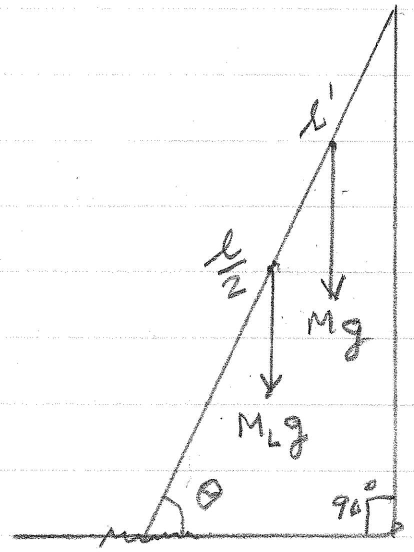
TEST QUESTIONS – EXAM III (PARTIAL LIST)

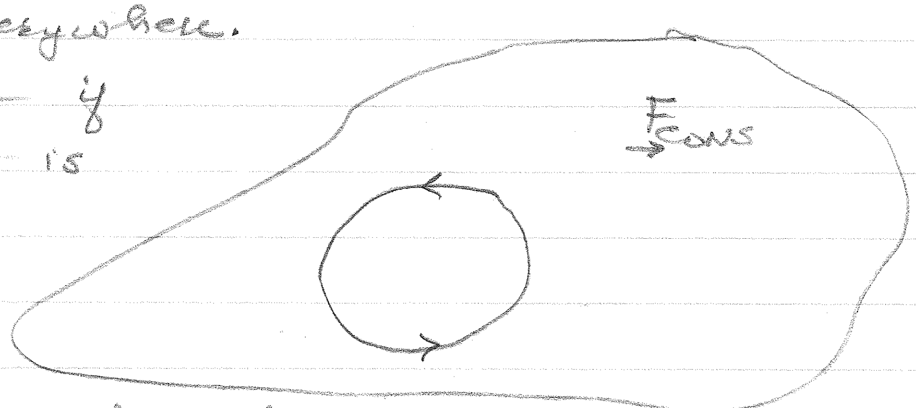
1. In using ladder where the wall is smooth but the floor has a frictional coefficient of μ_s, why is it necessary to make the angle θ as large as possible?



[M_L mass of ladder,
ℓ length of ladder
M mass of person standing at ℓ']

2 What is a conservative force?

3 The picture shows a region of space in which there is a conservative force everywhere.
Show that if an object is taken around the closed loop the net work done is zero.



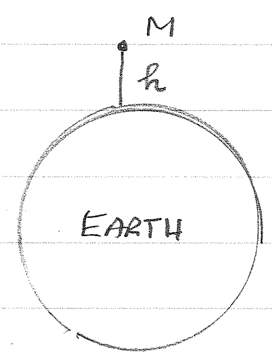
4. Show that the work done by the force of friction is always negative.

5. What is potential Energy? (Please do not write Mgh).

6. Why is it not possible to define a potential energy for the force of friction?

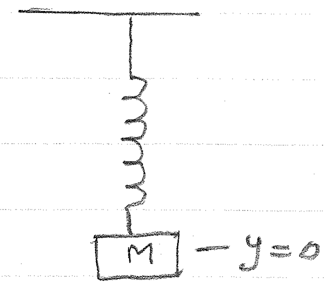
7. What is a "NO WORK" FORCE? SUPPORT YOUR ANSWER WITH EXAMPLES

8. Calculate the potential energy of the Earth - Mass system shown here →.



9. A mass of 5 kg is travelling at $5 m/s \hat{x}$ on a smooth horizontal surface when it runs into a rough patch where $\mu_k = 0.5$. How far will it travel before coming to a stop? Why?

10 Shown is a mass M hanging from a spring of spring constant k. You hold the mass at $y=0$ with the spring relaxed. There are two ways in which you can let go:



(i) lower M slowly while holding it all the time and allowing the spring to stretch and finally remove your hand leaving the system in Em (stretch Δy_1)

(ii) You let the mass go at $y=0$ and it drops by an amount Δy_2 before coming to rest momentarily. Show that

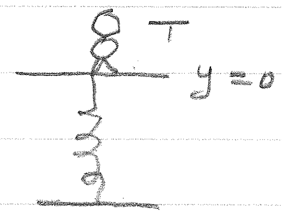
$$\Delta y_2 = 2\Delta y_1.$$

11. Why is there a negative sign on the right side of the equation

$$\Delta U = -\vec{F}_{cons} \cdot \Delta\vec{S} \qquad ?$$

where ΔU is the change in Potential energy.

