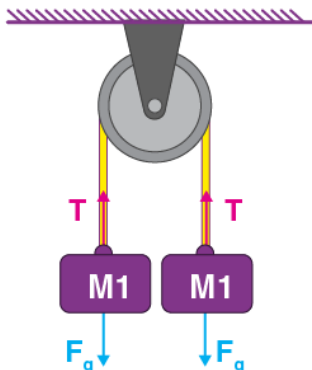
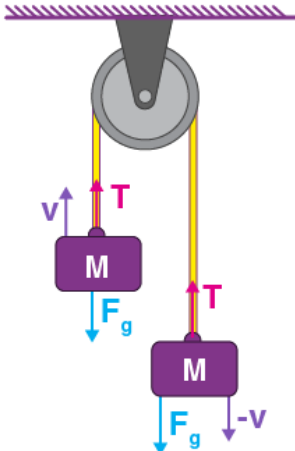
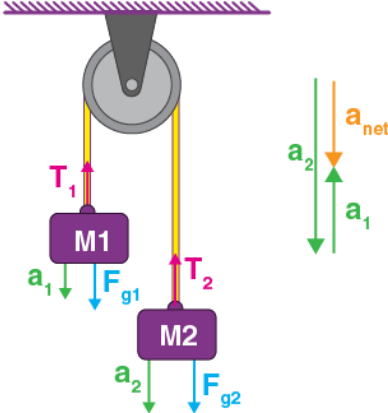


Harold's Physics Atwood Machine

Cheat Sheet

2 October 2026

Two Masses on a Pulley			
Diagram			
Scenario	$v = 0$ $v = \text{constant}$ $a = \text{constant}$		
Assume	$m_{\text{string}} = 0 \text{ kg}$ $\mu_{\text{pulley}} = 0$ • Massless string • Ideal frictionless pulley with negligible rotational inertia • String is taut and inextensible		
Givens	$M_1 = M = 0.20 \text{ kg}$ $v = 0 \frac{\text{m}}{\text{s}}$ or $= \text{constant} \frac{\text{m}}{\text{s}}$		$M_1 = 0.20 \text{ kg}$ $M_2 = 0.50 \text{ kg}$
Unknowns	$T = ? \text{ N}$		$ T_1 = ? \text{ N}$ $a_{\text{net}} = ? \frac{\text{m}}{\text{s}^2}$
Observations	$T_1 = T_2 = T$ $a = 0 \frac{\text{m}}{\text{s}^2}$		$ T_1 = -T_2 = T $ $a = \text{constant} \frac{\text{m}}{\text{s}^2}$
	$g = 9.81 \frac{\text{m}}{\text{s}^2}$		
Equations	$\sum F = F_a = Ma$ $T_1 - T_2 = 0$		$(M_2 - M_1)g = (M_2 + M_1)a$
	$F_{\text{net}} = T - F_g = 0$		$F_{g1} = M_1g$ $F_{g2} = M_2g$ $F_{g2} - F_{g1} = F_a$ $M = M_1 + M_2$ $ a_2 = a_1 = a_{\text{net}}$ $T - F_{g1} = M_1a_{\text{net}}$ $T - F_{g2} = -M_2a_{\text{net}}$

Solve	$F_g = M_1 g = M g$ $T = F_g$	$\begin{aligned} T - M_1 g &= M_1 a_{net} \\ -(T - M_2 g &= -M_2 a_{net}) \\ \hline -M_1 g + M_2 g &= (M_1 + M_2) a_{net} \\ (M_2 - M_1) g &= (M_1 + M_2) a_{net} \\ a_{net} &= \frac{(M_2 - M_1)}{(M_2 + M_1)} g \end{aligned}$
Substitute	$F_g = (0.20 \text{ kg}) \left(9.81 \frac{\text{m}}{\text{s}^2} \right)$ $F_g = 1.96 \text{ N}$ $T = F_g = 1.96 \text{ N}$	$F_{g1} = (0.20 \text{ kg}) \left(9.81 \frac{\text{m}}{\text{s}^2} \right) = 1.96 \text{ N}$ $F_{g2} = (0.50 \text{ kg}) \left(9.81 \frac{\text{m}}{\text{s}^2} \right) = 4.91 \text{ N}$ $F_a = F_{g2} - F_{g1} = 4.905 \text{ N} - 1.962 \text{ N} = 2.943 \text{ N}$ $M = M_1 + M_2 = 0.20 \text{ kg} + 0.50 \text{ kg} = 0.70 \text{ kg}$ $\begin{aligned} F_a &= M a_{net} \\ a_{net} &= \frac{F_a}{M} = \frac{2.94 \text{ N}}{0.70 \text{ kg}} = 4.20 \frac{\text{m}}{\text{s}^2} \end{aligned}$ $\begin{aligned} T_1 - T_2 &= 0 \\ T_1 &= T_2 \\ T &= M_1(g + a_{net}) \\ T &= M_2(g - a_{net}) \\ T &= (0.20 \text{ kg}) \left(9.81 \frac{\text{m}}{\text{s}^2} + 4.20 \frac{\text{m}}{\text{s}^2} \right) = 2.80 \text{ N} \end{aligned}$ $a_{net} = \frac{(M_2 - M_1)}{(M_2 + M_1)} g = \frac{(0.50 - 0.20)}{(0.50 + 0.20)} g = \frac{3}{7} g = 4.20 \frac{\text{m}}{\text{s}^2}$

Sources

- Atwood Machine (2025). <https://ucscphysicsdemo.wordpress.com/atwood-machine/>
- BYJU's (2025). What is Atwood's Machine? <https://byjus.com/physics/atwood-machine/>

Acknowledgements

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