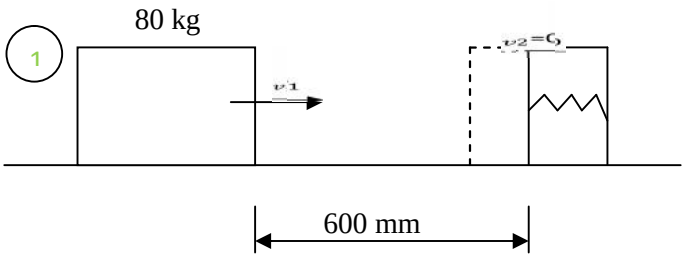
Problem:

A spring used to stop a 80kg package which is sliding on a horizontal plane. The stiffness of the spring is 20 kNm and it is held by cables so that it is initially compressed 120mm. Knowing that the package has a velocity of 2.5 m/sec in the position of 600 mm from and maximum additional of spring is 90mm. Determine co-efficient of friction.



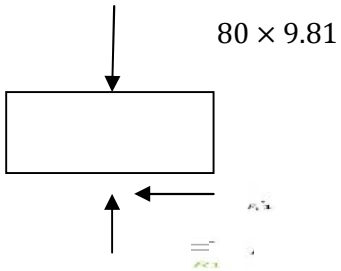
Solution:

Resolving vertically

$$R_1 = 80 \times 9.81 = 784.8\ N$$

$$F_1 = \mu R_1$$

$$= \mu \times 784.8\ N$$



Work done by the force

$$U_{1-2}force = -F \times x$$

$$x = Distance\ between\ package\ and\ spring + Deflection\ of\ spring$$

=600+40

$$x = 640\ mm = 0.64\ m$$

$$U_{1-2}force = -\mu \times 784.8 \times 0.64 = -502.272\,\mu\,N - m$$

Work done by the spring

$$U_{1-2}spring = \frac{1}{2}k(x_1^2 - x_2^2)$$

x_1=Initial deflection of the spring=120 mm=0.12m

x_2=Final deflection of the spring=120+30=150 mm=0.15mm

$$U_{1-2}\ spring = \frac{20 \times 10^3}{2}[0.12^2 - 0.16^2]$$

$$= -112\ N.m$$

Total work done $= (U_{1-2})_{Force} + (U_{1-2})_{spring}$

$$= -502.272\,\mu - 112$$

Applying work energy equation

$$U_{1-2} = T_2 - T_1$$

$$T_2 = \frac{1}{2}\ m\ v_2^2 = 0(Final\ velocity - 0)$$

$$T_1 = \frac{1}{2}\ m\ v_1^2 = \frac{1}{2} \times 80 \times 2.5^2 = 250Nm$$

$$-502.272\mu = -138$$

$$\mu = 0.274$$