MECHANICAL CALCULATIONS

DENSITY, SPECIFIC VOLUME

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}} \Longrightarrow \boxed{D = \frac{m}{V}}$$

$$\text{SPECIFIC VOLUME} = \frac{\text{VOLUME}}{\text{MASS}}$$

$$\boxed{\rho = \frac{V}{m}}$$

$$\text{RELATIVE DENSITY} = \frac{\text{DENSITY OF SUBSTANCE}}{\text{DENSITY OF WATER}} \qquad m^3/kg$$

pb 1

DETERMINE THE MASS OF AIR IN A ROOM 10m x 6m x 2.5 m

DENSITY OF AIR = 1.226 kg/m^3

pb 2

600 mL SULPHURIC ACID HAS A MASS OF 1.11 kg.
WHAT IS THE DENSITY AND RELATIVE DENSITY OF SULPHURIC ACID ?

pb 3

DETERMINE SPECIFIC VOLUME OF AIR AT SEA LEVEL AND NORMAL TEMPERATURE (15°C)

pb 1

VOLUME $V = 10 \times 6 \times 2.5 = 150\, m^3$

MASS OF AIR = DENSITY x VOLUME

$= 1.226 \times 150$

$= 183.9\, kg$

pb (2)

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}} = \frac{1.11}{600 \times 10^{-3}} = 1850 \ \text{Kg}/\text{m}^3$$

$$\text{RELATIVE DENSITY} = \frac{\text{DENSITY of SUBSTANCE}}{\text{DENSITY of WATER}} = \frac{1850}{1000} = 1.85$$

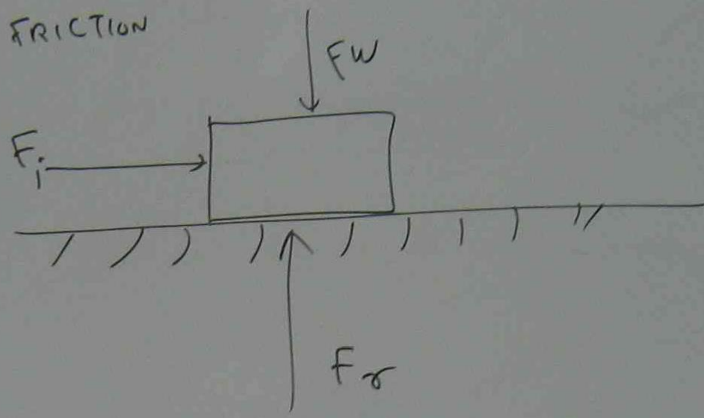
pb (3)

$$\text{SPECIFIC VOLUME} = \frac{\text{VOLUME}}{\text{MASS}} = \frac{1}{\text{DENSITY}}$$

$$= \frac{1}{1.226} = 0.8157 \ \text{m}^3/\text{kg}$$

FRICTION

THE PROPERTIES OF SURFACE THAT CAUSES THE RESISTANCE TO MOTION IS FRICTION



F_i = ACTION FORCE

F_w = WEIGHT

F_r = REACTION FORCE

$$\text{COEFFICIENT OF FRICTION} = \frac{F_r}{F_i}$$

$$\mu = \frac{F_r}{F_i}$$

FRICTION

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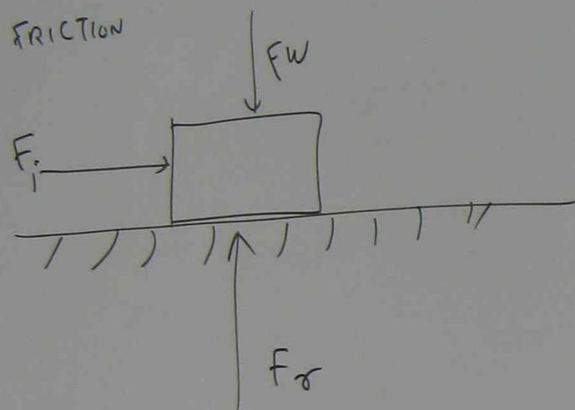


