Kinematic Problems

Numbers 1 and 2 are essentially problems 4.24 and 4.25 from the back of the KINEMATICS chapter from Fletch's Honors text, with a few extra questions thrown in. You can download both the Kinematics Chapter and the Solutions to the chapter end problems for that chapter. The solutions will numerically be the same, though the units will not be correct—meters/second should be rad/sec, etc. Problem 3 is Problem 8.2 from the Rotational Motion I chapter from Fletch's AP book. You have the solutions of these problems, also.

1.) A disk is rotating at -.25 rad/sec and angularly accelerates at -.98 rad/sec/sec.

a.) Through what angular displacement will the disk execute in 2 seconds.

b.) What will the disk's angular speed be after 2 seconds.

c.) Through how many radians will the disk rotate between t = 2 and t = 5 seconds?

d.) After 5 seconds, the angular velocity is -5.15 rad/sec. If the angular acceleration changes at that point to 3 rad/sec/sec, how long will it take for the disk to come to rest?

e.) Without actually using the time, determine through how many radians the disk will turn during the time calculated in *Part d*.

2.) Two disks are positioned along a common axis. They are not attached and move independently of one another. A nub on the top disk, which is moving with *constant* angular velocity of 18 rad/sec, passes a nub on the bottom disk at t = 0 seconds. At that point, the bottom disk is moving with angular velocity 4 rad/sec. At that point, the bottom disk begins to accelerate at 6 rad/sec/sec.

a.) How long does it take for the first nub to catch the second nub?

b.) Through how many radians will the nubs travel during the time internal needed for the bottom nub to catch the top nub?

c.) What is the angular velocity of the bottom disk at the second passing?

e.) How long will it take for the bottom nub to reach 100 rad/sec?

f.) How long does it take the bottom nub to reach 100 radians?

3.) An auto whose wheel radius is .3 meters moves at 15 m/sec. The car applies its brakes uniformly, slowing to 4 m/s over a 50 meters distance.

a.) What is the wheel's final angular velocity? (Though it might not be obvious why, this is a case in which $v = r\omega$.)

b.) What is the wheel's initial angular velocity?

c.) The car travels 50 meters. What is the angular displacement of the wheels during that travel?

d.) What is the wheel's angular acceleration during the slow-down?

e.) Using the information from "d", determine the car's translational acceleration.

f.) Without using the final angular velocity, determine how long was required for slow-down.

g.) Knowing the final angular velocity, determine how long it took for the slow down? (Obviously, the answer to this should be the same as "f"—you are just getting it using a different expression.)

i.) Determine the angular displacement of the wheels during the first .5 seconds of the slow-down.

j.) Determine how far the car traveled during the first .5 seconds of the slow-down. (think s = R(theta))
k.) Without using the time interval, determine the wheel's angular velocity after the first .5 seconds of the slow-down.
l.) Determine the angular displacement of one wheel between time t = .5 seconds and t = .7 seconds.
m.) Once the car has slowed to 4 m/s, it begins to pick up speed. Over a 3 second period, it reaches a wheel angular velocity of 20 rad/sec. Determine how far the car moves during that period.

Solutions:

1a.) -2.46 rad
b.) -2.21 rad/sec
c.) -11 rad
d.) 3.43 sec
e.) 4.42 rad

2a.) 4.67 seconds
b.) 84.1 rad
c.) 32 rad/sec
e.) 16 sec
f.) 5.14 seconds

The solutions to #3 are found under Problem 8.3 in Fletch's text in the kinematics chapter solutions. The numerical answers follow:

3a.) 13.33 rad/sec
b) 50 rad/sec
c.) 166.6 rad
d.) -6.97 rad/sec/sec
e.) -2.09 m/s
f.) 5.26 sec
g.) 5.26 sec
i.) 24.1 rad
j.) 7.23 m
k.) 46.5 rad/sec
l.) 9.16 rad
m.) 14.9 m