# Flat Ring Test (FRT)

## How to distinguish between surface of a sphere & surface of a torus

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**Flat Ring Test (FRT):** This is the simplest test used to distinguish between surface of a sphere & surface of a torus simply by freely placing a flat circular ring (of suitable diameter*) once anywhere on the unknown surface of sphere or torus and then observing the contact of periphery of ring with the surface, without walking or checking the entire surface.

It is based on the fact that the entire periphery of a flat circular ring (having a diameter less than the diameter of spherical surface) exactly touches the spherical surface everywhere i.e. when a flat circular ring is placed anywhere on a spherical surface there is no gap/space between spherical surface & all along the periphery of ring i.e. a flat circular ring has line contact with the spherical surface. On the other hand, the periphery of a flat circular ring (of diameter less than the inner diameter of torus) touches the surface of a torus everywhere exactly at two points i.e. when a flat circular ring of suitable diameter* is placed anywhere on the surface of a torus, the flat circular ring has two points of contact with the surface of torus. Unlike sphere, there is gap/space, except at two points, between periphery of a flat circular ring & surface of a torus and this gap is clearly observable if the diameter of ring is sufficiently large. Based on these facts we can easily distinguish between surface of a sphere & a torus of finite size.

***Diameter of flat circular ring suitable for test:** If diameter of sphere is $D$, and inner & outer diameters of the torus are $D_i$ & $D_0$ then the **suitable diameter** $\boldsymbol{d}$ of test ring is taken as $\boldsymbol{d < \mathbf{Min}\,(D, D_i)}$

Take a flat circular ring of suitable diameter* & freely place it with its periphery once anywhere on the given surface of a sphere or a torus. Now, check

1. If the entire periphery of the ring exactly touches the given surface i.e. if the **flat circular ring has line contact with the surface** then it is the **surface of a sphere**.
2. If the periphery of the ring touches the given surface exactly at two points i.e. if the **flat circular ring has point contact with the surface** then it is the **surface of a torus**.

**Conclusion: Simply, place a flat circular ring of suitable diameter* once anywhere on the given surface of sphere or torus & check if the entire periphery of ring exactly touches the unknown surface then it is the surface of a sphere otherwise it is the surface of a torus.** The reason is that a freely placed flat circular ring of a suitable diameter* always has a line contact with the surface of a sphere but never with the surface of a torus. Obviously, checking the type of contact of given surface with the periphery of a flat circular ring of finite size, is much simpler than walking or checking the entire surface of a sphere or a torus.

If the given surface of a sphere or a torus has perfect geometry i.e. if there is no surface irregularities of sphere & torus then this test can also be carried out by an observer to distinguish between very large surface of a sphere & a torus using a flat circular ring of suitable diameter*. However, the diameter of flat circular ring can be varied so as the gap/space between periphery of ring & the surface of a torus is clearly observable if it is a torus. Thus this test can also be used if surface of sphere or torus is very huge like that of a (hypothetical) spherical planet, using a flat circular ring of sufficiently large diameter.

**Note:** Above articles had been derived *& illustrated by Mr H.C. Rajpoot (B Tech, Mechanical Engineering)*

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