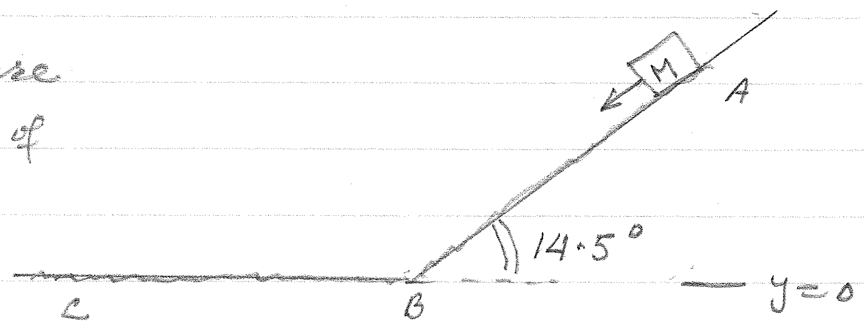
12. The toy T is placed on a platform as shown. You squeeze the spring by 1mm and let go. If T has a mass of 10^{-3}kg and it goes up to $y=3$m before falling back, what is the spring constant?



13. Two objects of masses M and 2M have the same linear momentum (magnitude), which one has the larger kinetic energy? Why?

14. Two objects of masses M and 2M have the same kinetic Energy which one will have the larger linear momentum (magnitude)? Why?

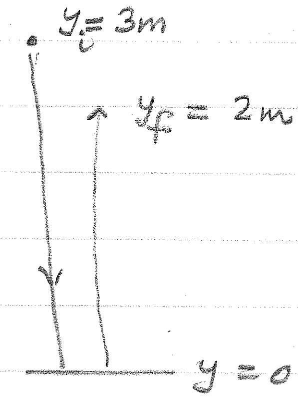
15. In the figure an object of mass 5kg is shown going



downhill on a track where $\mu_k = 0.1$ everywhere. When it passes point A it is moving at 15m/s. We are told the distance AB = 200m and the object eventually comes to rest at C. Calculate a) Potential Energy at A b) Kinetic Energy at A c) Potential energy at B d) Velocity at B e) the distance BC.

16. Is linear momentum of a system of many objects always conserved if $\vec{F}_{ext} = 0$? Justify your answer.

17. A 0.5kg object drops from rest from a 3m high table. On bouncing from the Earth it rises to 2m.



i) What is the Impulse received by the object?

(ii) What is the Impulse received by the Earth?

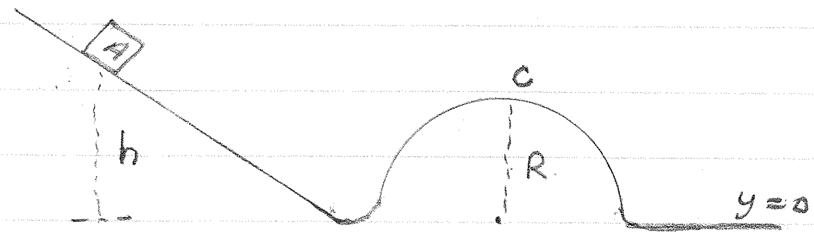
(iii) Is kinetic energy conserved in this Collision? Why?

18. State clearly the difference between a totally Elastic and a totally inelastic two body collision.

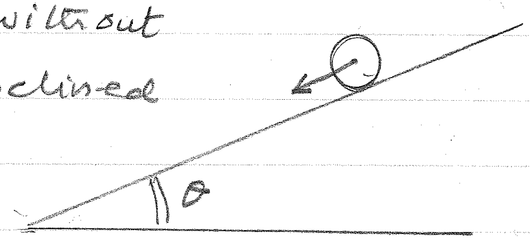
19. A puck of mass 5kg moving at $+2 m/s\ \hat{x}$ on a frictionless horizontal surface has a head-on totally Elastic collision with a puck of mass 10kg moving at $-1 m/s\ \hat{x}$. Calculate (i) the total momentum before the collision, (ii) the total kinetic energy after the collision (iii) the velocities of the two pucks after the collision.

