1438

فيزياء ١١٠

PHYSICS 110

طالبات

الدوري الثاني

Ch 4,5,6
ملخص قوانين
اختبار الدوري الثاني

م. أشرف بركات
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مركز نجوم التصوير
جدة – حي الصفا – شارع السبعين – بجوار
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٢٠ ريال

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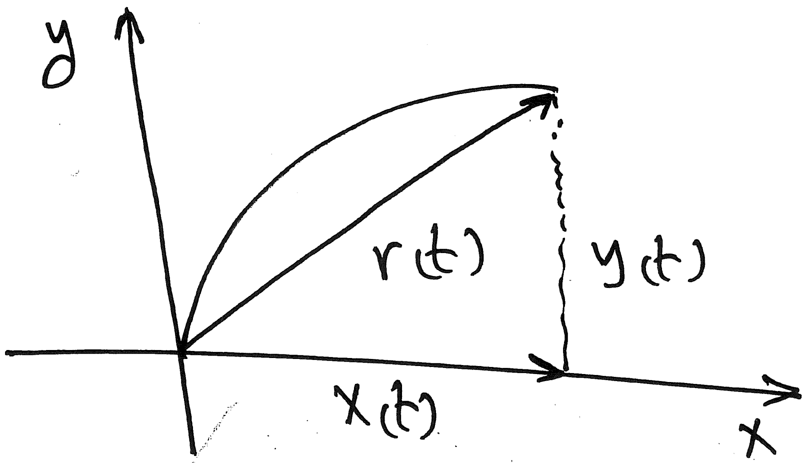
ملاحظة: المذكرة لا ترد ولا تستبدل بعد الشراء

Ch 4 ①

Motion in Two and Three dimensions



$\vec{r}(t)$ = Position vector (m) متجه الموضع

$$\vec{r}(t) = x(t)\,i + y(t)\,j \quad (m)$$

$$|\vec{r}| = \sqrt{x^2 + y^2} \qquad \theta = \tan^{-1}\left|\frac{y}{x}\right|$$

$\vec{v}(t)$ = velocity vector (m/s) متجه السرعة

$$\vec{v}(t) = \frac{d\vec{r}}{dt} = v_x(t)\,i + v_y(t)\,j \quad (m/s)$$

Ch 4

(2)

$\vec{a}(t)$ = acceleration vector (m/s^2) متجه التسارع

$$\vec{a}(t) = \frac{d\vec{v}}{dt} = a_x(t)\,\hat{i} + a_y(t)\,\hat{j} \quad (m/s^2)$$

$\vec{r}(t)$ —اشتقاق→ $\vec{v}(t)$ —اشتقاق→ $\vec{a}(t)$

---

in the time interval $[t_1, t_2]$

displacement $= \Delta\vec{r} = \vec{r_2} - \vec{r_1}$ (m)

average velocity $= \vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} = \frac{\vec{r_2} - \vec{r_1}}{t_2 - t_1}$ (m/s)

average acceleration $= \vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v_2} - \vec{v_1}}{t_2 - t_1}$ (m/s^2)

ch 4

(3)

6. Velocity is defined as:

(a) rate of change of position with time (b) position divided by time (c) a speeding up or slowing down (d) change of position

Solution

$$\vec{v} = \frac{d\vec{r}}{dt}$$

Velocity is defined as rate of change of position with time (a)

17. Acceleration is equal to

(a) $\frac{d\bar{v}}{dt}$ (b) $\frac{d\bar{r}}{dt}$ (c) $\frac{d\bar{v}}{dr}$ (d) $\frac{\Delta\bar{r}}{\Delta t}$

Solution:

$$a = \frac{d\vec{v}}{dt}$$ (c)

13. Acceleration is defined as:

(a) rate of change of position with time (b) speed divided by time (c) rate of change of velocity with time (d) change of velocity

Solution:

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Acceleration is defined as rate of change of velocity with time (c)

ch 4

1. If the x component of vector $\vec{r}$ is 2.6 m and the y component is -2.3 m then $\vec{r}$ in unit-vector notation is:

(A) $2.6\ \hat{i} - 2.3\ \hat{j}$ (B) $-2.3\ \hat{i} + 2.6\ \hat{j}$ (C) $6.2\ \hat{i} + 3.2\ \hat{j}$ (D) $3.2\ \hat{i} - 6.2\ \hat{j}$

Solution: $x = 2.6\ m$ $y = -2.3\ m$

$\vec{r} = x\hat{i} + y\hat{j} \Rightarrow x = 2.6\hat{i} - 2.3\hat{j}$ (A)

4. The coordinates of a car's position as function of time is given by: $x = 5t^2 + 16$, and $y = -t^3 + 5$, the magnitude of position vector $\vec{r}$ at t=2s is:

