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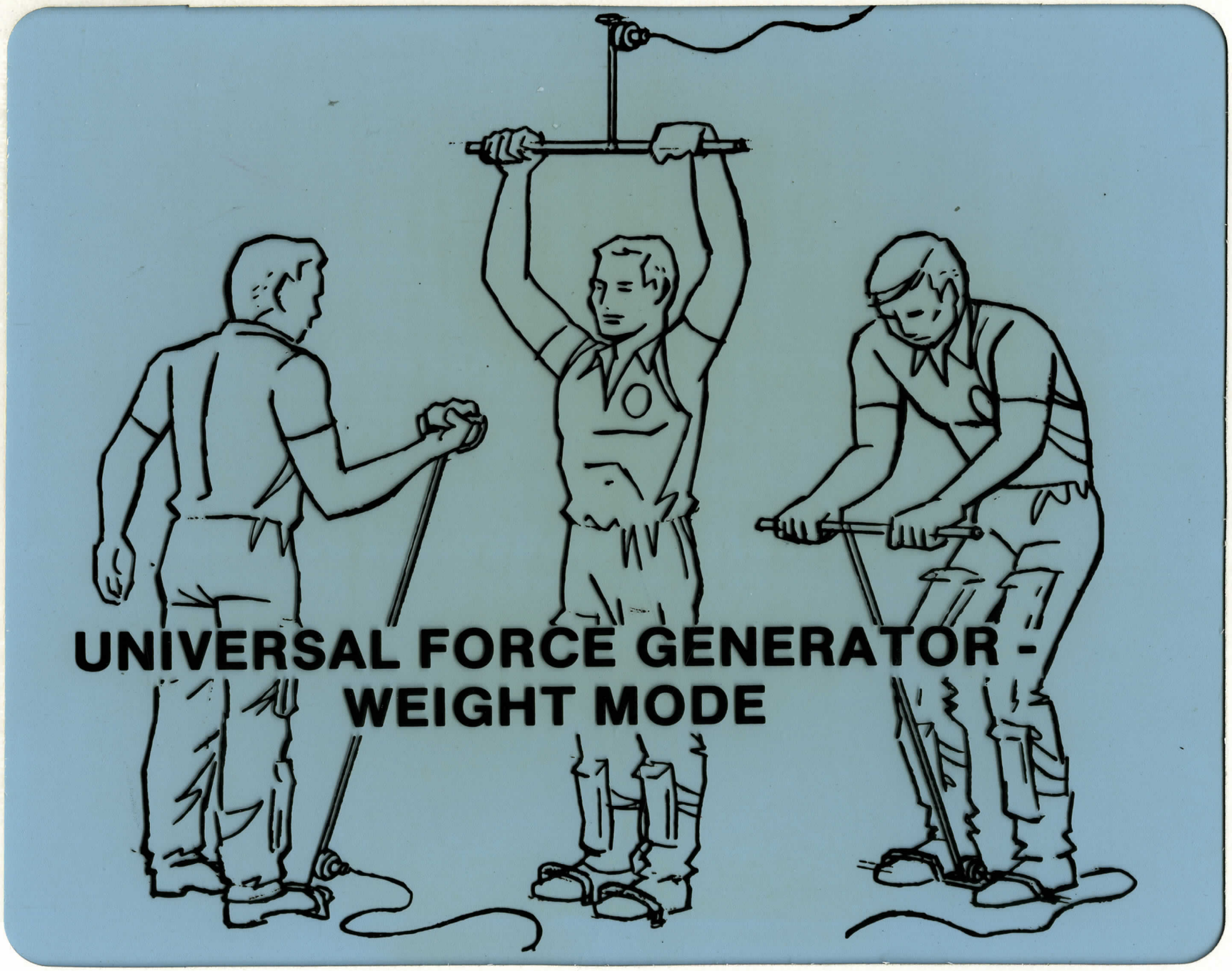

UNIVERSAL FORCE GENERATOR - WEIGHT MODE

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ADAPTATION TO WEIGHTLESSNESS

PRIMARY MECHANISM	ADAPTATION	COUNTERMEASURE
LOSS OF LOCOMOTOR FUNCTION	DISUSE ATROPHY OF: MUSCLE BONE JOINTS & TENDONS	RESTORE LOCOMOTOR FUNCTION FOR PERFORMANCE OF EXERCISE EQUIVALENT TO INDIVIDUAL'S USUAL 1g WORK AND EXERCISE
REDUCED MAXIMUM METABOLIC LOADS	REDUCED: MYOCARDIAL VOLUME, MASS, EFFICIENCY; PULMONARY MUSCULATURE, RESPIRATORY EFFICIENCY, BLOOD VOLUME	
REDUCED FORCES ON BACK, SHOULDER GIRDLE, ARMS & HANDS	DISUSE ATROPHY OF MUSCLE, ? BONE, JOINTS	SELECTED EXERCISE FOR INDIVIDUAL

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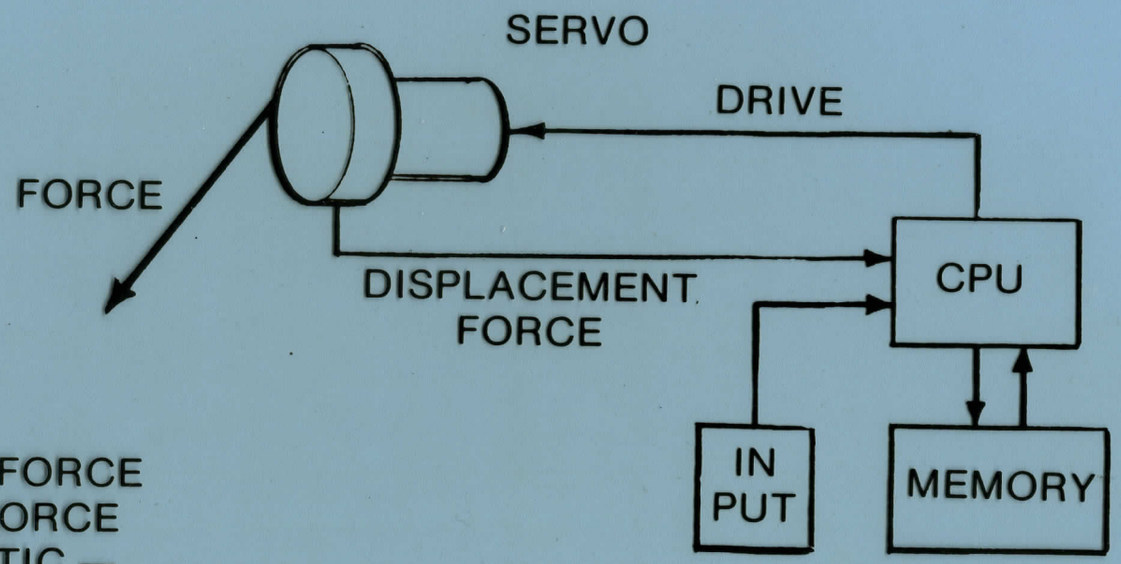
UNIVERSAL LOAD UNIT



