قوانین سه گانه نیوتن:

قانون اول: اگر به جسمی نیروی وارد نشود سرعت جسم تغییر نمی‌کند. (اگر ساکن باشد، ساکن می‌ماند و اگر متحرک باشد با سرعت ثابت به حرکت خود ادامه می‌دهد)

قانون دوم: اگر به جسمی نیروی وارد شود شتابی به آن می‌دهد که با نیرو راستا، هم‌جهت و با جرم جسم رابطه عکس دارد:

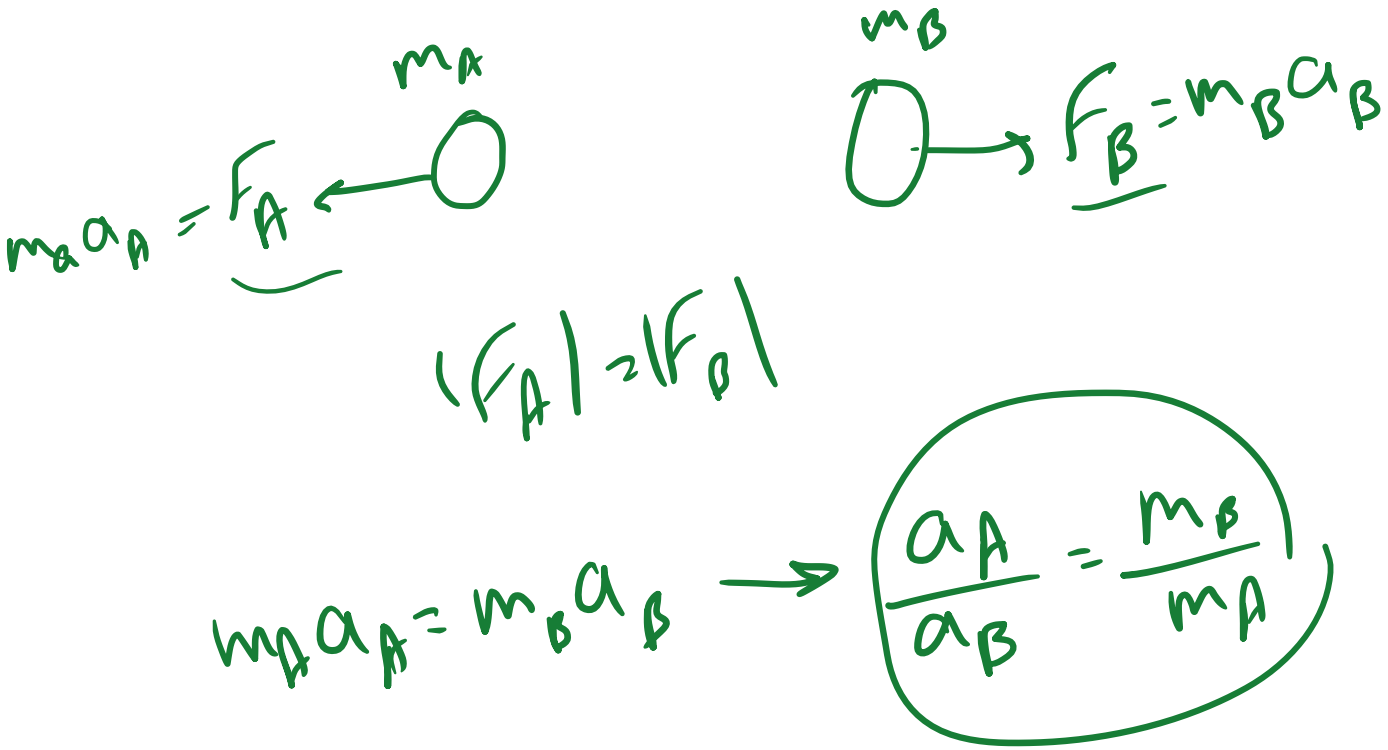
$$a = \frac{F}{m} \qquad (F = ma)$$

قانون سوم: اگر یک جسم به جسم دیگری نیرو وارد کند، جسم دوم نیز نیرویی برابر با همان نیرو ولی در خلاف جهت به آن وارد می‌کند

$$|F_{12}| = |F_{21}|$$

An isolated system is made of two point masses m_A and m_B.
Therefore, the acceleration of each mass is caused only by the force exerted by the other mass, and not by external forces.
Let a_A and F_A be the magnitude of the acceleration and of the net force acting on m_A, and a_B and F_B the magnitude of the acceleration and of the net force acting on m_B.
Then, at every time t,

