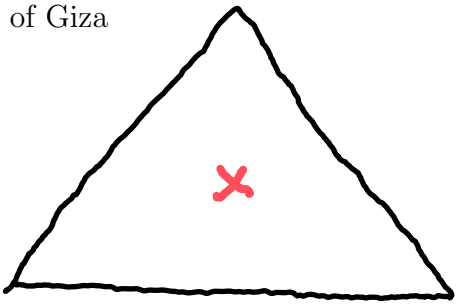
Problem 1

For each of the following objects, make a quick sketch and place a "×" at the center of mass. No calculations necessary. Just reason through these qualitatively with your group members.

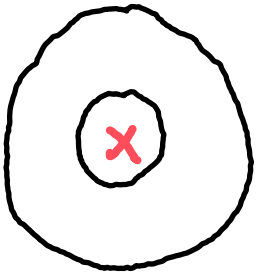
(a) An uncooked spaghetti noodle

(b) The great pyramid of Giza

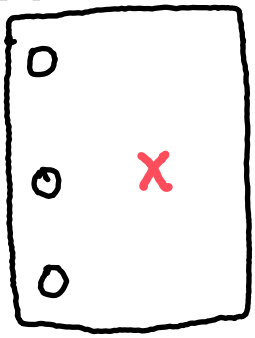


(c) A boomerang

(d) A glazed doughnut with a hole in the middle

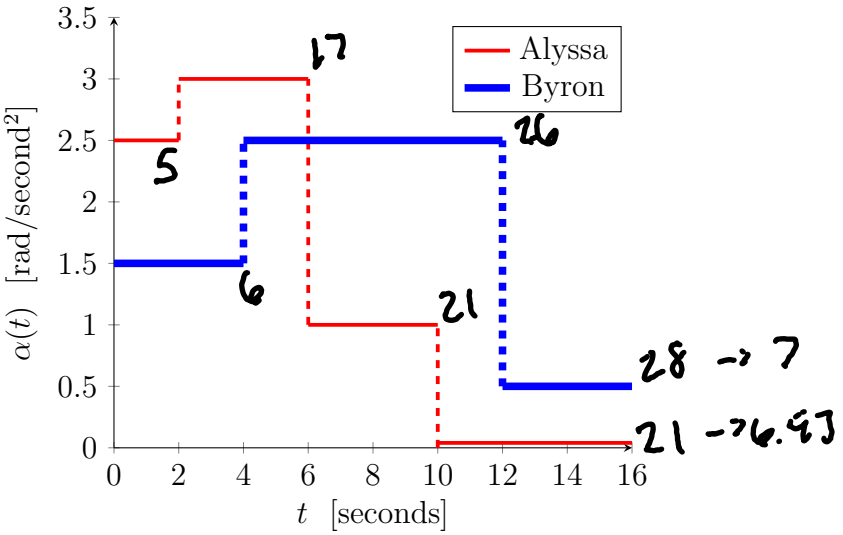


(e) A piece of notebook paper with three holes punched out along the left-hand side



Problem 2

Alyssa and Byron are heading out for a bike ride on **level ground**. Alyssa's wheels have a radius of 0.33 m, whereas Byron's have a radius of 0.25 m. They have each placed a rotation sensor on their front wheel which will track the wheel's angular acceleration $\alpha(t)$ in rad/s^2 throughout the ride. Shown below is a simplified model of the data collected during the first 16 seconds of their ride. Both riders start pedaling from rest, and their wheels roll without slipping for the entire ride.



(a) When, if at all, was Alyssa traveling with constant speed?

$t = 10$ to 16

(b) When, if at all, was Byron slowing down?

Never

(c) What was the greatest translational acceleration achieved? And by whom?

3 rad/sec^2 by Alyssa $1\ m/s^2$

(d) Whose wheels had the greater angular speed at $t = 16$ s?

Byron 28 rad/sec

(e) Who had the greater translational speed at $t = 16$ s?

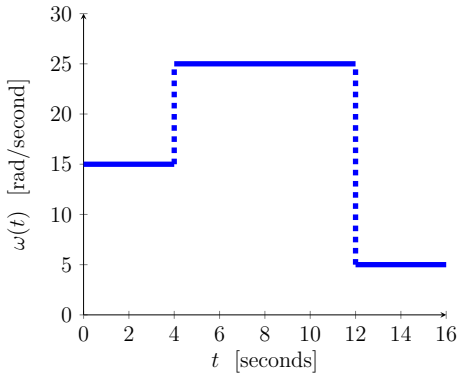
Byron 7 m/s

(f) Are the speeds you found in parts (d) and (e) above realistic?

