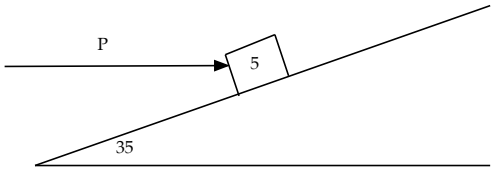
M1 Inclined Planes

The Following Involve Particles in Equilibrium

1. A box of 5 kg lies on a plane inclined at 35° to the horizontal. A horizontal force P is applied such that the box remains stationary on the slope.



   (a) Given that the plane is smooth, find P. □

   (b) Given, instead, that the plane is rough with $\mu = 0.2$, find the range of values of P for which the box remains stationary. □

The Following Involve Smooth Planes

2. A particle is projected up the line of greatest slope of a smooth plane. The plane makes an angle of 20° to the horizontal. The particle's initial speed is 12 ms^{-1}. How far does the particle travel up the plane before coming to instantaneous rest? (Give your answer to 4 sig figs.) $\boxed{21.48 \text{ m}}$

3. A particle is projected up the line of greatest slope of a smooth plane. The plane makes an angle of 30° to the horizontal. The particle's initial speed is 5 ms^{-1}. How far does the particle travel up the plane before coming to instantaneous rest? (Give your answer to 4 sig figs.) $\boxed{2.551 \text{ m}}$

4. A particle is projected up the line of greatest slope of a smooth plane. The plane makes an angle of θ° to the horizontal. The particle's initial speed is u ms^{-1}. How far does the particle travel up the plane before coming to instantaneous rest? $\boxed{\frac{u^2}{2g\sin\theta} \text{ m}}$

5. A particle is projected up the line of greatest slope of a smooth plane. The particle's initial speed is 5 ms^{-1}. The particle travels 3 m before coming to instantaneous rest. What is the angle the plane makes with the horizontal? (Give your answer to 3 sig figs.)

   $\boxed{\theta = 25.2°}$

6. A particle is projected up the line of greatest slope of a smooth plane. The particle's initial speed is 10 ms^{-1}. The particle travels 30 m before coming to instantaneous rest. What is the angle the plane makes with the horizontal? (Give your answer to 4 sig figs.)

   $\boxed{\theta = 9.79°}$

7. A particle is projected up the line of greatest slope of a smooth plane. The particle's initial speed is u ms^{-1}. The particle travels x m before coming to instantaneous rest. What is the angle the plane makes with the horizontal? $\boxed{\theta = \sin^{-1}\left(\frac{u^2}{2gx}\right)}$

The Following Include Friction

8. A particle of mass 2 kg is projected up the line of greatest slope of a rough plane. The coefficient of friction between the particle and the plane is $\frac{3}{4}$. The plane makes an angle of 20° to the horizontal. The particle's initial speed is 12 ms^{-1}.

(a) How far does the particle travel up the plane before coming to instantaneous rest?

7.02 m

(b) Does the particle then slide back down the slope? No

9. A particle of mass 3 kg is projected up the line of greatest slope of a rough plane. The coefficient of friction between the particle and the plane is $\frac{1}{10}$. The plane makes an angle of $45°$ to the horizontal. The particle's initial speed is 20 ms^{-1}.

(a) How far does the particle travel up the plane before coming to instantaneous rest?

26.2 m

(b) Does the particle then slide back down the slope? Yes