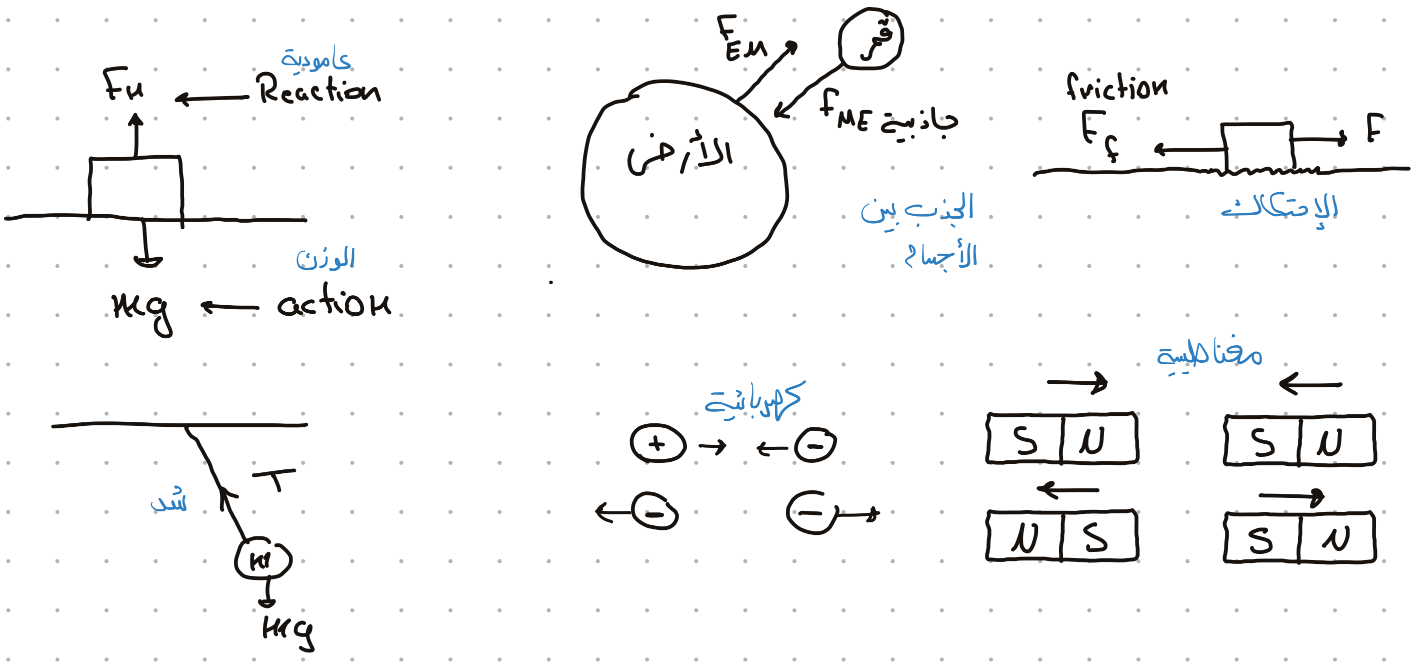
# FORCE ch.2 القوى

## أمثلة عن القوى :




## Kind of forces:

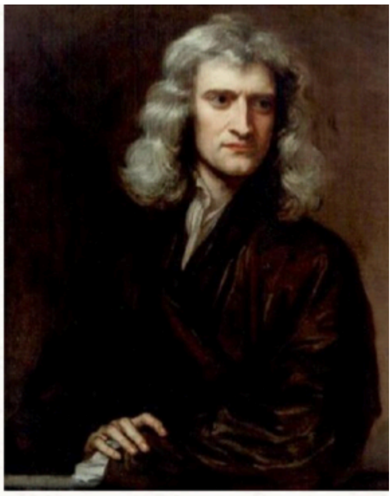
- Fundamental force أساسيات
  - * Gravitational
  - * electromagnetic
  - * weak nucleur
  - * strong nucleur

- Derived force مشتقات
  - * friction → الإحتكاك: من تنافر الإلكترونات
  - * normal

عبارة عن أكثر من قوة أساسية

## Newton's laws of motion

- They are three physical laws that, together, laid the foundation for classical mechanics.
- They describe the relationship between a body and the forces acting upon it, and its motion in response to those forces.
- More precisely, the first law defines the force qualitatively, the second law offers a quantitative measure of the force, and the third asserts that a single isolated force doesn't exist.

