Gear ratio:

The solar cell will supply I and U:

$$I = Isc - Is\left(e^{\frac{U}{m.N.Ur}} - 1\right)$$

So if we want the max power:

$$\mathbf{P = U \times I}$$

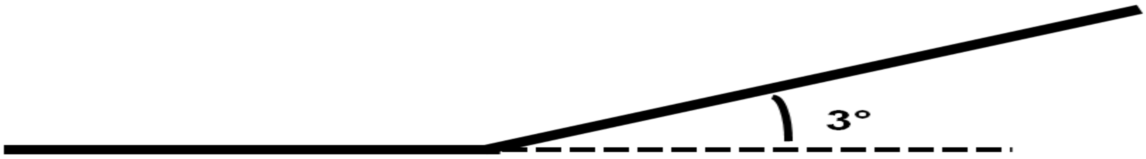
I have caculated it by maple14.

When $$\mathbf{U = 7.55V}$$

$$\mathbf{I = 0.93A}$$

$$\mathbf{Pmax = 7W}$$

Therefore:



$$U \cdot I \cdot \eta = F_{wheel} \cdot V_{A/B}$$

$$T_{wheel} = 8.55 \cdot 70\% \cdot I \cdot 10^{-3} \cdot n \qquad \text{(n is the gear ratio)}$$

$$T_{wheel} = F_{wheel} \cdot R_{wheel}$$

$$S = \tfrac{1}{2} a \cdot t^2 = \tfrac{1}{2} V_{A/B} \cdot t_{A/B} \qquad \text{(S = 6 m, at point A/B)}$$

$$F \cdot t = m \cdot \Delta V \rightarrow (F_{wheel} - F_{rolling}) \cdot t_{A/B} = m \cdot V_{A/B}$$

Estimate the weight of the car (m) and the radius of the wheel (R_{wheel}).

Taking m = 0.75kg, R_{wheel} = 0.04m, $F_{rolling}$ can be calculated by

$Fr = C_{rr} \times N$

N is the normal force

C_{rr} is the rolling resistance coefficient

C_{rr} = 0.015

U = 7.56V; I = 0.93A; η = 70%; S = 6m

So we calculate it by maple14:

$eq1 := 7 \cdot 0.7 = Fwheel \cdot Vab$

$$4.9 = Fwheel\, Vab$$

$eq2 := Twheel = 5.985 \cdot 0.001 \cdot n \cdot 0.9272$

$$Twheel = 0.0055492920\, n$$

$eq5 := Twheel = Fwheel \cdot 0.04$

$$Twheel = 0.04\, Fwheel$$

$eq3 := 6 = \frac{1}{2} \cdot Vab \cdot t$

$$6 = \frac{1}{2}\, Vab\, t$$

$eq4 := (Fwheel - 0.1104) \cdot t = 0.75 \cdot Vab$

$$(Fwheel - 0.1104)\, t = 0.75\, Vab$$

$simplify(solve(\{eq1, eq2, eq3, eq4, eq5\}, [Vab, n, t, Fwheel, Twheel]))$

$$[[Vab = 4.142427119, n = 8.526359055, t = 2.896852414, Fwheel = 1.182881402, Twheel = 0.04731525609], [Vab = -2.071213560 - 3.825725660\, I, n = -3.865290932 + 7.139554796\, I, t = -1.313242534 + 2.425682101\, I, Fwheel = -0.5362407012 + 0.9904868579\, I, Twheel = -0.02144962805 + 0.039619474321\, I], [Vab = -2.071213560 + 3.825725660\, I, n = -3.865290932 - 7.139554796\, I, t = -1.313242534 - 2.425682101\, I, Fwheel = -0.5362407012 - 0.9904868579\, I, Twheel = -0.02144962805 - 0.039619474321\, I]]$$

Now we get:

$$V_{max} = 4.142\, \frac{m}{s}$$

$$n = 8.53$$

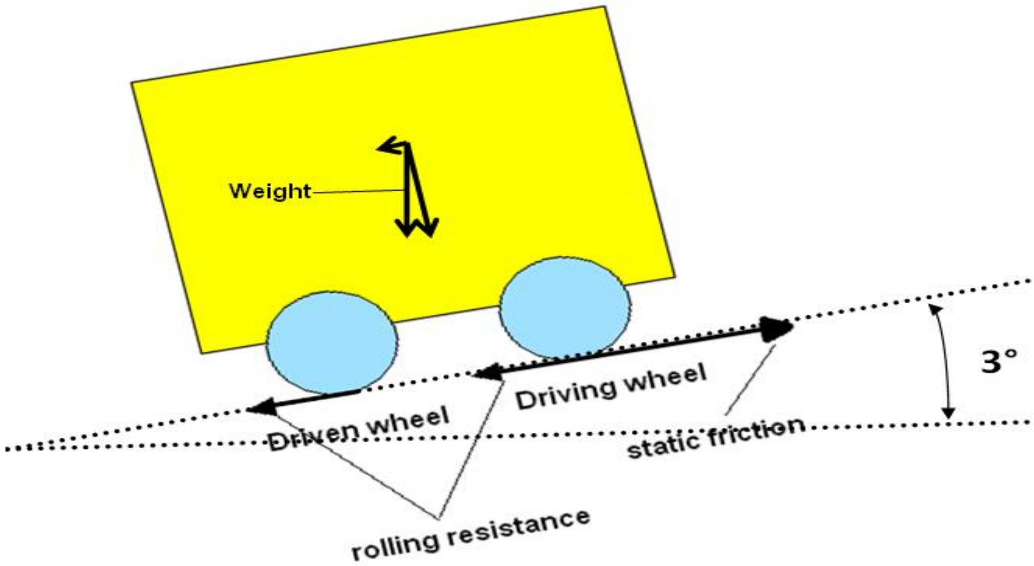
$$F_{wheel} = 1.183N$$

$$T_{wheel} = 0.0473N \cdot m$$

When the car gets max velocity, it will take t.

$$t = 2.897s$$

When our car arrives at the slope:



On the slope

Total resistant force:

Rolling resistance; Part of the weight;

Air resistance (neglected)

$F_r = F_{rolling} + mg \cdot \sin(3°) \approx 0.4953N$

Thus, On the slope $F_{wheel} > F_r$

$F_{wheel} = F_r = 0.4953N \rightarrow T_{wheel}$, gear ratio i is known

$\rightarrow$ I (current) $\rightarrow$ solar panel U-I graph $\rightarrow$ U

$\rightarrow U \cdot I \cdot \eta = F_{wheel} \cdot V \rightarrow V_{slope} = 4.77$ m/s

$V_{final} \approx 3.66$ m/s

In this case, $V_{A/B}$ and V_{final} are almost equal

So $t_{slope} < 8m / V_{A/B} \approx 1.813s$

$t_{total} \approx t_{A/B} + t_{slope} = 2.897 + 1.813 \quad = 4.71s$