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

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

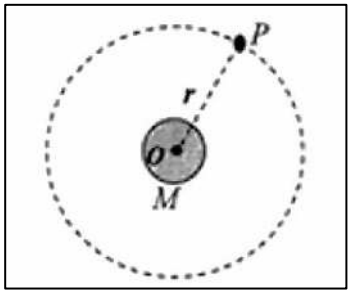
(Giove-A) 5

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

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

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

m_P Phobos

T_M = 24 h 37 min 22 s

O

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P Phobos M 1

2

P

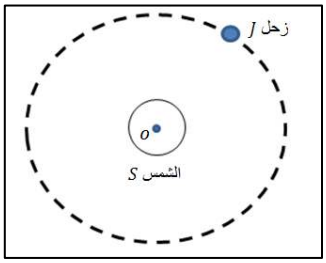
m_M G r T_P 3

T_P $\frac{T_P^2}{r^3} = 9{,}21\times10^{-13}\ S^2.m^{-3}$ 4

T_S S 5

2008 4

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



(O)

a

r M_s G v

v r T

2008 5

(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

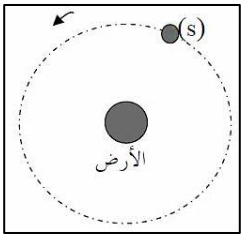
$(\frac{T^2}{r^3})$ 6

(SI)

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

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

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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

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

2011 7

2002 28 $m_L=90kg$ *(Alsat1)* 1

$T=98min$

1

h *(Alsat1)* 2

أ-

M_T, m_L, h, G, R_T

ب-

$r=R_T+h$ $v=\sqrt{\frac{GM_T}{r}}$

ج-

M_T, r, G T

(Alsat1) h

$G=6.67\times10^{-11}SI$ ، $M_T=6\times10^{24}kg$ ، $R_T=6.38\times10^3km$

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

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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: $g_0 = 9,8\mathrm{m}\cdot s^{-2}$.

$T_L = 25,5$ j $r = 384\times10^3$ km

1

v

1968 Apollo 2

$h_A = 110$ km

G M_L R_L h_A T_A

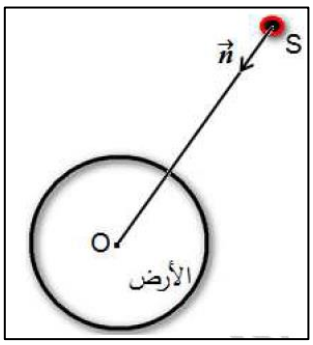
r_S 3

$M_L = 7,34\times10^{22}$ kg $G = 6,67\times10^{-11}$ N.m^2.kg^{-2}

M_T $\frac{M_T}{M_L} = 81,3$ $R_L = 1,74\times10^3$ km

4

14.55 $h = 700km$ (S)



(S) a

v (S) a

n r

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

(S) T_S r T_S

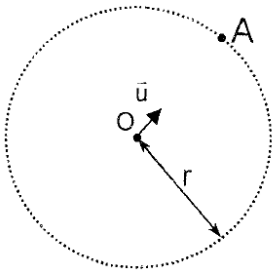
$$\frac{T_S}{r^3} = 9.85\times10^{-14}\ s^2.m^{-3}$$

M_T

$R_T = 6400km$ $G = 6.67\times10^{11}\ (SI)$

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2015 11



O

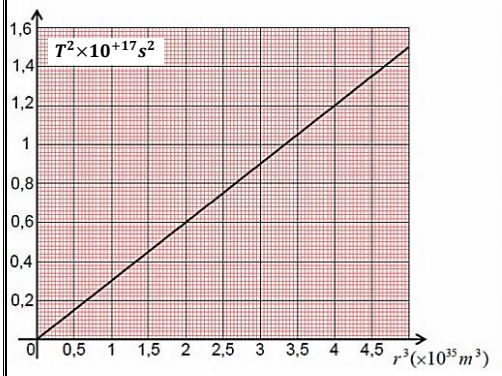
M_S r

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

A m_p

$\vec{u}$ r m_p M_S G $\vec{F}_{S/P}$ 2

G A $\vec{F}_{S/P}$ 3



r M_S 4

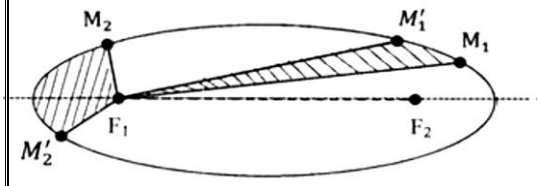
5

M_S $\frac{T^2}{r^3} = 3\times10^{-19}(SI)$

$G = 6.67\times10^{-11}SI$

2016 12

Δt P 1



$M_2M'_2$ $M_1M'_1$

r 2

	$r\times10^6Km$	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

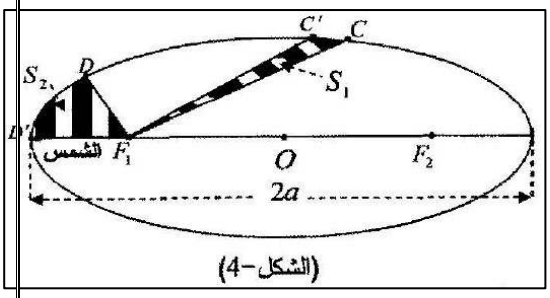
r M_S G T

M_S

r $T = 314j$ $11h$

$G = 6.67\times10^{-11}SI$

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(الشكل-4)

D C' C 4

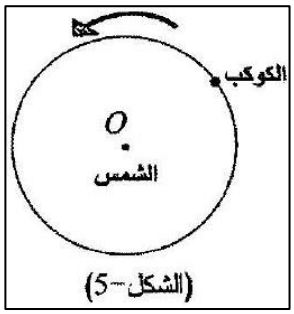
Δt D'

F_1 1

F_2 F_1

S_2 S_1 2

D' D C' C 3



(الشكل-5)

