23. A boy's catapult is made of rubber cord which is 42 cm long, with 6 mm diameter of cross-section and of negligible mass. The boy keeps a stone weighing 0.02 kg on it and stretches the cord by 20 cm by applying a constant force. When released, the stone flies off with a velocity of 20 ms^{-1}. Neglect the change in the area of cross-section of the cord while stretched. The Young's modulus of rubber is closest to : **[8 April 2019 I]**

(a) $10^6\ N/m^{-2}$ (b) $10^4\ N/m^{-2}$

(c) $10^8\ N/m^{-2}$ (d) $10^7\ N/m^{-2}$

23. (a) When a catapult is stretched up to length l, then the stored energy in it = Δk. E $\Rightarrow$

$$\frac{1}{2}\cdot\left(\frac{YA}{L}\right)(\Delta l)^2=\frac{1}{2}mv^2 \quad \Rightarrow y=\frac{mv^2L}{\Delta(\Delta l)^2}$$

$m = 0.02\,kg$

$v = 20\,ms^{-1}$

$L = 0.42\,m$

$A = (\pi d^2)/(4)$

$d = 6 \times 10^{-3}\,m$

$\Delta l = 0.2\,m$

$$y=\frac{0.02\times400\times0.42\times4}{\pi\times36\times10^{-6}\times0.04}=2.3\times10^6\,N/m^2$$

So, order is 10^6.