Engineering Dyanamics
Homework 5 Notes

1.
We can relate change in angular velocity to linear velocity, so $\omega = \omega_o + \alpha t$.
Additionally, $a = \alpha r$, $v = \omega r$ and $s = \theta r$, and where $\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$.
When in doubt, notice that you can simple replace x or s with θ, v with ω, and a with α.
By the way, remember that the angle, θ, is in radians.

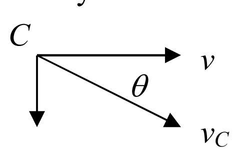
2.
See #1.

3.
A key feature here is to note that the contact velocity of each gear at the teeth is $v = \omega r$. For example, if ω_G is 65 rad/s, and the radius of gear A is 90 mm, the velocity of the teeth on gear A is 5950 mm/s. This is also the tooth velocity of gear B, which would be 5950 mm/s / 20mm, or 297.5 rad/s. You need to chain this through to get the final angular velocity.

4.
Phonographs. What a quaint concept. The hardest part here is to convert RPM to rad/s. Something that may not be obvious is that wheel A is actually riding against the inner surface of the turntable. Thus, $d_A + r_B = 9$ inches. Thus, you are looking for the ratio between these two and then solving for d, which is d_B.

5.
There is obviously something wrong with the English in this problem. In any event, the belt about pulley A has a velocity which can be determined easily (see above). From this you should be able to calculate the angular velocity of pulley B, and then apply the same process to calculate the angular velocity of pulley C.

6.
Be grateful that links BC and CD are symmetrical. Because of this symmetry, the velocity and acceleration of point C is half that of point B (by observation). (If that is not obvious, think that for every mm B moves to the left, C moves only half that. The relationship holds when applying velocity and acceleration.) When addressing this problem, the movement of point C can be thought of as a vector, where the tangential component is the hypotenuse of horizontal and vertical components. Knowing that the angle θ is given, the horizontal component of the magnitude of the movement (either velocity or acceleration) is the magnitude times the cosine of the angle, θ.

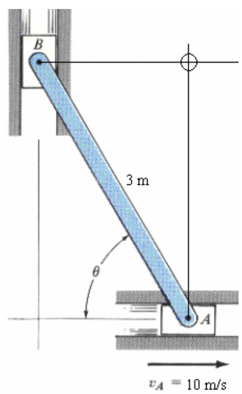


Look to problem #1 for converting velocity and acceleration to ω and α.

7.
The velocity and acceleration of the Scotch yoke will be equivalent to the vertical component of the velocity or acceleration (respectively). Given that the angular velocity is constant, the acceleration is the vertical component of the normal acceleration, where

$$a_n = \frac{v^2}{r}.$$

8.
Use an instant center as illustrated below. About the instant center, the angular velocity is the same for all points on the link or part which must be located by two lines *perpendicular* to the direction of travel of the two points, in this case, *A* and *B* .



9.
The velocity of block *C* is determined exclusively be the horizontal velocity of point *B*. Calculate the horizontal velocity of point *B*, and you have the velocity of point *C*.

10.
The pinion gear is moving upward at the tooth velocity, where $v=\omega r$. The rack, C, is moving upward at the tooth velocity *plus* the velocity of the pinion gear pushing it.

11.
We are given the angular velocity of link *AB*. From this you should be able to determine the velocity of joint *B*. I would approach this by using an instant center of link *BC*. Note that point *B* can only move vertically in the current position, and point *C* moves at a 45 degree angle to the lower left. Determine the instant center, then calculate the velocity of, say, point *B*. Use this to calculate the angular velocity of the entire link about the instant center. Then calculate the velocity of point *C*. Use the velocity of point C to determine the angular velocity of link *CD*.
(Hint, the instant center will be where the lines forming links *AB* and *CD* intersect.)

12.
Use $v=\omega r$ to calculate ω_A. The velocity of pulley B is half the cord velocity.

13.
The hub gear's angular velocity gives us the velocity at the teeth. Same with the ring gear, *R*. Think of them as two different velocity vectors. If the velocities at the teeth were the same, the spur gear, *S*, would remain stationary. Thus, whichever is higher will cause the spur gear to move in that direction, by half the difference. The angular velocity of the link is the result of half that difference. The angular velocity of the spur gear is a sum of the angular velocity of the link, and the hub gear, *H*. I would draw a vector diagram to get a better feel for it.

14.
Given the limitation of movement of point *C*, the velocity of point *C* is the same as the horizontal velocity of point *B*. Determine the velocity vector of point *B* and then use only the horizontal component.

15.
I hope you don't need much help calculating the velocity of point *A*. If the cord is unwrapping think of it as rolling. Given that, point *B* is moving at twice ωr. BY definition it is moving strictly downward. Point *C* is the most interesting because it is both rotating about the center and moving downward. I would be inclined to use point *A* as the instant center. Use that location as a center for your calculations.