During the first step of a sprint race a sprinter of mass 64kg generates a horizontal braking impulse of -3.2 Ns and a horizontal propulsive impulse of +56.0 Ns. What is the net horizontal mechanical work done by the sprinter in the first step?

**Solution.**

$$m = 64kg, p_1 = 56.0Ns, p_2 = -3.2Ns;$$

$$W - ?$$

The mechanical work is equal to the change in kinetic energy of the sprinter:

$$W = \Delta E_k.$$

$$\Delta E_k = E_{kf} - E_{ki};$$

$E_{ki}$ - the initial kinetic energy of the sprinter;
$E_{kf}$ - the final kinetic energy of the sprinter.

A sprinter is at rest then the initial kinetic energy is:

$$E_{ki} = 0.$$

The final kinetic energy of the sprinter is:

$$E_{kf} = \frac{mv_f^2}{2}.$$

Multiply the numerator and denominator by $m$:

$$E_{kf} = \frac{mv_f^2 m}{2m};$$

$$E_{kf} = \frac{m^2 v_f^2}{2m}.$$

The impulse of the object is $p = mv$, then the final kinetic energy of the sprinter is:

$$E_{kf} = \frac{p_f^2}{2m}.$$

The initial impulse of the sprinter is:

$$p_i = 0.$$

The final impulse of the sprinter is:

$$p_f = p_1 + p_2.$$

The final kinetic energy of the sprinter is:

$$E_{kf} = \frac{(p_1 + p_2)^2}{2m}.$$

The mechanical work is:

$$W = \frac{(p_1 + p_2)^2}{2m}.$$

$$W = \frac{\left(56Ns + (-3.2Ns)\right)^2}{2 \cdot 64kg} = \frac{(56Ns - 3.2Ns)^2}{2 \cdot 64kg} = 21.78J.$$

**Answer:**

The net horizontal mechanical work done by the sprinter in the first step is $W = 21.78J$.