وزارة التربية الوطنية

مديرية التربية لولاية الوادي

متقن شنوف حمزة الوادي

تمارين في مادة العلوم الفيزيائية

الاستاذ: قيطه نورالدين

الشعبة: رياضيات – تقني رياضي – علوم تجريبية

تمارين حول الوحدة الخامسة:

تطور حركة ميكانيكية

- حركة الكواكب والاقمار الصناعية
- حركة السقوط الشاقولي والسقوط الحر
- حركة القذائف.الحركات على المستوي.

تحضير بكالوريا 2019

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-1

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-

$\sum \vec{F} = m\vec{a}$

$\vec{F}_{B/A}$ B $\vec{F}_{A/B}$ B A

-2

( ) -

226 -

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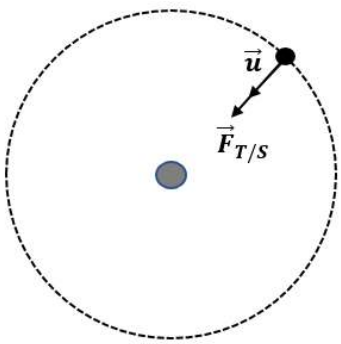
-

$T = \frac{2\pi r}{v}$ -2

$a_N = \frac{v^2}{r}$ -3

$F = G\frac{Mm}{r^2}$ -4

-5



$\sum \vec{F} = m\vec{a} \Longrightarrow \vec{F}_{T/S} = m\vec{a} \Longrightarrow G\frac{Mm}{r^2}\vec{u} = m\vec{a}$

$\Longrightarrow \vec{a} = \frac{GM}{r^2}\vec{u}$

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-6

$$\sum \vec{F} = m\vec{a} \implies \vec{F}_{T/S} = m\vec{a}$$

$$F_{T/S} = ma_N \implies G\frac{Mm}{r^2} = m\frac{v^2}{r} \implies v^2 = \frac{GM}{r} \implies v = \sqrt{\frac{GM}{r}}$$

-7

$$T = \frac{2\pi r}{v} \implies T^2 = \frac{4\pi^2 r^2}{v^2} = \frac{4\pi^2 r^2}{\frac{GM}{r}} \implies T^2 = \frac{4\pi^2 r^3}{GM} \implies T = \sqrt{\frac{4\pi^2 r^3}{GM}}$$

-8

h -

$$g = a = \frac{GM}{r^2} = \frac{GM}{(R_T + h)^2}$$

$h = 0$ -

$$g_0 = \frac{GM}{{R_T}^2}$$

g_0 g -

$$\frac{g}{g_0} = \frac{\frac{GM}{(R_T + h)^2}}{\frac{GM}{{R_T}^2}} = \frac{{R_T}^2}{(R_T + h)^2}$$

-9

-

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-

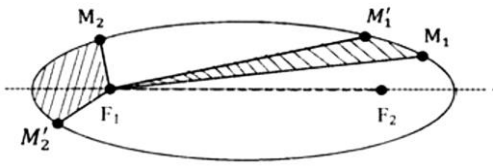
-10

-

-

-

$$\frac{T^2}{r^3} = K = \frac{4\pi^2}{GM}$$



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2009 **1**

(R) (h) (m_s)

1

2

R h M_T (G) (v^2) 3

(v) (h) 4

5

T≃24h

R = 6400 km ; $m_s = 2\times10^3$ kg ; $M_T = 5{,}97\times10^{24}$ kg ; $G = 6{,}67\times10^{-11}$ $Nm^2.kg^{-2}$

2009 **2**

GPS (Giove-A)

m = 700 kg (Giove-A)

h = $23{,}6\times10^3$ km (O) (Giove-A)

1

(Giove-A) 2

(Giove-A) 3

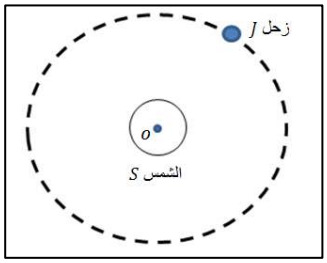
(Giove-A) T 4

(Giove-A) 5

$M_T = 5{,}98\times10^{24}$ kg G = $6{,}67\times10^{-11}$ SI

$R_T = 6{,}38\times10^3$ km

2008 **3**



(O)

	$M_s = 2\times10^{30}kg$
	$r = 7.8\times10^{8}km$
	$G = 6.67\times10^{-11}SI$

-

-

a

r M_s G v

v r T

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2008 **4**

(r) (m)

r G m M_T 1

G m M_T

r

(SI) (G) 2

$v = \sqrt{\frac{G.M_T}{r}}$ (v) 3

T T r (v) 4

r G M_T 5

$(\frac{T^2}{r^3})$ 6

(SI)

$r = 2{,}66\times10^4$ km

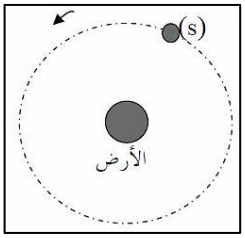
$\pi^2 = 10$ $M_T = 5{,}97\times10^{24}$ kg $G = 6{,}67\times10^{-11}$ SI

2013 **5**

m_s (S)

(S) .1

(S) .2



M_T G .3

h R_T

M_T h G R_T .4

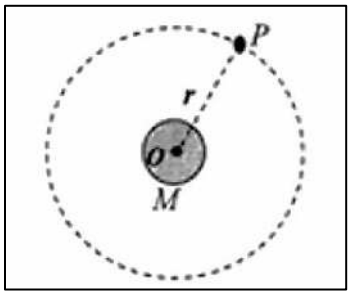
k $\frac{T^2}{(R_T+h)^3} = k$ .5

$G = 6.67\times10^{11}\,(SI)$ $M_T = 6\times10^{24}kg$ $R_T = 6380km$ $h = 35800km$ $\pi^2 = 10$

2012 **6**

M

Phobos (P)



$G = 6{,}67\times10^{-11}$ N.m^2.kg^{-2}

$r = 9{,}38\times10^3$ km P M

$m_M = 6{,}44\times10^{23}$ kg

T_M = 24 h 37 min 22 s m_P Phobos

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O

P Phobos M 1

2

P

m_M G r T_P 3

T_P $\frac{T_P^2}{r^3} = 9{,}21 \times 10^{-13}\ S^2.m^{-3}$ 4

T_S S 5

2014 **7**

R M_T

$\vec{F}_{T/S}$

-

h m_s R M_T G $\vec{F}_{T/S}$

$\vec{a}$

القمر الاصطناعي	*Alsat1*	*Astra*
$T\,(s)\times10^3$	5,964	86,160
$h(m)\times10^6$	0,70	35,65

-

-

g -

( ) $24h$ -

المعطيات: $G = 6{,}67\times10^{-11}\ N\cdot m^2\cdot kg^{-2}$ ، $R = 6380\ km$ ، $1\ jour = 23h\ 56\min$

تسارع الجاذبية عند سطح الأرض: $g_0 = 9{,}8\,m\cdot s^{-2}$.

2014 **8**

(S) *Alsat*2 2010 12

$1000km$ $600km$

(S) (S) .1

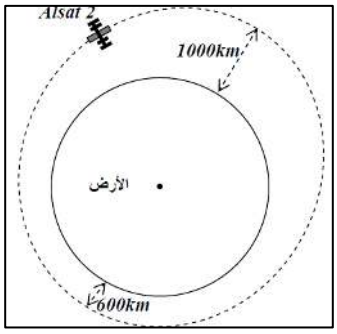
$M_T = 6\times10^{24}kg$ $R_T = 6400km$

$T_T = 24h$

-

(S) -

$h = 800km$ (S) .2



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(S) -

$m = 130kg$ -

.3

(S)

(S)

z .4

z -

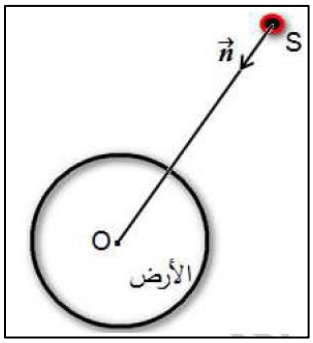
2012 **9**

14.55 $h = 700km$ (S)

(S) a .

n r v (S) a .

$v = \sqrt{\frac{GM_T}{r}}$.



(S) T_S r T_S .

$\frac{T_S}{r^3} = 9.85 \times 10^{-14} s^2.m^{-3}$.

M_T .

$R_T = 6400km$ $G = 6.67 \times 10^{11} (SI)$

10

1 **2** **1**

$h = 670km$

2

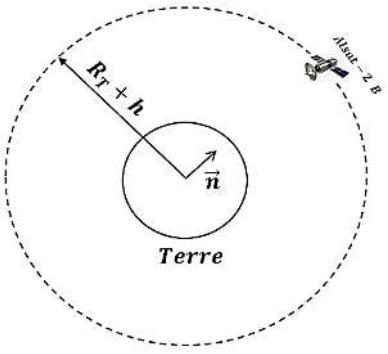
-1

2 -2

$\vec{n}$ G h R_T m M_T **2** -3

G -4

$\vec{a}$ -5



$v = \sqrt{\frac{GM}{R_T + h}}$ -6

-7

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	$h(km)$	$T(s)$	$r^3(m^3)$	$T^2(s^2)$
GLONASS	$19{,}1 \times 10^3$	$4{,}02 \times 10^4$		
Giove − A	23.6×10^3	$5{,}19 \times 10^4$		
Astra	35.65×10^3	$8{,}61 \times 10^4$		

$$T^2 = f\,(r^3)$$

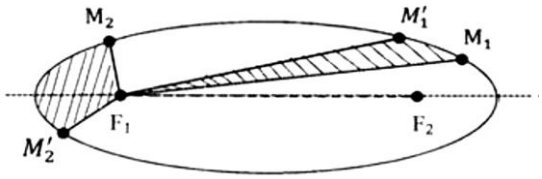
G

g **2**

$M_T = 5.97 \times 10^{24} kg$, $R_T = 6.38 \times 10^3 km$

2016 **11**

Δt P -1



$M_2M'_2$ $M_1M'_1$

r -2

	$r \times 10^6 Km$	T	$\frac{T^2}{r^3}(s^2.m^{-3})$
	108,2	$224j\ \ 16h$	
	149,6	$365j\ \ 6h$	
	227,9	$686j\ \ 22h$	

P -

P r M_S G

r M_S G T -

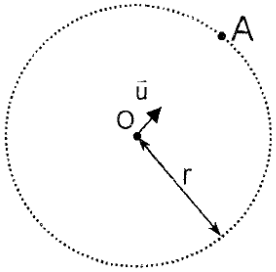
-

M_S -

r $T = 314j\ \ 11h$ -

$G = 6.67 \times 10^{-11} SI$

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O

M_S r

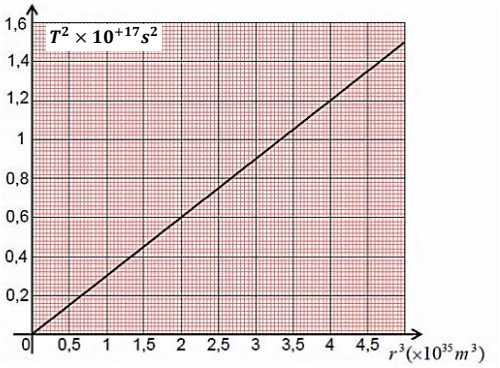
$\vec{F}_{S/P}$ -1

A m_p

$\vec{u}$ r m_p M_S G $\vec{F}_{S/P}$ -3

G A $\vec{F}_{S/P}$ -4

r M_S



-5

-6

-

M_S $\frac{T^2}{r^3} = 3 \times 10^{-19}(SI)$ -

$G = 6.67 \times 10^{-11} SI$

r m (S) .

