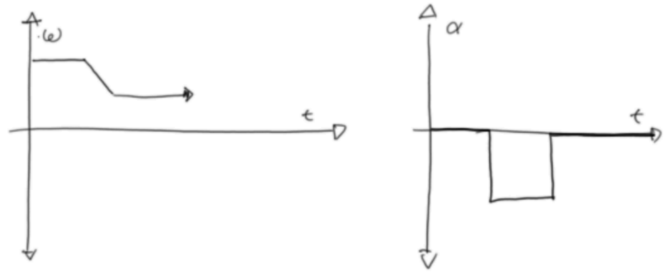
1. Left Figure: $\omega = +$, $\alpha = +$
   Middle Figure: $\omega = -$, $\alpha = -$
   Right Figure: $\omega = -$, $\alpha = +$
2. A. ωis zero as it is at the moment of when it changes direction
   B. αis negative, as it is accelerating towards the right, which will cause a clockwise movement
3. ωvs time and α vs time



4. Because we know that $v = r\omega$, we can find their radii with $r = \frac{v}{\omega}$
   B > C = D = F > A = E
5. The ball travels a distance of 15 circumferences.
   $3.5m = 15\pi d$
   $d = 0.0742m$
6. A.
   $\frac{2500\ rev}{1\ min} \times \frac{2\pi\ rads}{1\ rev} \times \frac{1\ min}{60\ sec} = 261.799\frac{rad}{s}$
   B.
   $v = r\omega = \frac{1}{2}d\omega$
   $v = 45.8148\frac{m}{s}$
   $a_R = \omega^2 r = \frac{1}{2}d\omega^2$
   $a_R = 11994.3\frac{m}{s}^2$
7. $\frac{240\ rev}{1\ min} \times \frac{2\pi\ rad}{1\ rev} \times \frac{1\ min}{60\ sec} \approx 25.13\frac{rads}{sec}$
   $\frac{360\ rev}{1\ min} \times \frac{2\pi\ rad}{1\ rev} \times \frac{1\ min}{60\ sec} \approx 37.69\frac{rads}{s}$
   $\alpha = 1.93\frac{rads}{sec^2}$
   $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
   $\theta = 204.116\ rads$
   $204.116\ rads \times \frac{1\ rev}{2\pi\ rads} = 32.4861\ revs$
   $d = 32.4861 \times \pi d = 33.6792m$
8. A. Their tangential acceleration will be equal, but that does not mean their angular accelerations are equal
   $a_S = a_L$

$a_S = r_S\alpha_S = 0.2088\frac{m}{s^2}$

$a_L = r_L\alpha_L \rightarrow \alpha_L = \frac{a_L}{r_L} = 0.8352\frac{rads}{s^2}$

B.

$\frac{65\ rev}{min} \times \frac{2\pi\ rads}{1\ rev} \times \frac{1\ min}{60\ sec} = 6.806\frac{rads}{s}$

$\omega = \omega_0 + \alpha t, t = \frac{\omega-\omega_0}{\alpha}$

$t = 8.14895s$

9. A. No. For example you can have a bar, person A pushes down on the left, person B pulls up on the right. The net force of the system is 0, but the bar will rotate, meaning that there is torque.
   B. No. You can apply force, but only force that has been applied perpendicular to the lever arm will cause torque. A person can push a bar to the right, the force being parallel to the lever arm. The net torque is 0, but the net force is still to the right, and not 0.
10. I'd rather just knock on them to see if they are hollow. Or you can spin both the spheres with the same speed. The one that is still spinning at the end is the hollow one, because the mass is concentrated farther away from the axis of rotation, thus causing it to be harder to slow down.
11. Let M be the mass of the key.

    $\tau_L = 6(2Mg) = 12Mg$

    $\tau_R = 5(3Mg) = 15Mg$

    Because $\tau_R$is greater than τ_L, the beam will spin clockwise.
12. $mgh = \frac{1}{2}mv^2 + \frac{1}{2}kmr^2\omega^2$

    $gh = \frac{1}{2}v^2 + \frac{1}{2}kv^2$

    $gh = v^2(\frac{1}{2} + \frac{1}{2}k)$

    $v = \sqrt{\frac{gh}{\frac{1}{2}k+\frac{1}{2}}}$

    $k$is inversely related to v

    A = C > B > D
13. We know that the sun rises from the east, and sets in the west. That means the earth must be rotating counter-clockwise in order to achieve this effect. If the earth is rotating counter clockwise, that means that it's angular velocity vector is pointing north.
14. $KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

    $\omega = \frac{v}{r}$

    $KE = \frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{r^2}$

    $KE = 55.647J$
15. A.

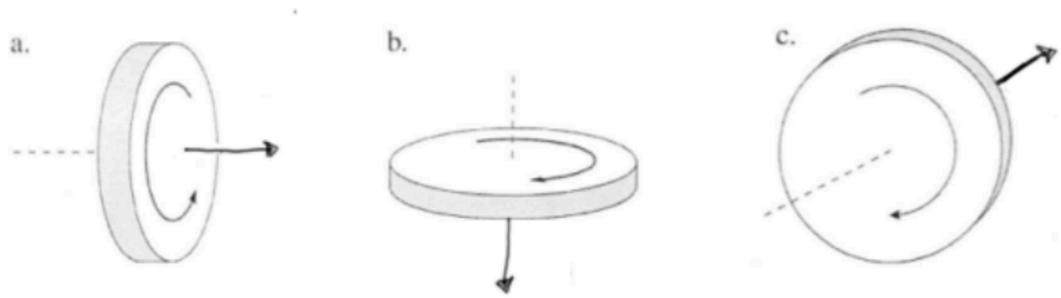
    $\frac{1\ rev}{2\ s} \times \frac{2\pi\ rads}{1\ rev} = 3.141\ \frac{rads}{s}$

    $\frac{3\ rev}{1\ s} \times \frac{2\pi\ rads}{1\ rev} = 18.849\ \frac{rads}{s}$

The net kinetic energy should remain the same.

$I_f = 0.7665\ kg \times m^2$

16. B = C > A > D
17.



18. $L = I\omega$

$L_1 = \frac{1}{2}mr_1^2\omega_1$

$L_2 = \frac{1}{2}mr_2^2\omega_2 = \frac{1}{2}m(2r_1)^2(\frac{1}{2}\omega_1) = mr_1^2\omega_1$

2 times larger.

19. A.

$I = mr^2 = 0.936kg \times m^2$

B.

$\tau = r_{\perp}F = 0.24nM$

20. A.

$\frac{10300\ rev}{1\ min} \times \frac{2\pi\ rads}{1\ rev} \times \frac{1\ min}{60\ s} = 1078.61$

$\tau = I\alpha = \frac{1}{2}mr^2\alpha$

$\alpha = 99.186\ \frac{rads}{s^2}$

$\omega^2 = \omega_0^2 + 2\alpha\theta$

$0 = 1078.61^2 + 2(99.186)\theta$

$\theta = 5864rads$

$\frac{5864}{2\pi} = 933.402revs$

B.

$\omega = \omega_0 + \alpha t$

$t = 10.87s$