O

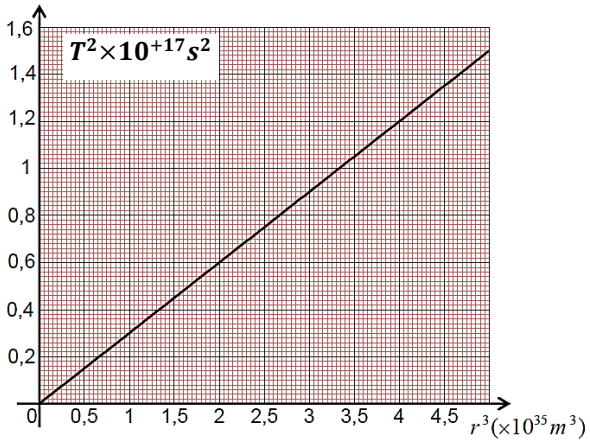
5 r

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

S 2005 28 *GIOVEA* *Galiléo*

$h = 23{,}6.10^{3}km$

1

2

G h R_T M_T 3

4

5

	$h(km)$	$T(s)$	$r^3(m^3)$	$T^2(s^2)$
GPS	$13{,}9\times10^3$	$2{,}88\times10^4$		
GLONASS	$19{,}1\times10^3$	$4{,}02\times10^4$		
METEOSAT	$35{,}7\times10^3$	$8{,}61\times10^4$		

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

R_T

Galiléo

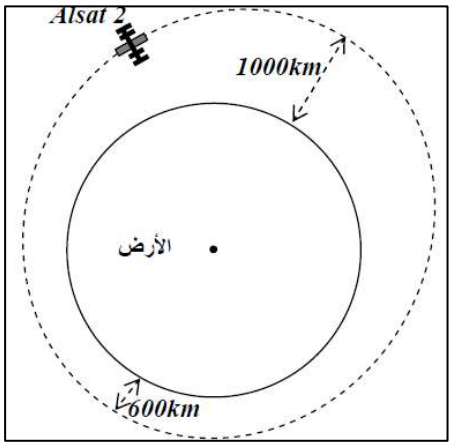
$G = 6{,}67\times10^{-11} SI$ ، $R_T = 6400 Km$

(S) *Alsat*2 2010 12

$1000km$ $600km$

(S) (S) 1

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



(S)

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

$h = 800km$ (S) 2

(S)

$m = 130kg$

3

(S)

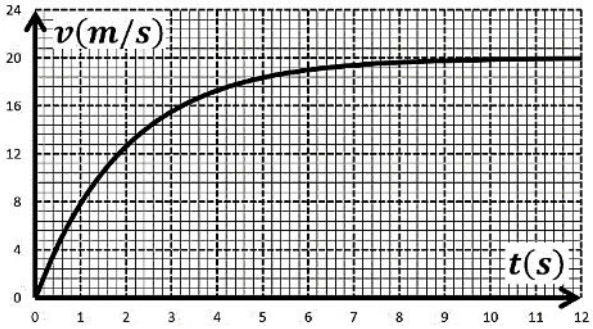
(S)

z 4

z -

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t *v*



1

v_ℓ

$t = 0$ a_0

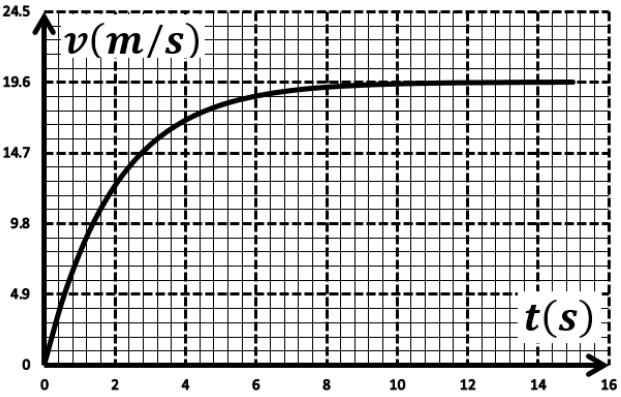
t = 3s

v(t) 2

m = 30 g $g = 9{,}80\ m.s^{-2}$

2010 17

$v =$ (S)



$f(t)$

(S) 1

2

v_{lim}

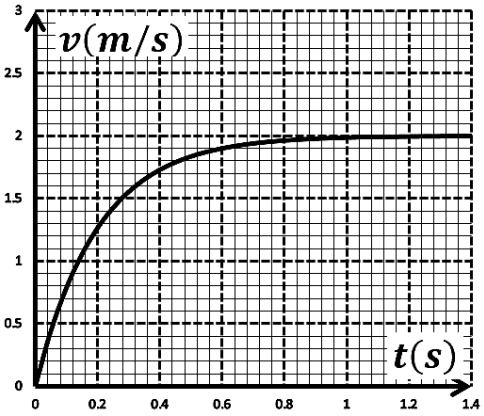
t=0

(S) 3

(S) 4

v

5



h m

$g = 10\ m/s^2$

$f = k.v^2$ 1

Oz

g m k v_{lim}

2

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v_{lim}

$\frac{m}{k}$ k

3

$v(t)$ 4

---

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

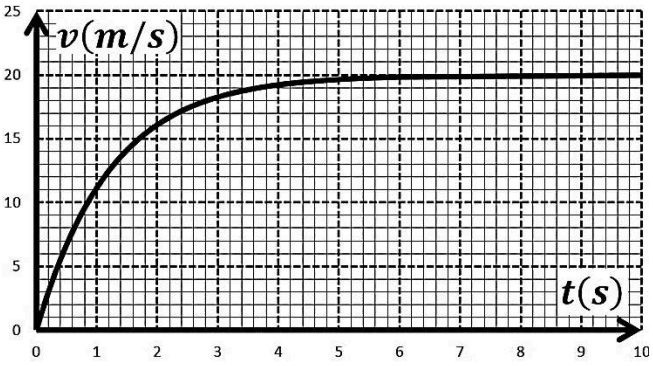
(oz) $1500m$

G

$\vec{f}$ $\vec{\pi}$ $\vec{P}$

$f = kv^2$

k



$\vec{\pi}$

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

v_l

k v_l

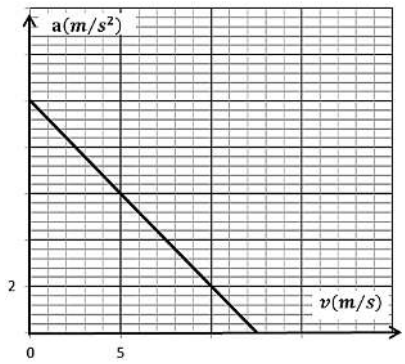
المعطيات: حجم الكرة: $V = \frac{4}{3}\pi r^3$، الكتلة الحجمية للهواء: $\rho = 1,3\ kg \cdot m^{-3}$ ، $g = 9,8\ m \cdot s^{-2}$.