SELECTABLE

- LEVEL OF FORCE
- TYPE OF FORCE
  - ISOKINETIC —
  - ISOTONIC

WEIGHT $F_w = m_x g + m_x \ddot{X}$

INERTIAL $F_i = m_x \ddot{X}$

SPRING $F_s = K_1 X$

RESISTIVE $F_r = K_2 \dot{X}$

SAFETY : FORCE & VELOCITY LIMITS

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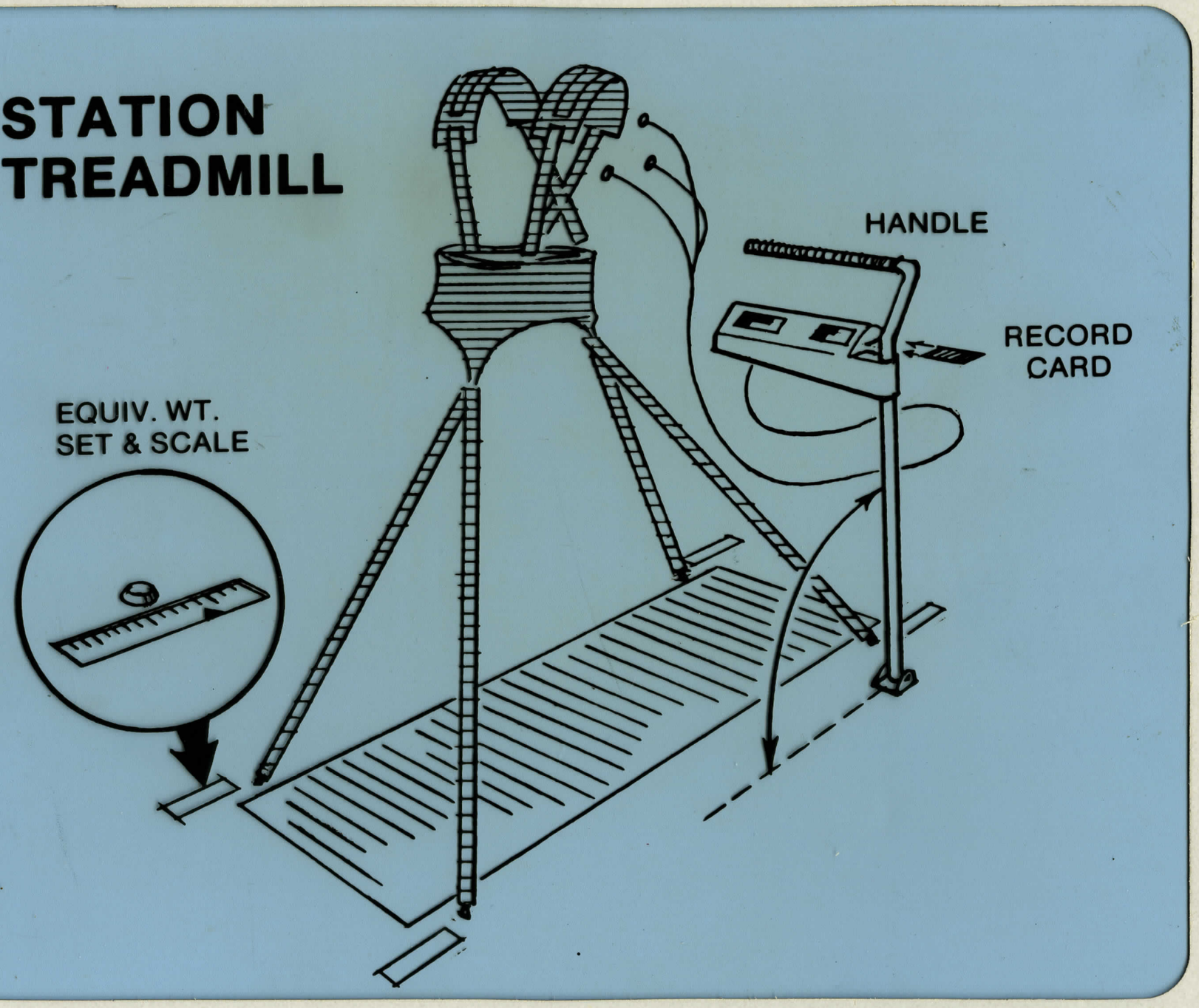
STATION TREADMILL



