Name: ____________________ **Section:** __________ **Score:** __________**/20**

1. Audio CD players read their discs at a constant rate (linear speed) and thus must vary the disc's rotational speed from around 500 rpm, when reading at the innermost edge, to 200 rpm at the outer edge.

(a) The radius of the innermost track (read first) is 2.3 cm. What is the radius of the outermost track? [5]

(b) When a music is over, the disc rotational speed is 200 rpm. To stop this rotation within 5 complete rotations, at least what average angular acceleration must be applied to the disk? Answer in rad/s^2. Pay attention to the sign. [5]

(**2** on the next page)

2. You are in a car moving at a speed V along a circular curve of radius R on a horizontal ground. Thanks to the frictional force (magnitude f) between the seat and your body, you need not lean on the wall.

(a) Write down the magnitude f of the frictional force. Your answer may be in terms of V, R, your body mass M, the acceleration of gravity g, and the coefficient μ_s of static friction between the seat and your body (you may not need all of them). [5]

(b) You jump up perpendicularly to the floor of the car (assume you are sufficiently away from the walls). Suppose the car is turning constantly to the left, where will you land, to the right or to the left of the original position? You must justify your answer briefly. [5]

Name: ____________________ **Section:** __________ **Score:** __________/**20**

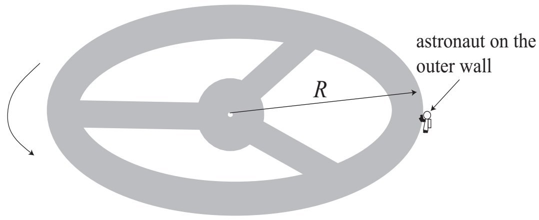
1. DVD players read discs at a constant rate (linear speed) and thus must vary the disc's rotational speed as it reads from the inner edge of the disc toward the outer edge of the disc. At the innermost edge of the disc, the rotational speed is 1500 rpm.

(a) The radius of the innermost track (read first) is 2.3 cm. The radius of the outermost track is 5.8 cm. What is the rotational speed (in rpm) of the disk when the movie is ending? [5]

(b) You start to play a wrong movie; the disc rotational speed is 1500 rpm. To stop this rotation within 18 complete rotations, at least what angular acceleration α (in rad/s^2) must be applied to the disk? [5]

(**2** on the next page)

2. We wish to make a space station with 'simulated' gravity by rotation.



(a) The inside of the outer wall (radius R) of the space station is used as the ground. We want the effective weight (i.e. normal force) of a person standing on this wall to be equivalent to his actual weight on the surface of the earth. What must be the rotational speed V of the outer wall? Your answer may include earth's gravitational acceleration g. [5]

(b) An astronaut of mass M holds on the outside of the wall of the station (assume the wall is not thick, so its radius is R). What force is needed to keep him on the wall? Give its direction and magnitude. [5]

Name: ____________________ **Section:** __________ **Score:** __________/**20**

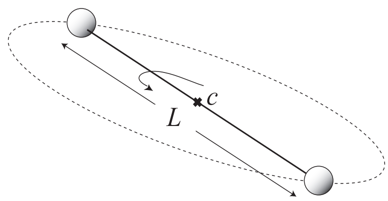
1. DVD disk is read starting from the innermost track at a radius of 2.3 cm. The required rotational frequency of the disk at which the innermost track is read is 25.5 Hz.

(a) Initially, the disk is at rest. From this state we wish to reach the required rotational frequency to play the innermost track in 5 s with a constant angular acceleration α. What is the required α (in rad/s^2)? [5]

(b) When a movie is coming to the end, the outermost track is being read at a radius of 5.8 cm. To read the information at a constant rate the DVD player keeps the constant linear speed (tangential speed) to scan the track. What must be the rotational frequency f (in Hz) of the disk at the end of the movie?

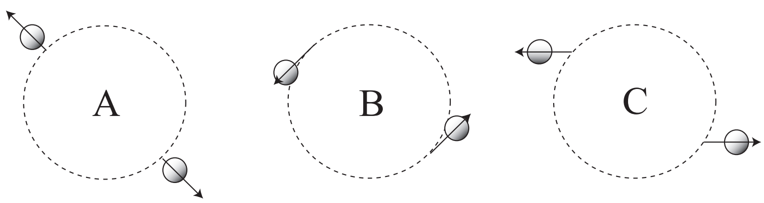
(**2** on the next page)

2. Two identical blocks of mass M is connected with a massless and flexible rope of length L. The system is in space and rotates in a plane around the stationary midpoint c (which does not move relative to distant stars) of the rope as illustrated.



(a) The rope can withstand the tension up to T. What is the largest angular speed ω_M of the rotation beyond which the rope snaps? Write ω_M down in terms of T, L and M. [5]

(b) Immediately after the rope snaps, what is the trajectories of the masses from a stationary observer (relative to point c). Choose the correct illustration from below and give a brief justification of your choice. [5]



Name: ________________ **Section:** ________ **Score:** ________**/20**

1. Audio CD players read their discs at a constant rate (linear speed) and thus must vary the disc's rotational frequency from 8 Hz, when reading the innermost track, to 3.5 Hz at the outer edge.

(a) The radius of the innermost track (read first) is 2.3 cm. What is the angular speed ω (in rad/s) of the disk, when the track at radius 3 cm is being played? [5]

(b) Since the music is boring, you wish to jump from a track of radius 3 cm to the track close to the end. The angular speed of the disc to play the track properly is 23 rad/s. To make this transition within 5 complete rotations with a constant angular acceleration (or deceleration), what angular acceleration α is required (in rad/s^2)? [5]

(**2** on the next page)

2. There is a planet of mass M whose rotational angular speed around its axis is ω (that is, its one day is $2\pi/\omega$).

(a) We wish to place a stationary satellite to this planet. How far (distance R) is it from the center of the planet? [Hint. A stationary satellite is a satellite which is always above a fixed location on the planet's equator, so such a satellite must rotate with the angular speed ω. You may use Newton's formula for gravitational force GmM/r^2 to supply the needed centripetal force. Express R in terms of G, M and ω.] [5]

(b) Unfortunately, although your formula was right, an engineer made a numerical mistake and the satellite rotates ahead of the planet. Now, you must fix it. Will you increase or decrease R? You must justify your answer. [5]