A small ring of mass m can slide on a smooth circular wire of radius r and centre O, which is fixed in the vertical plane. From a point on the wire at a vertical distance $r/2$ above O, the ring is given a velocity $\sqrt{gr}$ along the downward tangent to the wire. Show that it will just reach the highest point of the wire. Find the reaction between ring and wire when the ring is at a vertical distance $r/2$ below, O.


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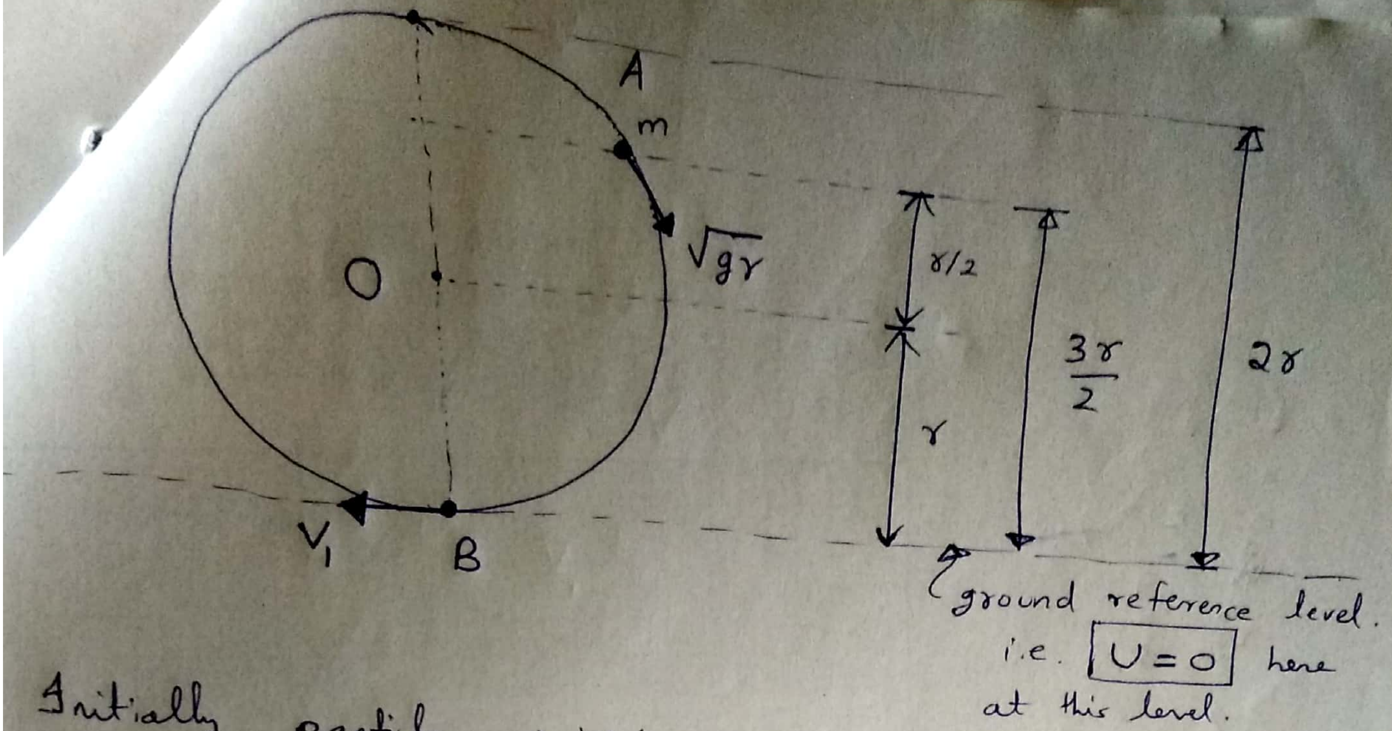
Ans. [3.5 mg]

A small ring of mass m can slide on a smooth circular wire of radius r and centre O, which is fixed in the vertical plane. From a point on the wire at a vertical distance 1/2 above , the ring is given a velocity gr along the downward tangent to the wire. Show that it will just reach the highest point of the wire. Find the reaction between ring and wire when the ring is at a vertical distance 1/2 below, O.