O $m = 100kg$

$f = kv$

(v) (a)

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



(g)

(v_ℓ)

$\frac{k}{m}$

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k

$0 \leq t \leq 7s$

2010 21

(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*

$v = f(t)$ *v* 1

$1\ cm \rightarrow 0{,}1\ s.$ *1 cm → 0,20 m.s^{-1}*

v_{lim}

(S

t=0s *(S)*

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

(S) *V* ρ

(S)

v *(S)*

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

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

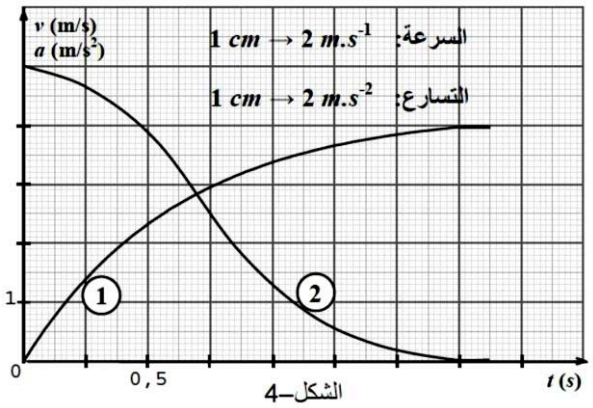
$v_0 = 0\ m.s^{-1}$

$\rho_{air}=1{,}3kg.m^{-3}$ r=1,5cm m=3g

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

1

2



الشكل-4

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

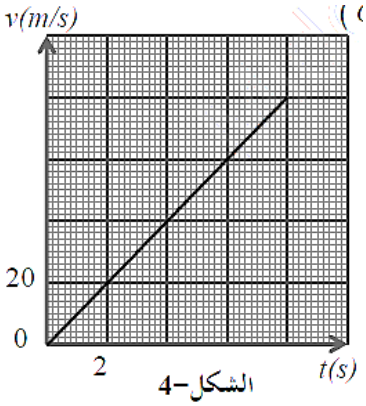
$a(t)$

v_ℓ

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

k -

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الشكل-4

$m = 80kg$ G (S)

$8s$ h

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

(S)

h

g

$f = kv^2$ h

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

m g k

β

$t = 0$ (S) -

-

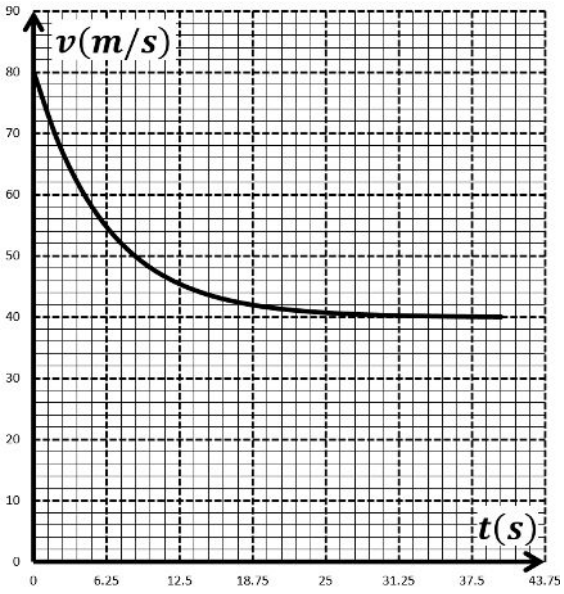
(S) v_{lim} -

(S)

v_{lim}

k

$g = 9.8\,m/s^2$

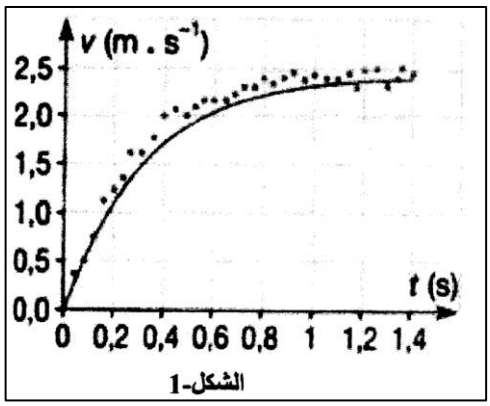


$f = k`v^2 \ldots\ldots\ldots(2)$ $f = kv \ldots\ldots\ldots(1)$

$k`$ k v f

-

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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

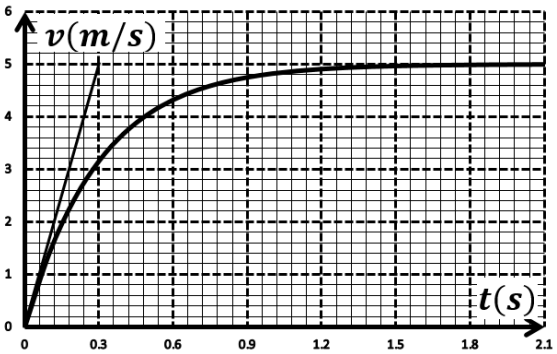
$g = 9.8\, m/s^2$ $V_b = 9m^3$ $\rho = 1.23\, kg/m^3$

---

m

m

$m = 4.1kg$



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

g K V_b ρ m B A

B

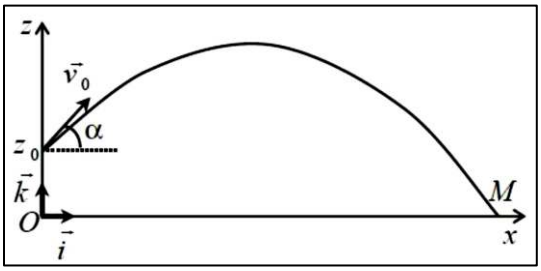
v_l

K

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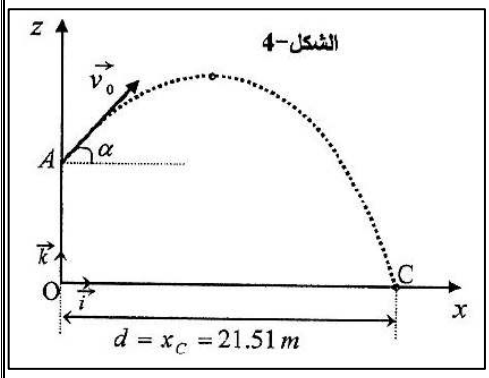
$v_0 =$ $oz_0 = h = 2.0m$ $t = 0$

