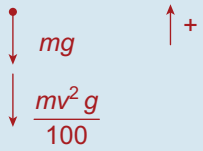
Q. 6. **Forces**



NZL: $\Sigma F = ma$

$$+\uparrow -mg\left[1 + \frac{v^2}{100}\right] = m\frac{dv}{dt}$$

$$\Rightarrow -g\left[\frac{100 + v^2}{100}\right] = \frac{dv}{dt}$$

$$\Rightarrow \int_{120}^{0} \frac{dv}{v^2 + 100} = -\frac{g}{100}\int_0^t dt$$

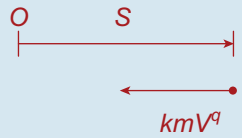
$$\Rightarrow \frac{1}{10}\left[\tan^{-1}\frac{v}{10}\right]_{120}^{0} = -\frac{g}{100}t$$

$$\Rightarrow \frac{gt}{10} = \tan^{-1} 12$$

$$\Rightarrow t = 1.518$$

$$\Rightarrow t = 1.5 \text{ s}$$

Q. 7. **Forces**



NZL: $\Sigma F = ma$

$$\rightarrow -kmv^q = mv\frac{dv}{ds}$$

$$\Rightarrow \int_u^0 v^{1-q}\,dv = -k\int_0^s ds$$

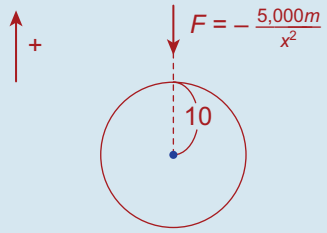
$$\Rightarrow \frac{1}{2-q}\left[v^{2-q}\right]_u^0 = -ks$$

$$\Rightarrow \frac{1}{2-q}\left[0^{2-q} - u^{2-q}\right] = -ks$$

$$\Rightarrow ks = \frac{u^{2-q}}{2-q}$$

$$\Rightarrow s = \frac{u^{2-q}}{(2-q)^k}$$ **QED**

Q. 8.



(i) $F = ma$

$$\Rightarrow -\frac{5{,}000\,m}{x^2} = ma$$

$$\Rightarrow a = -\frac{5{,}000}{x^2}$$

$$\Rightarrow v\frac{dv}{dx} = -\frac{5{,}000}{x^2}$$

$$\Rightarrow \int_{20}^{v} v\,dv = \int_{10}^{x} -\frac{5{,}000}{x^2}\,dx$$

$$\Rightarrow \frac{v^2}{2}\Big|_{20}^{v} = \frac{5{,}000}{x}\Big|_{10}^{x}$$

$$\Rightarrow \frac{v^2}{2} - 200 = \frac{5{,}000}{x} - 500$$

$$\Rightarrow \frac{v^2}{2} = \frac{5{,}000}{x} - 300$$

$$\Rightarrow v^2 = \frac{10{,}000}{x} - 600$$

$$\Rightarrow v = \sqrt{\frac{10{,}000}{x} - 600}$$

...let $x = \frac{30}{7} + 10 = \frac{100}{7}$

$$\Rightarrow v = \sqrt{700 - 600}$$

$$= \sqrt{100}$$

$$= 10 \text{ m/s}$$

(ii) At its greatest height, $v = 0$

$$\Rightarrow \frac{10{,}000}{x} - 600 = 0$$

$$\Rightarrow 10{,}000 - 600x = 0$$

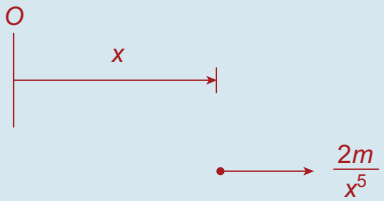
$$\Rightarrow x = \frac{10{,}000}{600}$$

$$= \frac{50}{3} \text{ m}$$

$\therefore$ height above surface $= \frac{50}{3} - 10$

$$= \frac{20}{3} \text{ m}$$

Q. 9. **Forces**



NZL: $\Sigma F = ma$

$$+\rightarrow -\frac{2m}{x^5} = mv\frac{dv}{dx}$$

$$\Rightarrow \int_0^v v\,dv = 2\int_d^x x^{-5}\,dx$$

$$\Rightarrow \frac{1}{2}\left[v^2\right]_0^v = -\frac{2}{4}\left[\frac{1}{x^4}\right]_d^x$$

$$\Rightarrow v^2 = \left[\frac{1}{d^4} - \frac{1}{x^4}\right]$$

$$\Rightarrow v = \sqrt{\frac{1}{d^4} - \frac{1}{x^4}} \quad \ldots(1)$$