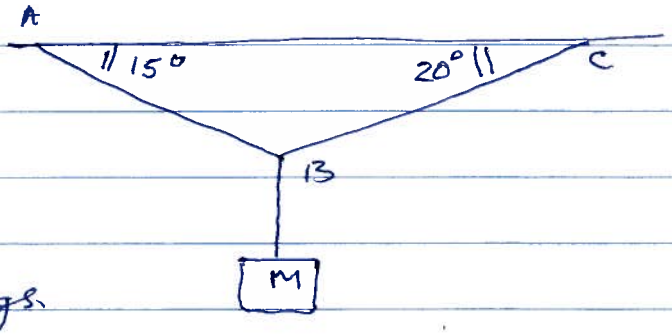




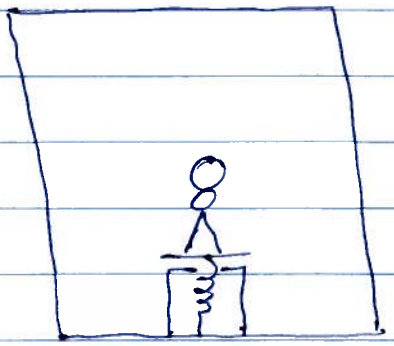
18 An object of mass 10kg is lying on a horizontal frictionless table. It is being pulled by a string exerting a force of 30N at an angle of 30° above $\hat{x}$. i) Draw the other forces acting on the object. ii) Calculate the values of the force vectors listed in i). iii) Calculate the acceleration of the object.



19. A mass of 5kg is hanging from the strings as shown. Calculate the tensions in the strings.



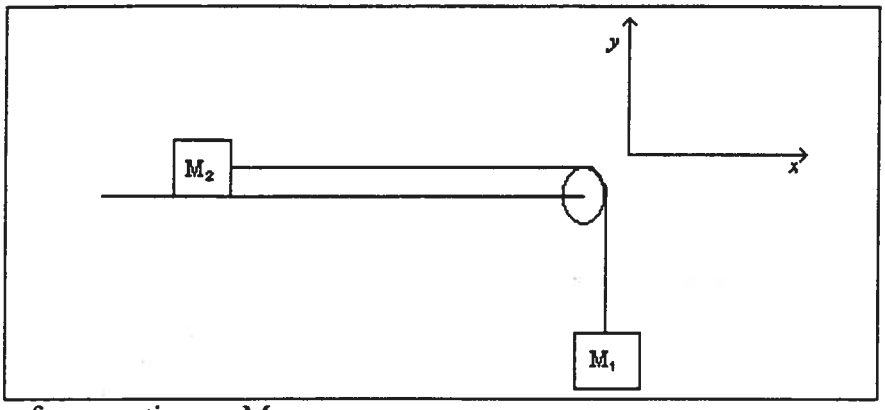
20 You are in an Elevator standing on a weighing machine. Your mass is 50 kg and the Elevator is at rest. i) What weight will the machine indicate?



ii) How will the apparent weight change if a) elevator moves with constant velocity $3\,m/s\,\hat{y}$, b) Constant acceleration $\underrightarrow{a} = +9.8\,m/s^2\,\hat{y}$.
c) Constant acceleration $\underrightarrow{a} = -9.8\,m/s^2\,\hat{y}$

Problem #21

Consider the situation shown in the figure $M_1 = 10\,kg$, $M_2 = 5\,kg$, the pulley is frictionless and so is the table.



a) Draw the forces acting on M_1.

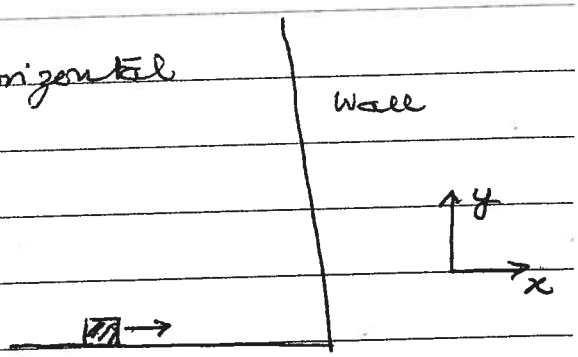
b) Draw the forces acting on M_2.

c) What is the acceleration of M_1?

d) What is the acceleration of M_2?

e) What is the tension in the string?

#22 The wall is vertical. On the horizontal floor (neglect friction) a 0.25kg puck approaches the wall from the left at 8m/s. When it bounces it moves leftward at 10m/s. It is in contact with the wall for 0.02 secs. Calculate i) velocity vector before the collision, ii) velocity vector after the collision iii) average acceleration of the ball iv) average force acting on the ball v) average force acting on the wall. vi) precise time interval for which iv) and v) are nonzero.



Problem 23

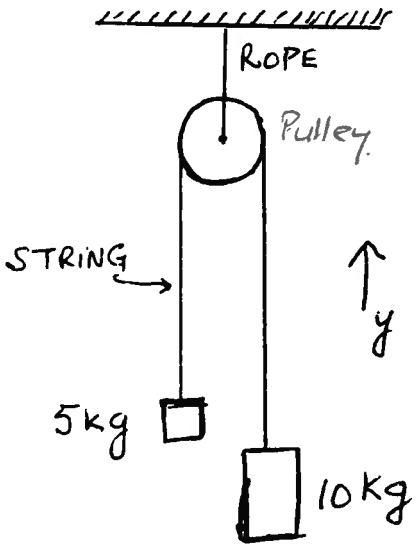
As shown, the massless pulley is hung from the ceiling by a stout rope. At $t = 0$, you let go of the 10 kg mass. Calculate

a) Acceleration of 10 kg mass. (5)

b) Acceleration of 5 kg mass. (5)

c) Tension in the string. (5)

d) Tension in the rope. (5)



Problem 24 Now that you are a "Physicist" & a friend asked you, how do you measure the diameter of the moon, what would you tell her?