Answers – Week 10

10-1. The position vector, the velocity vector and the acceleration all rotate at the rate of ω radians per second.
[*Only the angular velocity vector is fixed perpendicular to plane of circle.*]

10-3. Let us say plane of orbit is xy – plane.
Then $\underset{\rightarrow}{\alpha} = \alpha\,\hat{z}$

$\underset{\rightarrow}{a_c} = -r\,\omega^2\,\hat{r}$

and the tangential acceleration

$\underset{\rightarrow}{a_t} = r\,\alpha\,\hat{\tau}$

$$a = \sqrt{a_c^{\,2} + a_t^{\,2}} = r\left(\omega^4 + \alpha^2\right)^{\frac{1}{2}}$$

10-5. Force causes translation and hence linear acceleration $M\underset{\rightarrow}{a} = \underset{\rightarrow}{F}$

Torque causes rotation and hence angular acceleration I $\underset{\rightarrow}{\alpha} = \underset{\rightarrow}{\tau}$. In order to have a torque, the force must be applied at some distance $\underset{\rightarrow}{r}$ from the axis of rotation and the force must be perpendicular to $\underset{\rightarrow}{r}$.

10-7. $\text{Cos}\,\theta = \dfrac{2}{3}$

$\theta = 48.2°$

V = 2.56m/s

10-9. Yes, you need friction, because it provides the torque which causes the sphere to roll without slipping and friction force must act at the point of contact P. No work is done by the force of friction because to roll without slip the velocity and hence displacement at P must be ZERO at all times. Since there is no displacement at the point where the force of friction acts, no work is done.

10-11. Maximum a is μ_s g if you do not want the tire to “slip” against the road.
Earth provides the forward force which cannot exceed μ_s Mg. $a_{max} = 2.94$ m/s^2.