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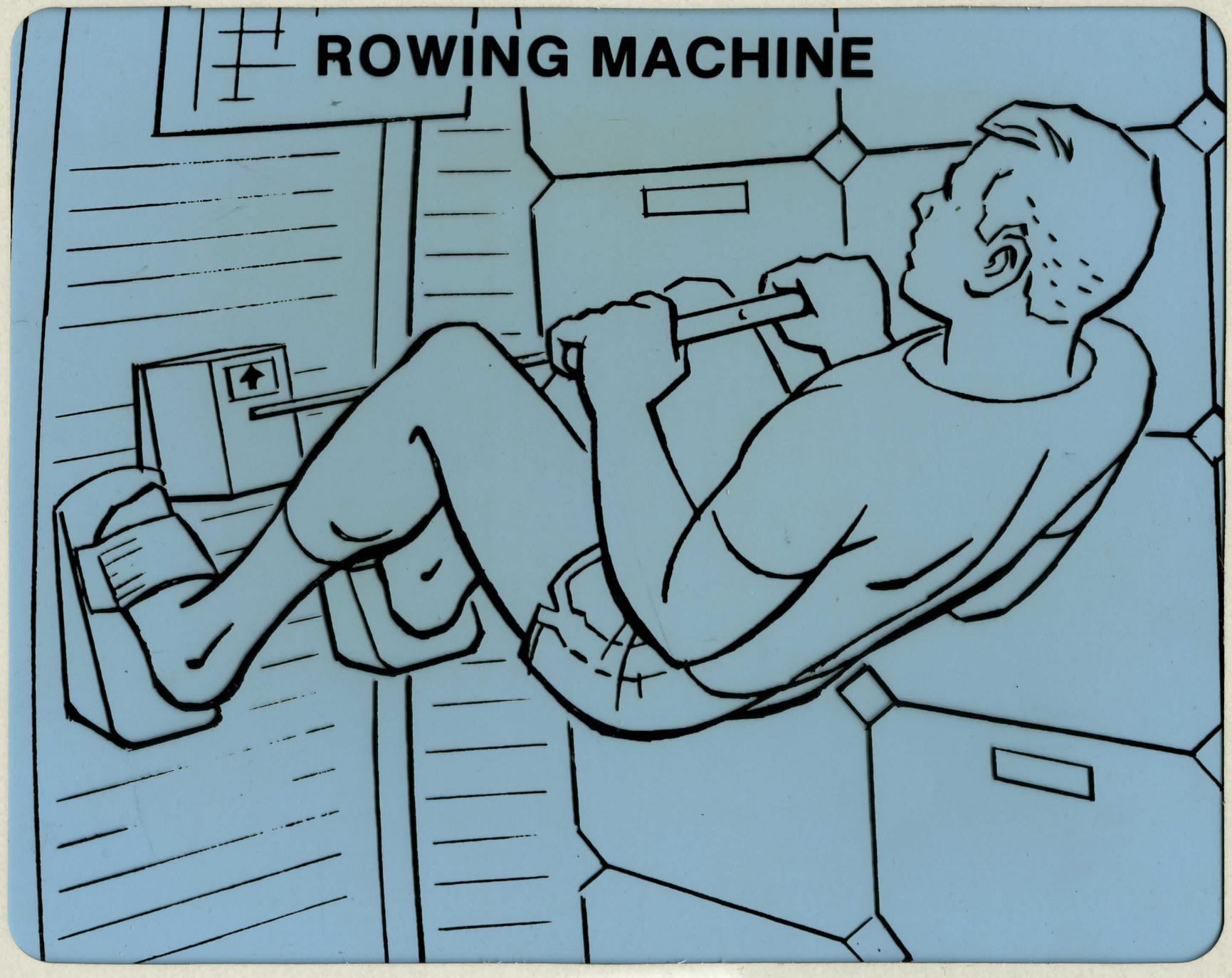

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ADAPTATION TO WEIGHTLESSNESS

PRIMARY MECHANISM	ADAPTATION	COUNTERMEASURE
ALTERED NEUROLOGICAL INPUTS		
VASCULAR PRESSURES	?	?
REDUCED & ALTERED LOADS ON SOMATO-SENSORY INPUTS, ESPECIALLY MUSCLE	NEW OPERATING POINTS (?)	EXERCISE $\bar{c}$ 1g EQUIVALENT LOADS
DISUSE OF COORDINATION FUNCTIONS, ESP LOCOMOTOR	? REDUCED EFFICIENCIES	EXERCISE FUNCTIONS
VESTIBULAR	? CNS REPROGRAMMING	NONE

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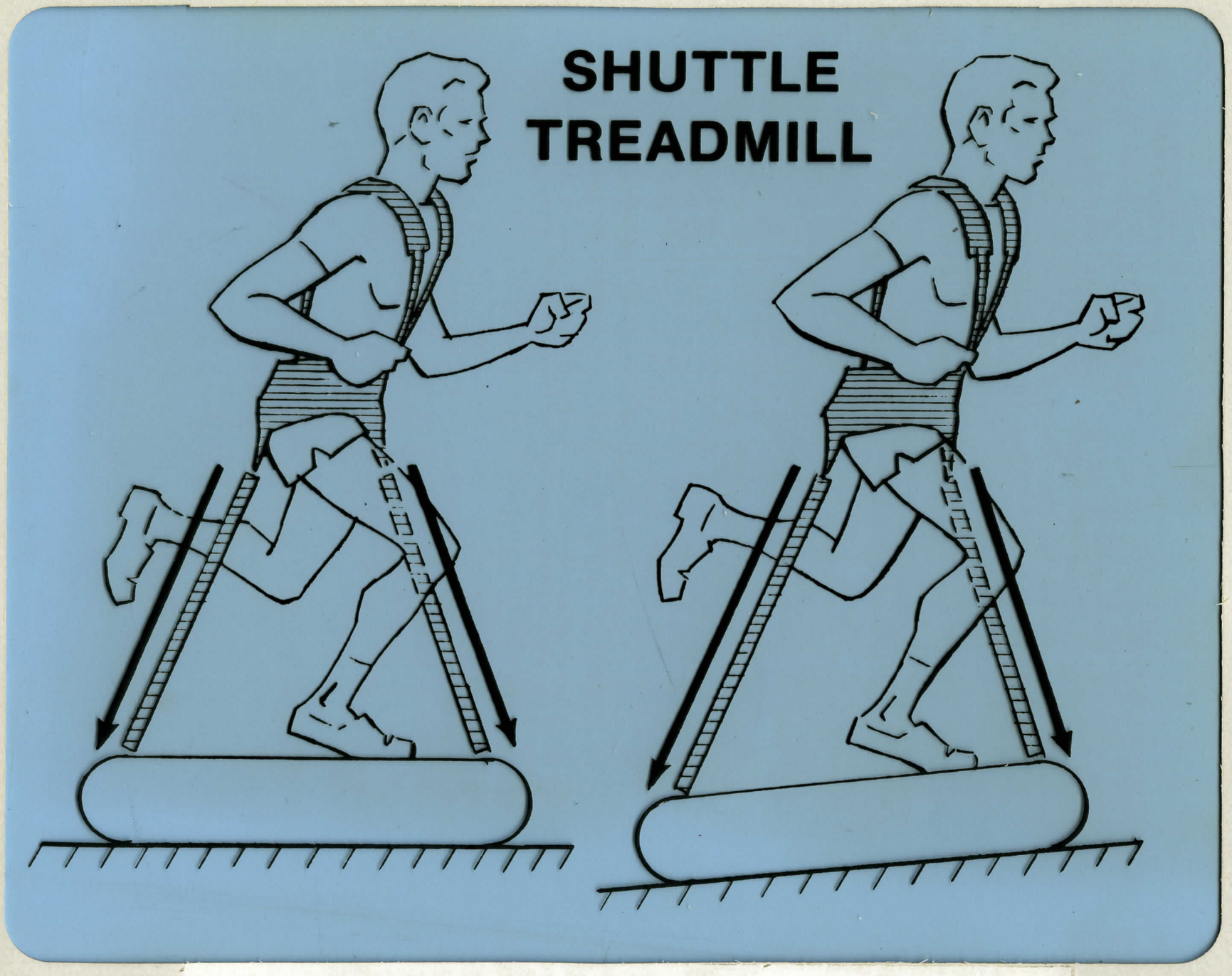
SHUTTLE TREADMILL



