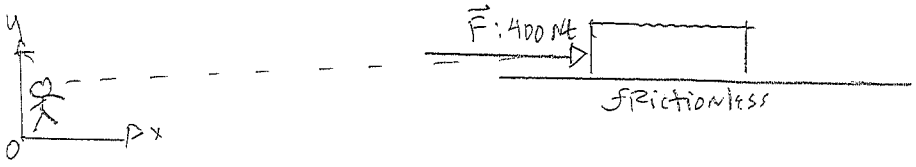
Classical Mechanics – 'Icebreaker' Review Problems 2-2-2022

Name _____

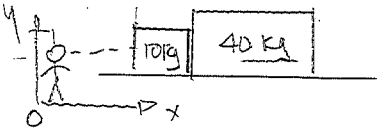
Write down a solution for each problem. Clearly develop the reasoning used in each of your solutions. Work individually.

1. Consider a bug on the surface of a sphere with center at O. It crawls at a constant rate from P_1 $(-2,-3,\sqrt{3})$ to P_2 $(\sqrt{6},\sqrt{7},\sqrt{3})$ over a period of 8 seconds. Assume CGS units.
   a.) Are linear velocity and angular velocity constant? Explain.
   b.) What distance did the bug travel?
   c.) Find the linear speed and angular speed of the bug.

2. Consider the following scenario... a force of 400 Newtons is applied to what appears to be a single mass viewed by an observer far away from the mass, as shown in the figure. The observer remains at rest relative to the mass, and the mass appears to accelerate along the horizontal axis on a frictionless surface relative to the observer.



   Upon closer inspection, the observer sees two masses instead of a single mass, wherein a smaller mass is buttressed up against a larger mass. The smaller mass is 10 kg, the larger mass is 40 kg.



   a.) Find the acceleration of the system of masses.
   b.) Find the acceleration of each mass.
   c.) Are there internal forces to consider between the masses? If so, explain and quantify, where possible.
   d.) Assume that the observer mounts a bicycle and travels at a constant rate opposite to the direction which the masses are travelling. Is the observer's frame-of-reference inertial? Why/why not?

3. Find a unit vector normal to the plane formed by the vectors in problem 1.

4. a.) Expand sinx in powers of x. b.) Expand ln(1+x) in powers of x.

5. Determine each of the following accurate to 4 places a.) $\cos 6^0$ b.) $\sin 65^0$ c.) $e^{0.1}$

6. Show that $e^{ix} = \cos x + i \sin x$

7. Integrate each of the following a.) $\int \ln x \, dx$ b.) $\int x^2 \cos x \, dx$

8. a.) Find the kinetic energy of a particle of mass 20 kg moving with velocity $3\mathbf{i} - 5\mathbf{j} + 4\mathbf{k}$ m/s.

   b.) Assume the velocity changes to $5\mathbf{i} + 6\mathbf{j} + 8\mathbf{k}$ m/s. Find the amount of work done.