THE LAW OF MACHINE

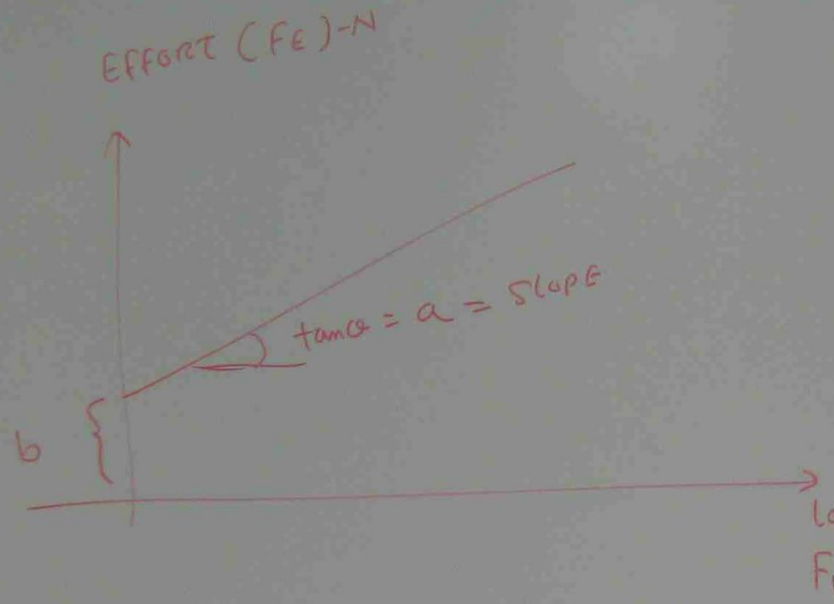
$$F_E = a f_L + b$$

F_E = EFFORT

F_L = LOAD

a = THE SLOPE OF THE GRAPH

b = VALUE OF F_E WHERE THE GRAPH CUTS F_E AXIS

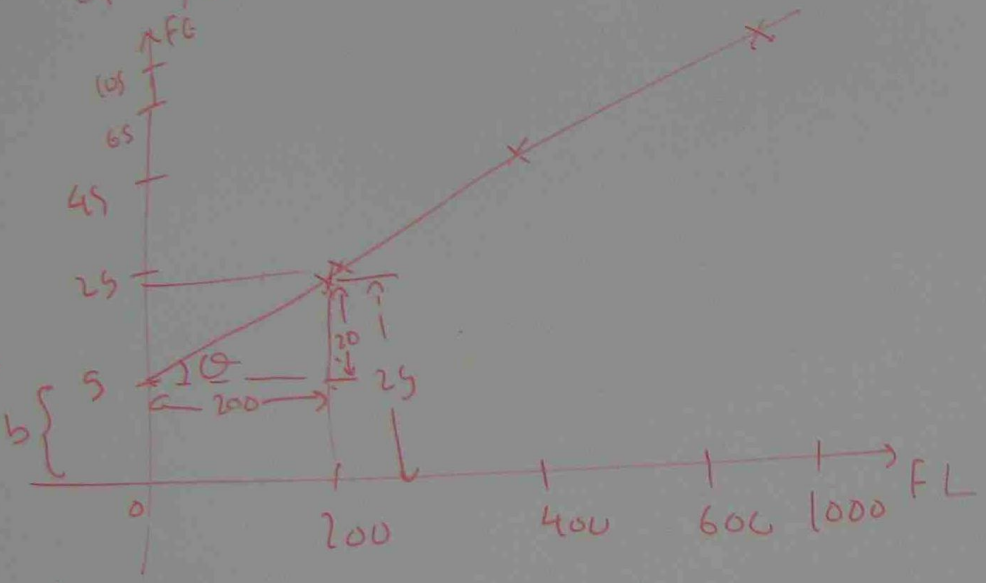


Pb THE MACHINE HAS BE TESTED UNDER DIFFERENT LOADS AND THE FOLLOWING EFFORTS WERE RECORDED FOR EACH of THE LOADING CONDITIONS

LOAD F_L (NEWTON)	0	200	400	600	1000
EFFORT F_E (NEWTON)	5	25	45	65	105

PLOT THE LOAD – EFFORT GRAPH AND DETERMINE THE LAW OF THE MACHINE.