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



$z = f(t)$

M



$d = 21.51m$

v_0

$h_A = 2m$ A

$\alpha = 45°$ $\vec{v}_0$

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

A

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

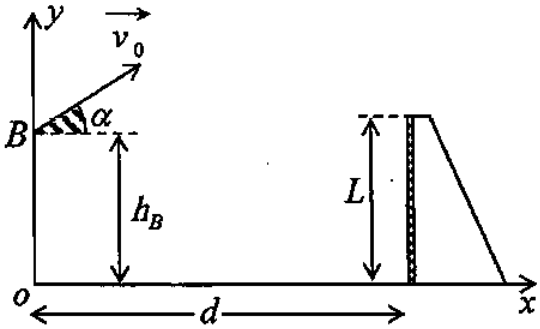
v_0 g α h_A $z = g(t)$

d g α h_A v_0

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

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

$h_B = 2m$ B $\alpha = 30°$



1

(Ox, Oy)

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

$y = f(x)$

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

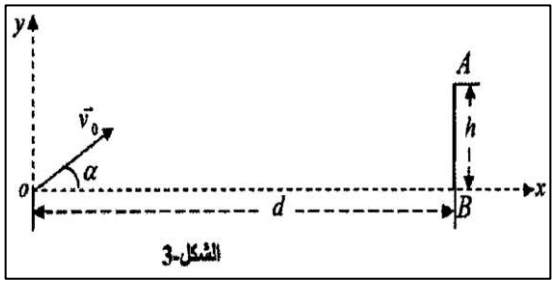
y x

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

$d = 25m$ O

$\alpha = 30°$ $\vec{v}_0$ $h = AB = 2.44m$

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



الشكل-3

A v_0

A

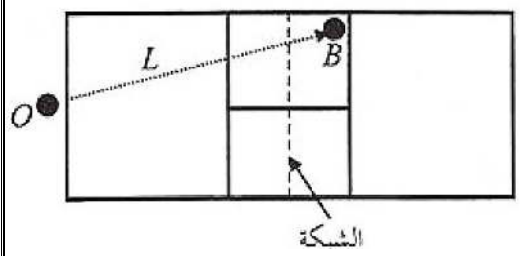
B v'_0

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

$6.4\ m$

B

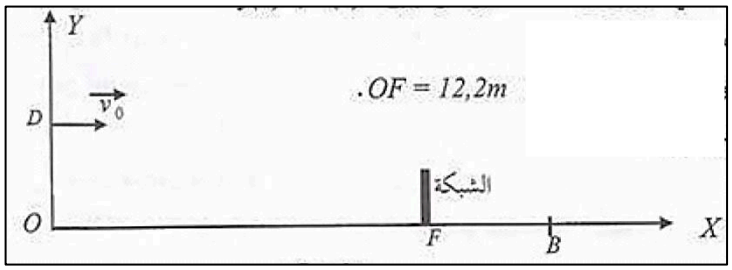
$OB = L = 18.7m$



D O $h = 2.2m$ D

$v_0 = 126km/h$

$g = 9.8m/s^2$



B D

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

$OF = 12.2m$

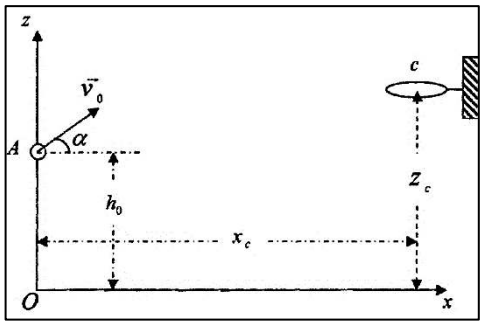
$h_0 = 2.10m$ A

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

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

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



z_c

β $\vec{v}_c$

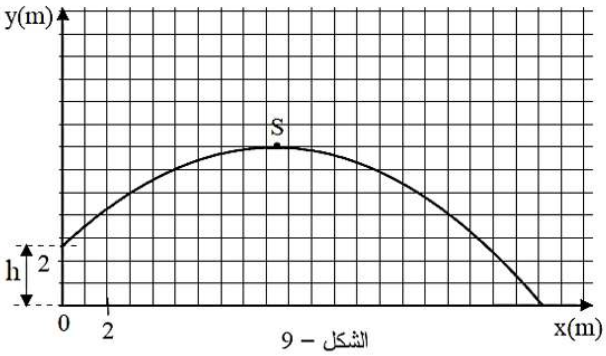
$g = 9.8\,m/s^2$ β v_c

$21.69\,m$

$h = 2.62\,m$

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

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



الشكل – 9

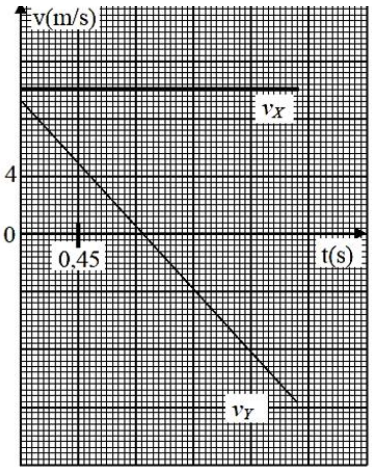
ox

v_{0y}

v_0

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

S $\vec{v}_s$



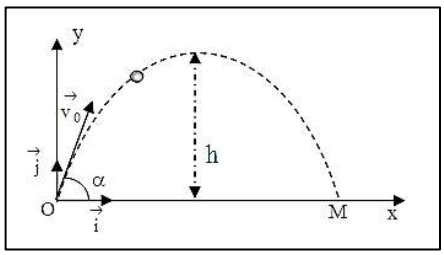
الشكل – 10

$\rho = 7.1\times10^3\,kg/m^3$ V

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

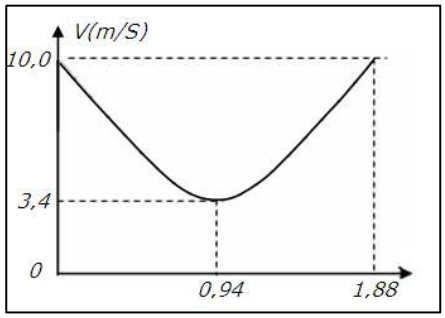
O $\vec{v}_0$ m $t = 0$

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



M O

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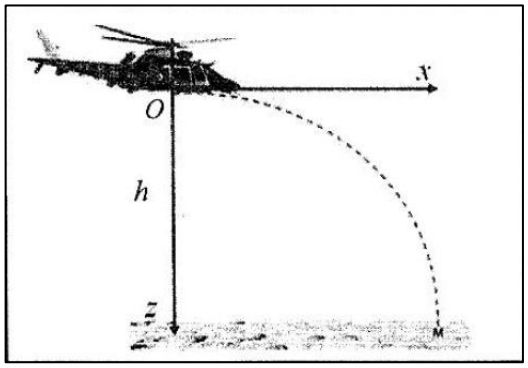
$\vec{v}_0$ v_0