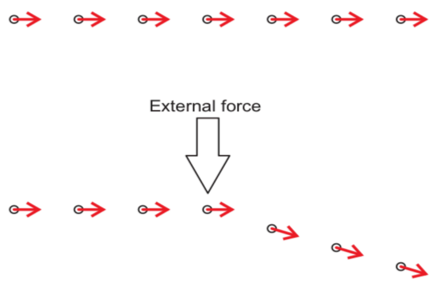


Newton's first law states that any object continues at rest, or at constant velocity (constant speed in a straight line), unless an external force acts on

$\Sigma F_x = 0 \rightarrow$ حالة إتزان

*ما في تسارع ← $a = 0$

إذا كان الجسم في حالة ساكنة أو يتحرك بسرعة ثابتة في خط مستقيم ، فإنه سيبقى في حالة ساكنة أو يستمر في التحرك في خط مستقيم بسرعة ثابتة ما لم تؤثر به قوة خارجية تجبره على تغيير ذلك .




Newton's Second Law :An external force gives an object an acceleration. The acceleration produced is pro- portional to the force applied, and the constant of proportionality is the mass.

تسارع أي جسم ناتج عن قوة مؤثرة عليه، يتناسب تناسباً عكسياً مع كتلة الجسم، وطردياً مع مقدار القوة وفي نفس اتجاهها

$F = ma$

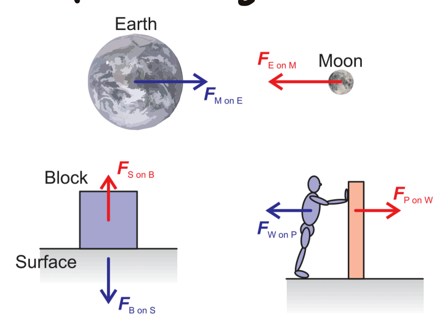
$W = mg$

$N = \frac{kg \cdot m}{s^2}$

Newton's Third Law

For every action there is an equal and opposite reaction.

$F_1 = -F_2$




Gravitational force قانون الجذب العام :

بين أي جسمين يوجد قوى جذب

$$F_{12} = \frac{G m_1 m_2}{r^2} \rightarrow F = mg$$

where $g = \frac{G m_{\text{الأرض}}}{r^2}$

fraction force

$f = \mu F_N$

↳ معامل الاحتكاك

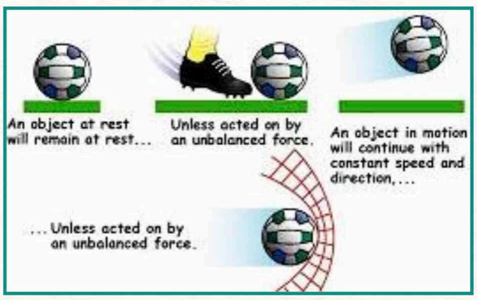
## Newton First Law

- How can an object move when it is experience zero net force?

**Because it was already moving!**

An object with no net force on it continues in its existing motion. If in motion, it continues to move with a constant velocity. If at rest, it remains at rest.

**Force does not cause velocity**. It cause **change** on object's velocity (acceleration).



**Example 2.1** ***A box on a box***

**Problem:**

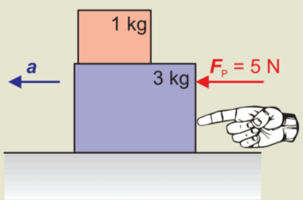



**Figure 2.4** Two boxes being pushed along a frictionless surface

As shown in Figure 2.4, a large 3 kg box is being pushed with a horizontal force of $F_P$ = 5 N and as a result is accelerating along the horizontal frictionless surface upon which it rests. The large box has a smaller 1 kg box resting on top of it. This box does NOT slide from the top of the big box as it accelerates.