ESTIMATE THE EFFORT TO MOVE THE LOAD OF 700N



$b = 5$, $a = \tan\theta = \frac{20}{200} = 0.1$

$F_E = aF_L + b$

$F_E = 0.1F_L + 5$

$F_L = 700N$, $F_E = ?$

$F_E = 0.1 \times 700 + 5 = 75$ ✗

LIMITING EFFICIENCY

$$\eta = \frac{MA}{VR} =$$

MA = MECHANICAL ADVANTAGE $= \frac{F_L}{F_E}$

VR = VELOCITY RATIO

$$\eta = \frac{F_L/F_E}{V_R}$$

$$= \frac{F_L}{F_E \times V_R}$$

$$= \frac{F_L}{(aF_L + b) \times V_R}$$

$$= \frac{F_L/F_L}{\frac{(aF_L + b) \times V_R}{F_L}}$$

$$= \frac{1}{\left(\frac{aF_L}{F_L} + \frac{b}{F_L}\right) \times V_R}$$

$$= \frac{1}{\left(a + \frac{b}{F_L}\right) V_R}$$

$$\eta = \frac{1}{aV_R + \frac{bV_R}{F_L}}$$

WHEN THE LOAD IS VERY LARGE, THE MACHINE CAN NOT RUN ANY MORE – LIMITING LOAD

$$F_L = \infty$$

$$\therefore \frac{bV_R}{F_L} = 0$$

$$\eta = \frac{1}{aV_R} = \text{LIMITING EFFICIENCY}$$

pb

IN PREVIOUS PROBLEM, CALCULATE EFFICIENCY FOR EACH LOAD AND LIMITING EFFICIENCY

$VR = 12$

$$\eta = \frac{FL}{FE \times VR}$$

$$\eta_1 = \frac{0}{9 \times 12} = 0$$

$$\eta_2 = \frac{200}{25 \times 12} = 0.66 \Rightarrow 66\%$$

$$\eta_3 = \frac{400}{45 \times 12} = 0.74 \Rightarrow 74.1\%$$

$$\eta_4 = \frac{600}{65 \times 12} = 0.769 \Rightarrow 76.9\%$$

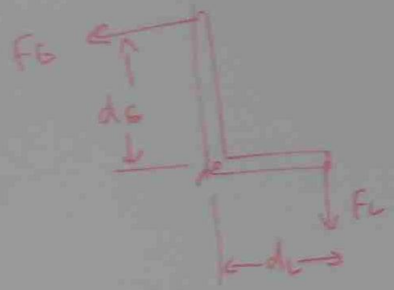
$$\eta_5 = \frac{800}{85 \times 12} = 0.784 \Rightarrow 78.4\%$$

$$\eta_6 = \frac{1000}{105 \times 12} = 0.794 \Rightarrow 79.4\%$$

LIMITING EFFICIENCY $= \frac{1}{a \times VR} = \frac{1}{0.1 \times 12} = 0.833 = 83.3$

