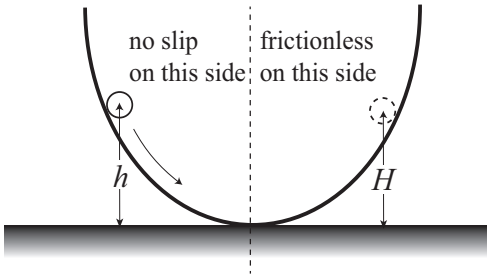
Physics 101 (F11) **Q8A**

Name: _____ **Section:** _____ **Score:** _____**/20**

1. A uniform disk (which will be replaced by a uniform hoop in (b)) starts to slide down the slope on the left side without slip from a stationary condition at height h, and then climbs up the right side slope which is frictionless.



(a) The height of the highest point reached by the disk on the right side slope is H. What is the ratio H/h? [Hint: You may assume the mass M and the radius R of the disk, although they are not needed.] [5]

(b) If the same experiment is repeated with the disk replaced by a uniform hoop of the same radius, is the ratio H/h larger (i.e., does the hoop climb up higher than the disk)? You must justify your answer. [5]

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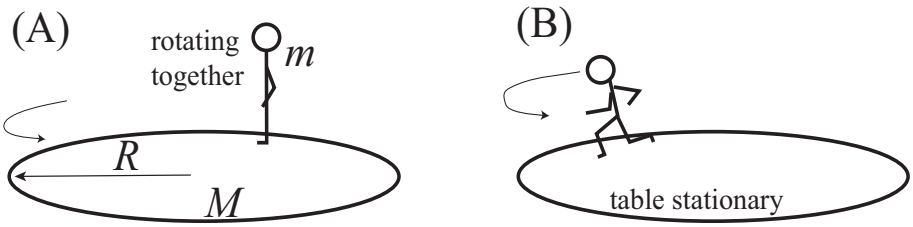
2. A uniform horizontal turntable of radius R and mass M can rotate around a vertical axle without friction. Initially, a person of mass $m = M/2$ is standing still on the turntable at its edge (R from the axle). The standing person and the turntable rotate together with the same angular speed ω (A in the figure).



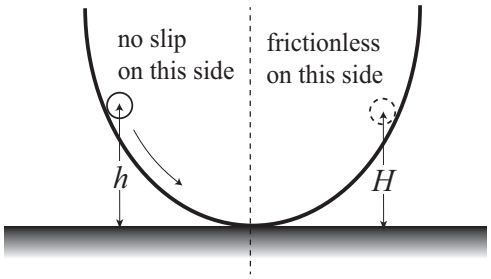
(a) The person starts to run along the edge of the turntable and the turntable comes to a complete halt (situation B). What is the angular speed Ω of the person around the axle? [5]

(b) Does the total kinetic energy increase or decrease from A to B? You must justify your answer. [5]

Physics 101 (F11) **Q8B**

Name: _____ **Section:** _____ **Score:** _____/20

1. A uniform solid ball (which will be replaced with a hollow sphere in (b)) starts to slide down the slope on the left side from a stationary condition at height h without slip, and then climbs up the right side frictionless slope.



(a) The height of the highest point reached by the solid ball on the right side slope is H. What is the ratio H/h? [Hint: You may assume the mass M and the radius R of the ball, although these are not needed.] [5]

(b) If the same experiment is repeated with the solid ball replaced by a uniform hollow sphere of the same radius, is the ratio H/h larger (i.e, does the sphere climb up higher than the ball)? You must justify your answer. [Hint: You may assume the ball and the sphere have the same mass, although this information is not needed.] [5]

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2. On a horizontal turntable, which can rotate around its vertical axle freely but whose moment of inertia you may ignore, is a person holding a massless stick of length L with a tiny ball of mass M at each end. Initially, she holds the stick horizontally by one end as in A, and is rotating with the stick at an angular speed ω.

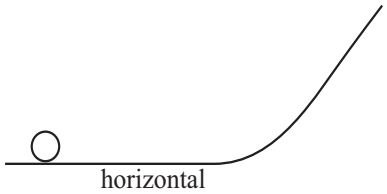
(a) She pulls in the stick and holds it horizontally by the mid point as in (B). Her new angular speed is Ω. What is Ω/ω? You may ignore her moment of inertia (for simplicity). [5]

(b) What is the work W done by the person in terms of M, L and ω? [5]

Physics 101 (F11) **Q8C**

Name: _____ **Section:** _____ **Score:** _____**/20**

1. Initially, a uniform disk has a speed of v, and then climbs up the slope, reaching the maximal height h.



(a) Then, oil is applied to the surface, and the floor and the slope become frictionless. The same experiment is repeated with the same initial speed, and the disk climbs up to the height H. What is H/h? [5]

(b) Now, the disk is replaced with a uniform hoop of the same size and the experiments with and without oil in (a) are repeated. Does the ratio H/h increase? You must justify your answer. [5]

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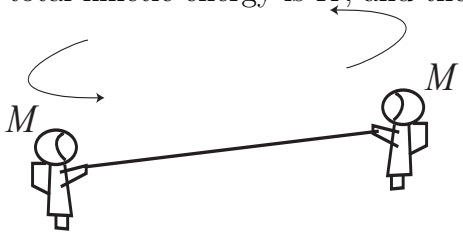
2. Two astronauts with the same mass M are pulling each other and rotating around their center of mass. Initially, the total kinetic energy is K, and the angular speed is ω.

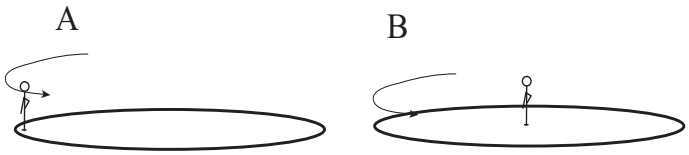


(a) What is the distance between the astronauts in terms of K, M and ω? [5]

(b) The astronauts pull each other and the mutual distance is halved. Let the new kinetic energy be K'. What is the ratio K'/K? [5]

Name: _____ **Section:** _____ **Score:** _____**/20**

1. A horizontal turntable of moment of inertia I and radius R can rotate around its central vertical axle. Initially, the turntable is rotating at a constant angular speed ω together with a person of mass m standing at the edge of the table stationary relative to the table (Situation A). Throughout this problem you may assume that the person is a point mass (= mass of insignificant size.)



(a) The angular speed of the turntable is Ω after the person walks to the center and stands just at the position of the axle (i.e. Situation B). What is Ω/ω in terms of I, m and R? [5]

(b) Does the person do a positive work between Situation A and Situation B? You must justify your answer. [5]

(**2** on the next page)

2. There are two horizontal floors A and B, the latter being higher by H than the former.

(a) A disk is given an initial translational speed of v. The disk rolls without slip all the way up to floor B, but comes to a halt. What is H in terms of v and g, the acceleration due to gravity? [5]

(b) Now, oil is applied all over, and the floors and slope are frictionless. Then, the experiment is repeated with the same disk with the same initial translational speed v. Can the disk reach floor B? You must justify your answer. [5]