CH # 9 MACHINES

Some important formulae:

i) $\text{M. A} = \frac{\text{W}}{\text{P}}$ ii) $\eta = \frac{Output}{Input} \times 100\%$

ii) $\text{M. A of inclined plane} = \frac{\text{l}}{\text{h}}$

iii) Input of screw jack = P x 2πr

9.1: An effort of 160N applied to a pulley system is able to lift a load of 750N through a vertical height of 1.2m. To do this the effort moves a distance of 7.2m. Calculate (a) The mechanical advantage of the pulley system (b) The efficiency.

GIVEN:
Effort applied = P = 160N
Load lifted = W = 750N
Distance moved by effort = d = 7.2m
Distance moved through load = h = 1.2m

REQUIRED:
Mechanical advantage = M.A = ?
Efficiency = **η** = ?

SOLUTION:
a) $M.A = \frac{W}{P}$

$M.A = \frac{750}{160}$

M.A = 4.68

b) $Efficiency = \frac{Output}{Input} \times 100\%$

$\eta = \frac{W \times h}{P \times d} \times 100\%$

$\eta = \frac{750 \times 1.2}{160 \times 7.2} \times 100\%$

$\eta = \frac{900}{1152} \times 100\%$

$\eta = 78.3\%$

9.2: The ratio between the lengths of the arms of lever is 4:1. How much force be applied to the longer arm so that a load of 20N suspended at the shorter can be balanced.

GIVEN:
Length of longer arm = 4m
Length of shorter arm = 1m
Load (Suspended at the shorter arm) = W = 20N

REQUIRED:
Force applied on longer arm for balancing (Effort) = P = ?

SOLUTION:
Lever can be balance if the clock wise torque produce in lever is equal to anti clock wise torque,
Clock wise torque = Anti-clock wise torque
Effort x Effort arm = Load x Load arm
P x Longer arm = W x Shorter arm
P x 4 = 20 x 1

$\text{P} = \frac{20}{4}$

P = 5N

9.3: An object of mass 100Kg is raised 2m above the ground using an inclined plane of length 10m. Calculate the effort applied parallel to the inclined plane.

GIVEN:
Mass of object = 100Kg
Height raised = h = 2m
Length of inclined plane = L = 10m

REQUIRED:
Effort applied = P = ?

SOLUTION:

$M.A\ of\ inclined\ plane = \frac{l}{h}$

$\frac{W}{P} = \frac{l}{h}\ (\therefore M.A = \frac{W}{P})$

$\frac{mg}{P} = \frac{l}{h}\ (\therefore W = mg)$

$\frac{(100)(9.8)}{P} = \frac{10}{2}$

$\frac{980}{P} = 5$

$\frac{980}{5} = P$

P = 196N

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9.4: An effort of 100N applied to a pulley system is able to lift a load of 400N through a vertical height of 1m. To do this the effort moves a distance of 8m. (a) The mechanical advantage of the pulley system (b) The efficiency.

GIVEN:
Effort applied = P = 100N
Load lifted = W = 400N
Distance moved by effort = d = 8m
Distance moved through load = h = 1m

REQUIRED:
(a) Mechanical advantage = M.A = ?
(b) Efficiency = **η** = ?

SOLUTION:
a) $M.A = \frac{W}{P}$

$M.A = \frac{400}{100}$

M.A = 4

b) $Efficiency = \frac{Output}{Input} \times 100\%$

$\eta = \frac{W \times h}{P \times d} \times 100\%$

$\eta = \frac{400 \times 1}{100 \times 8} \times 100\%$

$\eta = \frac{400}{800} \times 100\%$

$\eta = 50\%$

9.5: A load of 21000N placed on the top of a screw jack is lifted by a force of 300N. If the length of the Tommy-bar is 35cm and the pitch of the screw is 2.5mm. Find its mechanical advantage and efficiency.

GIVEN:
Effort applied = P = 300N
Load Placed = W = 21000N
Length of tommy bar = r = 35cm = 35/100 = 0.35m
Pitch of screw = h = 2.5mm = 2.5/1000 = 0.0025m
Mechanical advantage = M.A = ?
Efficiency = **η** = ?

$M.A = \frac{W}{P}$

$M.A = \frac{21000}{300}$

M.A = 70

$Efficiency = \frac{Output}{Input} \times 100\%$

$\eta = \frac{W \times h}{P \times 2\pi r} \times 100\%$

$\eta = \frac{21000 \times 0.0025}{300 \times 2(3.14)(0.35)} \times 100\%$

$\eta = \frac{52.5}{659.82} \times 100\%$

$\eta = 7.95\%$ (The answer 79.5% is wrong printed in text book)

9.6: The length of the handle of screw jack is 40cm and its pitch is 40mm. How much load can be lifted by applying force of 5N on the handle.

Solution:
Effort applied = P = 5N
Length of handle = r = 40cm = 40/100 = 0.4m
Pitch of screw = h = 40mm = 40/1000 = 0.004m

REQUIRED:
Load lifted = W = ?

SOLUTION:
$M.A\ of\ screw\ jack = \frac{2\pi r}{h}$

$\frac{W}{P} = \frac{2\pi r}{h}\ (\therefore M.A = \frac{W}{P})$

$W = \frac{2\pi r}{h} \times P$

$W = \frac{2(3.14)(0.4)}{(0.004)} \times 5$

W = 3140N

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