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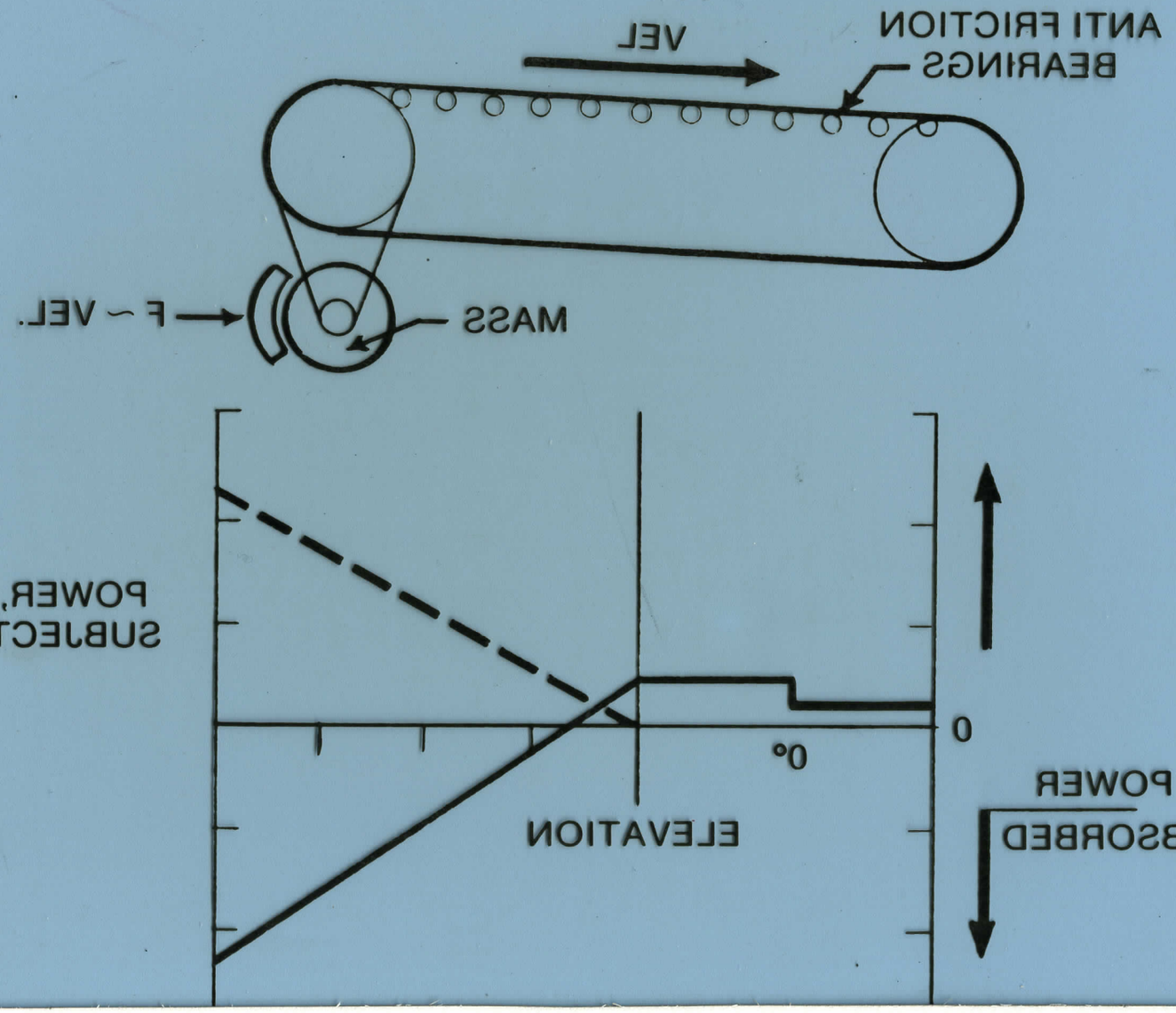
SHUTTLE TREADMILL ON EARTH