(a) 5 m (b) 1 m (c) 2.6 m (d) 4 m

Solution: $x = 5t^2 + 16$ $y = -t^3 + 5$

$\vec{r} = x\hat{i} + y\hat{j} \Rightarrow \vec{r} = (5t^2 + 16)\hat{i} + (-t^3 + 5)\hat{j}$

at $t = 2s \Rightarrow \vec{r} = (5(2)^2 + 16)\hat{i} + ((-2)^3 + 5)\hat{j}$

$\vec{r} = 36\hat{i} - 3\hat{j}$ (m)

$|\vec{r}| = \sqrt{(36)^2 + (-3)^2} = 36.12\ m$

Ch 4 (5)

2. The displacement of a particle moving from $\vec{r}_1 = 5\hat{i} - 6\hat{j} + 2\hat{k}$ to $\vec{r}_2 = -2\hat{i} + 6\hat{j} + 2\hat{k}$ is

(A) $-7\hat{i} + 12\hat{j}$ (B) $3\hat{i} + 4\hat{k}$ (C) $7\hat{i} - 12\hat{j}$ (D) $-3\hat{i} - 4\hat{k}$

Solution:

$$\vec{r_2} = -2i + 6j + 2k$$
$$\vec{r_1} = 5i - 6j + 2k$$

$$\vec{\Delta r} = \vec{r_2} - \vec{r_1} = -7i + 12j \quad (A)$$

3. A particle goes from (x_1=-2m, y_1=3m, z_1=1m) to (x_2=3m, y_2=-1m, z_2=4m). Its displacement is:

(a) $\hat{i} + 2\hat{j} + 5\hat{k}$ (b) $5\hat{i} - 4\hat{j} + 3\hat{k}$ (c) $-5\hat{i} + 4\hat{j} - 3\hat{k}$ (d) $-\hat{i} - 2\hat{j} - 5\hat{k}$

Solution:

$x_1 = -2m$, $y_1 = 3m$, $z_1 = 1m$ ⇒

$$\vec{r_1} = -2i + 3j + k$$

$x_2 = 3m$, $y_2 = -1m$, $z_2 = 4m$ ⇒

$$\vec{r_2} = 3i - j + 4k$$
$$\vec{r_1} = -2i + 3j + k$$

$$\vec{\Delta r} = \vec{r_2} - \vec{r_1} = 5i - 4j + 3k \quad (b)$$

ch 4 (6)

9. The position vector for a moving particle is: $\vec{r} = \hat{i} + 4t^2\hat{j} + t\hat{k}$, its velocity and acceleration as a function of time are:

(a) $\vec{v} = 8t\hat{j} + \hat{k}$, $\vec{a} = 8\hat{j}$ (b) $\vec{v} = \hat{i} + 8t\hat{j} + \hat{k}$, $\vec{a} = 8\hat{j} + \hat{k}$ (c) $\vec{v} = 8t\hat{j}$, $\vec{a} = \hat{i} + 8\hat{j}$ (d) $\vec{v} = 8t^2\hat{j} + t\hat{k}$, $\vec{a} = 8\hat{j}$

solution:

$$\vec{r} = i + 4t^2 j + t k$$

$$\vec{v} = \frac{d\vec{r}}{dt} = 0 + 8t j + k$$

$$\vec{a} = \frac{d\vec{v}}{dt} = 8 j$$

(a)

10. A particle moves in the xy plane. In which situation of the following V_x and V_y are both constant

Situation	X(m)	Y(m)
A	$2t^2$	$4t + 3$
B	$4t^3 - 2$	+3
C	$5t$	$2t + 1$
D	$-3t$	$t^2 - 1$

(a) A (b) B (c) C (d) D

solution: $\vec{v} = \frac{dr}{dt}$

C: $x = 5t \Rightarrow v_x = \frac{dx}{dt} = 5$ m/s

$y = 2t + 1 \Rightarrow v_y = \frac{dy}{dt} = 2$ m/s

(c)

السرعة ثابتة عندما تكون بدون ثابت لايحتوي على t

Ch 4

5. The components of a car's velocity as a function of time are given by :

$V_x = 2t + 3$, and $V_y = 4t - 1$, its velocity $\vec{V}$ at (t= 1 s) is:

(A) $\vec{V} = 9\hat{\imath} + 11\hat{\jmath}$ (B) $\vec{V} = 5\hat{\imath} + 3\hat{\jmath}$ (C) $\vec{V} = 7\hat{\imath} + 7\hat{\jmath}$ (D) $\vec{V} = 11\hat{\imath} + 15\hat{\jmath}$

Solution: $v_x = 2t + 3$ $v_y = 4t - 1$

$\vec{v} = v_x \hat{i} + v_y \hat{j} \Rightarrow \vec{v} = (2t+3)\hat{i} + (4t-1)\hat{j}$

at $t = 1s \Rightarrow \vec{v} = (2+3)\hat{i} + (4-1)\hat{j}$

$\vec{v} = 5\hat{i} + 3\hat{j}$ (B)