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

v_{0y} α

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

h OM



$v_0 = 50\,m/s$ h

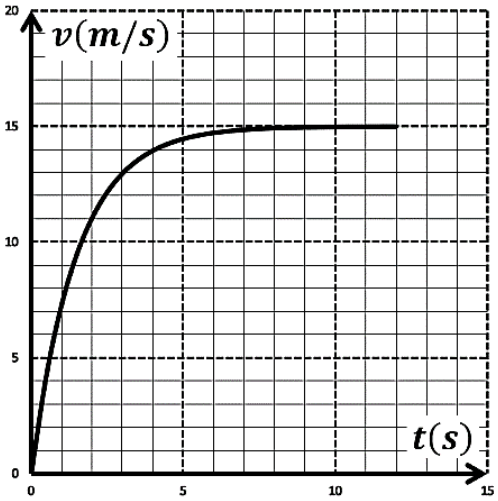
$t = 0$ G

M $\vec{v}_0$ O

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

$z(x)$

M



M h

$t = 0$

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

t

t

v_l

$t = 10s$ $t = 0$

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

$v_0 =$ Z_0 $m = 58g$

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

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

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$z = f(x)$

$10cm$ Z_0

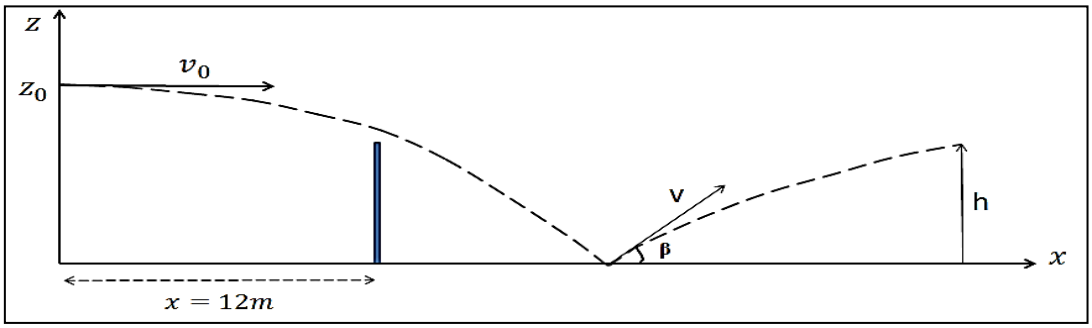
$24m$

v

$\beta = 15°$ v

$24m$

h



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

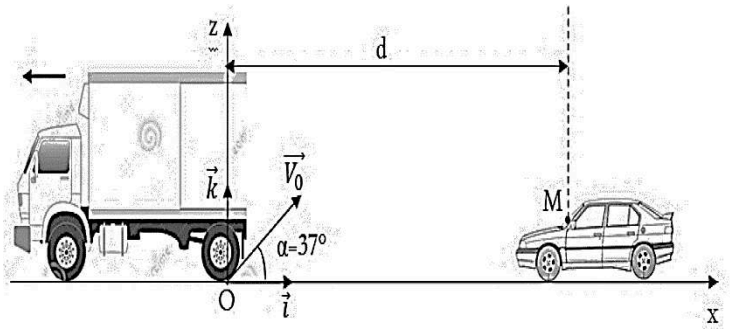
O $t = 0$

M $\alpha = 37°$ $v_0 = 12m/s$

$t = 0$ $90km/h$

$d = 44m$ M O

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



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

2 $z = f(x)$

3 M $x_M(t)$

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

4 t_M

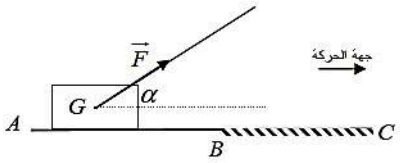
M h

5

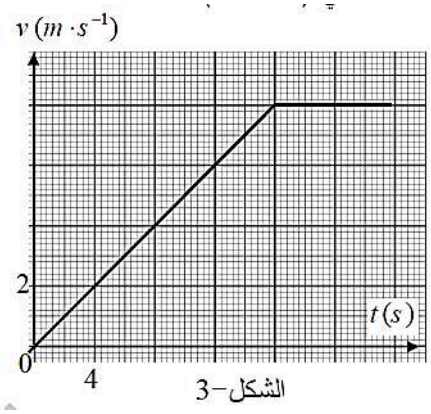
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$\alpha = 30°$ $\vec{F}$ G (AC) $m = 10kg$

t G (BC) (AB)



الشكل-2



الشكل-3

G

AC

$\vec{F}$

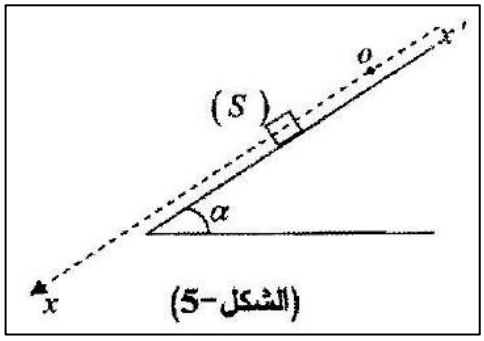
$\vec{f}$

$\overrightarrow{xx'}$ $\alpha = 20°$ $m = 100g$ (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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$g = 10m/s^2$

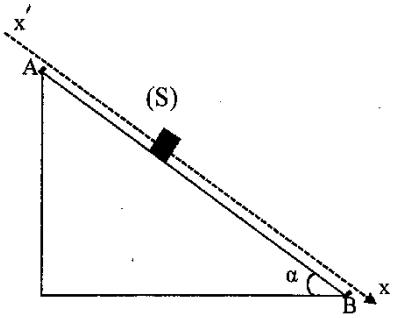
$\alpha = 35°$ AB $m = 900\text{g}$ (S)

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
$x(m)$	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