- A. $a_A = a_B$
- ✓ B. $\frac{a_A}{a_B} = \frac{m_B}{m_A}$
- C. $\frac{a_A}{a_B} = \frac{F_A}{F_B}$
- D. $\frac{a_A}{a_B} = \frac{m_A}{m_B}$
- E. $\frac{a_A}{a_B} = \frac{F_B}{F_A}$

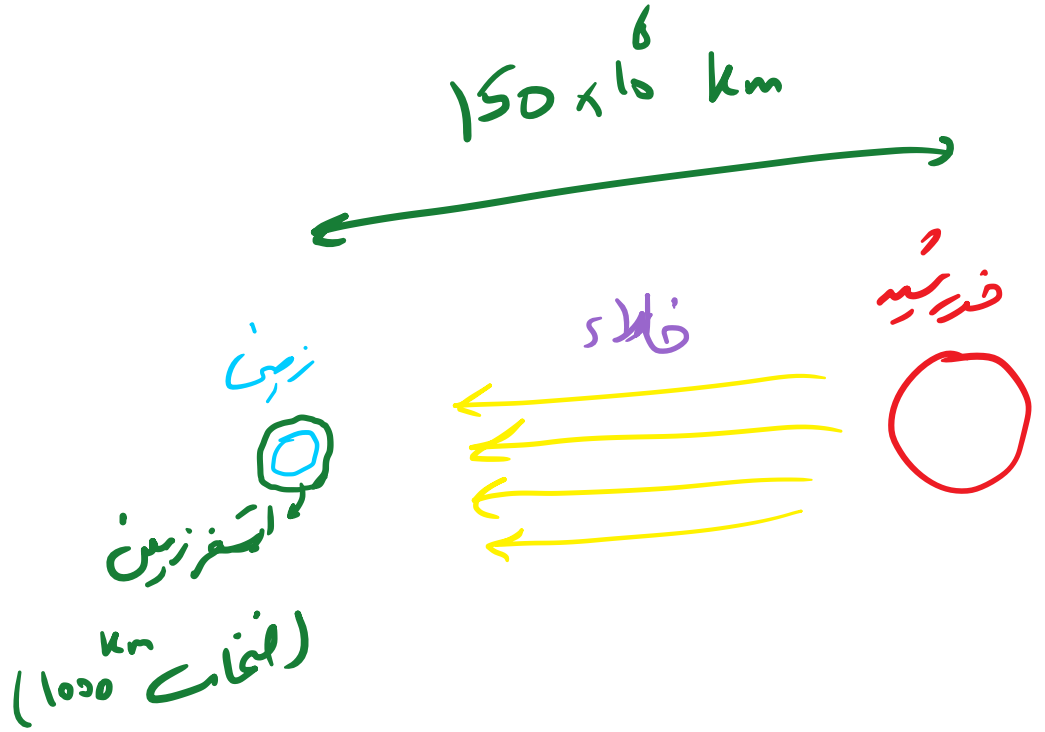


A manometer is used to measure

- A. the pressure
- B. a length of order of magnitude $10^{-9}m$
- C. the volumetric flow rate
- D. the density of a liquid
- E. a length in inches

The light reaching us from the stars mostly propagates

- A. through interstellar hydrogen
- B. through interstellar dust clouds
- C. in the ether
- D. through the atmosphere
- ✓ E. in vacuum



A temperature of $100^\circ C$ (degrees Celsius) is equivalent to

- A. $273.15\ K$
- B. $-100\ K$
- ✓ C. $373.15\ K$
- D. $293.15\ K$
- E. $100\ K$

°C | K

0 | 273.15

°C + 273.15 → K (كلفن)

$100^{\circ}C + 273.15 = 373.15\ K$

A charged particle is travelling through a magnetic field. Can this particle move on a straight line?

