1. One radian is the angle for which the arc length equals the:

   ☐ area

   ☐ radius

   ☐ circumference

   ☐ diameter

2. An object moving round a circle at constant speed is still accelerating because:

   ☐ it is slowing down

   ☐ its speed keeps increasing

   ☐ no resultant force acts

   ☐ its velocity keeps changing direction

3. How many radians are there in a complete circle?

   _____ rad

4. An object moves at 4.0 $\frac{\text{m}}{\text{s}}$ round a circle of radius 2.0 m. Find its centripetal acceleration.

   _____ m/s^2

5. An object goes once round every 2.0 s. What is its angular speed?

   _____ rad/s

6. The centripetal force points toward the centre of the circle.

   ☐ True ☐ False

7. Angular speed equals 2π divided by the _____.

   _____

8. A 2.0 kg ball moves at 4.0 $\frac{\text{m}}{\text{s}}$ round a circle of radius 2.0 m. What centripetal force is needed?

   _____ N

9. A point at radius 0.50 m turns at $\omega = 4.0\ \frac{\text{rad}}{\text{s}}$. What is its linear speed?

   _____ m/s

10. The centripetal force is:

    ☐ the net result of real forces (tension, gravity, friction…)

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☐ always zero for steady circular motion

☐ always provided by friction alone

1. **radius**

   $\theta = \dfrac{s}{r}$, so when the arc s equals the radius r, the angle is exactly one radian.

2. **its velocity keeps changing direction**

   Velocity is a vector. Even at constant speed, the changing direction means a changing velocity – an acceleration toward the centre.

3. **6.28 rad**

   A full circle has arc $s = 2\pi r$, so $\theta = \dfrac{2\pi r}{r} = 2\pi \approx 6.28$ rad.

4. **8 m/s²**

   $a = \dfrac{v^2}{r} = \dfrac{4.0^2}{2.0} = 8.0\ \dfrac{\text{m}}{\text{s}^2}$.

5. **3.14 rad/s**

   $\omega = \dfrac{2\pi}{T} = \dfrac{2\pi}{2.0} = \pi \approx 3.14\ \dfrac{\text{rad}}{\text{s}}$.

6. **True**

   Yes – always toward the centre, perpendicular to the velocity.

7. **period**

   $\omega = \dfrac{2\pi}{T}$ – the whole turn (2π) divided by the time for one turn.

8. **16 N**

   $F = \dfrac{mv^2}{r} = \dfrac{2.0 \times 4.0^2}{2.0} = 16$ N.

9. **2 m/s**

   $v = r\omega = 0.50 \times 4.0 = 2.0\ \dfrac{\text{m}}{\text{s}}$.

10. **the net result of real forces (tension, gravity, friction…)**

    It is whatever real force(s) happen to point to the centre – not a separate force of its own.

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