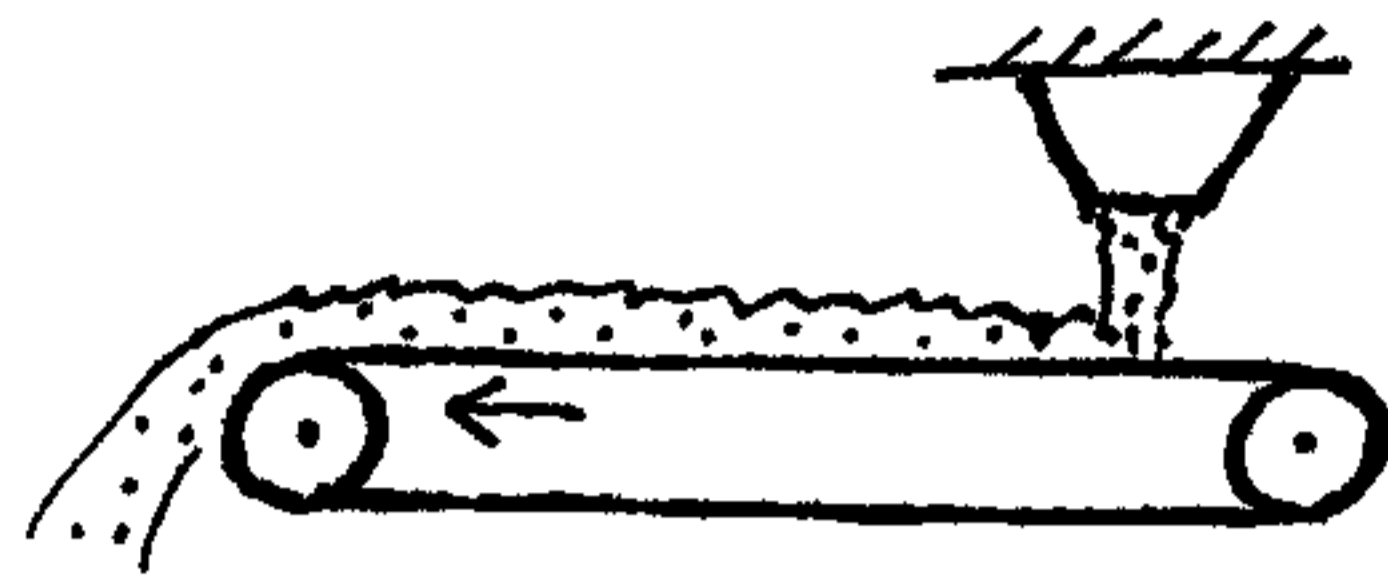


This is a problem involving systems of particles.



A chute is dumping sand onto a conveyor belt at the rate of 5 kg/s . The belt has a linear speed of 1.3 m/s . What is the power produced by the motor running the conveyor belt?

Solution:

\leftarrow (x -direction)

For a system that is gaining and losing mass:

$$\sum F_x = m \frac{dv}{dt} - u_1 \frac{dm_e}{dt} + u_2 \frac{dm_i}{dt} \quad (1)$$

m = mass of sand on conveyor belt

v = velocity of conveyor belt

u_1 = relative velocity of device as seen by an observer moving with the particles of the ejected mass (i.e. sand)

$\frac{dv}{dt}$ = acceleration of conveyor belt

$\frac{dm_e}{dt}$ = rate at which sand is leaving conveyor belt

u_2 = relative velocity of the device as seen by an observer moving with the particles of the injected mass (i.e. sand)

$\frac{dm_i}{dt}$ = rate at which sand is entering conveyor belt

Now, $v = 1.3 \text{ m/s}$

$u_1 = 0$ (since the sand leaving the conveyor belt is moving at the same velocity as the conveyor belt)

$\frac{dv}{dt} = 0$ (the belt has a constant speed)

$\frac{dm_e}{dt} = 5 \text{ kg/s}$

$u_2 = 1.3 \text{ m/s} \leftarrow$

$\frac{dm_i}{dt} = 5 \text{ kg/s}$

Substitute the above into equation (1):

$\Sigma F_x = (1.3)(5) = 6.5 \text{ N}$ (This force is supplied by the conveyor belt motor)

Therefore, Power = (Force) x (velocity)
 $= (6.5 \text{ N}) \times (1.3 \text{ m/s})$
 $= 8.45 \text{ Watts}$ (answer)