ذره باردار

میدان مغناطیسی

- A. No, the trajectory is always curved
- B. Yes, but only if the particle starts from rest
- C. Yes, unless the velocity of the particle is parallel to the direction of the magnetic field
- ✓ D. Yes, if the velocity of the particle is parallel to the direction of the magnetic field
- E. Yes, if the velocity of the particle is perpendicular to the direction of the magnetic field

به جز حالتی

سرعت

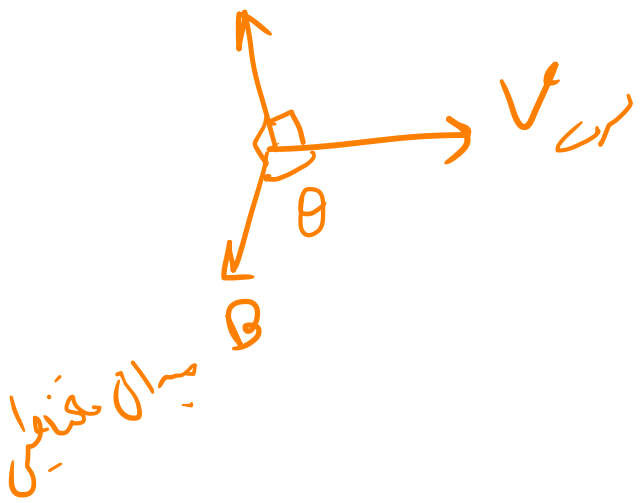
موازی

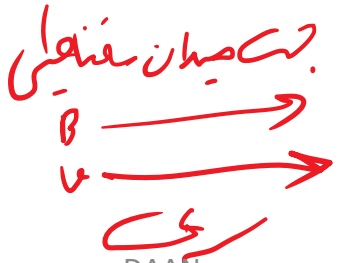
«اگر»

عمود

$F = qVB\sin\theta \rightarrow \theta = 0 \rightarrow$

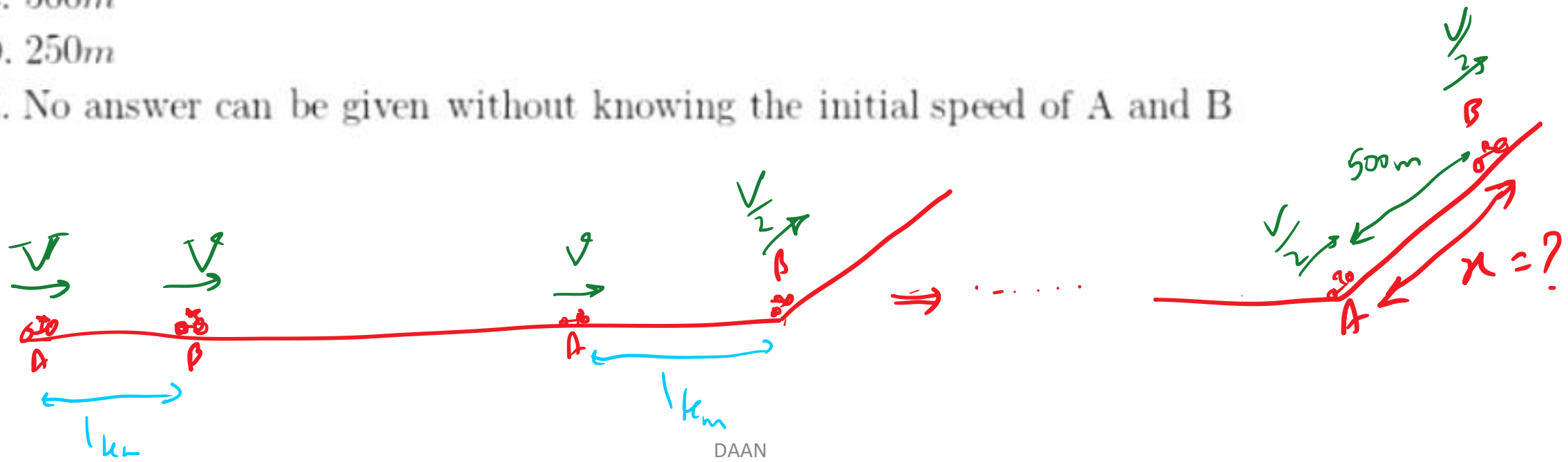
اگر V و B در امتداد هم یا خلاف جهت بر جسم وارد نمی‌شود پس جسم در امتداد خط مستقیم می‌تواند به حرکت خود ادامه دهد.