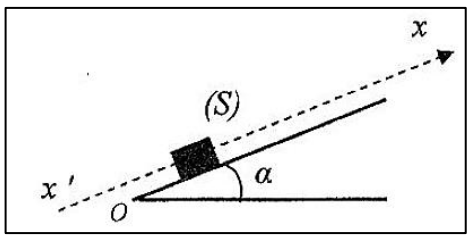
(S)

a

$\vec{f}$ 3

$\vec{f}$

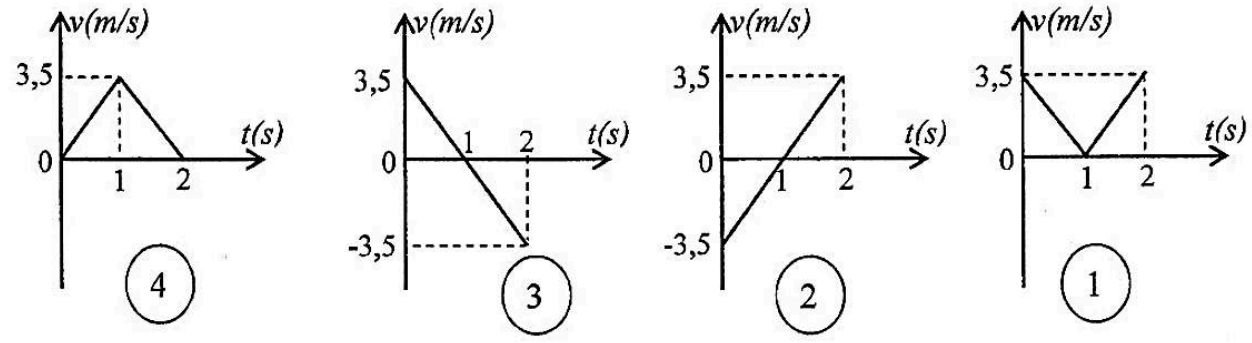
B



α

$\vec{v}_0$ O $t = 0$ $m = 1kg$ (S)

$v = f(t)$ (S)



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O (S)

(S)

α

$t = 2s$ $t = 0$

f

(S)

(S)

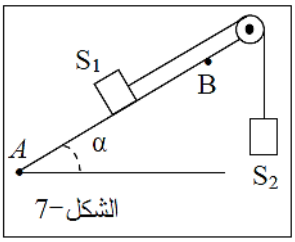
$f = 1N$

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

2014 41

$m_1 = 400g$ (S_1)

$m_2 = 400g$ (S_2) $\alpha = 30°$



الشكل-7

A (S_1) $t = 0$

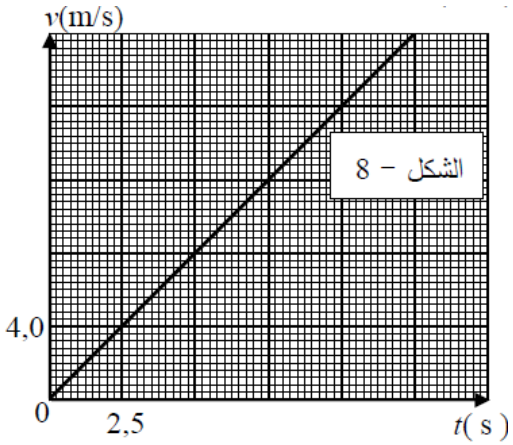
$g = 10m\times s^{-2}$

(S_2) (S_1)

(S_1)

$AB = 1.25m$ B (S_1)

(S_1)



الشكل – 8

$v = f(t)$

(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 42

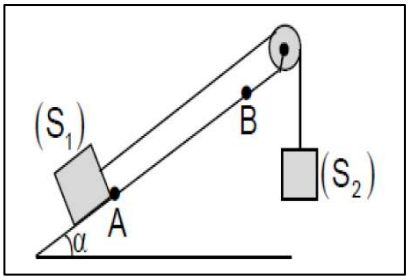
$m_1 =$ (S_1) $m_2 = 600g$ (S_2)

$\vec{f}$ $\alpha = 30°$ $800g$

$AB = x$ A $t = 0$

A

(S_1) (S_2)



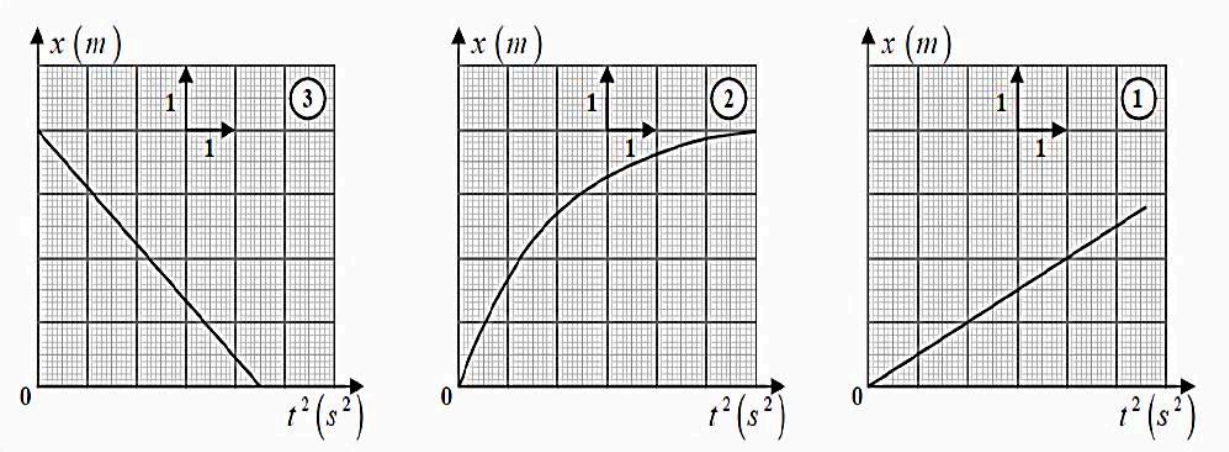
(S_1) (S_2)

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

(S_1)

(S_1) x



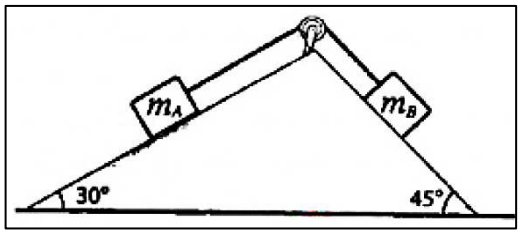
a

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

43

m_B B $m_A = 0.5kg$ A

$\beta = 45°$ $\alpha = 30°$

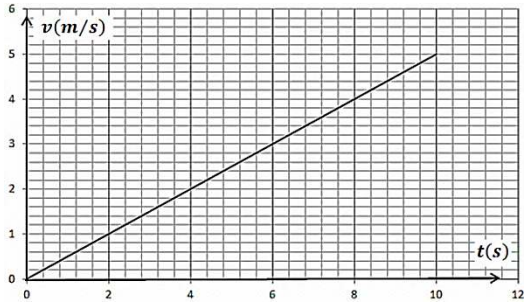


β α m_B m_A

m_B

$m_B = 2m_A$ B

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



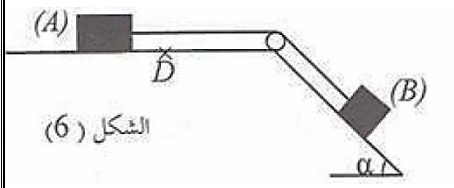
$5s$

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

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

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



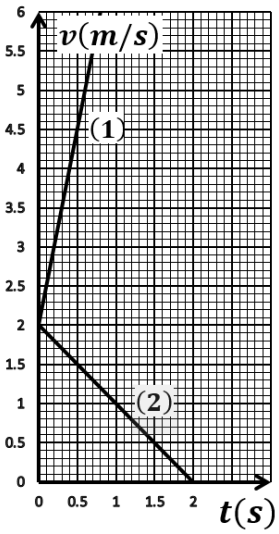
(A)