-

S T $\vec{F}_{T/S}$ -

. r m M_T G $\vec{F}_{T/S}$ -

-

. r M_T G v^2

S -

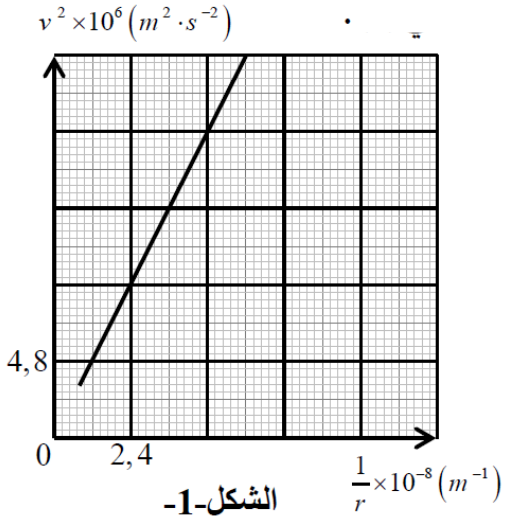
$v^2 = f\left(\frac{1}{r}\right)$

M_T

. r M_T G S T

$r =$ 1 -3

$42400km$



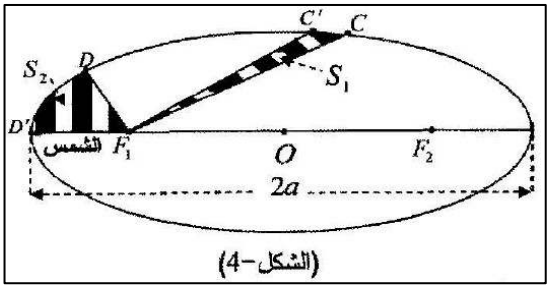
الشكل-1-

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1 1 3

1 2 3

, $G = 6.67 \times 10^{-11} SI$



(الشكل-4)

D C' C 4

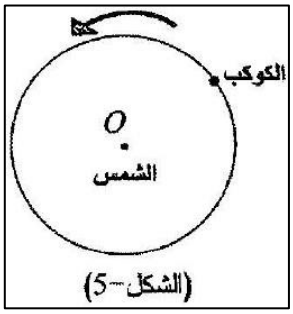
Δt D'

F_1 1

F_2 F_1

S_2 S_1 2

D' D C' C 3



(الشكل-5)

O

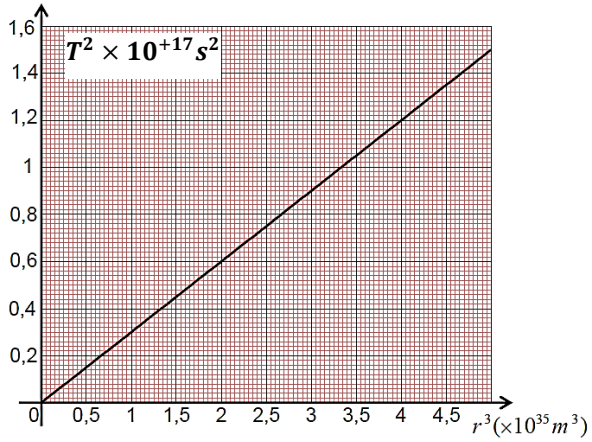
5 r

M $F = G\frac{mM}{r^2}$ $\vec{F}$

$G = 6{,}67\times10^{-11}$ SI G m

« satellite »

T 6 $T^2=f(r^3)$



1

2

G r T v

M

r^3 T^2 3

r^3 T^2 4

M 5

.

$h_1 = 41991km$

$h_2 = 200km$

$24.8°$

.

.

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.

r $v_s = \sqrt{\frac{GM_T}{r}}$.

$h_1 = 41991km$ $h_2 = 200km$

.

T .

.

$M_T = 5.97 \times 10^{24}kg$, $G = 6.67 \times 10^{-11}SI$, $R_T = 6.4 \times 10^{3}km$

$m = 700kg$

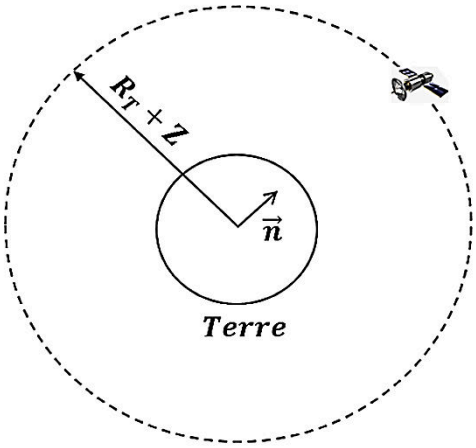
-1

-2

-3

$Z = 35786km$ -4

$M_T = 5.97 \times 10^{24}kg$



-

G M_T r v -

-

$24h$ -

-

-5

P $Z_P = 200km$

. A $Z_A = 35786Km$

P A -

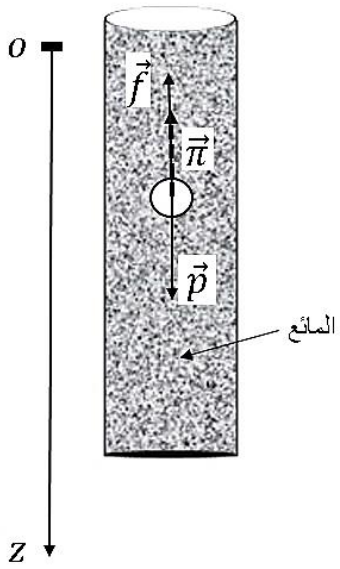
-

-

$R = 6378Km$ $G = 6.67 \times 10^{-11}$SI

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-1



- P $\vec{P} = m\vec{g}$
  - m -
  - g -
  - $\rho_s = \frac{m}{V}$ -
- π $\vec{\pi} = -\rho V\vec{g}$
  - ρ ▪
  - V ▪ (m^3)
- f
  - $f = kv$ ▪
  - $f = kv^2$ ▪

-2

▪

$$\sum \vec{F} = m\vec{a} \Longrightarrow \vec{P} + \vec{\pi} + \vec{f} = m\vec{a}$$

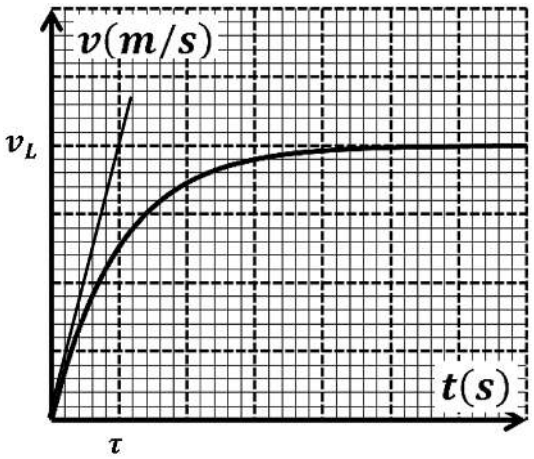
(oz)

$$P - \pi - f = ma \Longrightarrow mg - \rho Vg - kv = m\frac{dv}{dt}$$

$$\Longrightarrow mg - \rho Vg = m\frac{dv}{dt} + kv \Longrightarrow \frac{dv}{dt} + \frac{k}{m}v = g - \frac{\rho Vg}{m}$$

$$\Longrightarrow \frac{dv}{dt} + \frac{k}{m}v = g\left(1 - \frac{\rho V}{m}\right) \Longrightarrow \boldsymbol{\frac{dv}{dt} + \frac{k}{m}v = g\left(1 - \frac{\rho}{\rho_s}\right)}$$

•



▪ $\tau = \frac{m}{k}$ τ

▪ $\frac{dv}{dt} = 0$ v_L

$$\Longrightarrow \frac{k}{m}v_L = g\left(1 - \frac{\rho}{\rho_s}\right) \Longrightarrow \boldsymbol{v_L = \frac{mg}{k}\left(1 - \frac{\rho}{\rho_s}\right)}$$

▪ $v = 0$ a_0

$$\Longrightarrow \boldsymbol{a_0 = \frac{dv}{dt} = g\left(1 - \frac{\rho}{\rho_s}\right)}$$

▪ a_0

- $a_0 = g$
- $a_0 < g$

$$P - \pi = ma_0 \Longrightarrow \boldsymbol{\pi = P - ma_0}$$

-3

▪

$$\sum \vec{F} = m\vec{a} \Longrightarrow \vec{P} + \vec{\pi} + \vec{f} = m\vec{a}$$

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(oz)

$$P - \pi - f = ma \Longrightarrow mg - \rho V g - kv^2 = m\frac{dv}{dt}$$

$$\Longrightarrow mg - \rho V g = m\frac{dv}{dt} + kv^2 \Longrightarrow \frac{dv}{dt} + \frac{k}{m}v^2 = g - \frac{\rho V g}{m}$$

$$\Longrightarrow \frac{dv}{dt} + \frac{k}{m}v^2 = g\left(1 - \frac{\rho V}{m}\right)$$

$$\Longrightarrow \boldsymbol{\frac{dv}{dt} + \frac{k}{m}v^2 = g\left(1 - \frac{\rho}{\rho_s}\right)}$$

-
  - v_L $\frac{dv}{dt} = 0$

$$\Longrightarrow \frac{k}{m}{v^2}_L = g\left(1 - \frac{\rho}{\rho_s}\right) \Longrightarrow \boldsymbol{v_L = \sqrt{\frac{mg}{k}\left(1 - \frac{\rho}{\rho_s}\right)}}$$

  - a_0 $v = 0$

$$\Longrightarrow a_0 = \frac{dv}{dt} = g\left(1 - \frac{\rho}{\rho_s}\right)$$

  -

-
  -

$$\sum \vec{F} = m\vec{a} \Longrightarrow \vec{P} = m\vec{a}$$

(oz)

$$P = ma \Longrightarrow mg = ma \Longrightarrow a = g \Longrightarrow \boldsymbol{\frac{dv}{dt} = g \Longrightarrow \frac{d^2z}{dt^2} = g}$$

- $z_0 = 0 \quad v_0 = 0$

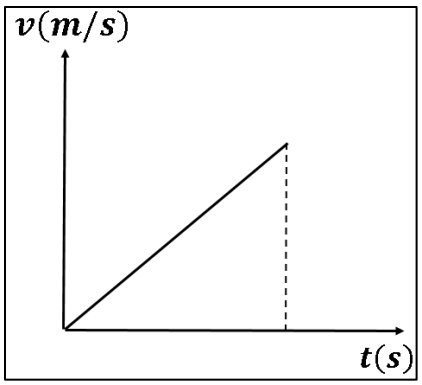
-

$$v = at + v_0 \Longrightarrow v = gt$$

-

$$z = \frac{a}{2}t^2 + v_0 t + z_0 \Longrightarrow z = \frac{g}{2}t^2$$

$$v^2 - {v_0}^2 = 2gh$$



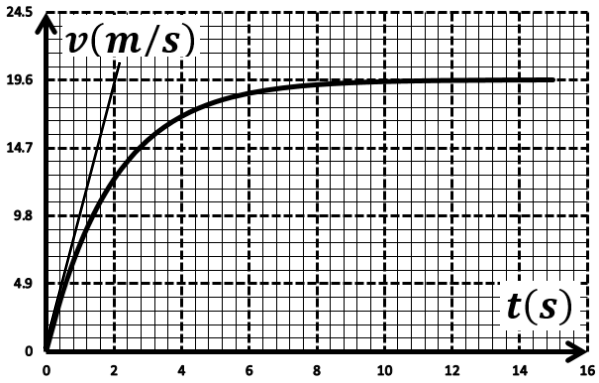
- a

- h z

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2010 **1**

(S)