A cyclist A follows another cyclist B at a distance of $1km$, and the two cyclists proceed at the same speed. Suddenly the road begins to climb with a constant slope. If we assume that both cyclists halve their speed when they start to climb, what is their distance when they both reach the sloping part of the road?

- A. $2km$
- B. $1km$
- ✓ C. $500m$
- D. $250m$
- E. No answer can be given without knowing the initial speed of A and B



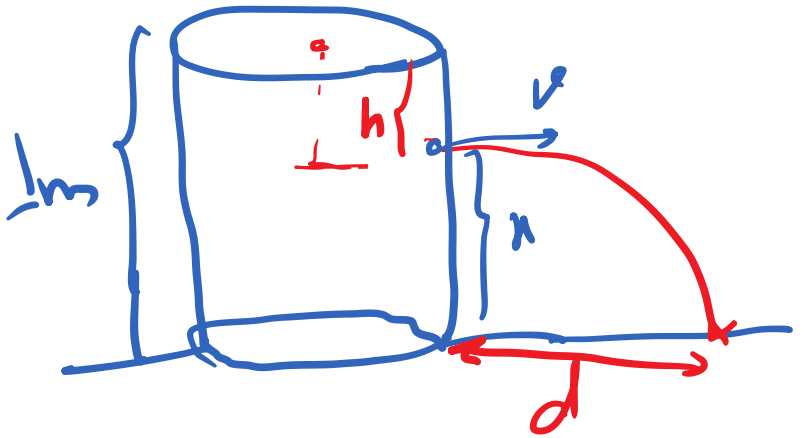
A cylindrical container, placed on a horizontal table, is filled with water up to a height of 1 m. At which height should we make a hole, so that the water jet pouring out of the container hits the table at the largest possible distance from the wall of the cylinder? (Assume that water is an ideal fluid)

- A. $0,65\ m$
- B. $0,45\ m$
- C. $0,50\ m$
- D. $0,25\ m$
- E. $0,75\ m$

تغییر پتانسیل گرانشی = انرژی پتانسیل = انرژی جنبشی

$$mgh = \frac{1}{2}mv^2 \rightarrow v^2 = 2gh$$

$$v^2 = 2g(1-x)$$



$$\frac{2x}{g} = \frac{d^2}{2g(1-x)}$$

$$4x(1-x) = d^2 \rightarrow 4x - 4x^2 = d^2$$

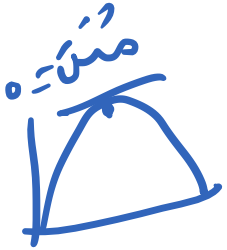
$$d = vt \rightarrow d^2 = v^2t^2$$

$$x = \frac{1}{2}gt^2 + v_0 t$$

ماکزیمم $\Rightarrow$ مشتق $= 0$

$$4 - 8x = 0$$

$$x = 0.5$$



$$\begin{cases} t^2 = \frac{2x}{g} \\ t^2 = \frac{d^2}{v^2} = \frac{d^2}{2g(1-x)} \end{cases}$$

فرآیند آدیاباتیک (گرمایی مبادله نشود) — انرژی داخلی — افزایش

In an adiabatic process the internal energy of an ideal gas increases by 2 J. How much work has been done on the gas?

decrease = کاهش

- A. It is impossible to answer without knowing how the pressure varies during the process
- B. It is impossible to answer without knowing how much heat has been exchanged
- C. 2 J ✓
- D. It is impossible to answer without knowing which type of gas is considered
- E. It is impossible to answer without knowing whether the process is reversible or not