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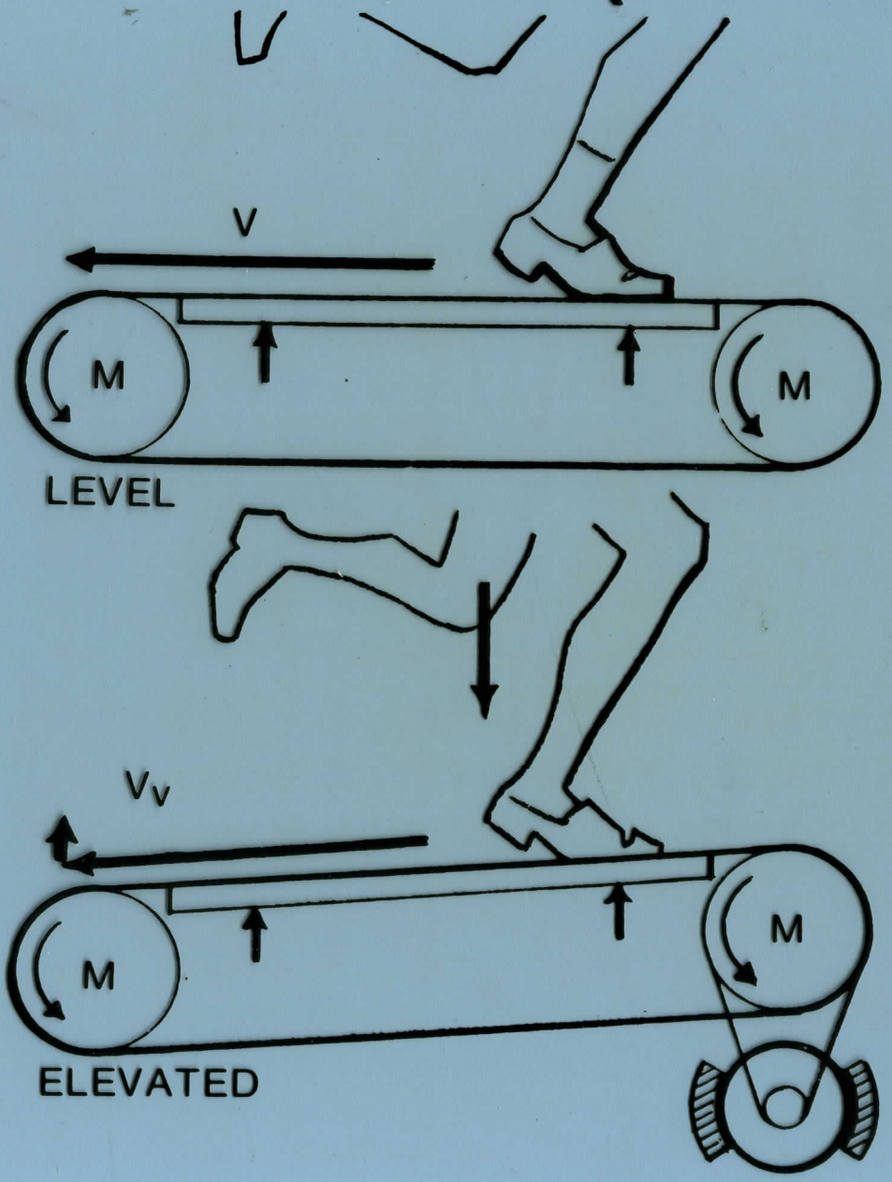
IDEAL TREADMILL (NO FRICTION)



EXTERNAL WORK = 0

MOTOR IS REQUIRED TO CHANGE SPEED

EXT. WORK = V_V TIME WT.

BRAKE IS REQUIRED TO ABSORB ENERGY

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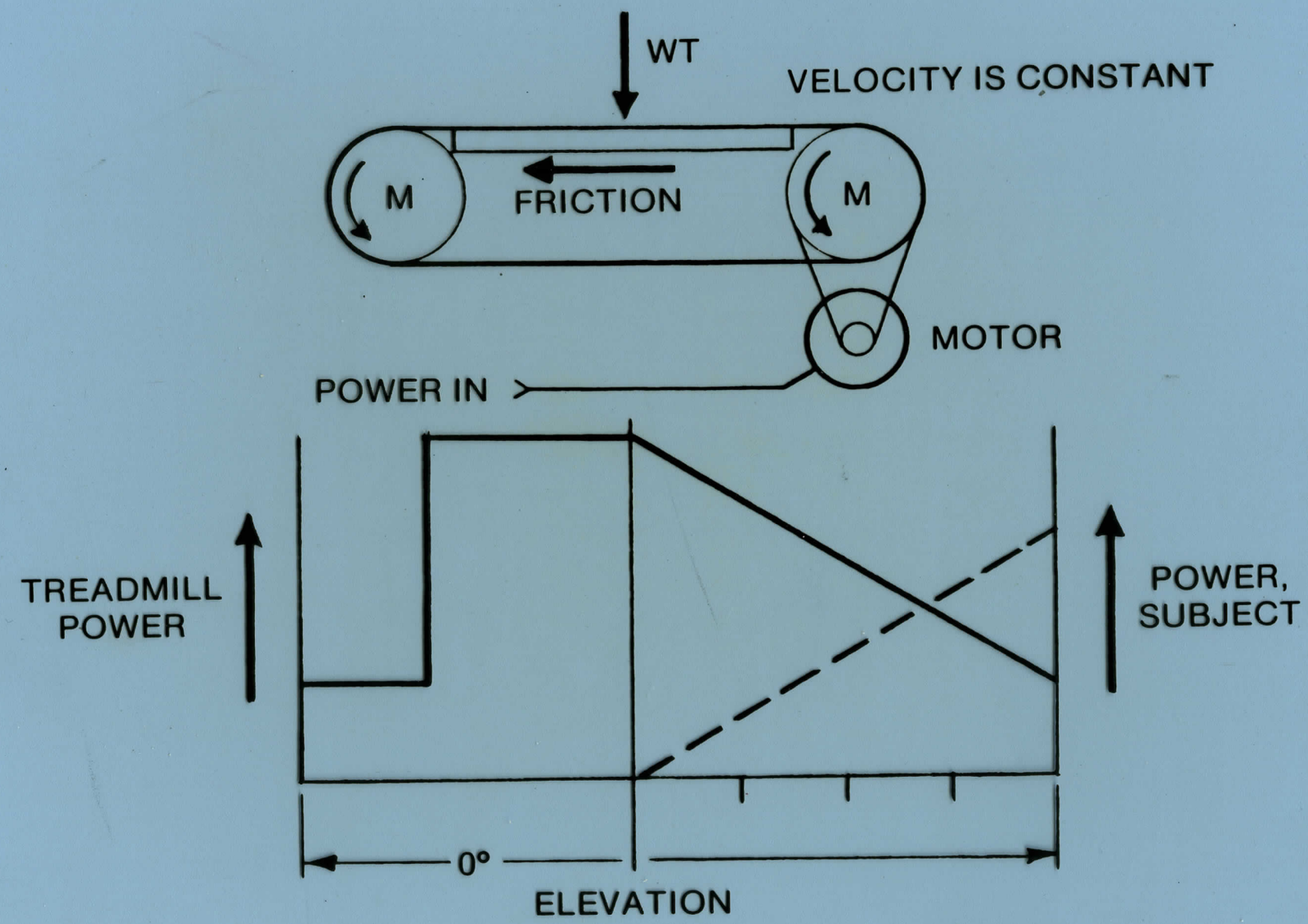
ACTUAL 1g TREADMILL



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ELEMENTARY TREADMILL THEORY - EARTH

TREADMILL MUST SUPPLY -

- VERTICAL LOAD SUPPORT
- HORIZONTAL MOVING SURFACE
- ADEQUATE HORIZONTAL MASS (INERTIA)