$v = f(t)$

(S) 1

2

v_{lim}

t=0

(S) 3

(S) 4

v

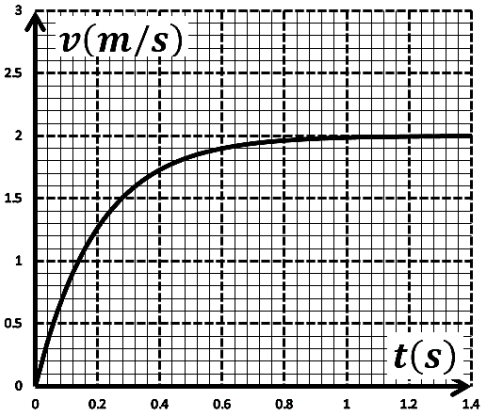
5

$g = 10\,m/s^2$ h m

$f = k.v^2$ -1

-

(Oz) -



g m k v_{lim}

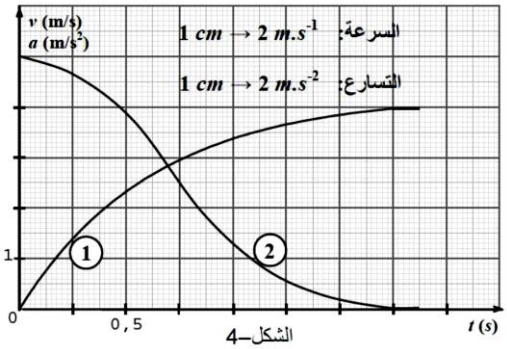
-2

v_{lim} -

$\frac{m}{k}$ k -

-3

$v(t)$ -4



الشكل-4

$v_0 = 0\ m.s^{-1}$

r=1,5cm m=3g

$g=9,8\ m.s^{-2}$ $f=kv^2$ $V=(4/3).\pi r^3$ $\rho_{air}=1,3kg.m^{-3}$

1

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2

$v = f(t)$ $a = h(t)$ 3

$a(t)$

v_ℓ

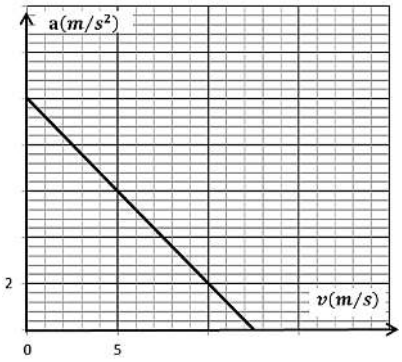
k $v_\ell = \sqrt{\frac{g}{k}(m - \rho_{air}V)}$

O $m = 100kg$

(a) $f = kv$

(v)

B A $\frac{dv}{dt} = Av + B$



(g)

(v_ℓ)

$\frac{k}{m}$

k

$0 \leq t \leq 7s$

2010 **5**

(Webcam) m *(S)*

(Avistep)

t(ms)	0	100	200	300	400	500	600	700	800	900
v(m.s^{-1})	0	0,60	0,90	1,02	1,08	1,10	1,12	1,13	1,14	1,14

1 cm → 0,1 s. 1 cm → 0,20 m.s^{-1} $v = f(t)$ *v* 1

v_{lim}

(S

t=0s *(S)*

(S) *V* ρ $\frac{dv}{dt} + Av = C\left(1 - \frac{\rho.V}{m}\right)$ *(S)* 2

(S)

v *(S)*

k $C = g$ $A = \frac{k}{m}$

k

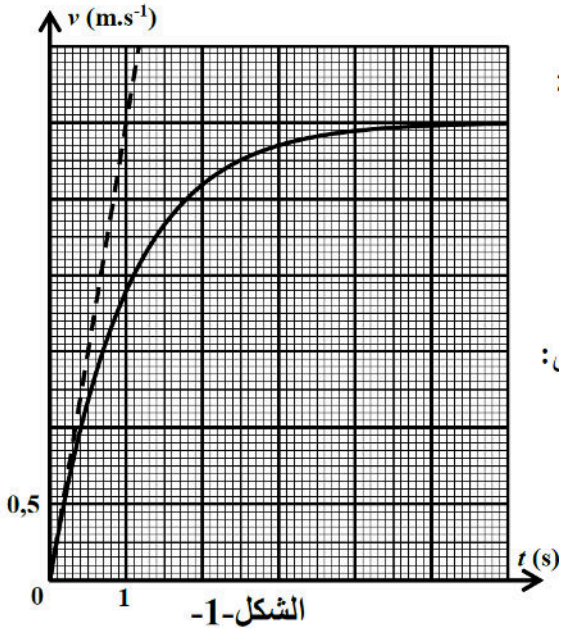
m = 19g *g =10 N.Kg^{-1}*

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G $m = 20\ g$

$(\overrightarrow{oz})$ $t = 0$

k $\vec{f} = k\vec{v}$ $v(t)$



الشكل-1-

-1

(

(

G -2

$\frac{dv}{dt} + Av = B$ (

g B m k A

ρ ρ_a

B (

-3

v_l (

$t = 0$ a_0 (

k τ (

(

-4

$g = 10\ m/s^2$

o $t = 0$ $m = 13g$ $D = 3cm$

(oz) $1500m$

G -

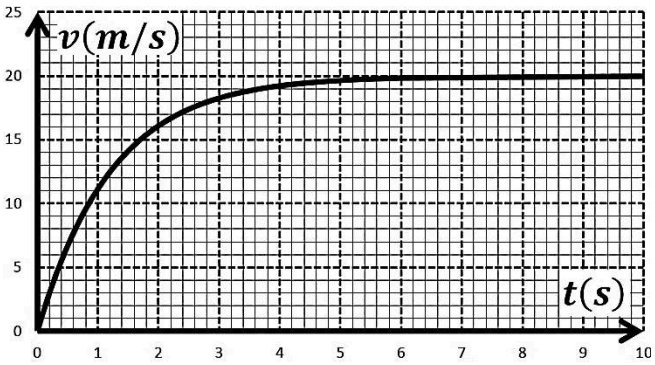
-

$\vec{P}$

$f = kv^2$ $\vec{f}$ $\vec{\pi}$

k -

-



$\vec{\pi}$ -

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$\frac{dv}{dt} = A - Bv^2$ -

v_l -

k v_l -

-

المعطيات: حجم الكرة: $V = \frac{4}{3}\pi r^3$، الكتلة الحجمية للهواء: $\rho = 1,3\ kg \cdot m^{-3}$ ، $g = 9,8\ m \cdot s^{-2}$.

2017 8

h

v k $f = kv^2$

$(t = 0)$ .1

$\vec{\Pi}$

v_l

k

$t = 0$ a_0 .2

.3

(

(

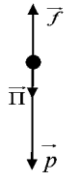
km/h $1000\ m$ (

$a = g(t)$ $v = f(t)$ (

$m = 2.5\ kg$ $g = 9.80\ m.s^{-2}$ $\Pi = 3\ N$ $k = 1.32\ SI$

2017 9

V m

3	2	1	المجموعة
			التمثيل المنجز

$t = 0$

$t > 0$ t

$\vec{f}$ $\vec{\Pi}$

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(1

(

(

$t = 0$ a_0 (

(2

a_0

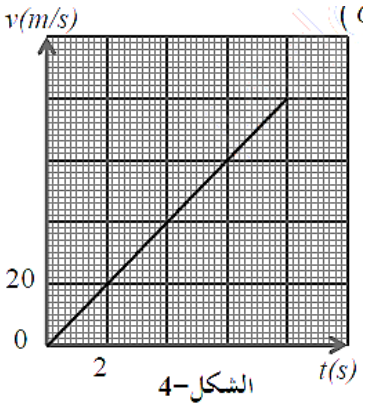
$t = 0$

v_{lim} (3

k V g k m v_{lim} (4

$t = 1.5s$ (5

$V = 3.6 \times 10^{-4}\ m^3$ $\rho_{air} = 1.3kg.m^{-3}$ $m = 2.6g$ $g = 9.80\ m.s^{-2}$ $f = kv$



4-الشكل

$m = 80kg$ G (S) -

$8s$ h

$(o\vec{k})$ $v(t)$

(S) -

h -

g -

$f = kv^2$ h -

(S) -

g k β $\frac{dv}{dt} = g\left(1 - \frac{v^2}{\beta}\right)$

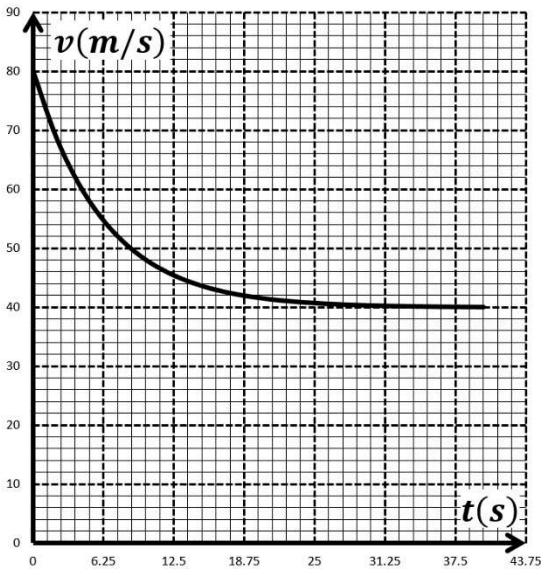
m

β -

$t = 0$ (S) -

-

(S) v_{lim} -



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(S) -

v_{lim} -

k -

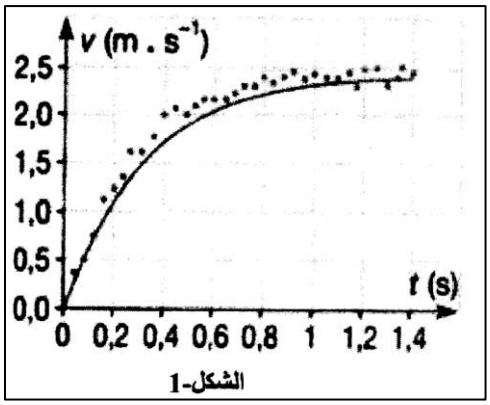
-

$f = k`v^2 \ldots\ldots\ldots(2)$ $f = kv \ldots\ldots\ldots(1)$

$k`$ k v f

-

-



الشكل-1

-

ρ ρ_0 -

k g m -

$\frac{dv}{dt} + Bv = A$ -

B A

v_{lim} v -

B A -

B A $v = f(t)$ -

$g = 9{,}81 m.s^{-2}$ ، $\rho = 4{,}1 kg.m^{-3}$ ، $\rho_0 = 1{,}3 kg.m^{-3}$

V_b g

K $f = K\rho v^2$ ρ

$g = 9.8\, m/s^2$ $V_b = 9m^3$ $\rho = 1.23\, kg/m^3$ _____ .

