Week 4-Problems

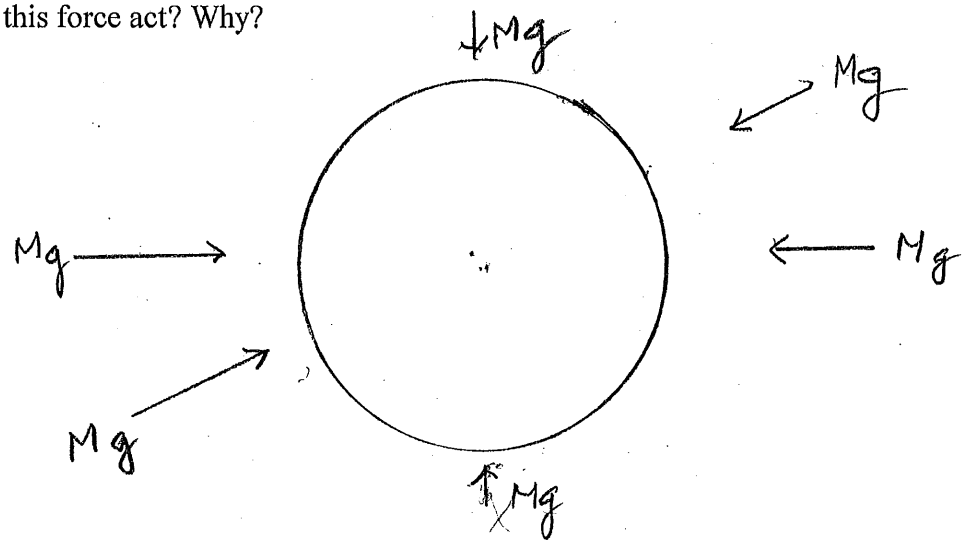
4-1 Write an essay on the "Amateur astronomer" experiment (we discussed in class) which determines (i) the speed of the moon and (ii) its radius, by reference to the speed of a point on the surface of the Earth.

4-2 Supposing your mass on Earth is 50kg.

A) If you go to the moon will your mass be different? Why?

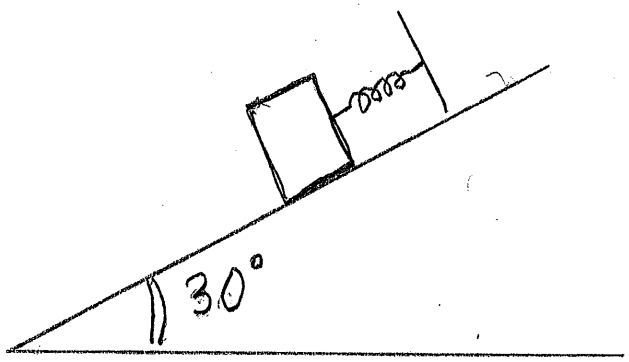
B) On the moon, the acceleration due to gravity is $-1.65\text{m/s}^2\,\hat{r}$. What is your weight on the moon? Why?

4-3 The Earth pulls on you with a force of $\underrightarrow{W} = -\text{Mg}\,\hat{r}$ where M is your mass and $g=9.8\text{m/s}^2$. With what force do you pull on the Earth? At what point does this force act? Why?

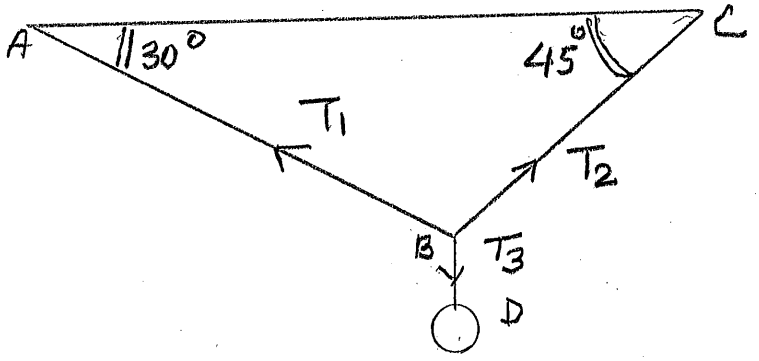


4-4 A railroad train consists of 10 cars each of mass 1000kg. In order to have an acceleration of $2\text{m/s}^2\,\hat{x}$, what force will the engine have to exert on the car immediately behind it? Why?

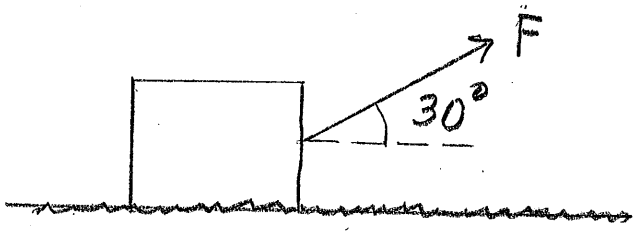
4-5 A block of 100kg is being held in place (see figure) on a frictionless inclined plane, which is 30° above the horizontal, by a spring of spring constant 10^4N/m.
What is (i) the normal force on the block,
(ii) the extension of the spring,
(iii) if you cut the spring what will be the acceleration?



