Questions

Multiple answers may be possible. Try to select all correct answers before checking the solutions.

Question 1 *Angular momentum*
Your teacher is spinning on a stool, arms outstretched. When she brings her arms closer to her body, the speed of rotation increases. What can be said about her moment of inertia ?

1. It increases because she is going faster
2. It decreases because her arms are closer to her body
3. It remains constant

Question 2 *ISS*
The astronauts on the ISS float in "weightlessness" because :

1. The ISS is far enough from Earth not to be subject to the influence of its gravitational field.
2. The ISS falls, and the passengers experience the same sensation as those in an elevator whose cables have snapped.
3. The centrifugal force in uniform circular motion exactly balances the force of gravitational attraction.

Question 3 *Loop-de-loop*
Consider a marble rolling along a loop. The ball is considered a sphere that rolls without slipping. The release height for the sphere to complete the loop depends on :

1. the radius of the sphere
2. the mass of the sphere
3. Whether the sphere is hollow or solid
4. None of the above

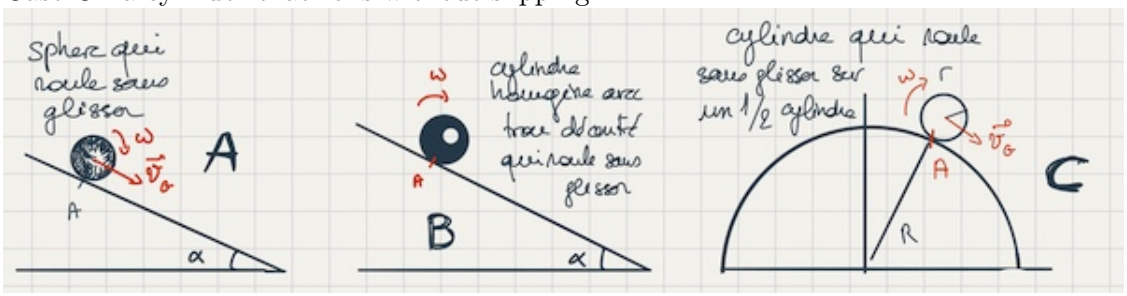
Question 4 *Flywheel 1*
Consider the following experiment : a string is wrapped around the axis of an object such that the object will rotate due to a mass that exerts tension on the string. When the object's moment of inertia is greater, the angular acceleration of the mass is lower. What can be said about the moment of the force exerted by the string on the axis ?

1. It is zero in all cases
2. It is the same in both cases
3. It is greater when the moment of inertia is lower (the angular acceleration is greater)
4. It is greater when the moment of inertia is greater (and the angular acceleration is lower)

Question 5 *Flywheel 2*
Consider the following experiment : a string is wrapped around the axis of an object such that the object will rotate due to a mass that exerts tension on the string. If we increase the radius of the axis, what happens to the torque applied by the tension ?

1. It increases
2. It decreases
3. It is the same

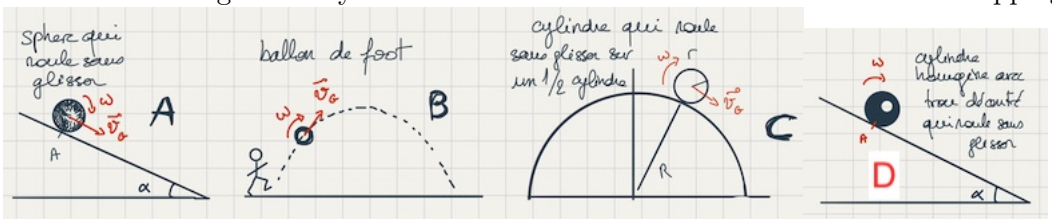
Question 6 *Reference point*
Consider the following three situations :
Case A : a sphere that rolls without slipping.
Case B : a homogeneous cylinder with an off-center hole that rolls without slipping.
Case C : a cylinder that rolls without slipping.



In which case(s) can the angular momentum theorem be applied at point A ?

1. case A
2. case B
3. case C

Question 7 *No-slip condition*
Consider the following three situations :
Case A : a sphere that rolls without slipping.
Case D : a sphere kicked into the air.
Case C : a cylinder that rolls without slipping.
Case D : a homogeneous cylinder with an off-center hole that rolls without slipping.



The objects all have a radius r. In which case(s) can we write for the solid that $r\omega = v_G$?

1. case A
2. case B
3. case C
4. case D

Solutions

1 Correct answer is 2 : It decreases because her arms are closer to her body

2 Correct answer is 2 or 3. The ISS feels gravity from the earth, but all parts of it are falling at the same speed. Gravity is the centripetal force, and therefore in the rotating frame creates the centrifugal force.

3 Correct answer is 3. Only the moment of inertial matters, which changes depending on if the sphere is hollow or solid.

4 Correct answer is 2. The mass is the same and the point of application is the same even if we change the moment of inertia of the object.

5 Correct answer is 1. We increase the lever amr so we increase the torque.

6 Correct answer is only case A. We can only calculate the angular momentum of a point that is the CoM, fixed, or moving colinear to the CoM. In all three cases point A is neither the CoM nor fixed. It only moves colinear to the CoM in case A.

7 Correct answer is case A and case C. If an object rolls without slipping around its geometrical center C, then $r\omega = v_C$. G is the geometrical center of the object in cases A B and C, but in case B the object is not rolling on a surface.