-

m -

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-

m -

$m = 4.1kg$ -

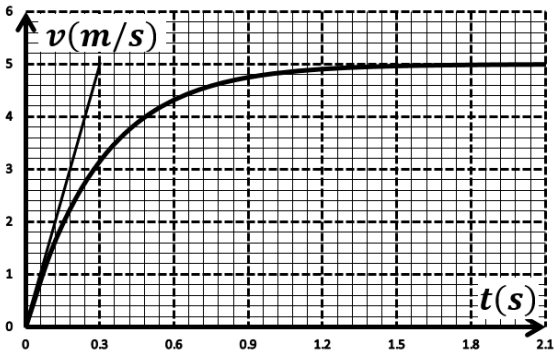
$\frac{dv}{dt} + Av^2 = B$ -

g K V_b ρ m B A

B -

v_l -

K -



13

h

$m = 80kg$ G (S) **.I**

(oz)

$g = 9.8m/s^2$

-

-

$8.7s$ -

$f = kv^2$ **.II**

-

(S) -

k B A $\frac{dv}{dt} = A + Bv^2$

m g

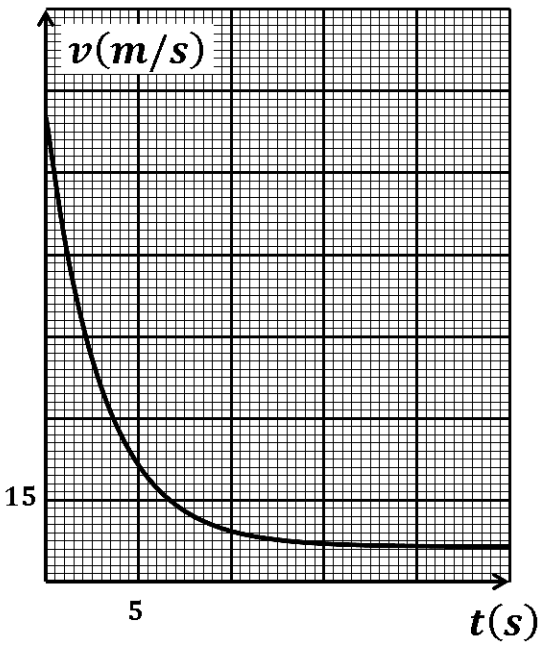
a_0 v_l -

(S) -

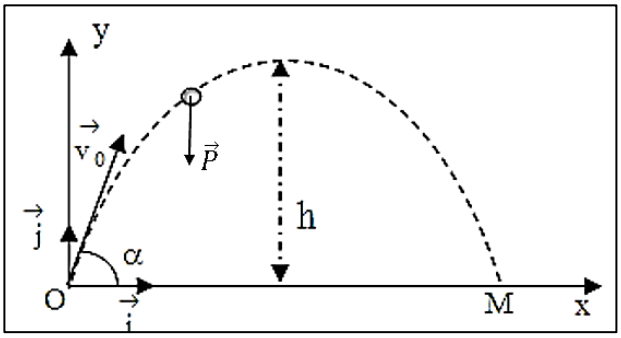
v_{lim} (

$t = 10s$ (S) (

k (



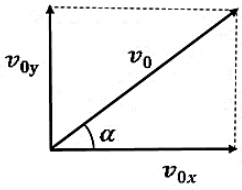
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الشروط الابتدائية: تختلف الشروط الابتدائية حسب الحركة المدروسة.

$x_0 = 0$

$y_0 = 0$



$$\cos\alpha = \frac{v_{0x}}{v_0} \Rightarrow v_{0x} = v_0\cos\alpha$$

$$\sin\alpha = \frac{v_{0y}}{v_0} \Rightarrow v_{0y} = v_0\sin\alpha$$

$$\begin{cases} v_x = v_B\cos\alpha \\ v_y = -gt + v_B\sin\alpha \end{cases}$$

-1

$$\sum \vec{F} = m\vec{a} \Rightarrow \vec{P} = m\vec{a} \Rightarrow \vec{g} = \vec{a}$$

$$\Rightarrow \begin{cases} a_x = 0 \\ a_y = -g \end{cases} \Rightarrow \begin{cases} \frac{dv_x}{dt} = 0 \\ \frac{dv_y}{dt} = -g \end{cases} \Rightarrow \begin{cases} \frac{d^2x}{dt^2} = 0 \\ \frac{d^2y}{dt^2} = -g \end{cases}$$

- $a_x = 0 \qquad (ox)$
- (oy)

-2

$$\sum \vec{F} = m\vec{a} \Rightarrow \vec{P} = m\vec{a} \Rightarrow \vec{g} = \vec{a}$$

$$\Rightarrow \begin{cases} a_x = 0 \\ a_y = -g \end{cases}$$

•

$$\Rightarrow \begin{cases} v_x = v_{0x} \\ v_y = at + v_{0y} \end{cases} \Rightarrow \begin{cases} v_x = v_0\cos\alpha \\ v_y = -gt + v_0\sin\alpha \end{cases}$$

•

$$\Rightarrow \begin{cases} x = v_{0x}t + x_0 \\ y = \frac{1}{2}at^2 + v_{0y}t + y_0 \end{cases} \Rightarrow \begin{cases} x = v_0\cos\alpha\, t \\ y = -\frac{1}{2}gt^2 + v_0\sin\alpha\, t \end{cases}$$

-3

$$x = v_0\cos\alpha\, t \Rightarrow t = \frac{x}{v_0\cos\alpha}$$

$$\Rightarrow y = -\frac{1}{2}gt^2 + v_0\sin\alpha\, t \Rightarrow y = -\frac{1}{2}g\left(\frac{x}{v_0\cos\alpha}\right)^2 + v_0\sin\alpha\left(\frac{x}{v_0\cos\alpha}\right)$$

$$\Rightarrow y = -\frac{gx^2}{2{v_0}^2cos^2\alpha} + tan\,\alpha\, x$$

-4

•

$v_y = 0$

$$v_y = -gt + v_0\sin\alpha = 0 \Rightarrow t = \frac{v_0\sin\alpha}{g}$$

•

$y = 0$

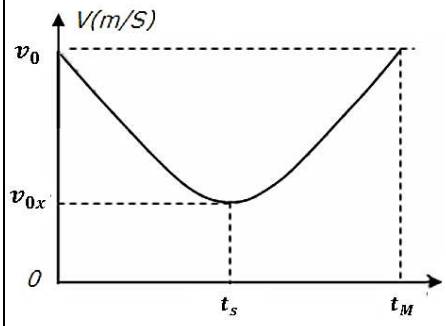
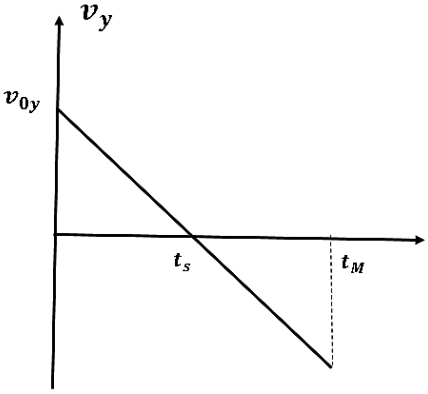
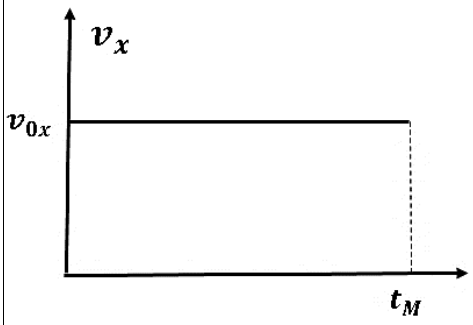
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$$y = -\frac{gd^2}{2{v_0}^2 cos^2\alpha} + tan\,\alpha\, d = 0 \Rightarrow \frac{gd}{2{v_0}^2 cos^2\alpha} = tan\,\alpha \Rightarrow d = \frac{2{v_0}^2 cos^2\alpha \times tan\,\alpha}{g}$$

$$\Rightarrow d = \frac{2{v_0}^2 \cos\alpha \times \sin\alpha}{g} \Rightarrow \boldsymbol{d = \frac{{v_0}^2 \sin 2\alpha}{g}}$$

$\alpha = 45°$ $\quad 2\alpha = 90°$ $\quad \sin 2\alpha = 1$ -

-5

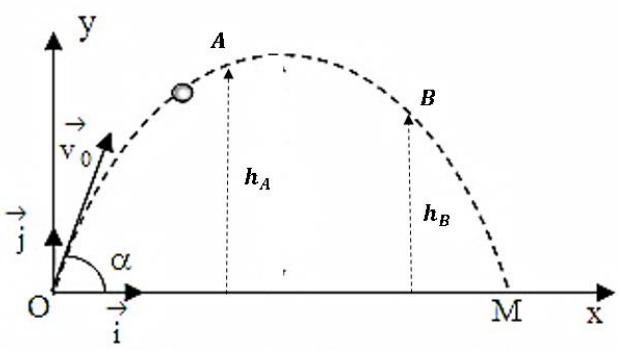
v	v_y	v_x
	 - $.t_s$ -	 -

v_0 $\quad \alpha$

$${v_0}^2 = {v_{0x}}^2 + {v_{0y}}^2$$

$$sin\,\alpha = \frac{v_{0y}}{v_0} \qquad \cos\alpha = \frac{v_{0x}}{v_0} \qquad tan\,\alpha = \frac{v_{0y}}{v_{0x}}$$

-6



$$v_B{}^2 - v_A{}^2 = 2gh_{AB}$$

$.B \quad A$

$$E_{CA} + E_{PPA} = E_{CB} + E_{PPB}$$

$$\Rightarrow \frac{1}{2}mv_A{}^2 + mgh_A = \frac{1}{2}mv_B{}^2 + mgh_B$$

$$\Rightarrow mgh_A - mgh_B = \frac{1}{2}mv_B{}^2 - \frac{1}{2}mv_A{}^2$$

$$\Rightarrow gh_A - gh_B = \frac{1}{2}v_B{}^2 - \frac{1}{2}v_A{}^2$$

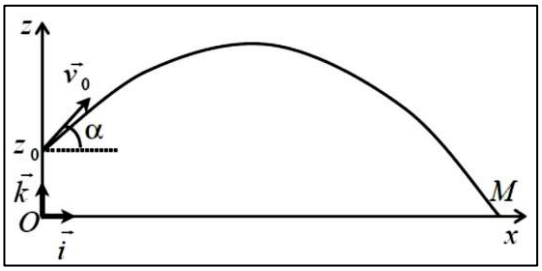
$$\Rightarrow \boldsymbol{{v_B}^2 - {v_A}^2 = 2g(h_A - h_B)}$$

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$oz_0 = h = 2.0m$ $t = 0$

$g = 9.8m \times s^{-1}$ $\alpha = 35°$ $v_0 = 13.7\,m/s$

-



-

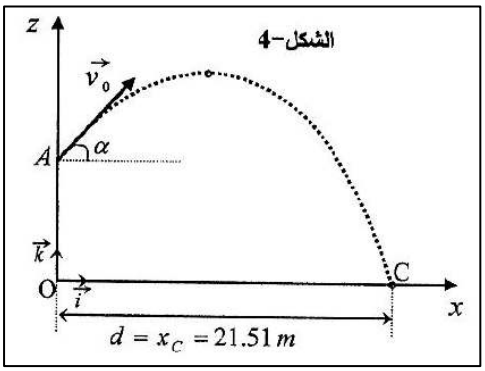
-

$z = f(t)$ -

M -

-

v_0



$d = 21.51m$

v_0

$h_A = 2m$ A -

$\alpha = 45°$ $\vec{v}_0$

$t = 0$ $(O, \vec{i}, \vec{k})$

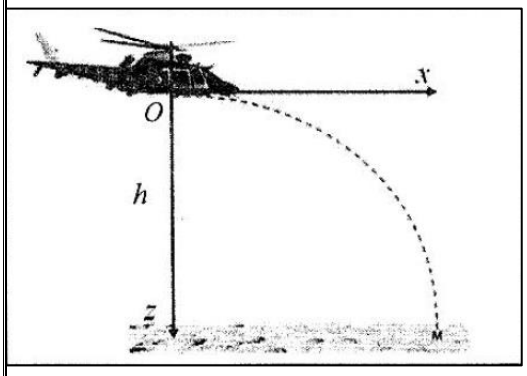
A

$z = h(t)$ $x = f(t)$ -

v_0 g α h_A $z = g(t)$ -

d g α h_A v_0 -

-



$v_0 = 50\,m/s$ h ___

$t = 0$ G

M $\vec{v}_0$ O

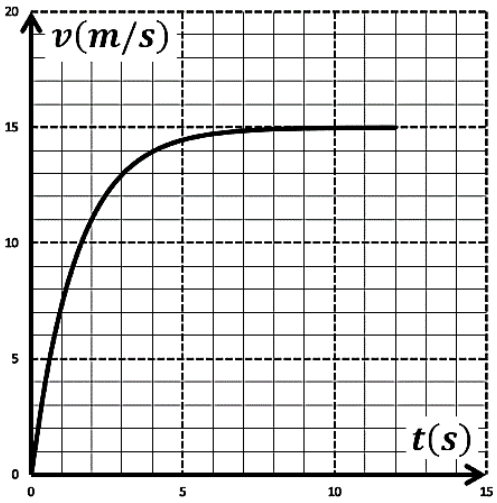
-

$z(t)$ $x(t)$ -

$z(x)$ -

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M -



M h

$t = 0$

$\vec{v}$ $\vec{f} = -100 \times \vec{v}$

t

-

t -

v_l -

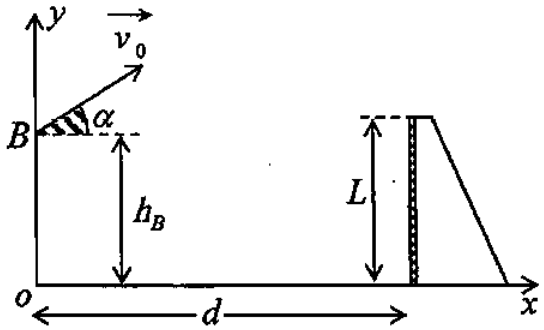
$t = 10s$ $t = 0$ -

$m = 150kg$ $h = 405m$ $g = 9.8m \times s^{-2}$

$v_0 = 10m/s$ $g = 10m/s^2$

$\overrightarrow{v_0}$ B $t = 0$

$h_B = 2m$ B $\alpha = 30°$



-1

(Ox, Oy)