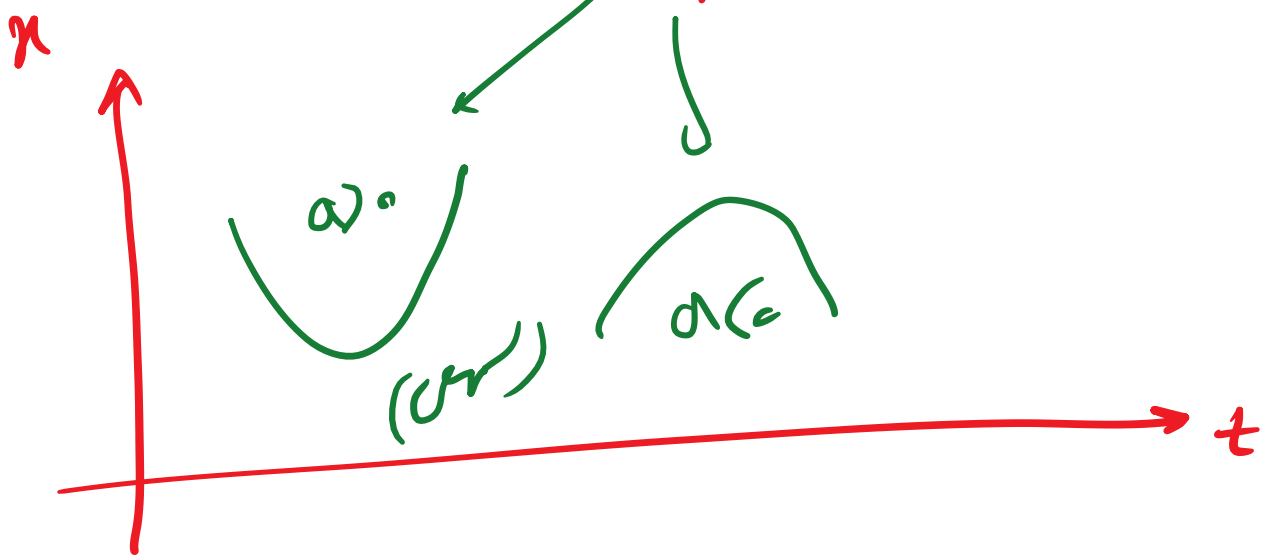
$$\Delta U = Q + W \Rightarrow 2 = 0 + W \rightarrow W = 2\ (J)$$

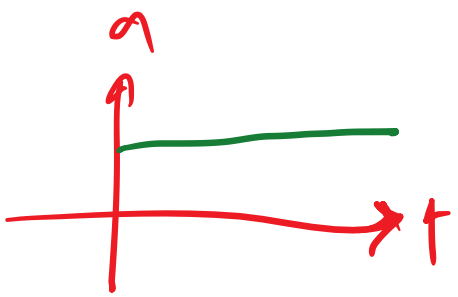
انرژی داخلی — گرمای داده شده به سیستم — کار داده شده به سیستم

2 ژول کار به سیستم داده شده است

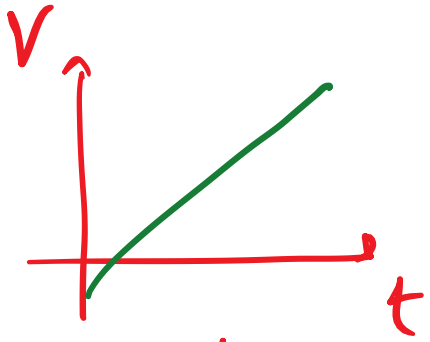
On a graph of displacement versus time, motion along a line with constant acceleration is represented as

- A. a horizontal straight line
- B. a hyperbola
- C. an ellipse
- ✓ D. a parabola
- E. an inclined straight line