20. In problem 19 what would be the velocity after the collision if the two pucks stuck together? Why?

21. Shown is a smooth track where the hump is a semi circle of radius $R = 20m$. The object A starts from rest at a height h. (i) What is the smallest value of h so that A will go over the "hill" (ii) If h is too large A will lose contact at C. What is the largest value of h so that A does not lose contact at C? Why?

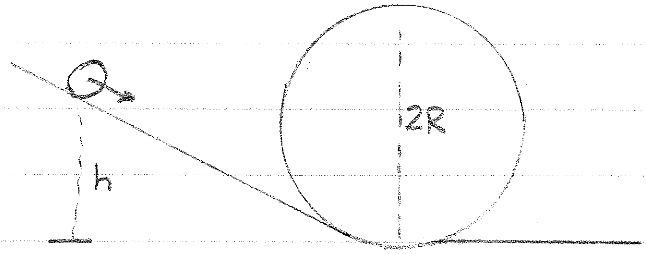


22. The sphere rolls without slipping down an inclined plane. i) Do you need friction for this to occur. ii) If so, how much work is done by the force of friction as the sphere rolls a distance of 1m? Why?



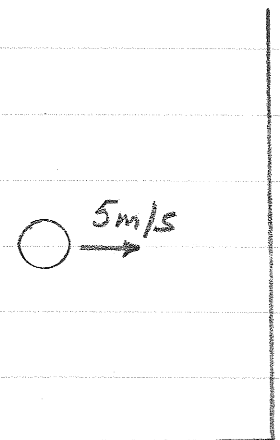
23. The gravitational potential energy in $U_g = Mgh$ while the potential energy of a stretched spring is $U_{sp} = \frac{1}{2}kx^2$. If $k = 100N/m$, $M = 2kg$ and $h = 0.1m$, what value of x would make $U_{sp} = 2U_g$? Why?

24 In a loop-the-loop experiment what is the minimum value of



h at which you must launch the ball ($I = \frac{2}{5}Mr^2$) so that it goes around the loop without dropping? Why? (assume that the ball rolls without slipping).

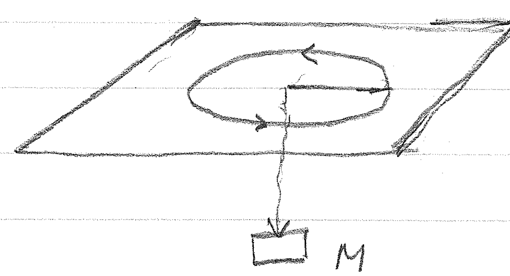
25 An object of mass 0.5kg travelling horizontally at $5m/s\,\hat{x}$ runs into a vertical wall. What is the change in the momentum of the wall if the collision is (i) totally Elastic, (ii) totally inelastic? Why?



26 What is the angular momentum of an Earth satellite whose period is one day and whose Mass is 100kg. [Hint: use Kepler's law

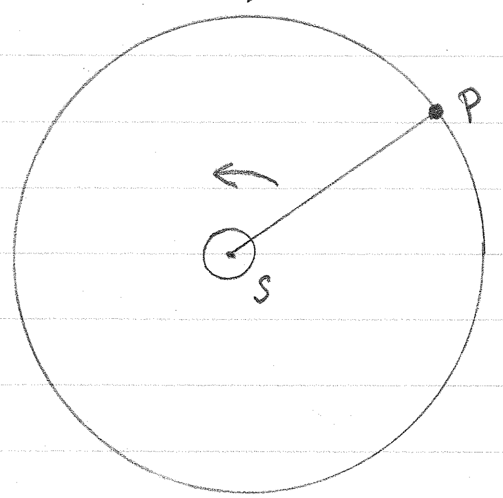
$$\frac{T_{sat}^2}{R_{sat}^3} = \frac{4\pi^2}{GM_E}$$]

27. As shown the object of mass 0.5kg is rotating with uniform speed on a smooth horizontal table. M = 5kg and the radius



of the circle is 1.5m. What is the angular velocity? Why? What is the angular momentum of the 0.5kg mass? If you pull on the 5kg mass will the angular momentum be altered? Why?

28. Show that for circular orbits Kepler's 3rd law is a consequence of the conservation of angular momentum. [The third law says that the radius from sun to planet sweeps out equal areas in equal intervals of time.]



29. What is the relationship between the angular momentum (magnitude) and the rotational kinetic energy of a rigid body? [Compare it to relation between translational kinetic energy and linear momentum].