Lifting Machines Formulas

List of 33 Lifting Machines Formulas

Lifting Machines

Machine Design Characteristics

1) Efficiency of Machine given Mechanical Advantage and Velocity Ratio

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

2) Effort Required by Machine to Overcome Resistance to Get Work Done

Open Calculator

fx $$P = \frac{W}{M_a}$$

ex $$200\text{N} = \frac{1000\text{N}}{5}$$

3) Frictional Effort Lost

Open Calculator

fx $$F_e = P - \frac{W}{V_i}$$

ex $$33.33333N = 200N - \frac{1000N}{6}$$

4) Ideal Effort given Load and Velocity Ratio

Open Calculator

fx $$P_o = \frac{W}{V_i}$$

ex $$166.6667N = \frac{1000N}{6}$$

5) Ideal Load given Velocity Ratio and Effort

Open Calculator

fx $$W_i = V_i \cdot P$$

ex $$1200N = 6 \cdot 200N$$

6) Load Lifted given Effort and Mechanical Advantage

Open Calculator

fx $$W = M_a \cdot P$$

ex $$1000N = 5 \cdot 200N$$

7) Mechanical Advantage given Load and Effort

Open Calculator

fx $$M_a = \frac{W}{P}$$

ex $$5 = \frac{1000\text{N}}{200\text{N}}$$

8) Useful Work Output of Machine

Open Calculator

fx $$W_l = W \cdot D_l$$

ex $$3750\text{J} = 1000\text{N} \cdot 3.75\text{m}$$

9) Velocity Ratio given Distance Moved due to Effort and Distance Moved due to Load

Open Calculator

fx $$V_i = \frac{D_e}{D_l}$$

ex $$6.4 = \frac{24\text{m}}{3.75\text{m}}$$

10) Work Done by Effort

Open Calculator

fx $$W_l = W \cdot D_l$$

ex $$3750\text{J} = 1000\text{N} \cdot 3.75\text{m}$$

Pulley Block

11) Efficiency of Geared Pulley Block

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

12) Efficiency of Weston's Differential Pulley Block

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

13) Efficiency of Worm Geared Pulley Block

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

14) Net Shortening of Chain in Weston's Differential Pulley Block

Open Calculator

fx $$L_c = \pi \cdot (d_l - d_s)$$

ex $$0.062832\text{m} = \pi \cdot (0.06\text{m} - .04\text{m})$$

15) Net Shortening of String in Worm Gear Pulley Block

Open Calculator

fx $$L_s = \frac{2 \cdot \pi \cdot R}{T_w}$$

ex $$0.274889\text{m} = \frac{2 \cdot \pi \cdot 1.4\text{m}}{32}$$

16) Velocity Ratio in Weston's Differential Pulley Block

Open Calculator

fx $$V_i = \frac{2 \cdot d_l}{d_l - d_s}$$

ex $$6 = \frac{2 \cdot 0.06\text{m}}{0.06\text{m} - .04\text{m}}$$

17) Velocity Ratio in Weston's Differential Pulley given Number of Teeth

Open Calculator

fx $$V_i = 2 \cdot \frac{T_1}{T_1 - T_2}$$

ex $$6.133333 = 2 \cdot \frac{46}{46 - 31}$$

18) Velocity Ratio in Weston's Differential Pulley given Radius of Pulleys

Open Calculator

fx $$V_i = 2 \cdot \frac{r_1}{r_1 - r_2}$$

ex $$6.545455 = 2 \cdot \frac{9\text{m}}{9\text{m} - 6.25\text{m}}$$

19) Velocity Ratio of Worm Geared Pulley Block

Open Calculator

fx $$V_i = \frac{d_w \cdot T_w}{R}$$

ex $$6.857143 = \frac{0.3\text{m} \cdot 32}{1.4\text{m}}$$

Screw Jack

20) Efficiency of Differential Screw Jack

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

21) Efficiency of Screw Jack

Open Calculator

fx $$\eta = \frac{\tan(\psi)}{\tan(\psi + \theta)} \cdot 100$$

ex $$0.839817 = \frac{\tan(12.9^\circ)}{\tan(12.9^\circ + 75^\circ)} \cdot 100$$

22) Efficiency of Worm Geared Screw Jack

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

23) Torque Required while Load is Ascending in Screw Jack

Open Calculator

fx $$T_{asc} = \frac{d_m}{2} \cdot W \cdot \tan(\theta + \Phi)$$

ex $$2748.452\text{N*m} = \frac{0.24\text{m}}{2} \cdot 1000\text{N} \cdot \tan(75^\circ + 12.5^\circ)$$

24) Torque Required while Load is Descending in Screw Jack

Open Calculator

fx $$T_{des} = \frac{d_m}{2} \cdot W \cdot \tan(\theta - \Phi)$$

ex $$230.5179\text{N*m} = \frac{0.24\text{m}}{2} \cdot 1000\text{N} \cdot \tan(75^\circ - 12.5^\circ)$$

