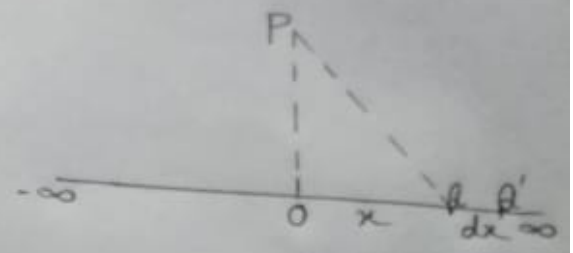
Q. (1)(b) Find the potential at an external point due to rod infinite on both sides.

Let PO be perpendicular from the external point P to the given rod, infinite in both directions.



Take any point Q on the rod and suppose $OQ = x$. An element of the rod at Q is $QQ' = dx$.

m = mass per unit length of the rod

Its mass is $m\,dx$, where

The potential at P due to $QQ' = \frac{m\,dx}{PQ}$

$$= \frac{m\,dx}{\sqrt{x^2+h^2}}$$

where $OP = h$

∴ The potential of the rod at

$$= \int_{-\infty}^{\infty} \frac{m\,dx}{\sqrt{x^2+h^2}}$$

$$= 2 \int_0^\infty \frac{r_m \, dx}{\sqrt{x^2 + h^2}}$$

$$= 2 r_m \left[\log \left(x + \sqrt{x^2 + h^2} \right) \right]_0^\infty$$

$$= C - 2 r_m \log h$$

where C is an infinite constant.