$y(t)$ $x(t)$ -

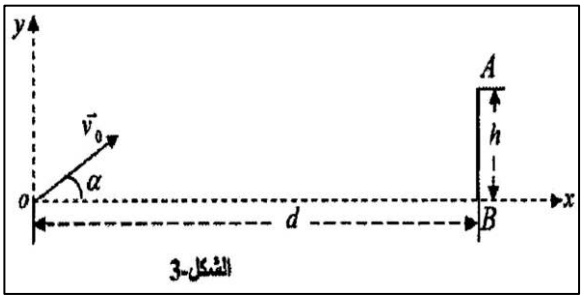
$y = f(x)$ -

-

$L = 2{,}44m$ $d = 10m$ -2

y x -

-



$g = 10m \times s^{-2}$

O

$h =$ $d = 25m$

$\vec{v}_0$ $AB = 2.44m$

$\alpha = 30°$

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$(\overrightarrow{ox}, \overrightarrow{oy})$ -

-

A v_0 -

A

B v'_0 -

$0.92\ m$ $8.23\ m$ $23.8\ m$

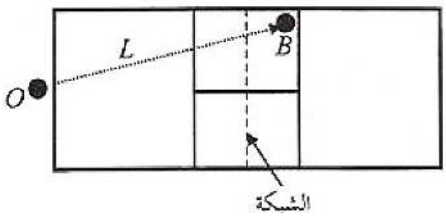
$6.4\ m$

$OB = L = 18.7m$ B

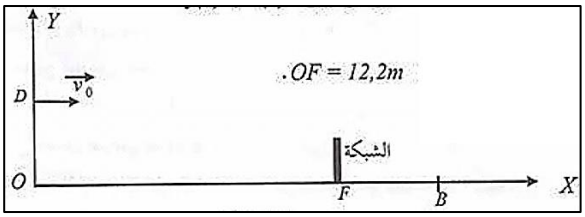
O $h = 2.2m$ D

$v_0 = 126km/h$ D

$g = 9.8m/s^2$



B D -



$y(t)$ $x(t)$ -

-

$OF = 12.2m$ -

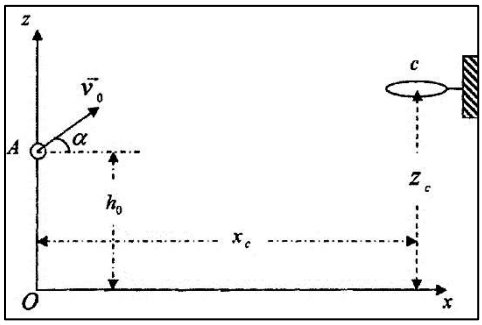
-

$h_0 = 2.10m$ A

$(x_c = 4.5m, z_c)$ C G $37°$ $v_0 = 8\,m/s$

$(\overrightarrow{ox}, \overrightarrow{oy})$

$(\overrightarrow{ox}, \overrightarrow{oy})$ -



z_c -

β $\vec{v}_c$ -

$g = 9.8\,m/s^2$ β v_c

$21.69\ m$

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$h = 2.62\ m$

$\alpha = 43°$ $v_0 = 13.7\ m \times s^{-1}$

$v_y(t)$ $v_x(t)$

.

ox -

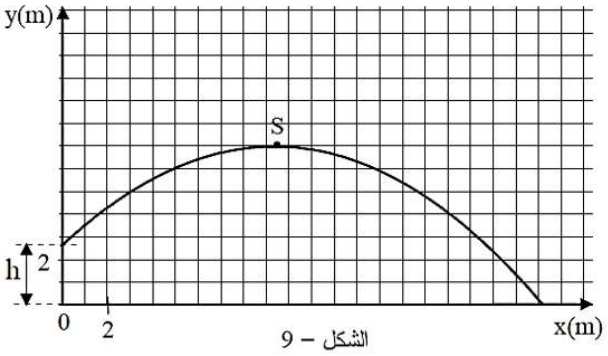
v_{0y} -

v_0

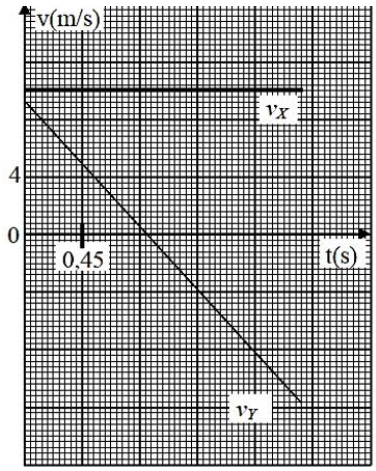
$\alpha = 43°$ $v_0 = 13.7\ m \times s^{-1}$

S $\vec{v}_s$ -

.



الشكل – 9



الشكل – 10

$\rho = 7.1 \times 10^3\ kg/m^3$ V

$\rho = 1.29\ kg/m^3$

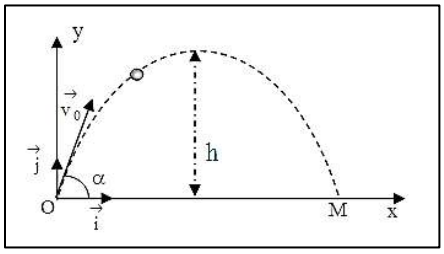
-

-

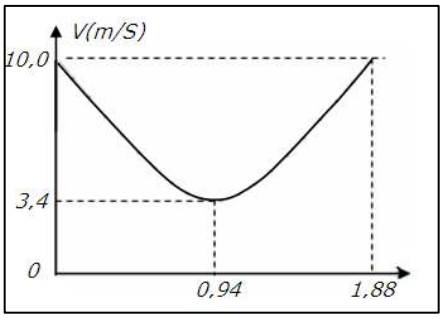
-

O $\vec{v}_0$ m $t = 0$

$(O, \vec{i}, \vec{j})$



M O



$\vec{v}_0$ v_0 -

$\vec{v}_0$ v_{0x} -

v_{0y} α

$(0 \le t \le 1{,}88)s$ $v_y(t)$ $v_x(t)$

h OM

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$v_0 =$ Z_0 $m = 58g$

$Z_0 = 0.9m$ $12m$ $28\,m/s$

$g = 9.8m \times s^{-2}$ $(ox; oz)$

$z = f(x)$

$10cm$ Z_0

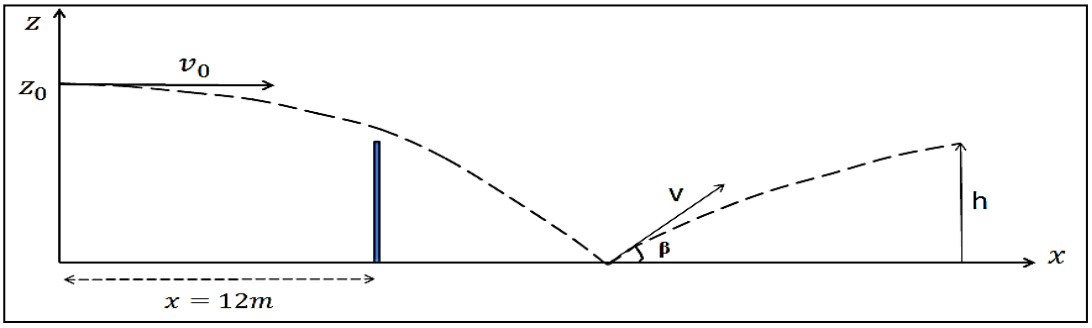
$24m$

v

$\beta = 15°$ v

$24m$

h

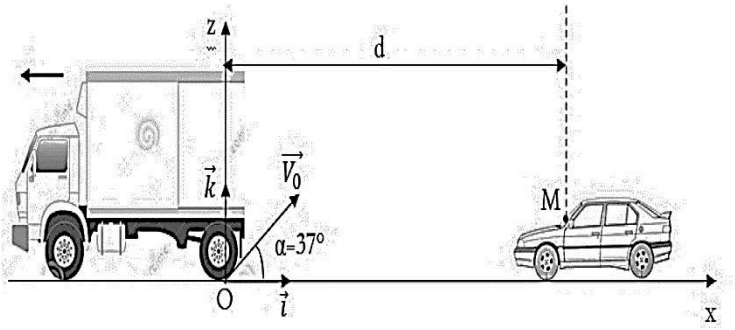


$g = 9{,}8m/s^2$

O $t = 0$

M $\alpha = 37°$ $v_0 = 12m/s$

$t = 0$ $90km/h$



$d = 44m$ M O

$(O, \vec{i}, \vec{j})$ -1

$z(t)$ $x(t)$

$z = f(x)$ -2

M $x_M(t)$ -3

$(O, \vec{i}, \vec{j})$

M h t_M -4

-5

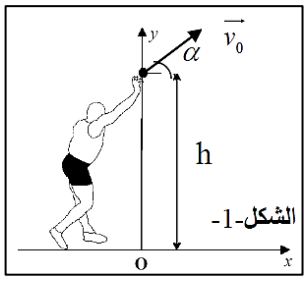
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2016

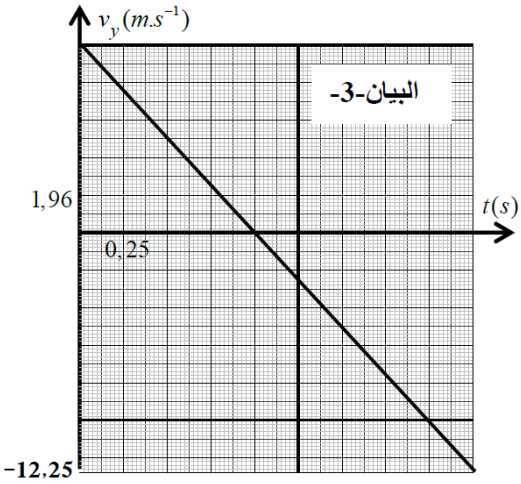
D

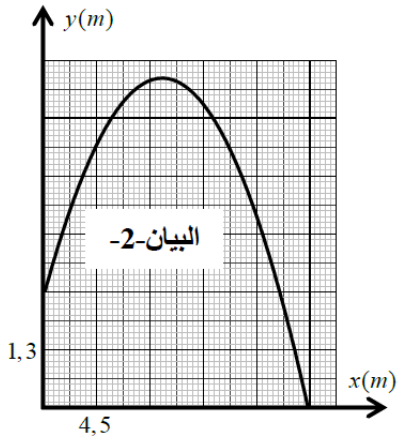
(O,x,y) (G)

