March 11th, 2021 | Section 8.1

[redacted] After landing with an initial speed of 80 m/s an airplane comes to a stop after moving 500 m down the runway under constant acceleration. What is the magnitude of the average net force (in N) would a 75 kg person riding on the airplane experience as the airplane slows to a stop?

① Solution

$F = ma$?
$75\,kg$

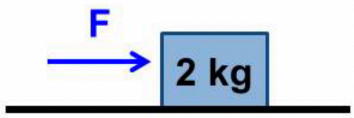
$$V_f^2 = V_i^2 + 2a\Delta S \Rightarrow a = \frac{V_f^2 - V_i^2}{2\Delta S} = \frac{0 - 80^2}{2 \cdot 500m}$$
$$= -6.4 m s^{-2}$$

Passenger experience $F = ma = 75 \cdot (-6.4) = -480N$

$$F_{net} = 480N$$

②

(2) The following time dependent force is applied to a 2 kg block that is initially at rest on a frictionless and horizontal surface.



$$F(t) = \left(4\frac{\text{N}}{\text{s}}\right)t$$

What is the net work (in J) done by this force during the first 3 s it is applied?

Solution

$\Delta K = W_{net}$

$$F = ma \Rightarrow a = \frac{F}{m} = \frac{4}{2}t = 2t$$

$$a = \frac{dv}{dt} \Rightarrow dv = a\,dt \Rightarrow \int dv = \int a\,dt$$

$$\Rightarrow \int_0^{V_f} 1\,dv = \int_0^{t_f} a\,dt \Rightarrow V_f = t_f^2$$

need Vf in terms of tf

Therefore, we find

$$v(t) = \left(1\,\frac{m}{s^3}\right)t^2$$

Let's finally find ΔK:

$$\Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

vanishes as $v_i = 0$

$$= \frac{1}{2}mv_f^2$$

$$= \cancel{\frac{1}{2}\cdot 2}\cdot t^4$$

$$= (3\,s)^4$$

$$= 81\,J$$

(3)

(2) A block with a mass of 6 kg is at rest on a horizontal and frictionless surface. A constant 12 N force is then applied to the block as shown in the figure. What is the displacement (in m) of the block 4 s after the force is applied?

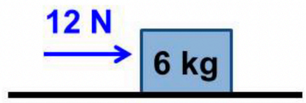
Solution

$$F = ma \Rightarrow a = \frac{F}{m} = \frac{12}{6} = 2$$

$$\Delta s = \frac{1}{2}a\Delta t^2 = \frac{1}{2}\cdot 2\cdot 4^2 = 16\,m$$

(4)

~~13.~~ A block with a mass of 6 kg is at rest on a horizontal and frictionless surface. A constant 12 N force is then applied to the block as shown in the figure. What is the work (in J) done by the 12 N force during the first 4 s the force is applied to the block?



Solution

From (3), $\Delta s = 16\,m$

$$W = F\Delta s = (12N)\cdot(16m) = 192\,J$$

(5) What's the change in Kinetic Energy?

Solution

$$\Delta K = W_{net} \Rightarrow \Delta K = 192\,J$$

(6) What's the average net force (in N) required for a woman to accelerate her 0.6 kg fist from rest to $13.5\,ms^{-1}$ over a horizontal distance of 0.75 m?

Solution $\Delta U = 0$

$$\Delta K = W_{net} = (F_{net})_{avg}\,\Delta x$$

$$\Rightarrow (F_{net})_{avg} = \frac{\Delta K}{\Delta x} = \frac{\frac{1}{2} m v_f^2}{\Delta x} = \frac{\frac{1}{2}\cdot 0.6 \cdot 13.5}{0.75}$$

$$= 72.9\,N$$