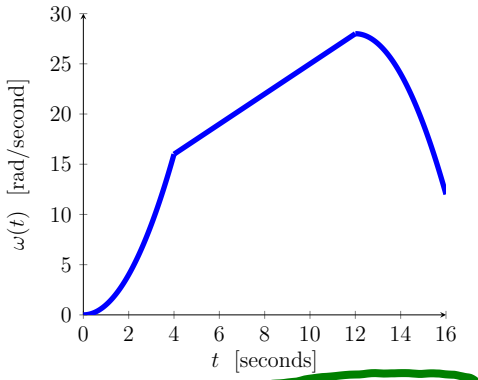
Yes

(g) Which graph below correctly shows the angular speed of Byron's wheels throughout the ride?

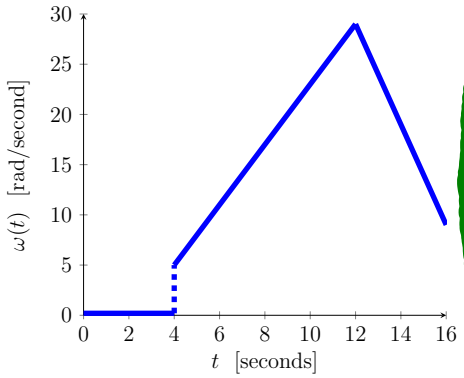
Graph (1)



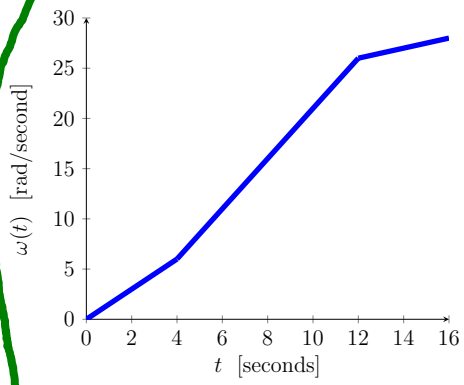
Graph (2)



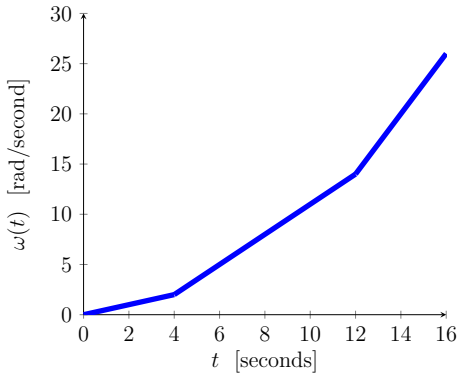
Graph (3)



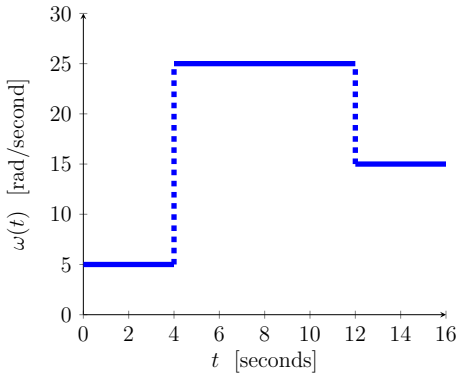
Graph (4)



Graph (5)



Graph (6)



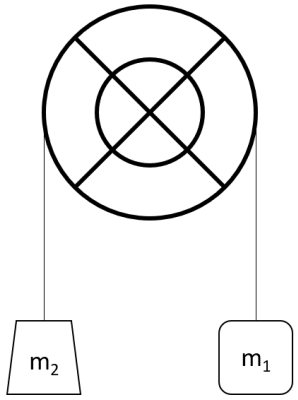
Problem 3

A large vertical wheel that is used for lifting grain consists of two thin wooden rings connected
together with two iron rods. The outer ring has a mass of 15.0 kg and a radius of 65.0 cm.
The inner ring's radius is half the outer ring's radius, and it has a mass of 7.0 kg. Each rod has a mass of 28.9 kg, and the bag of corn has mass m1 = 22:7 kg. The bag is tied to a rope (with negligible mass) that wraps around the wheel a number of times before connecting to a counterweight with mass $m_2 = 35.0$ kg. Suddenly the rope breaks just above the counterweight. What is the acceleration of the bag of corn at this moment? Assume that the friction of the wheel's axle is negligible and that the rope does not slide on the wheel (at least not immediately) since it has been wrapped around the wheel a number of times.

$m_1 = 22.7$ kg $\quad I_{rod} = \frac{1}{12}mL^2$ $\quad L_o = 65$ cm

$m_2 = 35$ kg $\quad L_R = 65$ cm

$m_R = 28.9$ kg $\quad g = 9.8$ m/s^2



$I_{rod} = \frac{1}{6}\,28.9 \cdot .65^2$

$= 8.14$ kgm^2

$I_o = 15(0.65)^2 = 6.3375$

$I_1 = 7(0.325)^2 = 0.739$

$I_1 = 15.21$ kgm^2

$F = 22.7(9.8) = 222.46$ N

$\tau = I\alpha$

$\alpha = \frac{a_T}{R} = \frac{9.8}{.65} = 15.0769$ rad/sec^2

$\tau = 15.21 \cdot 15.08 = 229.32$