Solutions to practice questions Chapters 10-11

1) We use the formula for the tangential velocity:

$v=\omega r$.

We need to go from rpm to rad/s: 20 rpm=20*(2πrad/rev)*(1/60m/s)=2.1 rad/s.
v=2.1rad/s*0.25 m= 0.52 m/s

Answer: B.

2) We use the formula for the centripetal acceleration:

$a_{cp}= \omega^2 r$ → $\omega^2=a_{cp}/r$ → $\omega=4.0$ rad/s.

Answer: D.

3) The average angular acceleration is:

$\alpha=\Delta\omega/\Delta t=(11.0rad/s-2.0rad/s)/(5.5s)=1.6rad/s^2$.

Answer: C.

4) At the top of the path, the sum of the weight and the string tension must be equal to the centripetal force:

$mg+T=ma_{cp}$ → $T=m(a_{cp}-g)$

The centripetal acceleration is: $a_{cp}= \omega^2 r$.

We have:

$T=(\omega^2 r-g)=7.8$ N.

Answer: A.

5) The total kinetic energy of the ball is the sum of the translational and rotational kinetic energies:

$K=1/2mv^2+1/2I \omega^2$.

Since the linear speed is v=4.0m/s, the angular one is: $\omega=v/r=40$rad/s.

From this information and with the problem data we can calculate K:

$K=1/2*(7.0kg)*(4.0m/s)^2+1/2*(0.028kgm^2)*(40rad/s)^2=78.4J$

Answer: D.

6) We can picture the problem as follows:

We write the rotational equilibrium equation: the sum of all torques has to be =0.
We take as rotation axis the pin connection (at the wall).

We get:

$\Sigma\boldsymbol{\tau}=0$ → $-mgL/2+TL\sin\theta=0$ → $T=mgL/(2L\sin\theta)=69N$.

Answer: B.

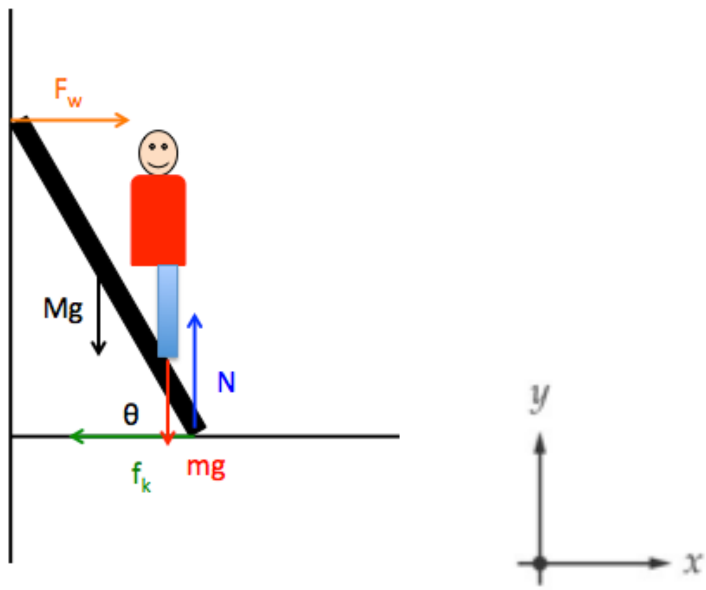
7) $\tau=I\alpha$ → $\alpha=\tau/I=3.24rad/s^2$

8 s later, the angular velocity will be: $\omega=\alpha\Delta t=(3.24rad/s^2)*(8s)=25.9$ rad/s.

The angular momentum is: $L= I\omega=0.88$ kgm^2/s.

Answer: A.

8) We picture the problem as follows:



We need to find f_k. Other unknowns are the normal force N and the wall force F_w. We have three unknowns and three equations (translational equilibrium along x and y and rotational equilibrium). We choose the point at which the ladder touches the floor as axis of rotation.

$\Sigma F_x=0 \quad \rightarrow \quad F_w-f_k=0 \quad \rightarrow F_w=f_k$

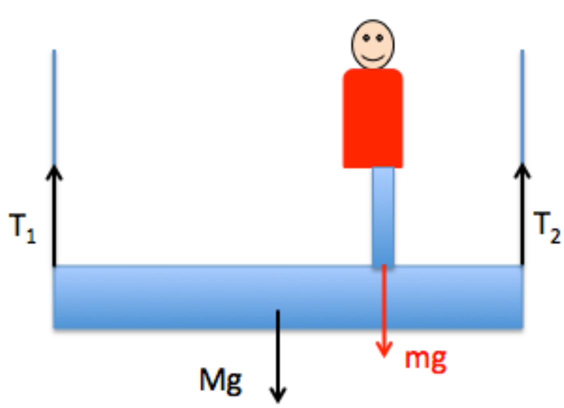
$\Sigma F_y=0 \quad \rightarrow \quad N-mg-Mg=0 \quad \rightarrow N=(M+m)g$

$\Sigma \tau=0 \quad Mg\cos\theta L/2+mg\cos\theta L/4-F_w\sin\theta L=0 \quad \rightarrow \quad F_w=(M/2+m/4)g\,\mathrm{cotg}\theta$

$\rightarrow \quad f_k=(M/2+m/4)g\,\mathrm{cotg}\theta= 170$ N.

Answer: A.

9) The situation is as follows:



We can solve the problem imposing that the net-torque acting on the scaffold+man system is =0:

Let x be the distance between the man and the rope in question, and L the length of the billboard. We take the other rope as the axis of rotation. This means that the worker is L - x far from the axis of rotation.

$\Sigma\boldsymbol{\tau}=0 \rightarrow \quad -mg*(L-x)-Mg*L/2+T_2*L=0$

where we want T=550N.

Solving for x we get:

x=L+(Mg*L/2)/(mg)-T*L/(mg)=2.5m.

Answer: C.