Q.2 A car is moving in x-y plane, has x-and y-coordinates that vary with time $x = 2 - t^2$ and $y = 2t + 3$. Where x (in meters) and t (in seconds). At t=0 the position vector is:

(A) $2\hat{i}$ m (B) $2\hat{i} + 3\hat{j}$ m (C) $25\hat{k}$ m (D) $9\hat{j}$ m (E) $10\hat{j}$ m

Q.3 Referring to question (2), the magnitude of the instantaneous velocity at t=2 s is:

(A) 1 m/s (B) 3.3 m/s (C) 1.64 m/s (D) 4.5 m/s (E) 25 m/s

Solution $x = 2 - t^2$ $y = 2t + 3$

$\vec{r} = x\hat{i} + y\hat{j} \Rightarrow \vec{r} = (2 - t^2)\hat{i} + (2t+3)\hat{j}$

at $t = 0 \Rightarrow \vec{r} = (2-0)\hat{i} + (0+3)\hat{j} = 2\hat{i} + 3\hat{j}$ (B)

$\vec{v} = \frac{d\vec{r}}{dt} = -2t\hat{i} + 2\hat{j}$

at $t = 2s \Rightarrow \vec{v} = -2(2)\hat{i} + 2\hat{j} = -4\hat{i} + 2\hat{j}$

$|\vec{v}| = \sqrt{(-4)^2 + (2)^2} = 4.47$ m/s (D)

Ch 4

8. A car travels east at 200 m/s and then travels west at 200 m/s, the change in its velocity is:

(a) zero (b) 400 m/s east (c) 400 m/s west (d) 200 m/s west

solution:

$v_1 = 200\ m/s$ east $\Rightarrow \vec{v}_1 = 200\,\hat{i}$

$v_2 = 200\ m/s$ west $\Rightarrow \vec{v}_2 = -200\,\hat{i}$

$\vec{\Delta v} = \vec{v}_2 - \vec{v}_1 = -200\hat{i} - 200\hat{i} = -400\hat{i}$

$= 400\ m/s$ west (c)

west | east

$-\hat{i}$ | $\hat{i}$

11. The components of a car's velocity as a function of time are given by $v_x = 6t^2 - 5$, $v_y = -3t^3$. The acceleration components are:

(A) $a_x = 10t$, $a_y = -12t^2$ (B) $a_x = 4t$, $a_y = -6t^2$ (C) $a_x = 6t$, $a_y = -15t^2$ (D) $a_x = 12t$, $a_y = -9t^2$

solution

$v_x = 6t^2 - 5 \qquad v_y = -3t^3$

$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow a_x = \frac{dv_x}{dt} = 12t$

$a_y = \frac{dv_y}{dt} = -9t^2$

(D)

Ch 4 (9)

Q.1 The velocity of a particle moving in the x-y plane is $\vec{v}(t) = [(12t - 3t^2)\hat{i} + 5\hat{j}]$ m/s. The acceleration is zero when the time is:

(A) 12 s (B) 2 s (C) zero (D) 14 s (E) 5 s

Solution:

$$\vec{v}(t) = ((12t - 3t^2)\hat{i} + 5\hat{j}) \text{ m/s}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = (12 - 6t)\hat{i} + 0\hat{j}$$

$$\vec{a} = 0 \Rightarrow 12 - 6t = 0$$

$$-6t = -12 \Rightarrow t = 2\text{ s} \quad \text{(B)}$$

Q.4 The x-and y-coordinates of a particle in motion, as functions of time t, are given by: $x=5t^2-3t+6$ m $y=3t-3$ m. The magnitude of the acceleration is:

(A) Zero (B) 10 m/s^2 (C) 5 m/s^2 (D) 12 m/s^2 (E) 15 m/s^2

Solution:

$$x = 5t^2 - 3t + 6 \qquad y = 3t - 3$$

$$\vec{r} = x\hat{i} + y\hat{j} \Rightarrow \vec{r} = (5t^2 - 3t + 6)\hat{i} + (3t - 3)\hat{j}$$

$$\vec{v} = \frac{d\vec{r}}{dt} \Rightarrow \vec{v} = ((10t - 3)\hat{i} + 3\hat{j}) \text{ m/s}$$

$$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{a} = (10\hat{i} + 0\hat{j}) \text{ m/s}^2$$

$$|\vec{a}| = \sqrt{(10)^2 + (0)^2} = 10 \text{ m/s}^2 \quad \text{(B)}$$

Ch 4

(15)

Ex: The velocity of a particle moving in the x-y plane is $\vec{v}(t) = (6t - 4t^2)\hat{i} + 8\hat{j}$ (m/s). The acceleration is zero when the time is

السارع

(a) 8 s (b) 1.5 s (c) 10 s (d) 0.75 s

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solution:

$$\vec{v}(t) = (6t - 4t^2)\hat{i} + 8\hat{j}$$

$$\vec{a} = \frac{d\vec{v}}{d} = (6 - 8t)\hat{i}$$

$$\vec{a} = 0 \Longrightarrow 6 - 8t = 0 \Longrightarrow 8t = 6$$

$$t = \frac{6}{8} = 0.75 \text{ s} \quad (d)$$

Ex: A particle moved a displacement $\vec{\Delta r} = (36\hat{i} + 12\hat{k})$ m in 4 s. Its average velocity is:

تحرك — ازاحة — سرعته المتوسطة

(a) $9\hat{i} + 3\hat{j}$ (b) $9\hat{i} + 3\hat{k}$ (c) $9\hat{i} + 3\hat{j} + \hat{k}$

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solution: $\vec{\Delta r} = 36\hat{i} + 12\hat{k}$ $\quad \Delta t = 4$ s

$$\vec{v}_{ave} = \frac{\vec{\Delta r}}{\Delta t} = \frac{36\hat{i} + 12\hat{k}}{4} = 9\hat{i} + 3\hat{k} \text{ (m/s)} \quad (b)$$

Ch 9

2. A car goes from $\vec{v}_i = 2\hat{i} + 4\hat{j}$ to $\vec{v}_f = 3\hat{i} + 9\hat{j}$ in 5 s. **The average acceleration** of the car

A) $\vec{a}_{avg} = \hat{i} - 6\hat{j}$ B) $\vec{a}_{avg} = 0.2\hat{i} + \hat{j}$ C) $\vec{a}_{avg} = 3\hat{i}$ D) $\vec{a}_{avg} = \hat{i} - \hat{j}$

Solution :

$$v_i = 2\hat{i} + 4\hat{j}$$

$$v_f = 3\hat{i} + 9\hat{j} \qquad \Delta t = 5\,s$$

$$a_{ave} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t}$$

$$= \frac{(3\hat{i} + 9\hat{j}) - (2\hat{i} + 4\hat{j})}{5}$$

$$= \frac{\hat{i} + 5\hat{j}}{5}$$

$$= 0.2\hat{i} + \hat{j}$$

(B)

Ch 4 (13)

ملاحظة هامة

إذا كان الجسم يتحرك بتسارع ثابت (دالة ثابتة لا يحتوي على t) يمكن تطبيق قوانين الحركة بتسارع ثابت

مثل $\vec{v} = \vec{v}_0 + \vec{a}t$

16. A particle leaves the origin with initial velocity $\bar{v}_0 = 8\hat{i} + 12\hat{j}$ m/s and a constant acceleration $\bar{a} = 4\hat{i} - 2\hat{j}$ m/s^2. The particle's velocity at t = 6 s is:

(a) $\bar{v} = 24\hat{j}$ $\bar{v} = 32\hat{i} + 24\hat{j}$ (c) $\bar{v} = 32\hat{i}$ (d) $\bar{v} = 32\hat{i} - 12\hat{j}$

Solution:

$\vec{v}_0 = 8i + 12j$ $\vec{v} = ??$

$\vec{a} = 4i - 2j$ تسارع ثابت لا يحتوي على t $t = 6s$

$$\vec{v} = \vec{v}_0 + \vec{a}t$$

$$= (8i + 12j) + (4i - 2j)6$$

$$= 8i + 12j + 24i - 12j$$

$$= 32i \ (m/s)$$ (c)

ch 4 ⑬

Ex A Particle moving with initial velocity (جسم يتحرك بسرعة ابتدائية)

$\vec{V_0} = -2i + 4j$ m/s, and acceleration $\vec{a} = -5i + 8j$ m/s², the X-Component V_x of the final velocity at (t=7s) is? (وتسارع — مركبة X — للسرعة النهائية)

ⓐ -7 m/s ⓑ -17 m/s ⓒ -27 m/s ⓓ -37 m/s

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solution

الحركة بتسارع ثابت

لأنه $\vec{a}$ لا يتغير مع t

$\vec{V_0} = -2i + 4j$ m/s $\vec{V} = ?$

$\vec{a} = -5i + 8j$ m/s² $t = 7$ s

$$\vec{V} = \vec{V_0} + at$$

$$= (-2i + 4j) + (-5i + 8j)(7)$$

$$= -2i + 4j - 35i + 56j$$

$$= -37i + 60j \text{ m/s}$$

$$V_x = -37 \text{ m/s}$$ ⓓ

Projectiles المقذوفات

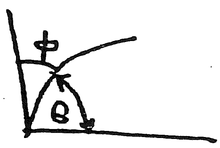
الحالة الخاصة : الجسم يعود إلى مستوى القذف (حالة الأرض أرض)