Initially, particle at 'A'

Conserving Energy at A (initial) and B (final)

$$\boxed{U_i + K_i = U_f + K_f}$$ (Energy Conservation)

$$U_A + K_A = U_B + K_B$$

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$$mg\left(\frac{3r}{2}\right) + \frac{1}{2}m\left(\sqrt{gr}\right)^2 = 0 + K_B$$

$$\frac{3mgr}{2} + \frac{mgr}{2} = K_B$$

$$\boxed{2mgr = K_B}$$

Now conserving energy at B (initial) & C (final)

$$U_i + K_i = U_f + K_f$$

$$U_B + K_B = U_C + K_C$$ (∵ Just reaches ⇒ velocity = 0)

$$0 + 2mgr = U_C + 0$$

$$\therefore \boxed{U_C = mg(2r)}$$

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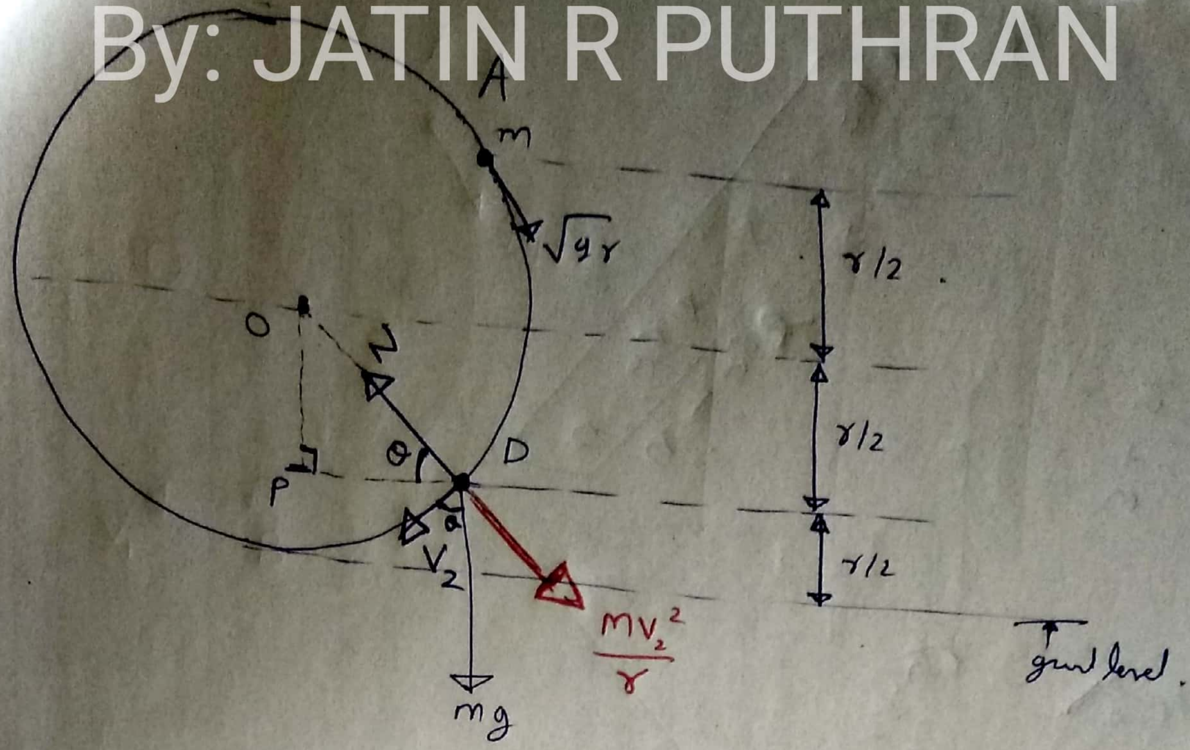
Scanned with CamScanner



In ΔOPD,

$$\sin\theta = \frac{P}{H} = \frac{r/2}{r} = \frac{1}{2}$$

$$\Rightarrow \boxed{\theta = 30^\circ}$$

Energy conservation at A & D
(initial) (final)

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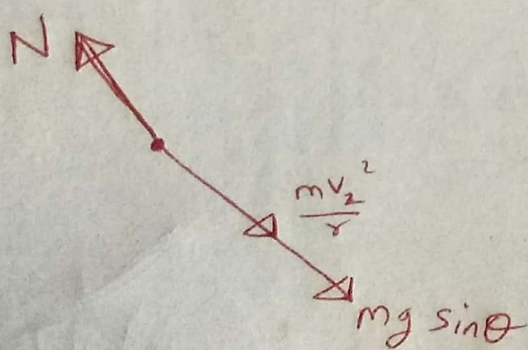
$$U_i + K_i = U_f + K_f$$

$$U_A + K_A = U_D + K_D$$

$$mg\left(\frac{3r}{2}\right) + \frac{1}{2}m\left(\sqrt{gr}\right)^2 = mg\left(\frac{r}{2}\right) + \frac{1}{2}mV_2^2$$

$$\frac{3mgr}{2} + \cancel{\frac{mgr}{2}} = \cancel{\frac{mgr}{2}} + \frac{1}{2}mV_2^2$$

$$\therefore \boxed{V_2^2 = 3gr}$$



$$\therefore N = mg\sin\theta + \frac{mV_2^2}{r}$$

$$N = mg \times \frac{1}{2} + \frac{m}{\cancel{r}} \times 3g\cancel{r}$$

$$\boxed{N = 3.5\,mg}$$

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(^~^)
The video explanation of the solution is uploaded on my YouTube channel :)


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