25) Velocity Ratio of Differential Screw Jack

Open Calculator

fx $$V_i = \frac{2 \cdot \pi \cdot l}{p_a - p_b}$$

ex $$6.283185 = \frac{2 \cdot \pi \cdot 12\text{m}}{34\text{m} - 22\text{m}}$$

26) Velocity Ratio of Simple Screw Jack

Open Calculator

fx $$V_i = \frac{2 \cdot \pi \cdot l}{P_s}$$

ex $$5.385587 = \frac{2 \cdot \pi \cdot 12\text{m}}{14\text{m}}$$

27) Velocity Ratio of Worm Geared Screw Jack

Open Calculator

fx $$V_i = \frac{2 \cdot \pi \cdot R_w \cdot T_s}{P_s}$$

ex $$6.485145 = \frac{2 \cdot \pi \cdot 0.85\text{m} \cdot 17}{14\text{m}}$$

28) Velocity Ratio of Worm Geared Screw Jack with Double Threaded

Open Calculator

fx $$V_i = \frac{2 \cdot \pi \cdot R_w \cdot T_w}{2 \cdot P_s}$$

ex $$6.103666 = \frac{2 \cdot \pi \cdot 0.85\text{m} \cdot 32}{2 \cdot 14\text{m}}$$

29) Velocity Ratio of Worm Geared Screw Jack with Multiple Threads

Open Calculator

fx $$V_i = \frac{2 \cdot \pi \cdot R_w \cdot T_w}{n \cdot P_s}$$

ex $$6.103666 = \frac{2 \cdot \pi \cdot 0.85\text{m} \cdot 32}{2 \cdot 14\text{m}}$$

Worm Wheel

30) Efficiency of Worm and Worm Wheel

Open Calculator

fx $$\eta = \frac{M_a}{V_i}$$

ex $$0.833333 = \frac{5}{6}$$

31) Velocity Ratio of Worm and Worm Wheel

Open Calculator

fx $$V_i = \frac{D_m \cdot T_w}{2 \cdot R_d}$$

ex $$6.857143 = \frac{0.15\text{m} \cdot 32}{2 \cdot 0.35\text{m}}$$

32) Velocity Ratio of Worm and Worm Wheel, if Worm has Multiple Threads

Open Calculator

fx $$V_i = \frac{d_w \cdot T_w}{2 \cdot n \cdot R_d}$$

ex $$6.857143 = \frac{0.3\text{m} \cdot 32}{2 \cdot 2 \cdot 0.35\text{m}}$$

33) Velocity Ratio of Worm and Worm Wheel, if Worm is Double Threaded

Open Calculator

$$V_i = \frac{d_w \cdot T_w}{4 \cdot R_d}$$

$$6.857143 = \frac{0.3\text{m} \cdot 32}{4 \cdot 0.35\text{m}}$$

Variables Used

- **D_e** Distance Moved Due to Effort *(Meter)*
- **d_l** Diameter of Larger Pulley *(Meter)*
- **D_l** Distance Moved Due to Load *(Meter)*
- **d_m** Mean Diameter of Screw *(Meter)*
- **D_m** Minimum Diameter of Effort Wheel *(Meter)*
- **d_s** Diameter of Smaller Pulley *(Meter)*
- **d_w** Diameter of Effort Wheel *(Meter)*
- **F_e** Frictional Effort Lost *(Newton)*
- **l** Length of Lever Arm *(Meter)*
- **L_c** Net Shortening of Chain *(Meter)*
- **L_s** Net Shortening of String *(Meter)*
- **M_a** Mechanical Advantage
- **n** Number of Threads
- **P** Effort *(Newton)*
- **p_a** Pitch of Screw A *(Meter)*
- **p_b** Pitch of Screw B *(Meter)*
- **P_o** Ideal Effort *(Newton)*
- **P_s** Pitch *(Meter)*
- **R** Radius of Pulley *(Meter)*
- **r_1** Radius of Larger Pulley *(Meter)*
- **r_2** Radius of Smaller Pulley *(Meter)*

- R_d Radius of Load Drum *(Meter)*
- R_w Radius of Effort Wheel *(Meter)*
- T_1 Number of Teeth of Larger Pulley
- T_2 Number of Teeth of Smaller Pulley
- T_{asc} Torque Required While Load is Ascending *(Newton Meter)*
- T_{des} Torque Required While Load is Descending *(Newton Meter)*
- T_s Number of Teeth in Screw Shaft
- T_w Number of Teeth on Worm Wheel
- V_i Velocity Ratio
- W Load *(Newton)*
- W_i Ideal Load *(Newton)*
- W_l Work Done *(Joule)*
- η Efficiency
- θ Angle of Friction *(Degree)*
- Φ Limiting Angle of Friction *(Degree)*
- ψ Helix Angle *(Degree)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion

Check other formula lists

- **Lifting Machines Formulas**

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