F_i = ACTION FORCE

F_w = WEIGHT

F_r = REACTION FORCE

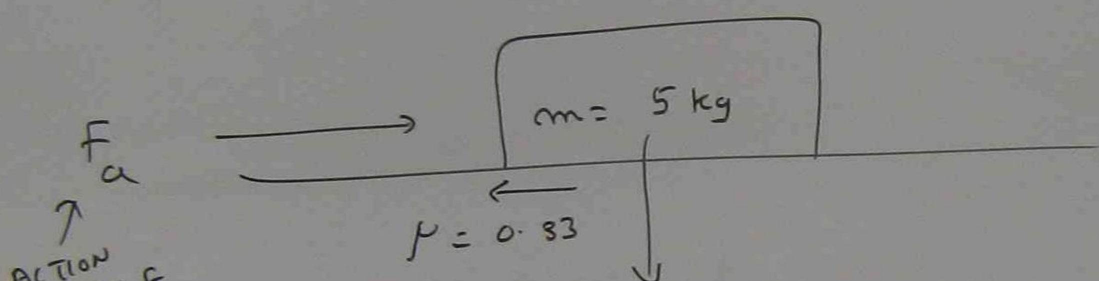
$$\text{COEFFICIENT OF FRICTION} = \frac{F_r}{F_i}$$

$$\mu = \frac{F_r}{F_i}$$

SURFACE	TYPICAL VALUE OF COEFFICIENT OF FRICTION
METAL ON METAL (GREASY)	0.1
HARD WOOD	0.2
METAL ON METAL (DRY)	0.2
WIRE ROPE ON METAL PULLEY	0.2
WOOD ON WOOD	0.35
RUBBER	0.4
HARDWOOD	0.35
BRAKE LINING	0.4
MASONARY ON BRICK	0.6
RUBBER TYRE ON CONCRETE	0.8

Pb 4

A BODY MASS 5 kg REST ON A HORIZONTAL SURFACE AND THE COEFFICIENT OF FRICTION BETWEEN THE TWO SURFACES IS 0.33. WHAT HORIZONTAL FORCE WILL BE REQUIRED TO START THE BODY MOVING?



$f_w = mg = 5 \times 9.81 = 49.05$ N

$f_a = \mu \times f_w$

$= 0.33 \times 49.05 = 16.2$ N

Pb ⑤

A HORIZONTAL FORCE OF 50 N WAS REQUIRED TO START A 10 kg BLOCK MOVING ON HORIZONTAL SURFACE. WHAT IS THE VALUE OF COEFFICIENT?

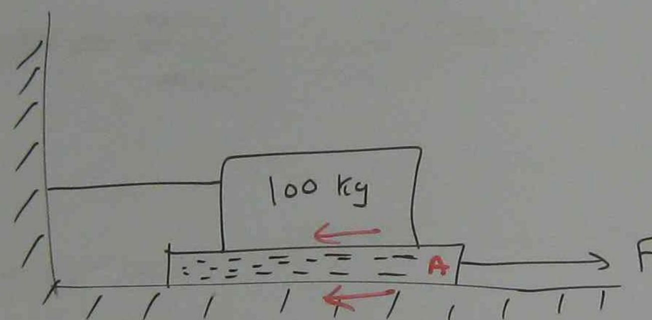
$F_a = 50\ N$

$F_w = F_N = mg = 10 \times 9.81 = 98.1$

$$\mu = \frac{F_a}{F_N} = \frac{50}{98.1} = 0.51$$

pb ⑥

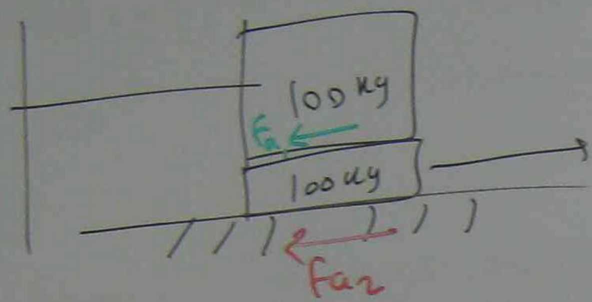
A 100 kg BLOCK RESTS ON A PLANE. THE COEFFICIENT OF FRICTION BETWEEN ALL SURFACE IS 0.2. DETERMINE THE FORCE REQUIRED TO PULL THE PLATE FROM UNDER THE BLOCK.