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

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

D (A)

(B) (A)



(A)

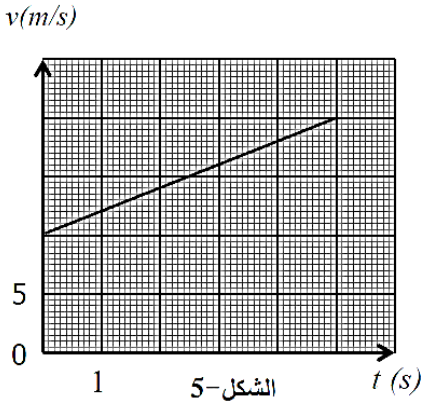
α $\vec{f}$

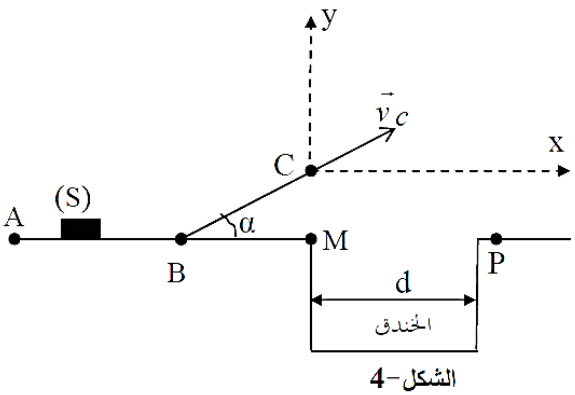
2013 45

d $\alpha = 10°$ BC AB

$m = 170kg$ G (S)

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





(S)

AB

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

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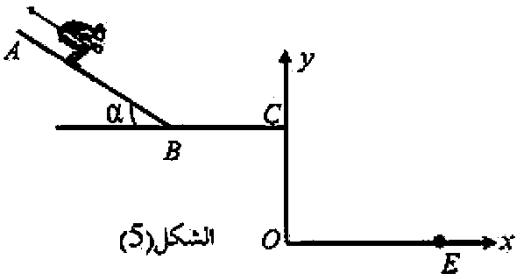
AB (S) $\vec{F}$

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

(Cx, Cy) (S)

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

2015 46



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 $\vec{f}$

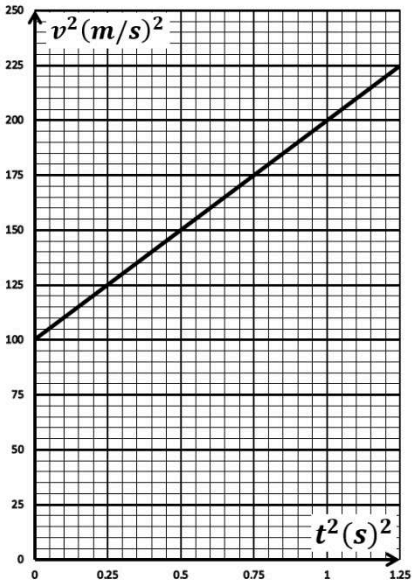
AB

C BC

E

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

(ox, oy)



E

t^2 v^2 v_y v_x v

E C

h

2016 47

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

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f (S) a

O (S) N f 2

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

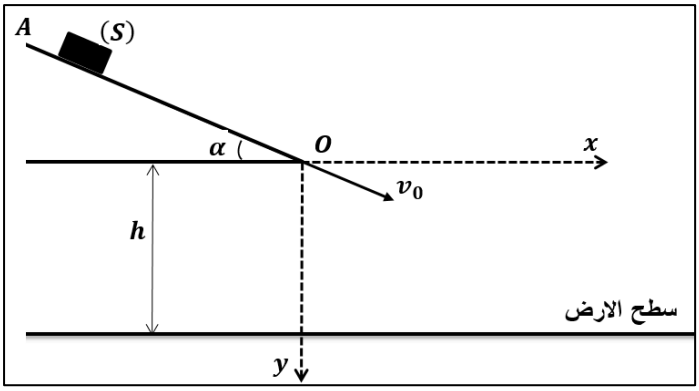
$y = f(x)$

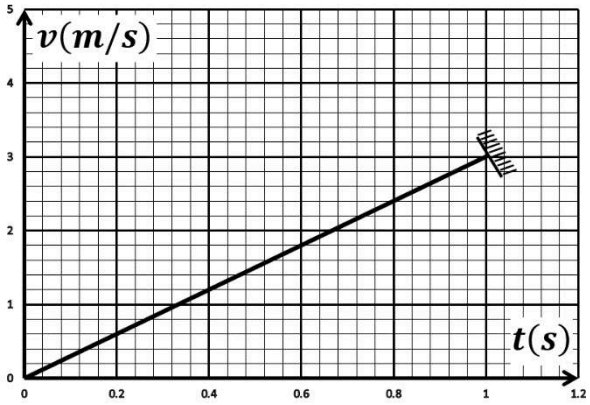
(S) v_0

AO (S) a

f 1

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





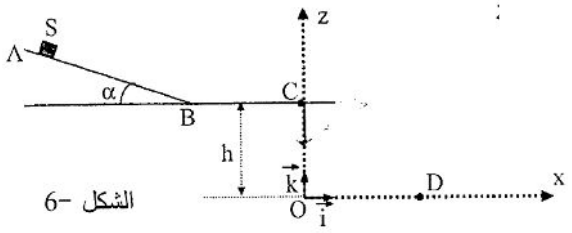
2015 48

$AB = 2\,m$ $\alpha = 30°$ $g = 10m/s^2$

A (S) $ABCD$ $m = 100g$ (S)

(S) $\overrightarrow{v_c}$ C $v_B = 2m/s$ B

AB



الشكل 6-

AB

$\vec{f}$

BC

D O $h = 0.8\,m$ C (S)