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ADAPTATION TO WEIGHTLESSNESS

PRIMARY MECHANISM	ADAPTATION	COUNTERMEASURE
LOSS OF HYDROSTATIC PRESSURE	SHIFT AND LOSS OF .5 - 1 L BLOOD	EXERCISE WITH LARGE METABOLIC LOADS TO PREVENT ADDITIONAL VOL REDUCTION
	SHIFT AND LOSS OF 2 - 3+ L OF FLUID FROM LEGS	'PRIME' SYSTEM BY ORAL INTAKE OF WATER & ELECTROLYTES PRIOR TO ENTRY
		SHIFT FLUIDS TO LEGS PRIOR TO ENTRY
	FACIAL & MUCOSAL EDEMA	

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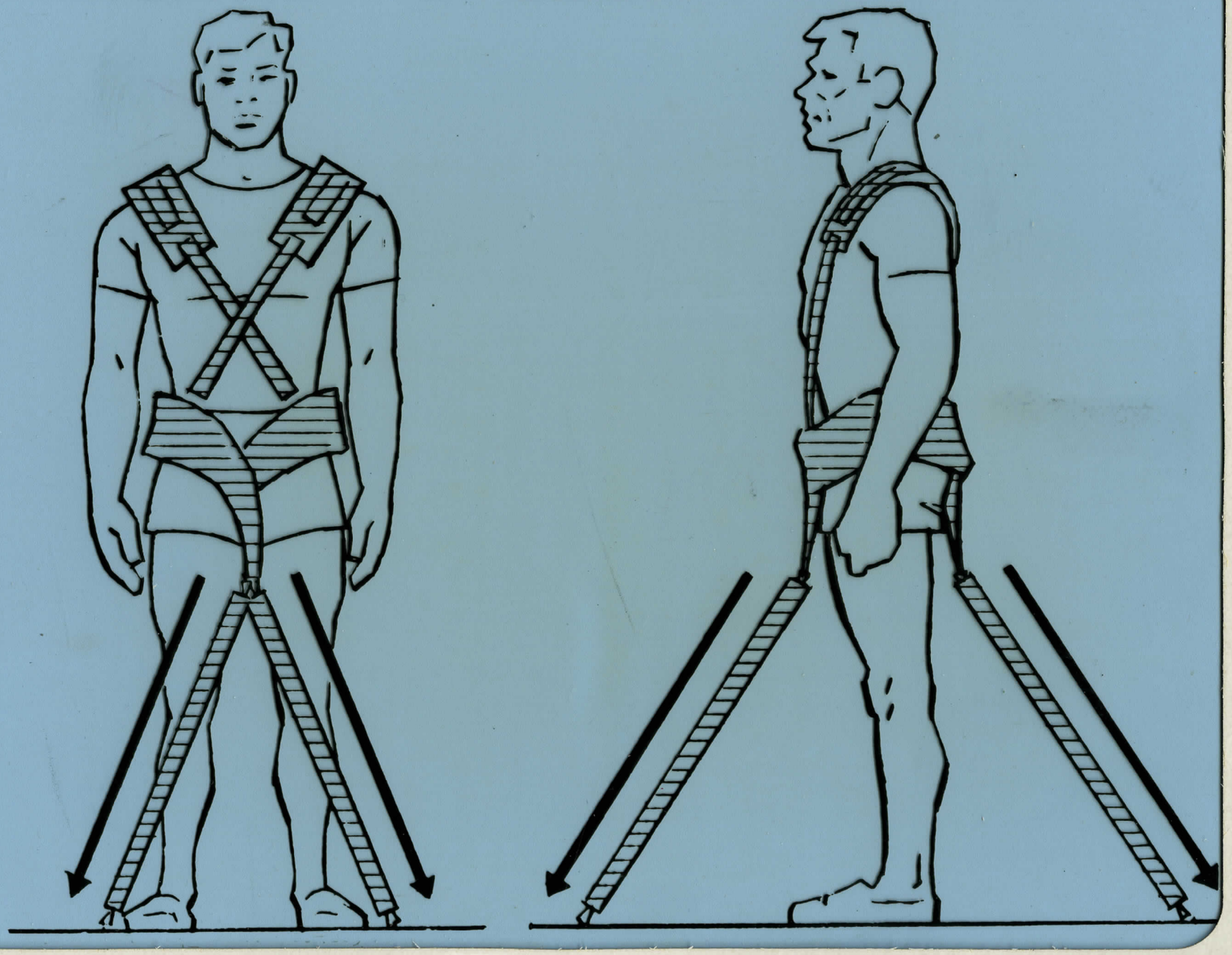
APPLICATION OF SUBSTITUTE FORCE