$$F_a = \mu F_w = \mu mg = 0.2 \times 100 \times 9.81$$
$$= 196.2\ N$$

<u>TWO SURFACES</u>

$$F_{a\ TOTAL} = 2 \times F_a = 2 \times 196.2 = 392.4\ N$$

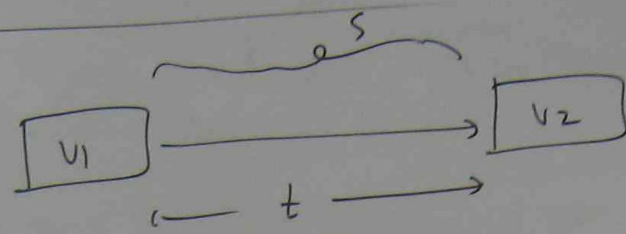


$$Fa_1 = \mu \times fw_1 = 0.2 \times mg = 0.2 \times 100 \times 9.81 = 196.2\ N$$

$$fa_2 = \mu\ fw_2 = 0.2\ (100+100) \times 9.81 = 392.4\ N$$

$$Fa_{TOTAL} = fa_1 + fa_2 = 488.6\ N$$

EQUATIONS OF LINEAR MOTION



v_1, v_2 = VELOCITIES

t = TIME

$$s = \frac{v_1 + v_2}{2} \times t$$

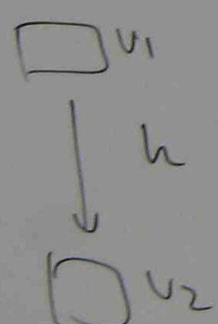
DISTANCE

a = ACCELERATION

$$s = v_1 t + \frac{a t^2}{2}$$

$$a = \frac{v_2 - v_1}{t}$$

$$v_2 = v_1 + a t$$



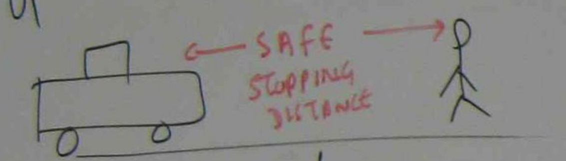
$$h = v_1 t + \frac{1}{2} g t^2$$

$$v_2 = v_1 + g t$$

pb 1

FIND THE TOTAL EMERGENCY STOPPING DISTANCE OF A CAR .. AND TOTAL TIME TAKEN FROM THE POINT WHERE THE DRIVER SIGHTS THE DANGER IF THE DRIVER'S REACTION TIME BEFORE APPLYING THE BRAKE IS 0.4 sec. INITIAL VELOCITY IS 60 km/hr AND RETARDATION DUE TO BRAKE IS 7.5 m/s²

V_1



$|\leftarrow S_1 \rightarrow|\leftarrow S_2 \rightarrow|$ $V_2 = 0$

CAR MOVEMENT DURING THE DECISION TIME 0.4 sec

BRAKE $V_1 = 16.67$

THE DISTANCE OF MOVEMENT AFTER APPLYING BRAKE

$$V_1 = \frac{60 \times 1000}{3600} = 16.67 \text{ m/s}$$

$$S_1 = 16.67 \times 0.4 = 15 \text{ m}$$

$$V_2 = V_1 + at$$

$$0 = 16.67 + (-7.5) \times t$$

$$t = \frac{-16.67}{-7.5} = 2.22 \text{ sec}$$

$$S_2 = V_1 t + \frac{1}{2} a t^2$$

$$= 16.67 \times 2.22 + \frac{1}{2}(-7.5)(2.22)^2$$

$$= 18.5 \text{ m}$$

$$S_{TOTAL} = S_1 + S_2 = 15 + 18.5$$

$$= 33.5 \text{ m} \;//$$