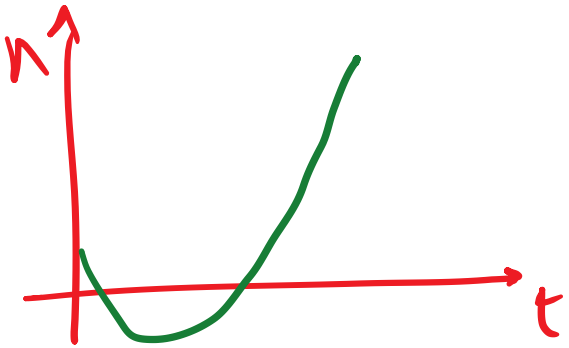




$a = \frac{dv}{dt}$



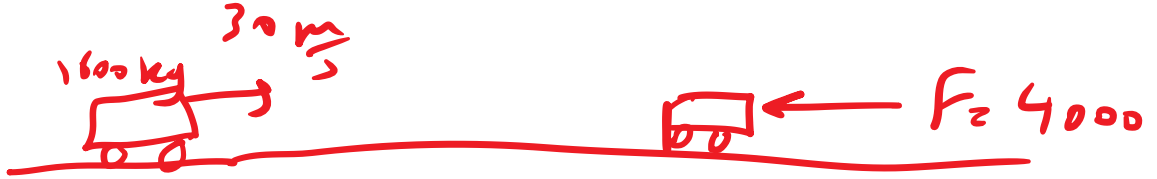
$v = \frac{dx}{dt}$



A car with a mass of $1600kg$ is moving along a straight line at a constant speed of $108km\,h^{-1}$. How many seconds it takes for the car to stop if it is subjected to a constant braking force of 4000 N?

- A. 75
- ✓ B. 12
- C. 43
- D. 7,5
- E. 0,027

$$V = 108\ \frac{km}{h} = \frac{108}{3.6} = 30\ \left(\frac{m}{s}\right)$$



$$F = ma \Rightarrow 4000 = 1600a \rightarrow a = 2.5\ \left(\frac{m}{s}\right)$$

شتاب در جهت مخالف حرکت

حرکت با شتاب ثابت

$$V = at + V_0$$

$$0 = -2.5 \times t + 30 \rightarrow 2.5t = 30$$

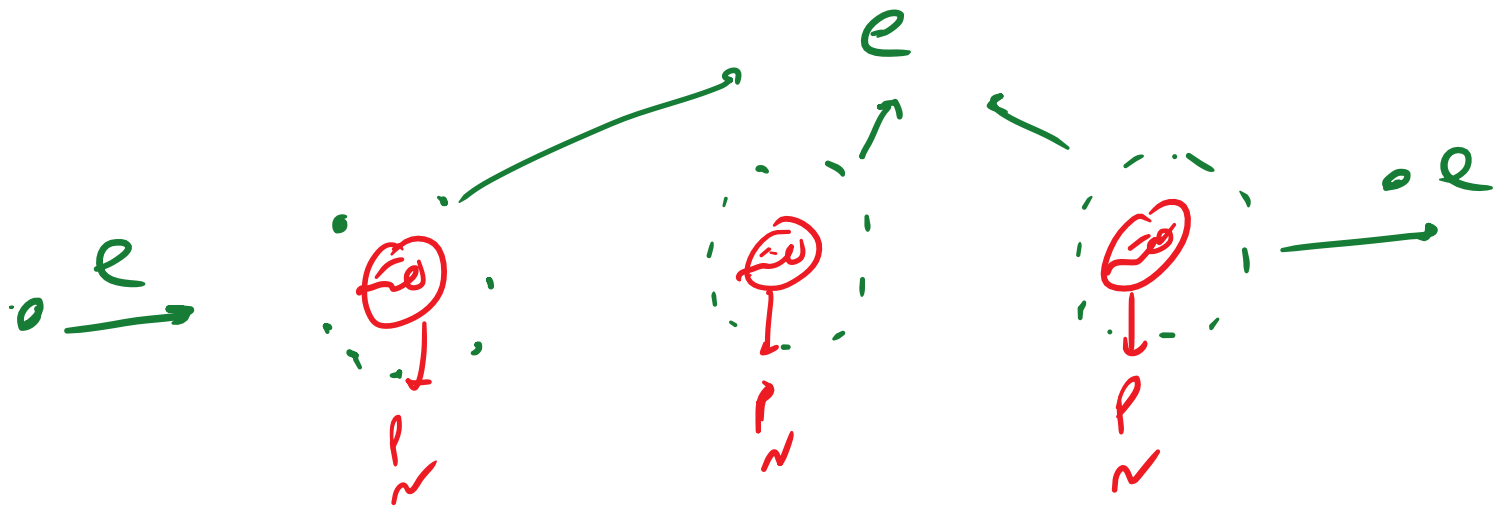
$$t = \frac{30}{2.5} = 12\ (s)$$

ثانیه

The current that flows in a metallic conductor is due to

فلزها دارن (فلز غیر عایق - جریان الکترون ها از خود عبور میدهد)

- A. the motion of a fluid called electricity
- ✓ B. the motion of negative charges (electrons)
- C. the propagation of electromagnetic waves
- D. the motion of positive charges (protons)
- E. the motion of negative charges (electrons) and positive charges (protons) in opposite directions



In a long-jump competition, what is the trajectory of the center of mass of an athlete, if we neglect air friction?