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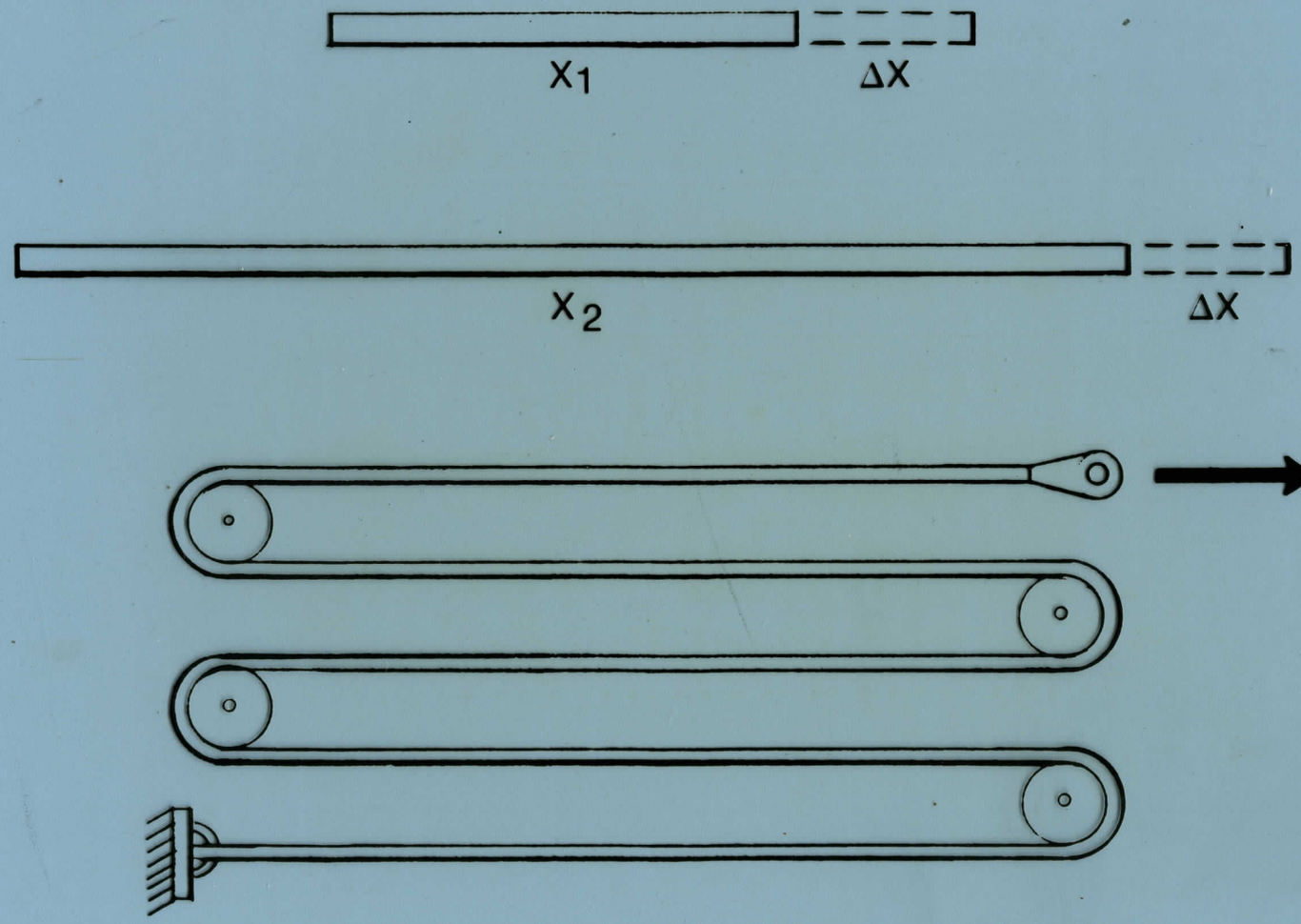
PRACTICAL FORCE GENERATOR



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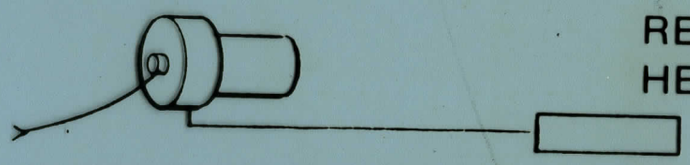
SUBSTITUTION FOR GRAVITATIONAL FORCES

GENERATION OF CONSTANT FORCES (F = K)

- CONSTANT FORCE (NEGATOR) SPRINGS

HEAVY, LIMITED LIFE

- CONSTANT FORCE MOTORS



REQUIRE POWER, HEAVY, COMPLEX

- APPROXIMATION OF CONSTANT FORCE WITH ELASTIC CORDS — (BUNGEES)

$F = KX \quad F_0 + \Delta F = K(X + \Delta X)$ FOR ΔF TO BE SMALL $\Delta X \ll X_1$

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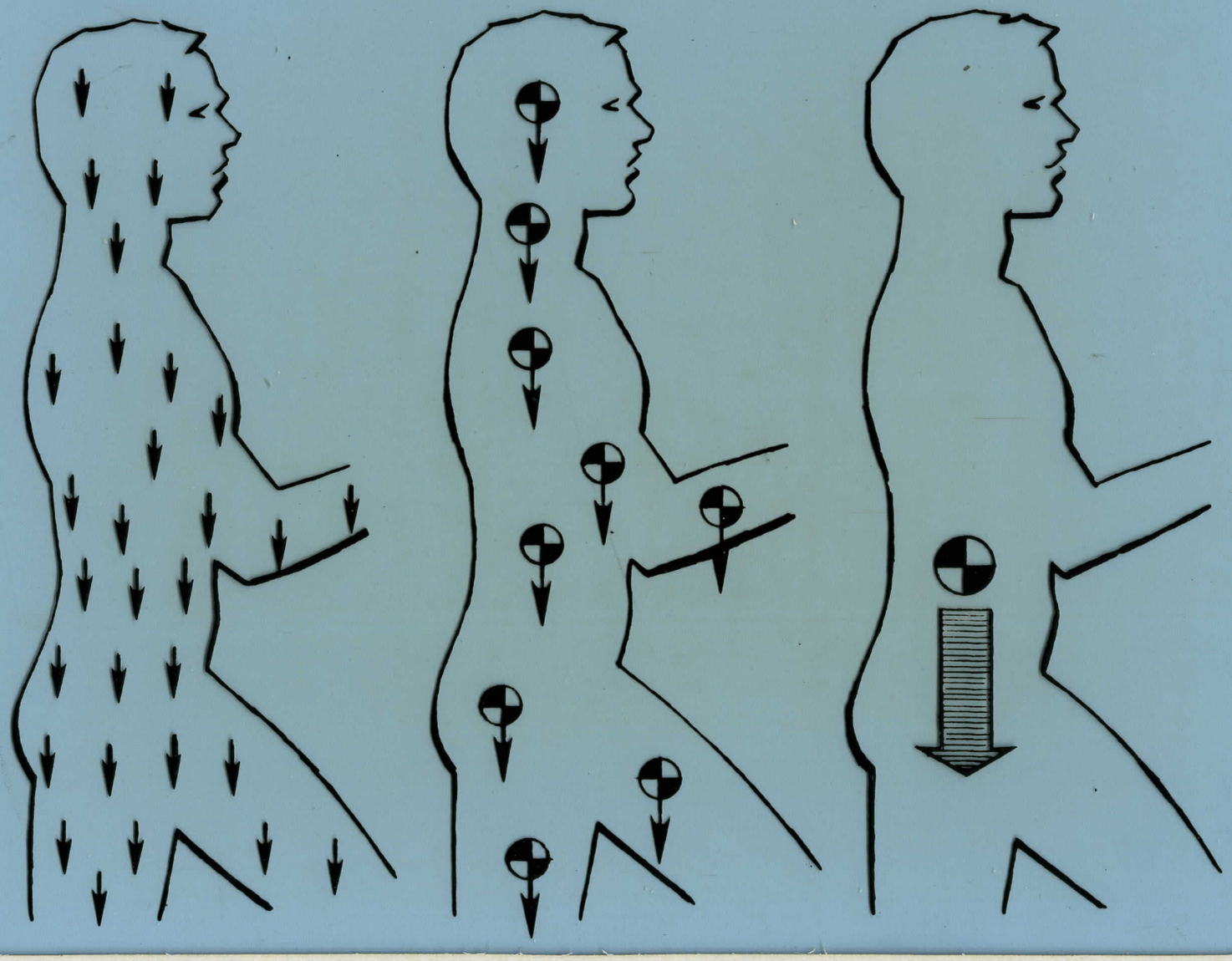
GRAVITATIONAL FORCES