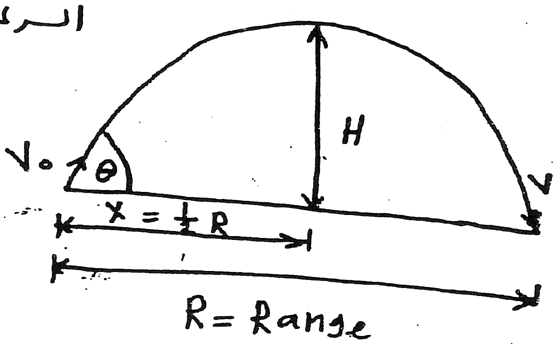
v_0 = initial speed السرعة الابتدائية

θ = angle of Projection زاوية القذف
وتحسب دائماً مع الأفقي

إذا أعطانا الزاوية مع الرأسي

$\theta = 90 - \phi$





لاحظ المسار على شكل قطع مكافئ (Parabola)

H= maximam height (altitude) أقصى ارتفاع

R= Range المدى المسافة الأفقية بين نقطة القذف ونقطة الاصطدام بالأرض

t= total time (time of flight)
زمن الطيران (الزمن الكلي)
لاحظ زمن الصعود = زمن الهبوط

⇐ إذا طلب في السؤال زمن الوصول لأقصى ارتفاع (زمن الصعود)

$$\text{زمن الصعود} = \frac{t\ \text{الكلي}}{2}$$

⇐ دائماً في المقذوفات مثل السقوط الحر $a = -g = -9.8\,m/s^2$

Ch 4

ملاحظة هامة جداً

المركبة الأفقية للسرعة دائماً ثابتة $V_x = V_0 \cos\theta$

لأن التسارع على اتجاه x صفر $a_x = 0$

عند أقصى ارتفاع يكون at maximum height يكون

المركبة الرأسية للسرعة (V_y)

① $V_y = 0$ vertical component of the velocity $= 0$

الإزاحة الرأسية (y)

② vertical displacement $= y = H$

الإزاحة الأفقية (X)

③ horizontal displacement $= X = \frac{1}{2} R$

④ $t_{\text{أقصى ارتفاع}} = t_{\text{زمن الصعود}} = \frac{t_{\text{الكلي}}}{2}$

في المقذوفات $\vec{a} = 0 - 9.8\hat{j}$ m/s^2

في اتجاه y فقط

$$R = \frac{v_0^2 \sin(2\theta)}{g}$$

$$H = \frac{v_0^2 (\sin\theta)^2}{2g}$$

$$t_{\text{الكلي}} = \frac{2V_0 \sin\theta}{g}$$

$$\tan\theta = \frac{4H}{R}$$

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

لاحظ

ملاحظة هامة جداً

للحصول على أكبر قيمة لـ R عندما $\theta = 45°$

أقصى إزاحة أفقية

maximum range = maximum horizontal distance $= R_{max}$

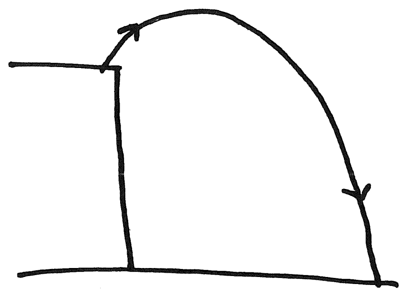
$\theta = 45°$ ⇒ $R_{max} = \frac{v_0^2}{g}$ (مهم جداً)

ch 4

23. A stone thrown from the top of a tall building follows a path that is:

(a) circular (b) parabolic (c) hyperbolic (d) a straight line

Solution:



المسار ع شكل قطع مكافئ

parabolic path

(b)

19. The maximum range of a projectile is at launch angle

(A) $\theta = 25°$ (B) $\theta = 35°$ (C) $\theta = 45°$ (D) $\theta = 55°$

Solution:

for maximum range $\theta = 45°$ (C)

20. In the projectile motion the acceleration in the horizontal direction is:

(A) 19.6 m/s^2 (B) zero (C) 9.8 m/s^2 (D) 4.9 m/s^2

Solution:

في حركة المقذوفات دائماً

$a_x = 0$ لأن السرعة في اتجاه محور x ثابتة

(B)

لكن التسارع في اتجاه محور y هو $a_y = -g$

أي أن $\vec{a} = -g\hat{j}$

ch 4

Q.2 At the highest point, the magnitude of the acceleration of a projectile is:

(A) $-9.8\ m/s^2$ (B) Zero (C) $4.9\ m/s^2$ (D) $19.6\ m/s^2$ (E) $9.8\ m/s^2$

solution:

دائماً في السقوط الحر وحركة المقذوفات التسارع عند أي لحظة هو

$a = -g = -9.8\ m/s^2$ ↓ رأسياً لأسفل نحو الأرض

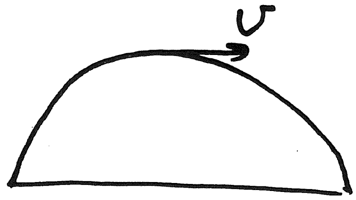
$|a| = g = 9.8\ m/s^2$ (E)

toward the ground

Q.10 The initial velocity of a projectile is 150 m/s. The angle between the velocity vector and the trajectory at the projectile's maximum height is:

(A) 90° (B) 45° (C) Zero (D) 63.1° (E) 36.9°

Solution:



في حركة المقذوفات متجه السرعة مماسي مع المسار

وبالتالي الزاوية بين المسار ومتجه السرعة هي صفر

(C)

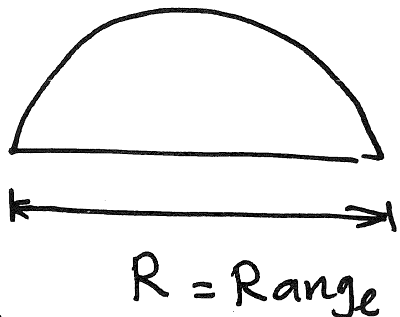
Ch 4

31. The horizontal range is the horizontal distance the projectile has traveled when it returns to ……

(a) the origin (b) its max. height (c) its final height (d) its initial height

Solution:

The horizontal range is the horizontal distance the projectile has traveled when it returns to its initial height (d)



المدى هي المسافة الأفقية التي يتحركها المقذوف من عودته لنفس الارتفاع الابتدائي

35. In the projectile motion the horizontal velocity component v_x remains constant because the acceleration in the horizontal direction is:

(a) $a_x > 0$ (b) $a_x = g$ (c) $a_x > g$ (d) $a_x = 0$

Solution:

في الاتجاه الأفقي

$a_x = 0$ $V_x = V_o \cos \theta$

(d)

ch 4

(19)

25. A ball is thrown at V_0 and angle θ_0 above horizontal and returned to its initial height. The path of the ball is called:

(a) Range (b) Trajectory (c) Horizontal path (d) Vertical path

26. In question 25, the horizontal component of the ball's velocity V_{x0} is:

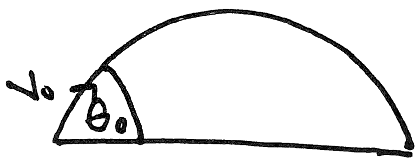
(a) V_{x0} = unchanged (b) V_{x0} = zero (c) $V_{x0} = V_0$ (d) V_{x0} is changed

27. In question 25, at the maximum height, the vertical component of the ball's velocity V_y is:

(a) $V_y = V_x$ (b) $V_y = V_0$ (c) V_y = zero (d) $V_y = V_{0y}$

Solution:

The Path of the ball is called trajectory (b)



$V_x = V_0 \cos\theta$ دائماً ثابتة

V_{x0} = unchanged (a)

at the maximum height $V_y = 0$ (c)

24. Two projectiles are in flight at the same time. The acceleration of one relative to the other:

(a) is always 9.8 m/s^2 (b) can be as large as 19.8 m/s^2 (c) can be horizontal (d) is zero

Solution

(d) تسارع جسم بالنسبة للأخر تساوي صفر

Ch 4

(20)

Q.16 A boy kicks a ball at an angle of 30° to the horizontal with a speed of 14.0 m/s. The time it takes to reach the horizontal range is:

(A) 0.92 s (B) 0.71 s (C) 0.15 s (D) 1.43 s (E) 0.38 s

Q.17 boy kicks a ball at an angle of 30° to the horizontal with a speed of 14.0 m/s. The maximum height that the ball can reach is:

(A) 9.87 m (B) 4.13 m (C) 15.33 m (D) 12.68 m (E) 2.5 m

Q.18 boy kicks a ball at an angle of 30° to the horizontal with a speed of 14.0 m/s. The horizontal range that the ball can reach is:

(A) 17.32 m (B) 19.7 m (C) 15.33 m (D) 12.68 m (E) 14.0 m

Solution:

$\theta = 30^\circ$ $v_0 = 14 \text{ m/s}$

$$t = \frac{2v_0 \sin\theta}{g} = \frac{2(14)\sin 30^\circ}{9.8}$$

$$= 1.43 \text{ s} \quad \text{(D)}$$

$$H = \frac{v_0^2 (\sin\theta)^2}{2g} = \frac{(14)^2(\sin 30)^2}{2\times 9.8}$$

$$= 2.5 \text{ m} \quad \text{(E)}$$

$$R = \frac{v_0^2 \sin 2\theta}{g} = \frac{(14)^2 \sin(2\times 30)}{9.8}$$

$$= \frac{(14)^2 \sin 60^\circ}{9.8} = 17.32 \text{ m} \quad \text{(A)}$$

ch 4

(21)

Q.5 A boy kicks a ball at an angle of 40° to the horizontal with a speed of 14.0 m/s. The time it takes to reach the highest point is:

(A) 0.92 s (B) 0.77 s (C) 0.15 s (D) 1.12 s (E) 0.38 s

solution:

$\theta = 40°$ $v_0 = 14$ m/s

$t_{\text{الكلي}} = \frac{2 v_0 \sin\theta}{g} = \frac{2(14)\sin 40}{9.8}$

$= 1.84$ s

$t_{\text{أقصى ارتفاع}} = \frac{t_{\text{الكلي}}}{2} = \frac{1.84}{2} = 0.92$ s (A)