4-6 As shown a 10kg mass is being supported by the three strings BD, AB, and BC, calculate the tensions in T_3, T_1, T_2, respectively.



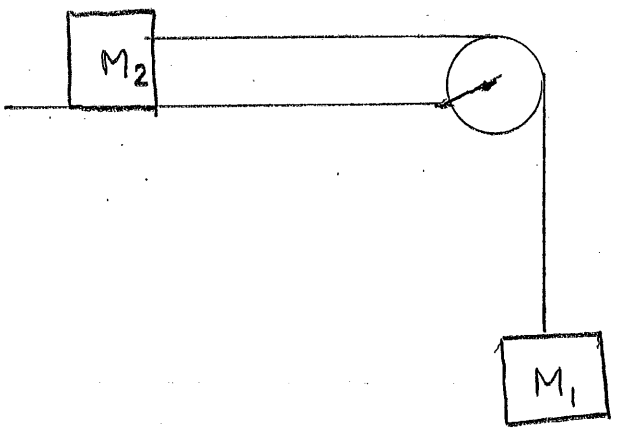
4-7 As shown a 5kg block is sitting on a rough, horizontal surface. The 20N force acting at 30° above the horizon moves it at a constant speed, what is the coefficient of kinetic friction between the mass and the surface? If the coefficient of static friction is 0.5, will the force be able to move the mass?



4-8 A 10kg child on roller skates starts up a 10° incline at 15km/h. Assuming she does not propel herself, how far up the incline does she travel before stopping? Ignore friction.

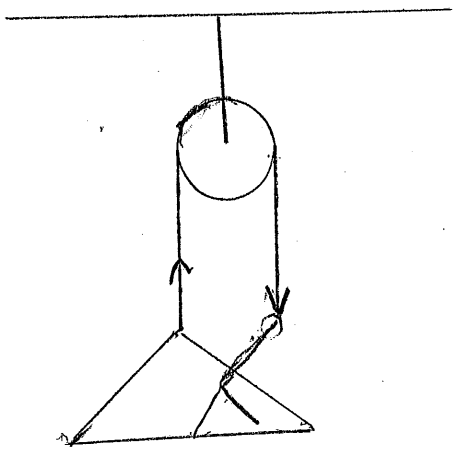
4-9 A person drops from a ledge 1m above the floor. Estimate the force on her 50kg torso when she land (i) by bending her knees and stopping her torso in 20cm, (ii) stiffly and her torso is stopped within 4cm.

4-10 Two blocks are connected by a massless string as shown. M_1= 2kg and M_2 = 5kg. What is their acceleration and the tension in the string if the table is (i) frictionless, (ii) has a kinetic friction coefficient of 0.15?

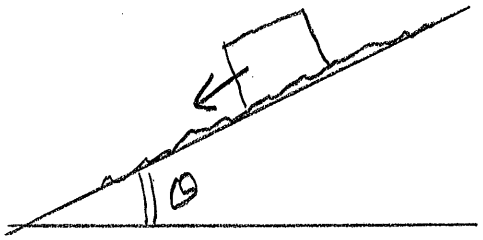


4-11 A person is standing on a scale in an elevator. If his mass is 60kg, what weight will the scale record if the elevator is (i) at rest, (ii) moving up at a constant velocity of 20.5m.s, (iii) moving up at a constant acceleration of $0.2m/s^2$, (iv) moving down at a constant acceleration of $0.2m/s^2$.

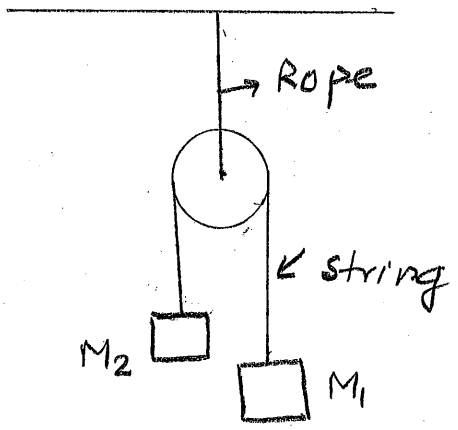
4-12 A painter of mass 75kg stands on a platform of mass m= 15kg.He pulls on a rope that passes around a pulley. Determine the tension is the rope given that (i) he is at rest and (ii) he accelerates upward at $0.4m/s^2$.



4-13 A block is sitting on a rough incline ($M_s = 0.5$) as shown. If you start increasing θ at what angle will it just begin to slide? Why?



4-14 Atwood's Machine: As shown, a massless, frictionless pulley is supported by a rope from the ceiling. A light string passes over the pulley and carries the masses $M_1 = 10kg$ and $M_2 = 5kg$. Calculate (i) accelerations of M_1 and M_2,
(ii) tension in the string, and
(iii) tension in the rope.



4-15 Starting from rest, how far will M_2 move in 2 seconds?

4-16 A pendulum is hanging inside a car, as shown. If the car is stationary the pendulum hangs vertically. Discuss what happens (i) if the car moves at a uniform velocity $V\hat{x}$, (ii) if the car has a uniform acceleration $\underset{\rightarrow}{a} = 2\text{m/s}^2\,\hat{x}$.