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FORCES FREQUENTLY ENCOUNTERED

ELASTIC (SPRING)

$F_3 = K_{sp} \cdot \text{DISPLACEMENT}$

VISCOUS

$F_4 = K_v \cdot \text{VELOCITY}^N$

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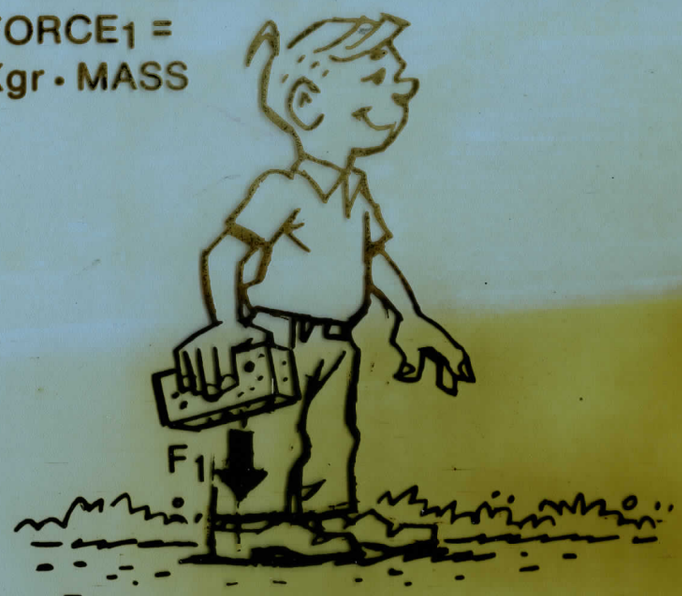
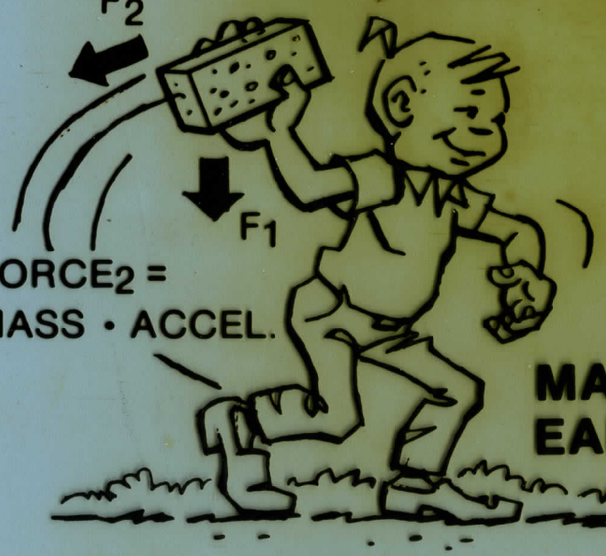
FORCES FREQUENTLY ENCOUNTERED

FORCE$_1$ =
Kgr • MASS



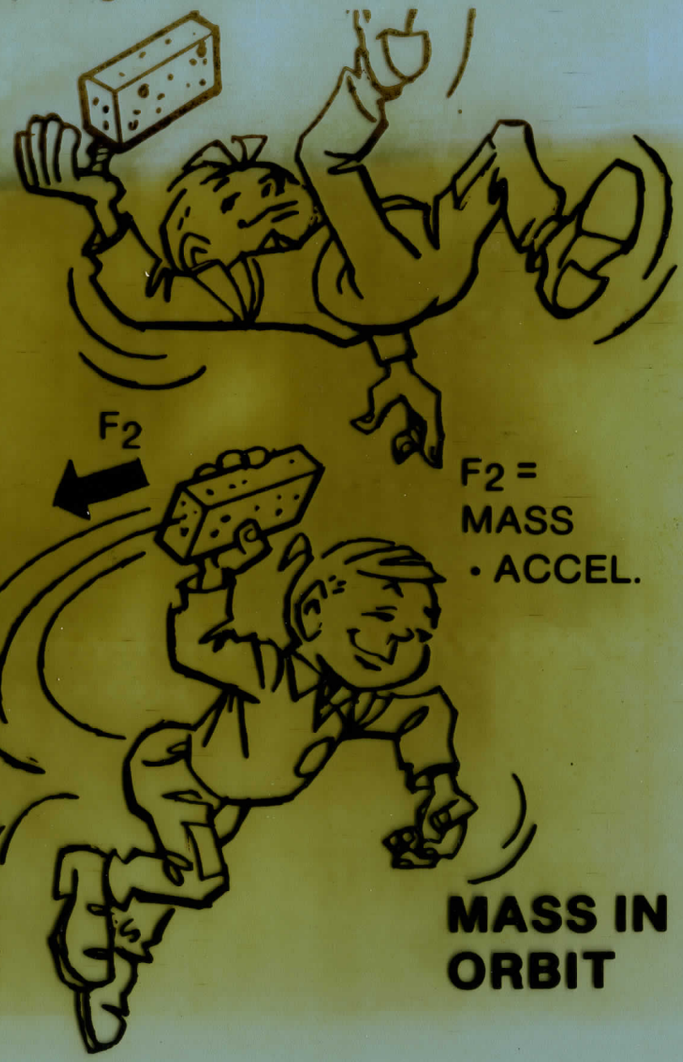
F$_2$



FORCE$_2$ =
MASS • ACCEL.

MASS ON
EARTH

FORCE$_1$ = Kgr • MASS - MASS • ACCEL. = 0



F$_2$ =
MASS
• ACCEL.

MASS IN
ORBIT