29. A ball kicked with a velocity of 15 m/s and with an angle of θ from the horizontal. The maximum range is:

A) 25.85 m B) 40.82m C) 50.20 m D) 22.96 m

solution:

$v_0 = 15$ m/s $R_{max} = ??$

$R_{max} = \frac{v_0^2}{g} = \frac{(15)^2}{9.8} = 22.96$ m

(D)

Ch 4 (22)

Q.14 A projectile is launched to achieve a maximum range of 140 m, the speed of the projectile must be:

(A) 17 m/s (B) 27 m/s (C) 37 m/s (D) 45 m/s (E) 10 m/s

Solution:

$R_{max} = 140\,m \qquad v_0 = ??$

$R_{max} = \frac{v_0^2}{g} \Rightarrow 140 = \frac{v_0^2}{9.8} \Rightarrow$

$v_0 = 37\ m/s$ (c)

Ex: A Projectile is launched at an angle such that the maximum height reached equals the horizontal range. The launch angle is:

(a) 22.5° (b) 45° (c) 30° (d) 76°

Solution: $H = R \qquad \theta = ??$

$\tan\theta = \frac{4H}{R} \Rightarrow \tan\theta = \frac{4R}{R} = 4 \Rightarrow$

$\theta = \tan^{-1}(4) = 75.96°$ (d)

Ch 4 (23)

Q.7
A ball shot up making an angle θ with the horizontal, with a speed of 30 m/s. The time that the object needs to reach its maximum range is:

(a) 4.3 s (b) 3.1 s (c) 42.4 s (d) 0.41 s (e) 6.1 s (f) 129.9 s

---

solution:

$v_0 = 30$ m/s

maximum range ⟹ $\theta = 45°$

$$t = \frac{2v_0 \sin\theta}{g} = \frac{2(30)\sin 45°}{9.8}$$

$= 4.33$ s (a)

Q.9
A ball was projected upward at angle θ_0 with the horizontal and an initial speed of 50 m/s. The ball reached the highest point after three seconds, the angle θ_0 is:

(a) 11.3° (b) 34.4° (c) 36° (d) 60° (e) 5.7° (f) 30°

Solution:

$v_0 = 50$ m/s $\theta = ?$

أقصى ارتفاع $t = 3$ s ⟹ $t_{\text{المدى}} = 2(3) = 6$ s

$$t = \frac{2v_0 \sin\theta}{g} \Rightarrow 6 = \frac{2(50)\sin\theta}{9.8}$$

$\sin\theta = 0.588$

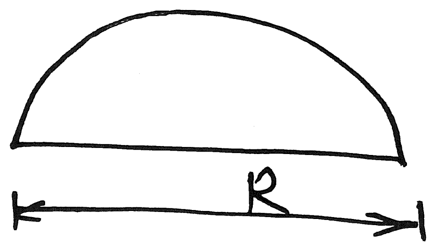
$\theta = \sin^{-1}(0.588) = 36°$ (c)

22. A large cannon fired a ball at an angle of 30^0 above the horizontal with initial speed 980m the projectile will travel what horizontal distance before striking the ground?

(a) 4.3 km (b) 8.5 km (c) 43 km (d) 85 km

Solution: $\theta = 30^\circ$ $v_0 = 980$ m/s

$$R = \frac{v_0^2 \sin 2\theta}{g}$$



$$= \frac{(980)^2 \sin(2\times 30)}{9.8}$$

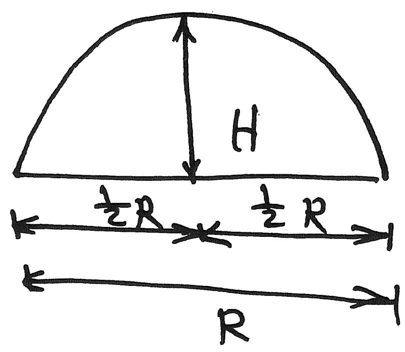
$= 84870.5$ m $\simeq 85$ km (d)

Q.8
A stone is thrown up with a speed of 20 m/s making an angle 45° with the horizontal. The height of the stone at half the range is:
(a) 199.6 m (b) 99.8 m (c) 20.4 m (d) 10.21 m (e) 203.8 m (f) 40 m

Solution: $v_0 = 20$ m/s $\theta = 45^\circ$

الارتفاع عند منتصف المدى هو H

$$H = \frac{v_0^2 (\sin\theta)^2}{2g}$$



$$= \frac{(20)^2 (\sin 45)^2}{2\times 9.8} = 10.2\text{m}$$ (d)

Ch 4 (26)

32. You are to launch a rocket, from just above the ground, with one of the following initial velocity vectors: (1) $\bar{v}_0 = 20\hat{i} + 70\hat{j}$, (2) $\bar{v}_0 = -20\hat{i} + 70\hat{j}$, (3) $\bar{v}_0 = 20\hat{i} - 70\hat{j}$, (4) $\bar{v}_0 = -20\hat{i} - 70\hat{j}$. Rank the vector according to the launch speed greatest first.

