Answer on Question #39297, Physics – Mechanics | Kinematics | Dynamics

Question:

1) An object is placed on the surface of a smooth inclined plane of inclination θ.it takes time t to reach the bottom. if the same object is allowed to slide down inclined plane on inclination θ, it takes time nt to reach the bottom where n is a number greater than 1. what is coefficient?

2) The force required to just move a body up the inclined plane is double the force required to just prevent the body from sliding down the plane. The coefficient of friction is μ. find the inclination θ of the plane

3) A particle inside a hollow sphere of radius r, having coefficient of friction(1/√3), up to what height can particle be at rest?

Answer:

1) The first question is confusing, so we assume that objects are placed on the same height h and the second included plane has the inclination θ_1. Let us consider the first case. Objects has the acceleration $a = g\sin\theta$ and moves on the distance $\ell = h\tan\theta$. So,

$$\ell = \frac{at^2}{2} = \frac{g\sin\theta\, t^2}{2} \Rightarrow t = \sqrt{\frac{2h}{g\cos\theta}}.$$

In the same way one can obtain

$$nt = \sqrt{\frac{2h}{g\cos\theta_1}}.$$

Whence

$$\frac{nt}{t} = \sqrt{\frac{2h}{g\cos\theta_1}} \Big/ \sqrt{\frac{2h}{g\cos\theta}} \Rightarrow n = \sqrt{\frac{\cos\theta}{\cos\theta_1}}.$$

2) The friction force is

$$F_f = \mu mg\cos\theta.$$

The force required to move a body up equals

$$F_1 = \mu mg \sin\theta + F_f.$$

The force required to prevent a body from sliding down equals

$$F_2 = \mu mg \sin\theta - F_f.$$

By conditions,

$$\frac{F_1}{F_2} = 2 = \frac{\mu mg \sin\theta + \mu mg \cos\theta}{\mu mg \sin\theta - \mu mg \cos\theta}$$

$$\sin\theta = 3\cos\theta \Rightarrow \theta = \arctan 3.$$

3) The friction force equals

$$F_f = \mu mg \cos\theta,$$

where $\mu = 1/\sqrt{3}$, $cos\theta = \frac{r-h}{r}$, h is a height needs to be found. The friction force prevents a particle to slide down under the action of the component of the gravitational force

$$F_1 = mg \sin\theta.$$

So,

$$F_f = F_1 \Rightarrow \mu mg \cos\theta = mg \sin\theta$$

$$\tan\theta = \mu \Rightarrow \theta = 30°.$$

$$\cos\theta = \frac{\sqrt{3}}{2} = \frac{r-h}{r} \Rightarrow h = \frac{2-\sqrt{3}}{2} r.$$