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VCE Physics Unit 3

Area Of Study 1, Motion In One And Two Dimensions, Study Notes 8

Apparent Weight

Apparent weight is the weight that is *experienced,* the weight a person *seems* to be or *feels*, when under acceleration that's additional to that of gravity. It is a consequence of the normal reaction force acting against their actual weight in accordance with Newton's third law of motion. When there's no accelerations other than those due to gravity, this normal reaction force, and therefore apparent weight, is equal in magnitude (although opposite in direction) to actual weight, because one cancels the other out, making the net force zero:

Where F_W = Weight force, in N

F_N = Normal reaction force, **and apparent weight**, in N

m = mass, in kg

g = acceleration due to gravity, -9.8 or -10 ms^{-2}

$$\vec{F}_W = m\vec{g}$$

$$\vec{F}_{net} = \sum \vec{F} = m\vec{g} + \vec{F}_N$$

The normal reaction force, and thereby the apparent weight, is altered when there's acceleration acting in addition to those of gravity. If the force causing the acceleration is in an upwards direction it will add to the normal reaction force, making apparent weight greater (a person will "feel heavier"). If the force causing the acceleration is in a downwards direction it will subtract from the normal reaction force, making apparent weight less.

Where a = acceleration other than gravity, in ms^{-2} [**consider as negative if in a downward direction**]

$$\vec{F}_{net} = \sum \vec{F} = m\vec{g} + \vec{F}_N$$

$$\therefore m\vec{a} = m\vec{g} + \vec{F}_N$$

$$\rightarrow \vec{F}_N = m\vec{a} - m\vec{g}$$

[**Note that a and g are vectors! Use negative for down and positive for up.** Otherwise, draw a diagram and resolve the vectors.]

A negative result for F_N would indicate that apparent weight is experienced in an upward direction.

See the next page for table that exemplifies this concept of apparent weight.

For a person travelling in an elevator:

Description of motion	**Direction of motion**	**Direction of acceleration**	**Apparent weight** (qualitative, relative to being stationary)	**Quantified explanation** (Using F_N=ma-mg, considering a person of m=$70kg$, g=$^-10ms^{-2}$ and accelerations of magnitude = $3ms^{-2}$)
Getting faster upwards	Up	Up (positive)	More	$70(3)-70(^-10)=$**910N**
Getting slower upwards	Up	Down (negative)	Less	$70(^-3)-70(^-10)=$**490N**
Getting faster downwards	Down	Down (negative)	Less	$70(^-3)-70(^-10)=$**490N**
Getting slower downwards	Down	Up (positive)	More	$70(3)-70(^-10)=$**910N**
Constant velocity	Irrelevant	None	Same as actual weight	$70(0)-70(^-10)=$**700N**
Stationary	Not applicable	None	Same as actual weight	$70(0)-70(^-10)=$**700N**
Snapped cable: "free fall"	Down	Down (negative)	Zero	$70(^-10)-70(^-10)=$ **0N**

Apparent Weightlessness And Free Fall

Apparent weightlessness is experienced by a mass in free fall. This is when F_{net} is equal to F_W (or mg is equal to ma). Weight force caused by acceleration due to gravity is not "felt" when in free fall because there's nothing to apply the normal reaction force:

$$\vec{F}_N = 0 = apparent\ weight$$

$$\therefore \vec{F}_{net} = \sum \vec{F} = m\vec{g} + 0 = m\vec{a}$$

$$\therefore \vec{F}_{net} = \vec{F}_W\ (because\ m = m,\ a = g\ \ and\ \ \vec{F}_N = 0)$$