$\overrightarrow{v_D}$ D

C (S)

$z = -\frac{g}{2v_c^2}x^2 + h$ $(O; \vec{i}; \vec{k})$ (S)

OD O D

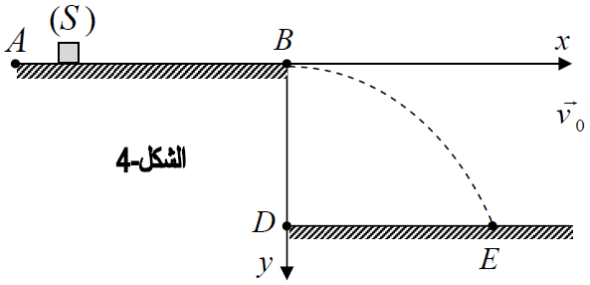
v_D

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

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

(S)



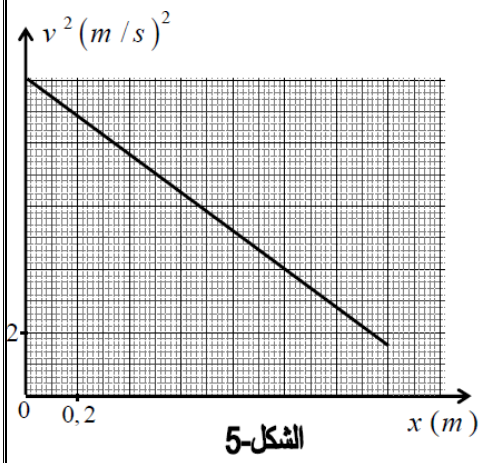
الشكل-4

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

A

m v_0 f $x(t)$ $v(t)$

$v^2 = f(x)$



الشكل-5

x v^2

$\vec{f}$ v_0

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

$\overline{BD} = 0.5m$ E

B (S)

(Bx, By)

$y = f(x)$

E (S) DE

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

2008 50

$v(km/h)$ سرعة السيارة	50	80	90	100	110
$d_1(m)$ مسافة الاستجابة	14	22	25	28	31
$d_2(m)$ المسافة الموافقة لمدة الكبح	14	35	45	55	67

τ_1 τ_1 d_1 $\vec{v}$

d_2 d_1 D τ_2 d_2

$D = d_1 + d_2$

M G

τ_1

$\frac{d_1}{v}$

d_2 τ_1

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$\vec{F}_{f/_G}$

d_2 v^2 v

$v^2 = g(d_2)$

$M = 900kg$ $\vec{F}_{f/_G}$

2008 51

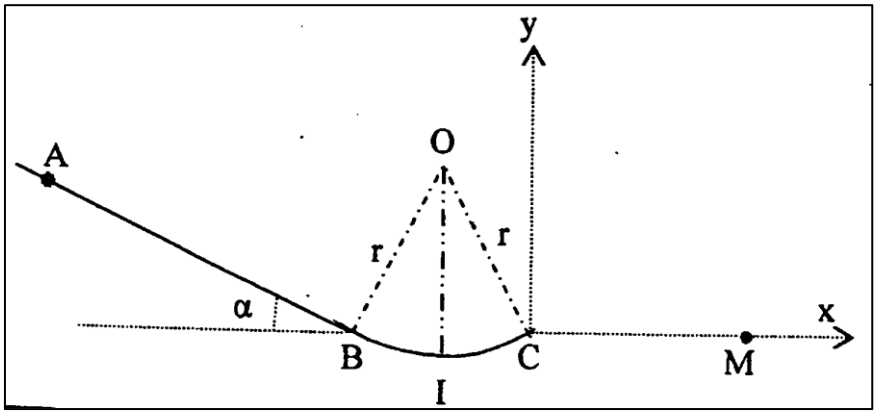
$\alpha = 30°$ AB A (S)

$AB = L$

O C B A r O BC B AB

C B

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

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

C

CM M C B (S)

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ABCD $m = 0.1kg$ (s)

B h A AB

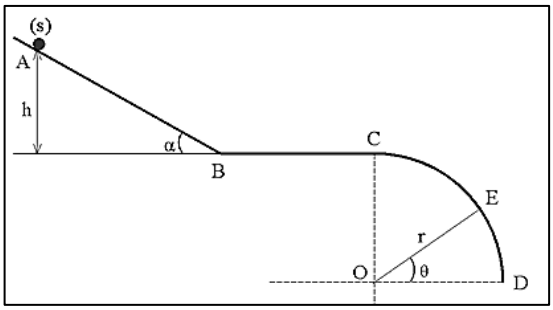
$r = 3m$ O CD

$v_B = 10\text{m/s}$ B A (s) 1

B A s

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

(BC) (s) 2



(s)

$v_c =$ (C)

$3m/s$

(E) (s) 3

r θ g E (s)

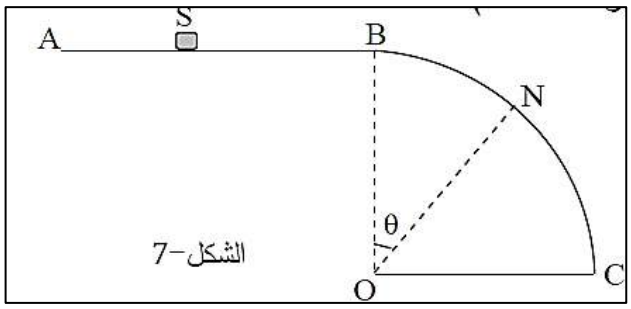
θ

$r = 10m$ BC $m = 100g$ (S)

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

$\vec{v}_B$ BC B (S) $0.8N$

N

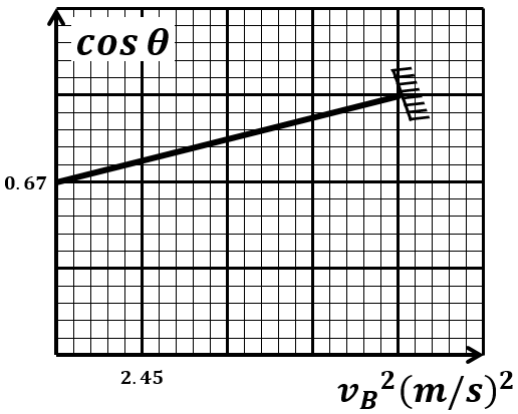


AB (S)

v_A

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

θ $v_B{}^2$ $\cos\theta$



$\vec{v}_N$ N (S)

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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