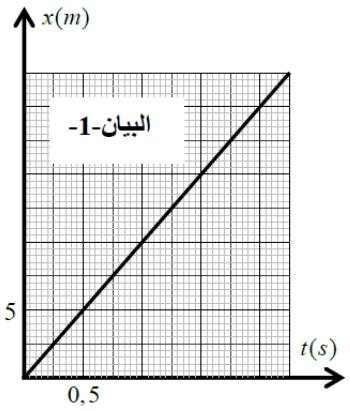
h $t=0$



الشكل-1-







.1

(oy) (ox)	G	1	1
h	a_y a_x	v_{0y} v_{0x}	2 1
		$y(t)$ $x(t)$	3 2
		2	4 1
v_0	α		5 1
	D		6 1

$t=2.25s$ $t=0$ .2

$t=2.25s$

$t=2.25s$ G .3

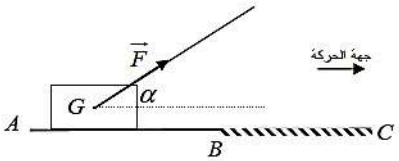
m g h v_0 .4

$g=9{,}8m/s^2$

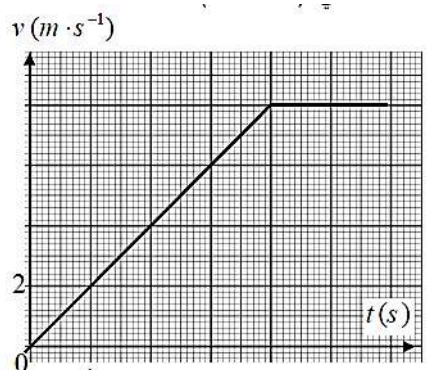
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$\alpha = 30°$ $\vec{F}$ G (AC) $m = 10kg$

t G (BC) (AB)



الشكل-2



الشكل-3

G -

AC

$\vec{F}$ -

$\vec{f}$

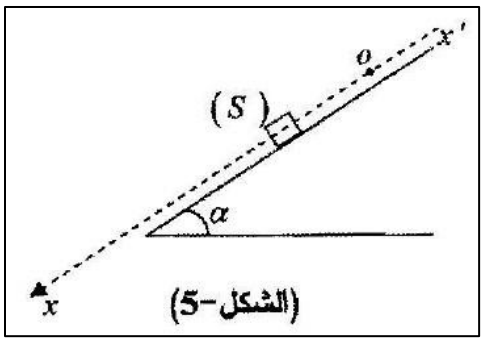
$\overrightarrow{xx'}$ $\alpha = 20°$ $m = 100g$ (S)

Aviméca

$t(s)$	0	0.04	0.06	0.08	0.1	0.12
$v(m/s)$	v_0	0.16	0.20	0.24	0.28	0.32

$v = f(t)$ -

-



(الشكل-5)

a (S) -

$t = 0$ v_0 -

$t_2 = 0.08s$ $t_1 = 0.04s$ -

-

a_0 -

a a_0 -

$\vec{f}$ -

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$g = 10m/s^2$

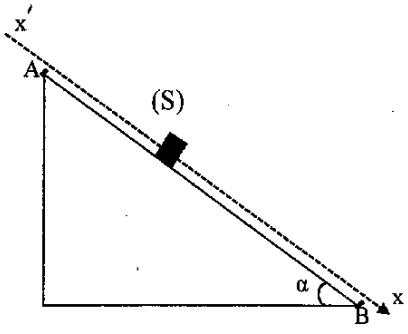
$\alpha = 35°$ AB $m = 900g$ (S)

A

AB

	G_0	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8
$t(s)$	0.00	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64
$x(cm)$	0.0	1.5	6.0	13.5	24.0	37.5	54.0	73.5	96.0

$\tau = 80ms$ B G_8 A G_0



G_6 G_5 G_4 G_3 G_2 -1

G_5 G_4 G_3

(S) -2

(S) -

-

a

$\vec{f}$ -3

$\vec{f}$ -

B -

α AB $m = 500g$ (S)

$f = 0.5N$ (S)

B v_0 A α

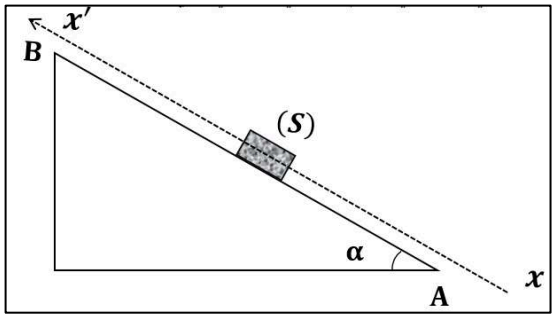
AB

	G_0	G_1	G_2	G_3	G_4	G_5	G_6	G_7
$t(s)$	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
$x(m)$	0	0.47	0.88	1.23	1.52	1.75	1.92	2.03
$v(m/s)$								
$v^2(m/s)^2$								

$\tau = 100ms$ A G_0

-1

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$v^2 = f(x)$

(S) -2

(S) -

-

a

-

x v^2 -

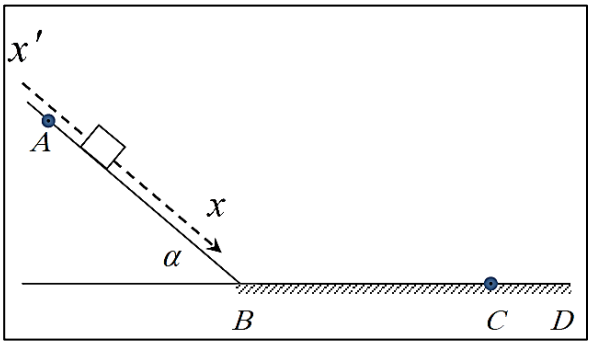
2 -3

v_0 -

AB -

$g = 10m/s^2$ α -

v_B α $m = 800g$



B A

$v = f(t)$

$g = 10\,m/s^2$

(

v_B (

AB (

(

(

α (

B (

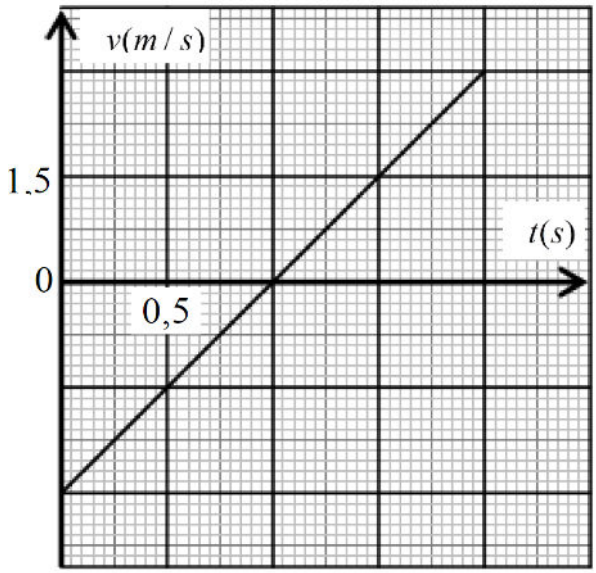
BD B (

$1.8m$ B C

BD (

D B (

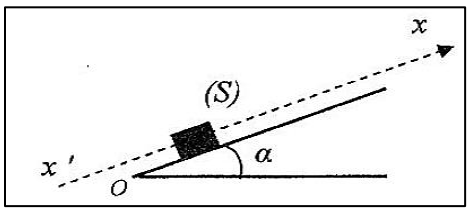
BC (



BD (

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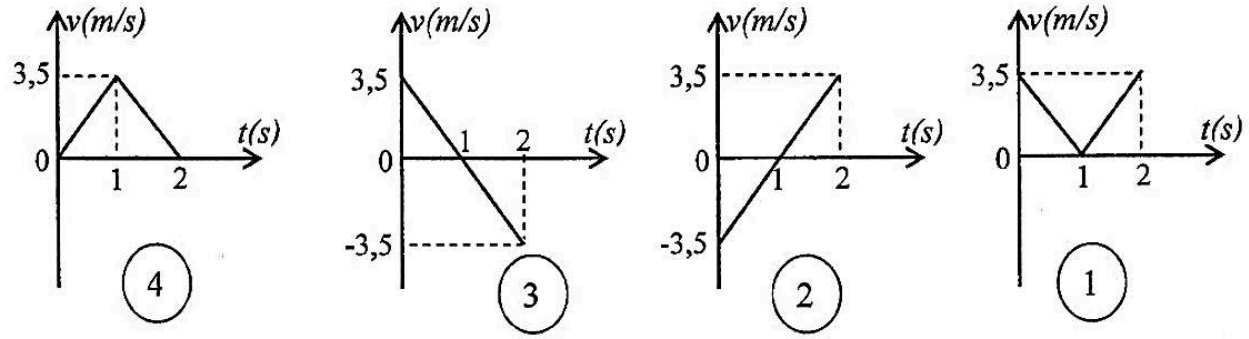
$t = 0$ $m = 1kg$ (S) α -



$\vec{v}_0$ O

(S)

$v = f(t)$



O (S) -

(S) -

α

$t = 2s$ $t = 0$

f -

(S) -

(S) -

$g = 9.8m \times s^{-2}$ $f = 1N$

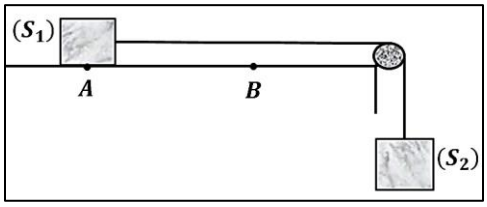
7

$g = 10m/s^2$

(S_1) (S_2) $m_2 = 500g$ (S_2) $m_1 = 500g$ (S_1)

A (S_1) $t = 0$ f (S_1)

A $AB = 2m$



(S_2) (S_1) -

(S_2) (S_1) -

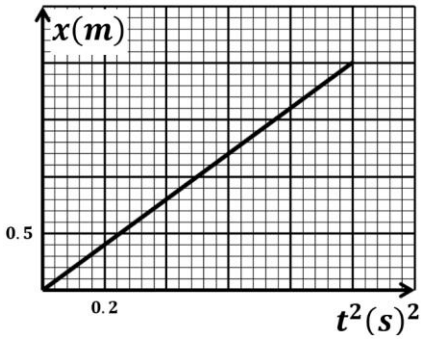
$\frac{d^2x}{dt^2} = \frac{g}{2} - \frac{f}{2m_1}$ x -

(S_1) -

-

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(S_1) x -



$t = 0$

a -

B -

T f -

B (S_1) -

-

-

(S_1) -

(S_1) (S_2) -

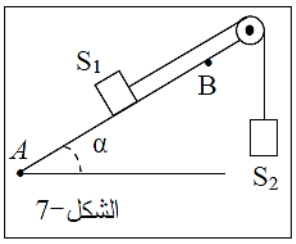
(S_1) (S_2) -

$g = 10m/s^2$

2014 **8**

$m_1 = 400g$ (S_1)

$m_2 = 400g$ (S_2) $\alpha = 30°$



A (S_1) $t = 0$

$g = 10m \times s^{-2}$

(S_2) (S_1) -

(S_1) -

$AB = 1.25m$ B (S_1)