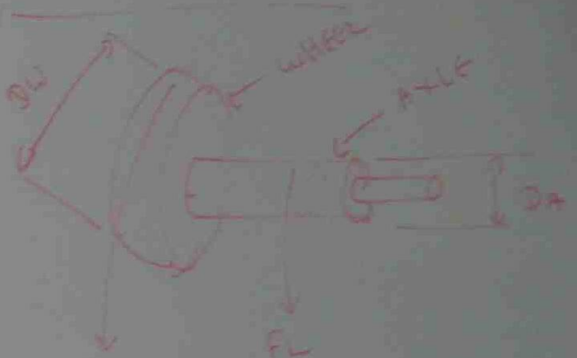
VELOCITY RATIO OF DIFFERENT MACHINES

LEVER



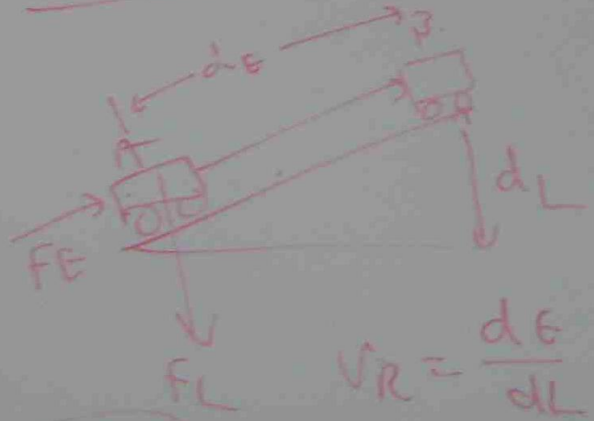
$$V_R = \frac{dE}{dL}$$

WHEEL AND AXLE



$$V_R = \frac{DW}{DA}$$

INCLINED PLANE



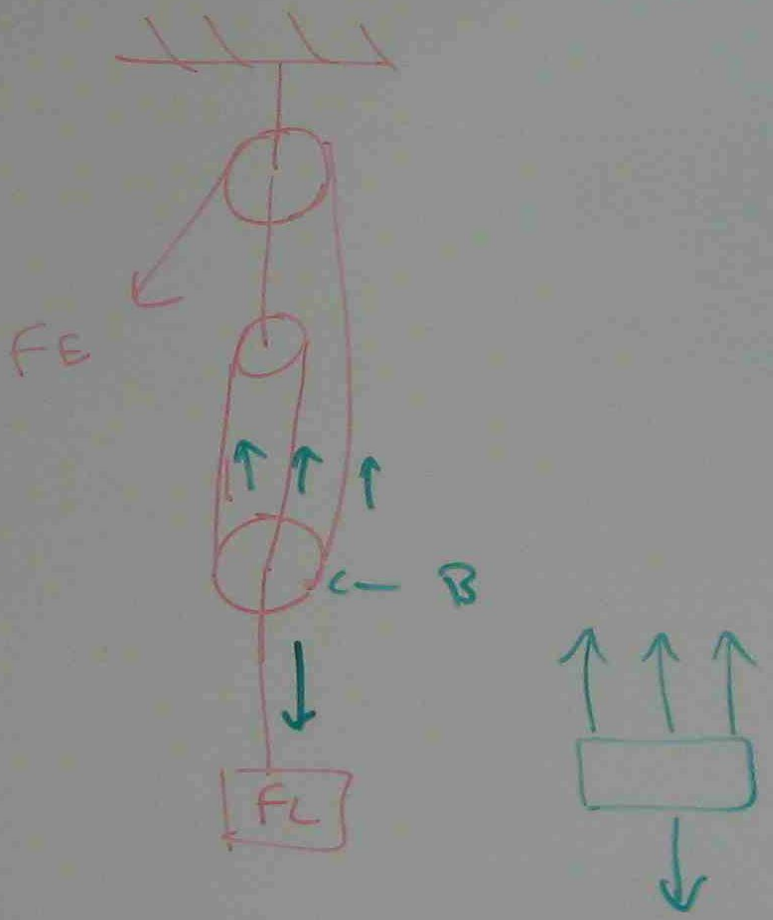
$$V_R = \frac{dE}{dL}$$

SCREW JACK

$$V_R = \frac{2\pi r}{l}$$

·833 = 83·3%

PULLEY AND PULLEY BLOCK



$V_R = 3$

pb THE FOLLOWING QUESTIONS REFER TO THE SAME MACHINE

(a) GIVEN THAT THE EFFORT REQUIRED TO LIFT A LOAD OF 5T IS 343 N. CALCULATE THE MECHANICAL ADVANTAGE

(b) IF THE EFFORT MOVES 200mm FOR EVERY mm MOVED BY THE LOAD, CALCULATE VELOCITY RATIO

(c) IF THE LOAD IS LIFTED A TOTAL DISTANCE OF 1.37m CALCULATE OUT PUT WORK AND IN PUT WORK

(d) CALCULATE EFFICIENCY

(e) CALCULATE FRACTIONAL EFFORT.

(a) M

(b)

(c)

(d) $\eta = \frac{MA}{VR} = \frac{5000/343}{200}$

$= \frac{14.57}{200}$

$= 0.072$