مسیر حرکت مرکز جرم وزش باد

- A. an arc of hyperbole
- B. a curve whose shape depends on the speed at the moment of detachment
- C. a curve whose shape depends on the attitude of the athlete's body during the jump
- ✓ D. an arc of parabola
- E. an arc of ellipse

The magnitude of the gravitational field at the surface of the earth is the ratio between the weight and the mass of a body. How is it measured in the International System of Units?

- A. $newton \cdot kilogram$
- B. $newton \cdot metre$
- C. $kilogram - force \cdot kilogram^{-2}$
- ✓ D. $metre \cdot second^{-2}$
- E. $kilogram \cdot metre \cdot second^{-2}$

وزن

$W = mg$ ← شتاب ← $\frac{m}{s^2}$

$g = \frac{W}{m}$

What is the angular speed, measured in rad/s, of the minute hand of a watch?

- A. $2\pi \times 60$
- B. $2\pi/60^2$
- C. $2\pi/60^3$
- D. $2\pi/60$
- E. It depends on the length of the hand

$\omega = \frac{2\pi}{T} = \frac{2\pi}{60^2}$

T: زمان کہ عقربہ ساعتہ دقیقہ شمار، یک دور کامل بزنہ

60^2: یک ساعت = 3600 ثانیہ

زمان کہ عقربہ ساعتہ یک دقیقہ شمار، یک دور کامل بزنہ

ω: سرعت زاویایی یک جسم

Boyle's law states that at any given temperature the pressure p times the volume V of an ideal gas is constant, namely we can write $pV = c$. The units of the constant c are therefore

- A. $\mathrm{N\,m^2}$
- ✓ B. $\mathrm{N\,m}$
- C. $\mathrm{J\,m^3}$
- D. $\mathrm{J\ m^{-3}}$
- E. $\mathrm{J\,m}$