(a) At what rate are the boxes accelerating?

(b) What are the magnitudes and directions of the friction forces acting on each box?

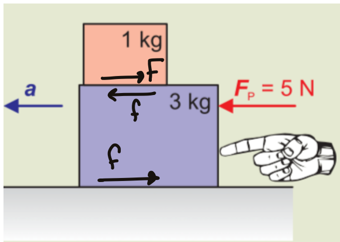
(c) What are the magnitudes and directions of the normal forces acting on each box?

$F = 5N \quad m = 3 \quad m = 1$

(a) $F = ma \rightarrow 5 = 4 * a$

$a = 1.25\ m/s^2$

(b) الصندوق الكبير → الإحتكاك عكس إتجاه القوة العادية و إذاً $\overrightarrow{f}$




حسب قانون نيوتن الثالث

↳ $F = -f \rightarrow f = ma$

$1 * 1.25$

$= 1.25\ N$

السؤال مغلوط ف skip
لأنه في إحتكاك بين الصندوق الكبير مع الأرض
و إحتكاك الصندوق الكبير مع الصغير
و إحتكاك الصندوق الصغير مع الكبير

(c) $\Sigma F_y = 0 \xrightarrow{\text{normal force}} N = W$

الصندوق الصغير → $N = mg \rightarrow 10\ N$

الصندوق الكبير → $N = (m_1 + m_2) g \rightarrow 40\ N$

↳ لأنه وزن الصندوق الصغير بأثر

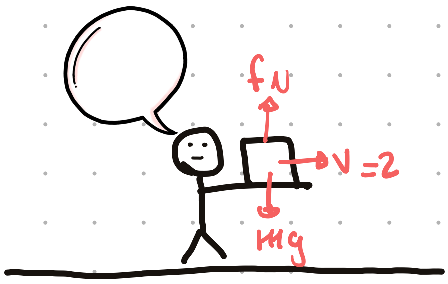
**2.1** A courier is delivering a 5 kg package to an office high in a tall building.

(a) What upwards force does the courier apply to the package when carrying it horizontally at a constant velocity of $2\,\mathrm{m\,s^{-1}}$ into the building?

(b) The courier uses the elevator to reach the office. While the elevator (containing the courier who is holding the package) is accelerating upwards at $0.11\,\mathrm{m\,s^{-2}}$ what upwards force is the courier applying to the package?

(c) When the elevator is traveling upwards at a constant speed of $6\,\mathrm{m\,s^{-1}}$ what upwards force does the courier apply to the package?

(d) In order to stop at the correct floor the elevator accelerates downwards (decelerates) at a rate of $0.20\,\mathrm{m\,s^{-2}}$. What is the upwards force the courier applies to the package during the deceleration?




Answer: (a) Taking upwards as the positive direction, $F_{app} = 50\,\mathrm{N}$, (b) $F_{app} = 50.55\,\mathrm{N}$, (c) $F_{app} = 50\,\mathrm{N}$, d) $F_{app} = 49\,\mathrm{N}$

(1) $\Sigma F_y = 0 \rightarrow$ فش تسارع

$\Sigma F = N - mg$

$0 = N - 5 * 10 \Rightarrow N = 50\,N$ للأعلى

(2) $\Sigma F_y = ma$ ← تسارع المصعد

$N - mg = ma$

$N = ma + mg$

$(5 * 0.11) + (5 * 10) = 50.55\,N$ للأعلى

(3) سرعة ثابتة ← $0 = a$

$f_N - mg = ma = 0$

$f_N = mg = 5(10) = 50\,N$

(4) $\Sigma F_y = ma$

$N - mg = ma$

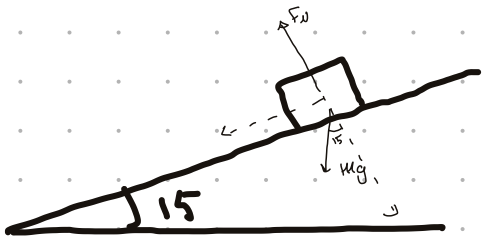
$N = ma + mg \rightarrow 5(-0.22) + 5(10)$

$= 49\,N$

**2.2** You live at the top of a steep (a slope of 15° above the horizontal) hill and must park your 2200 kg car on the street at night.