(S_1) -

$v = f(t)$

(S_1) -

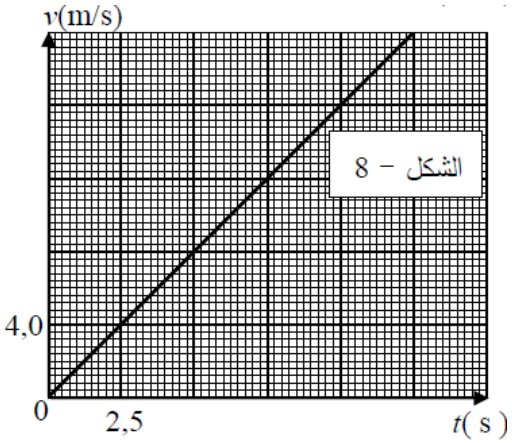
-

(S_1)

$\vec{f}$ $\frac{dv(t)}{dt} = \frac{g}{2}(1 - \sin\alpha) - \frac{f}{2m_1}$

(S_1)

$\vec{T}$ $\vec{f}$



2011 **9**

$m_1 =$ (S_1) $m_2 = 600g$ (S_2)

$\vec{f}$ $\alpha = 30°$ $800g$

A $AB = x$ A $t = 0$

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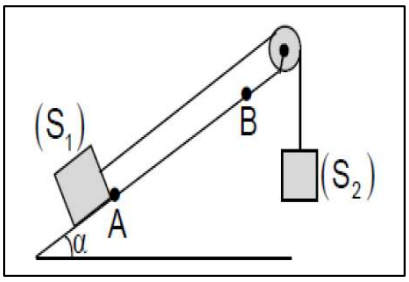
(S_1) (S_2) -

(S_1) (S_2) -

$\frac{d^2x}{d^2} = \frac{(m_2 - m_1 \sin\alpha)}{m_1+m_2} g - \frac{f}{m_1+m_2}$ x -

(S_1) -

-



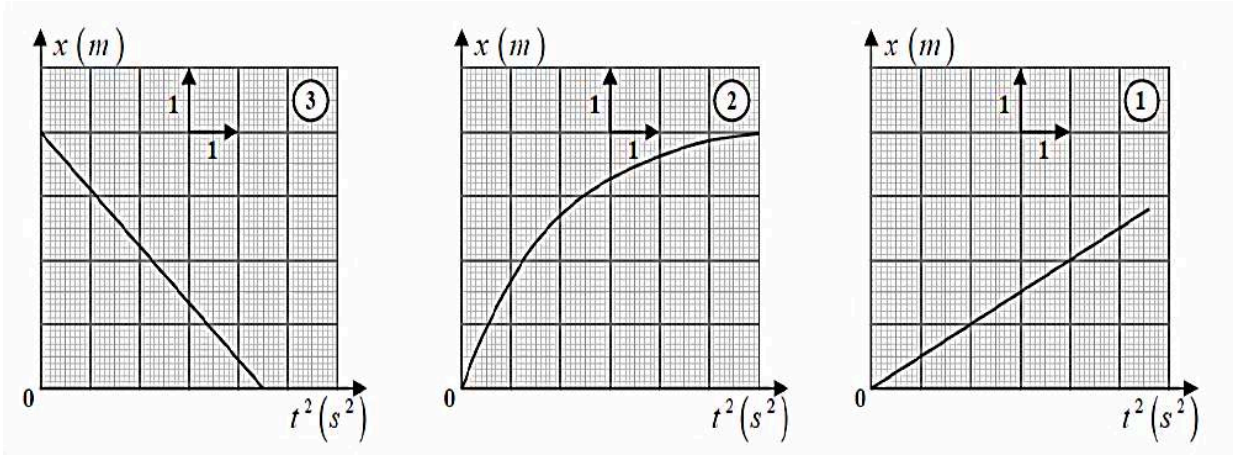
x -

(S_1)

-

a -

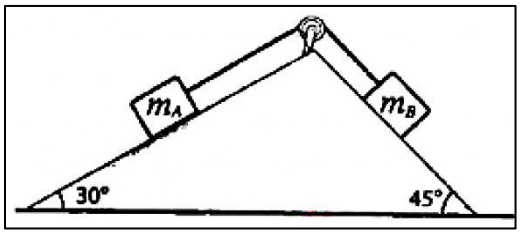
$g = 9.8m \times s^{-1}$ T f -



10

m_B B $m_A = 0.5kg$ A

$\beta = 45°$ $\alpha = 30°$



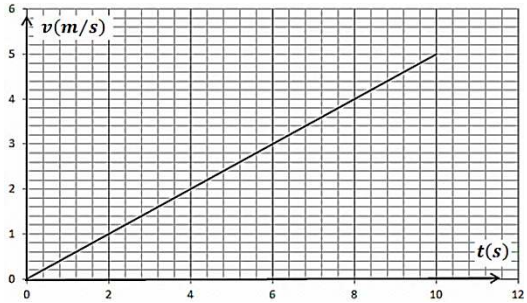
β α m_B m_A -

m_B

$m_B = 2m_A$ B -

$a = 3\,m/s^2$ -

$5s$ -



-

-

-

-

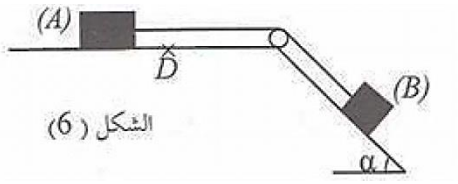
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$$a = \frac{g}{3}(2\sin\beta - \sin\alpha) - \frac{2f}{3m_A}$$

$g = 10\,m/s^2$ T f -

2015 **11**

$m_B = 150g$ (B) $m_A = 300g$ (A)



(A)

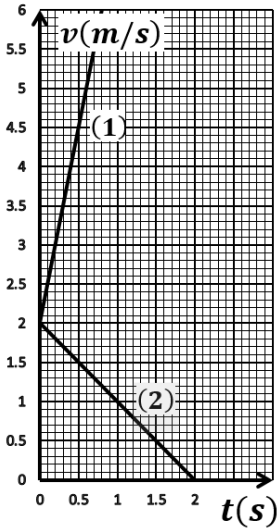
$g = 10m/s^2$ $\vec{f}$

-

f g m_B m_A α β $\frac{dv}{dt} + \beta = 0$

D (A) -

(B) (A)



-

-

-

(A) -

α $\vec{f}$

2013 **12**

d $\alpha = 10°$ BC AB

$m = 170kg$ G (S)

B $t_1 = 5s$ $v_A = 10\,m \times s^{-1}$ $t = 0$ A (S) -

v_B

(S)

AB

BC $f = 500N$ $\vec{F}$ BC -

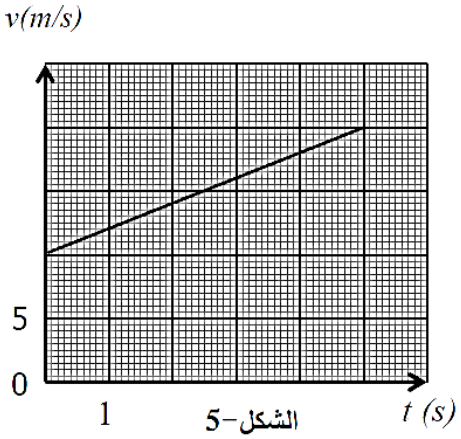
AB (S) $\vec{F}$ -

P $v_C = 25\,m \times s^{-1}$ C (S) -

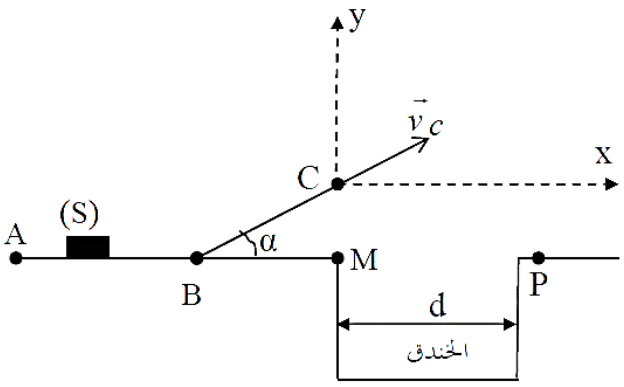
(Cx, Cy) (S) -

$BC = 56.3m$ $d = 40m$ -

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الشكل-5



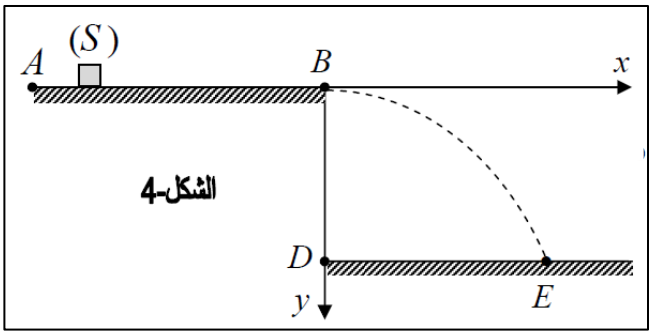
الشكل-4

2014 **13**

A $\vec{v}_0$ $m = 400g$ (S) $t = 0$

$\vec{f}$ (S) $AB = 1.4m$ B

(S) -



الشكل-4

$\frac{dv}{dt} = -\frac{f}{m}$

$v(t)$ A

m v_0 f $x(t)$

$v^2 = f(x)$ -

x v^2 -

$\vec{f}$ v_0

$\vec{v}_B$ B AB (S) -

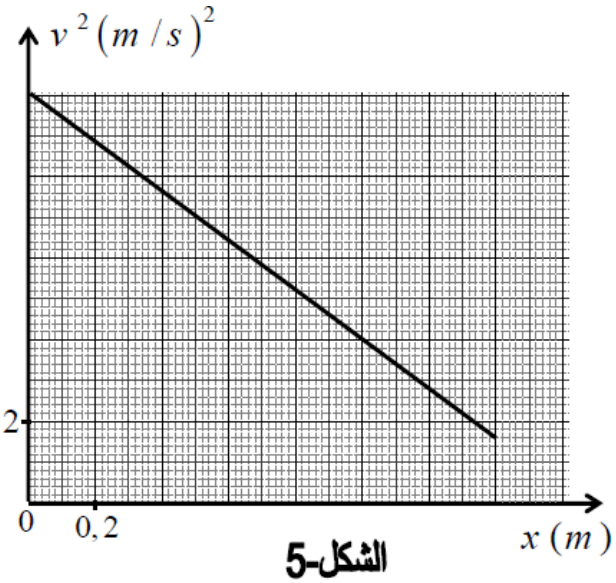
$\overline{BD} = 0.5m$ E

(S) -

(Bx, By) B

$y = f(x)$ -

E (S) DE

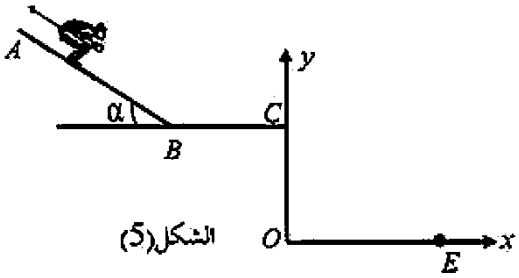


الشكل-5

$g = 10m \times s^{-2}$

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2015 **14**



الشكل(5)

$AB = 50m$ $\alpha = 30°$ AB

BC

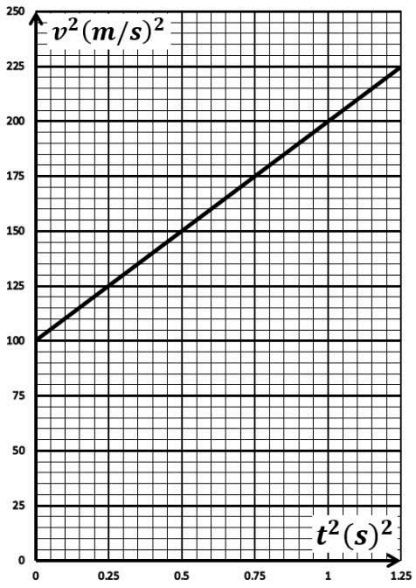
h CO

$g = 10m/s^2$ $m = 80kg$

B A -

$v_B = 20\,m/s$ B ABC $\vec{f}$

AB



C BC -

E

$y(t)$ $x(t)$ -

(ox, oy)