$PV = nRT$ کامل گاز

P: فشار — V: حجم

n: تعداد مول — R: ثابت جهانی گازها — T: دما بر حسب کلوین

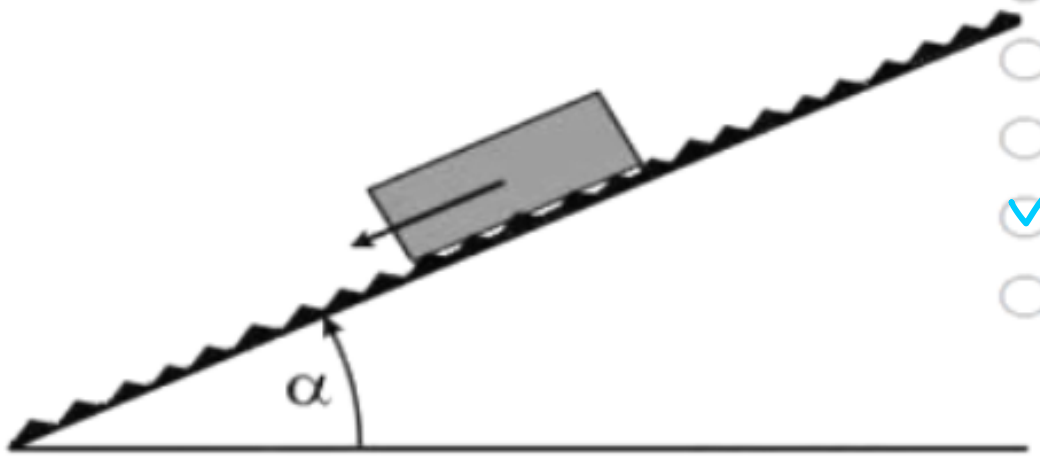
T و n و R ثابت $\rightarrow PV = C$

$P = \frac{F}{A}$ — فشار — F: نیرو — A: مساحت

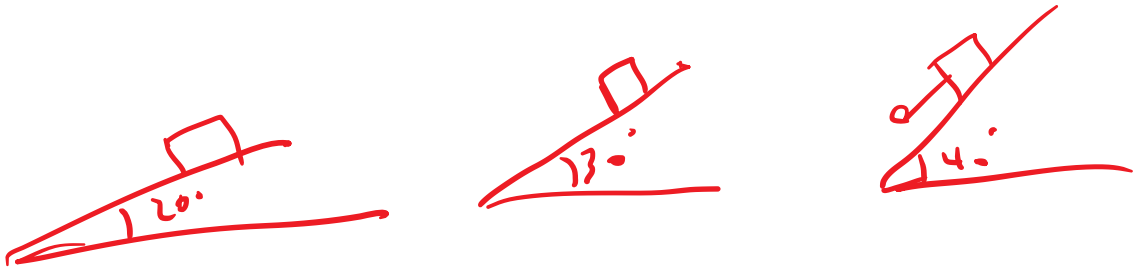
$\left(\frac{N}{m^2}\right)$

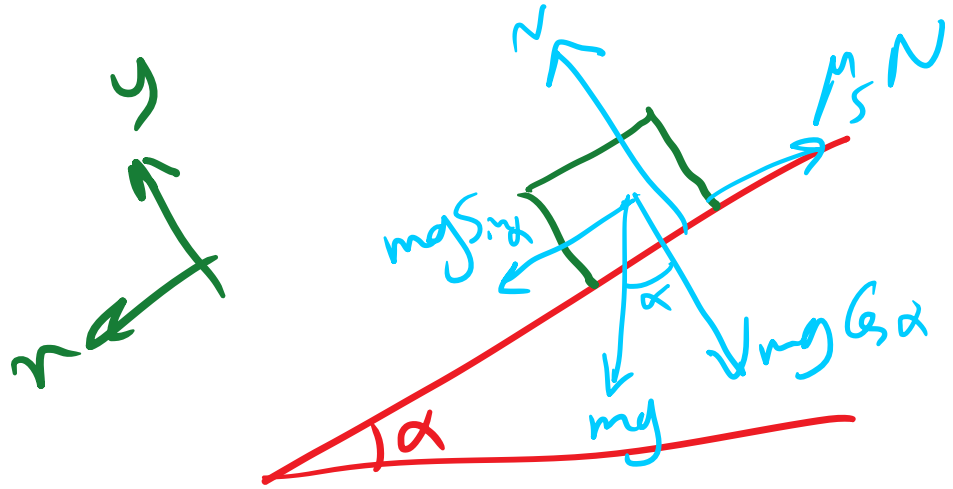
$PV = C \xrightarrow{\text{واحد}} \frac{N}{m^2} \times m^3 = N.m$

A rigid body stands motionless on a rough incline (with friction). The slope of the incline is progressively increased until the body starts moving. The angle α of the incline with the horizontal at which this happens depends on



- A. the mass of the body
- B. the local value of the gravity acceleration
- C. the contact area between the body and the incline
- ✓ D. the coefficient of static friction
- E. the weight of the body





$$\sum F_y = 0 \rightarrow N - mg\cos\theta = 0$$

$$N = mg\cos\theta$$

$$\sum F_x = 0 \Rightarrow mg\sin\alpha - \mu_s N = 0$$

$$mg\sin\alpha = \mu_s \times mg\cos\theta$$

$$\mu_s = \frac{\sin\alpha}{\cos\alpha} = \tan\alpha$$

$$\boxed{\alpha = \tan^{-1}(\mu_s)}$$

In the absence of friction, would a pendulum put in motion oscillate forever?

- A. No, because the kinetic energy of the pendulum is continuously changing
- B. No, because the motion of a pendulum is not uniform
- C. No, because while the pendulum oscillates its angular momentum changes
- D. Yes, because while the pendulum oscillates its momentum is conserved
- ✓ E. Yes, because while the pendulum oscillates its total mechanical energy does not change