(a) You unwisely leave your car out of gear one night and your handbrake fails. Assuming no significant frictional forces are acting on the car, how quickly will it accelerate down the hill?

(b) The increase in insurance premiums due to the results of your mistake mean that you cannot afford to fix your handbrake properly. You resolve to always leave your car in gear when parked on a slope. If the rolling frictional force caused by leaving the drive-train connected to the wheels is 5000 N, at what rate will your car accelerate down the hill if the handbrake fails again?




لازم تقنع نفسك أنه الزاوية 15

a) $F_x = mg \sin 15 = ma_x$

$a_x = g \sin 15 = 2.6 \ m/s^2$

b) $\Sigma F_x = mg \sin 15 - f = ma_x$

$a_x = g \sin 15 - \frac{f}{m}$

$= 10 \sin 15 - \frac{5000}{2200}$

$2.6 - 2.27 = 0.33 \ m/s^2$

**2.8** During a car crash a 65 kg person's head goes from travelling at 50 km $h^{-1}$ to stationary in 0.15 s.

(a) What is the magnitude of the average net force acting on the head of a person with a 4.5 kg head?

(b) How does this compare with the weight force acting on the person?

(a) $v_f = v_i + at$

$0 = \frac{50 \times 1000}{3600} + a(0.15)$

$a = -925 \ m/s^2$

$\frac{F_H}{mg} = \frac{416.6}{65(10)} = 0.64$ times

**2.9** A 10 kg box is being pushed up a slippery ramp as shown in Figure 2.1. The coefficient of friction between the box and the ramp is just $\mu = 0.1$.

(a) What force does the man need to apply to the box to keep it traveling up the ramp at a steady speed?

(b) What fraction of the weight force of the box is this?

If the angle of the ramp is raised to 45° then:

(c) What force does the man need to apply to the box to keep it traveling up the ramp at a steady speed now?

(d) What fraction of the weight force of the box is th

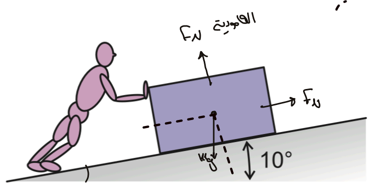



**Figure 2.1** A box is pushed up a ramp

Answer: (a) 27 N (b) 0.27 × $mg$ (c) 78 N (d) 0.78 × $mg$

a) $F_{net_x} = F - f - mg \sin\theta = 0$

$F_y = F_N - mg\cos\theta = 0 \Rightarrow F_N = mg\cos\theta$

$f = \mu F_N = \mu mg \cos\theta$

$F = mg \sin\theta + \mu mg \cos\theta$

$10(10)\sin 10 + 0.1(10)10\cos 10$

$17.36 + 9.848$

$= 27.2 N$

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b) $\frac{F}{mg} = \frac{27.2}{100} = 0.272$

c) $F = 10(10)\sin 45 + 0.1((10)(10))\cos 45$

$= 77.8N$

**2.10** A 1.6 kg chicken is blown into a wall by a strong gust of wind, and held there as shown in Figure 2.2. If the maximum coefficient of friction between the chicken and the wall is $\mu_{max} = 0.25$, what minimum force must the gust of wind be applying to the chicken?

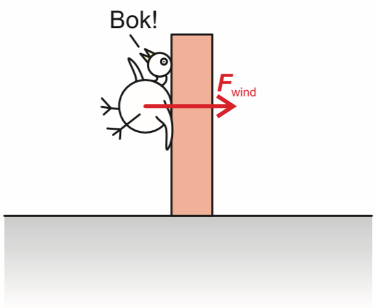


**Figure 2.2** A chicken is blown into a wall.

Answer: $F_{wind} = 64$ N