Part I

1. If the radius of the path of a body in uniform circular motion is doubled and the speed is kept the same the force needed must be

   (a) half as great as before.

   (b) the same as before.

   (c) twice as large as before.

   (d) four times the size as before.

   Answer (a). Since speed is constant not frequency.

2. The angular velocity of the minute hand of a clock is
   (a) $\frac{1}{30}\pi$ rad/s. (b) $\frac{1}{1800}\pi$ rad/s. (c) 2π rad/min. (d) 60 rad/min.
   Answer (b) the minute hand take 60 minutes or 3600 seconds to get around the clock.

3. A heavy ball of mass 1.00 kg is whirled at a constant speed of 2.00 ms^{-1} on the end of a string in a horizontal circle of radius 1.50 m. The work done by the tension in the string during exactly one revolution is

   (a) 0 J (b) 2.67 J (c) 8.01 J (d) 25.1 J.
   Answer (a). Tension is perpendicular to displacement so it does no work.

4. A body which is traveling around a circle at constant speed

   (a) is not accelerated.

   (b) has constant acceleration.

   (c) is accelerated in the direction of motion.

   (d) none of the above.

   Answer (d). The direction of velocity and acceleration change so neither is constant! (although the magnitude is constant in both cases)

5. On a rainy day the coefficient of friction between the tires of a car and a level road surface is reduced to half its usual value. The maximum safe velocity for rounding a curve is

   (a) reduced to 71% of its original value.

   (b) reduced to 50% of its original value.

   (c) reduced to 25% of its original value.

   (d) unchanged.

   Answer (a). You can travel at more than half the initial velocity because half the velocity requires only 1/4 the force.

Part II

1. A 50 kg pilot performs a vertical loop of radius 250 m in her plane.

   (a) Find her speed if she feels weightless at the top of the loop.
   If she feels weightless then the normal force is zero. Then $F_{\text{net}} = w = mg \;\Rightarrow\; mg = \frac{mv^2}{r} \;\Rightarrow\; v = \sqrt{gr} = 49.5$ m/s

   (b) If the maximum normal force she can withstand without fainting is 2000 N find her maximum safe speed at the bottom of the loop.
   At the bottom of the loop the normal force of the seat on the pilot acts up.

   So $F_{\text{netmax}} = N - mg = 2000 - 50 \times 9.8 = 1510$ N. But since $F_{\text{net}} = \frac{mv^2}{r}$ then

   $v_{\text{max}}^2 = \frac{1510 \times r}{m} = 7550 \;\Rightarrow\; v_{\text{max}} = 87$ m/s

   (c) In passing from the top of the loop to the bottom of the loop her plane speeds up due to the action of gravity. Will she need to brake in order to avoid fainting at the bottom of the loop?
   Assuming she doesn't brake (and that the effect of air resistance is negligible) then mechanical energy is conserved so

   $$\frac{1}{2}mv_0^2 + mgh = \frac{1}{2}mv^2 \;\Rightarrow\; v^2 = v_0^2 + mgh = (49.5)^2 + 2(9.8)(500) = 12250 \;\Rightarrow\; v = 111 \text{ m/s}$$

   Since this velocity is greater than the maximum velocity she will need to brake.