-

E

t^2 v^2 v_y v_x v -

E C -

h

2016 **15**

$AO = d = 1{,}5m$ (S) f

N O A $\alpha = 45°$

$m = 500\text{g}$ (S) $g = 9.8m/s^2$

(S)

(S) N AO

$(x_N = 0.62m\ , y_N = h = 1.00m\ )$

AO (S) a f -1

$f = m(\text{g}\sin\alpha - a)$ AO (S) -

f (S) a -

O (S) N f -2

(Ox, Oy) (S) $y(t)$ $x(t)$ -

$y = f(x)$ -

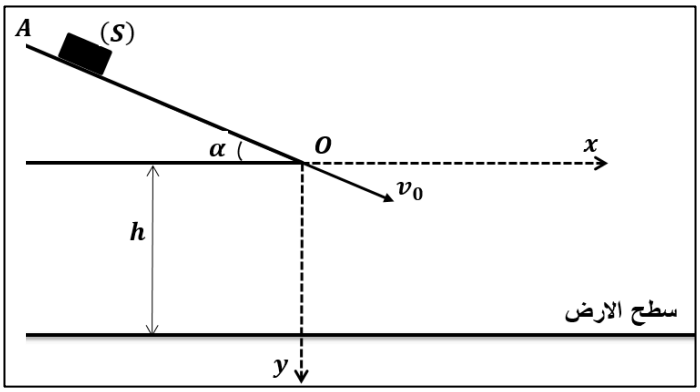
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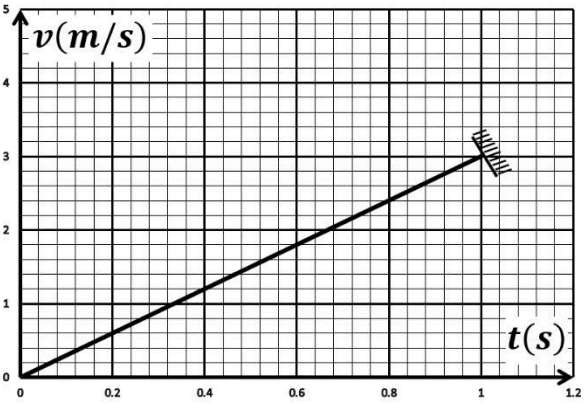
(S) v_0 -

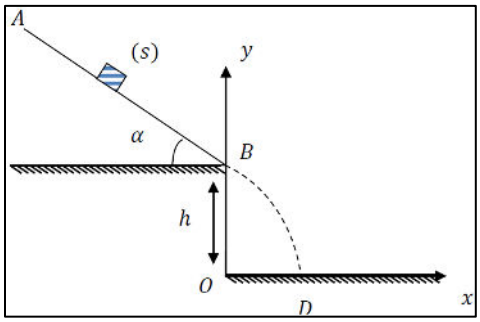
AO (S) a -

f 1 -

$1.8N \leq f \leq 2.0N$ -3







$g = 9.81\,m/s^2$

m (S)

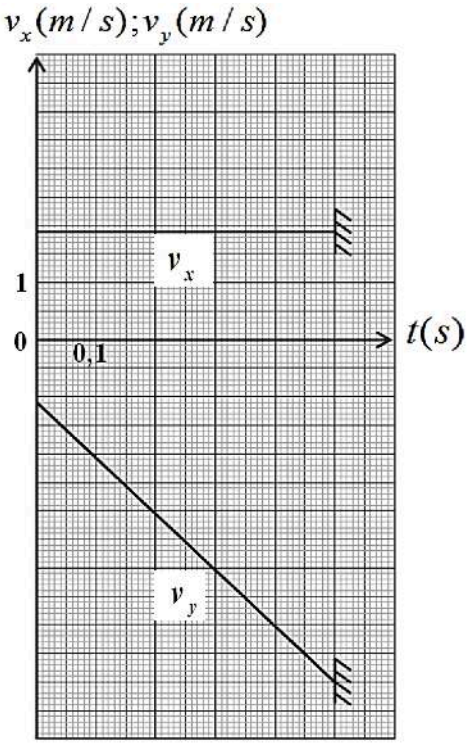
$AB = 1m$ α A

B

.I

$\vec{f}$

$f(N)$	0,5	1,0	1,5	2,0
$a(m/s^2)$	3,9	2,9	1,9	0,9



(S) a (1

(S) a (2

$\vec{f}$

m α (3

B A (S) (4

(S) (5

$v_B = 2.19m/s$ $\vec{f}$ (

$\vec{f}$ (

D B (S) .II

$(\overrightarrow{ox}, \overrightarrow{oy})$ v_y v_x

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$(\overrightarrow{ox}, \overrightarrow{oy})$ (S) (1

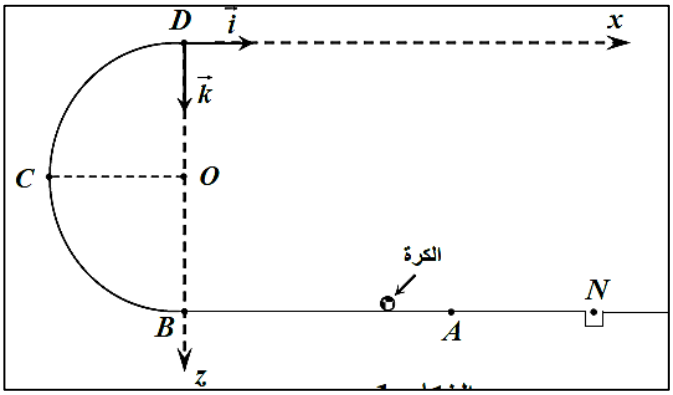
x_D h (2

D (S) (3

A $m = 45g$

BCD B A N D C B N

B D $r = 0.5m$ O



C -

A -

D -

$v_D = 6.71m/s$

v_A (

D $\vec{R}$ (

$R = m\left(\frac{{v_A}^2}{r} - 5g\right)$

$x = 2v_D \times \sqrt{\frac{r}{g}}$ A (

(

$AB = 2\,m \quad AN = 1\,m \quad g = 10\,m/s^2$

2008 **18**

$\alpha = 30°$ AB A (S)

$AB = L$

O C B A r O BC B AB

C B

$r = 2\,m \quad L = 5\,m \quad g = 10\,m/s^2$ $m = 0.2kg$ (S)

α g L B (S) -

C (S) -

(S) α g m -

$v_I = 7.37\,m/s$ I (S) BC I

I (S)

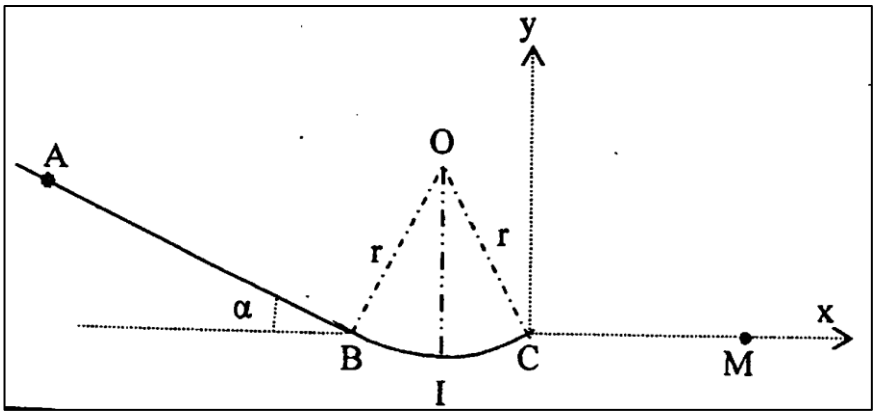
BC C (S) -

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(S) $t = 0$ (S) $y = f(x)$ $(\overrightarrow{Cx}, \overrightarrow{Cy})$ -

C

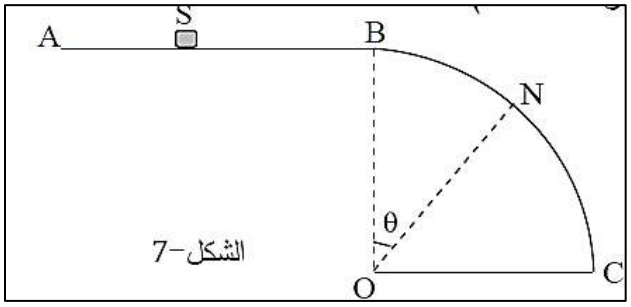
CM M C B (S) -



A $r = 1m$ BC $m = 100g$ (S)

$f = 0.8N$ $AB = d = 1m$ $\vec{v}_A$

N $\vec{v}_B$ BC B (S)



الشكل-7

AB (S) -

v_A

$$v_A{}^2 = v_B{}^2 + \frac{2 \times d \times f}{m}$$

θ $v_B{}^2$ $\cos\theta$ -

N (S)

$\vec{v}_N$

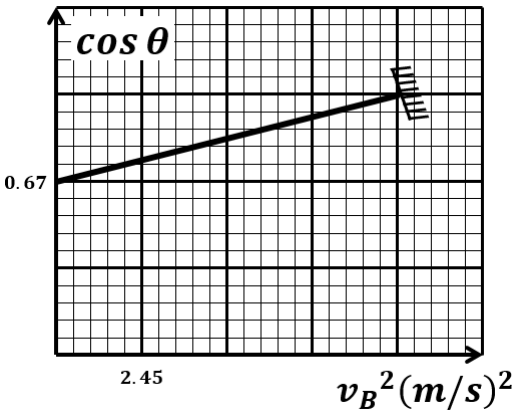
θ r g $v_B{}^2$ $v_N{}^2$ -

(S) $\vec{R}$ -

r g $v_B{}^2$ $\cos\theta$

N (S)

g



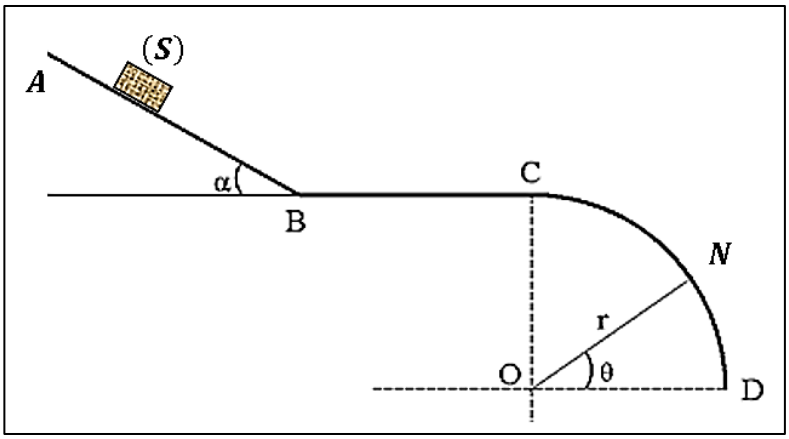
v_A θ -

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$AB = 2\,m$ $\alpha = 30°$ A $m = 0.5kg$ (S)

$\vec{f}$ 5

5



$v_B = 2.5\,m/s$ B f -1

a

AB (S)

(BC) (S) -2

-

$BC = 0.5\,m$ v_C -

r C (S) -3

$\theta = 60°$ N

$v_N{}^2 = v_C{}^2 + 2gr(1 - sin\theta)$ -

m r β v_N (S) R -

$r = \frac{v_C{}^2}{g(3sin\theta - 2)}$ -

$g = 9.8m/s^2$

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