(a) 4 >3 > 2 > 1 (b) 4 > 2 > 3 >1 (c) 1 > 2 > 3 > 4 (d) all the same

Solution:

speed $= |v|$

(1) $|\vec{v}_0| = \sqrt{(20)^2 + (70)^2} = 72.8 \text{ m/s}$

(2) $|\vec{v}_0| = \sqrt{(-20)^2 + (70)^2} = 72.8 \text{ m/s}$

(3) $|\vec{v}_0| = \sqrt{(20)^2 + (-70)^2} = 72.8 \text{ m/s}$

(4) $|\vec{v}_0| = \sqrt{(-20)^2 + (-70)^2} = 72.8 \text{ m/s}$

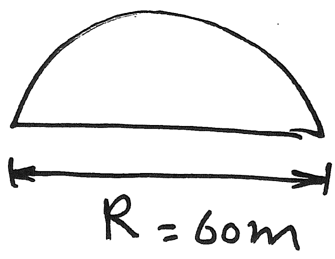
all the same (d)

Q.7 A projectile is fired from the ground at 45° above the horizontal. If it reaches the ground at 60 m from the starting point, the initial velocity is:

(A) 34.3 m/s (B) 10 m/s (C) 196 m/s (D) 24.25 m/s (E) 12 m/s

Solution: $\theta = 45^\circ$ $v_0 = ??$

$$R = \frac{v_0^2 \sin 2\theta}{g} \Rightarrow 60 = \frac{v_0^2 \sin 90^\circ}{9.8}$$



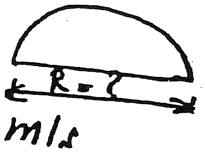
$v_0 = 24.25 \text{ m/s}$

Ex A baseball leaves the bat (المضرب) with an initial velocity $\vec{v}_0 = 10i + 20j$ (m/s). Its range (المدى) is:

(a) 40.8 m (b) 102 m (c) 20.4 m (d) 61.2 m (e) 81.6 m

---

solution: $\vec{v}_0 = 10i + 20j$



$$v_0 = \sqrt{(10)^2 + (20)^2} = 22.36 \text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{20}{10}\right) = 63.4^\circ$$

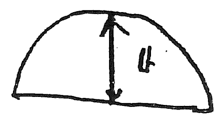
$$R = \frac{v_0^2 \sin(2\theta)}{g} = \frac{(22.36)^2 \sin(2 \times 63.4^\circ)}{9.8} = 40.85 \text{ m} \quad (a)$$

Ex A ball is projected (تقذف) above the horizontal (الأفقي) with an initial velocity (سرعة ابتدائية) $\vec{v}_0 = 25i + 25j$ (m/s). The maximum height (أقصى ارتفاع) the ball (الكرة) rises (ترتفع) is:

(a) 1 m (b) 20.4 m (c) 2.4 m (d) 31.89 m (e) 10.2 m

---

solution: $\vec{v}_0 = 25i + 25j$ (m/s)



$$v_0 = \sqrt{(25)^2 + (25)^2} = 35.36 \text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{25}{25}\right) = 45^\circ$$

$$H = \frac{v_0^2 (\sin\theta)^2}{2g} = \frac{(35.36)^2 (\sin 45^\circ)^2}{2 \times 9.8} = 31.89 \text{ m}$$

Ch 4 (27)

---

28. A ball is thrown with initial velocity v_0=120 m/s at an angle θ_0=60° above the horizontal, the velocity v_0 in unit vector notation is:

(a) $\bar{v}_0 = 104\hat{i} + 60\hat{j}$ (b) $\bar{v}_0 = 60\hat{i} + 104\hat{j}$ (c) $\bar{v}_0 = 60\hat{i}$ (d) $\bar{v}_0 = 104\hat{j}$

---

29. In question 28, the acceleration in the horizontal direction when t=5 s is:

(a) 24 m/s² (b) – 9.8 m/s² (c) zero (d) 600 m/s²

Solution: $v_0 = 120$ m/s $\theta = 60°$

$\vec{v}_0 = v_0 \cos\theta\, i + v_0 \sin\theta\, j$

$\vec{v}_0 = 120 \cos 60\, i + 120 \sin 60\, j$

$\vec{v}_0 = 60 i + 103.9 j$ (m/s)

(b)

---

in the horizontal direction

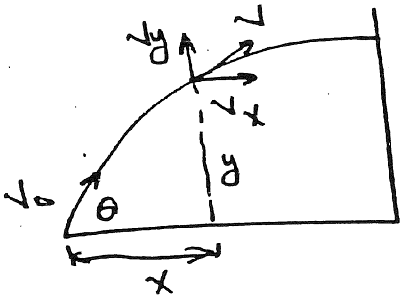
$a_x = 0$ دائماً

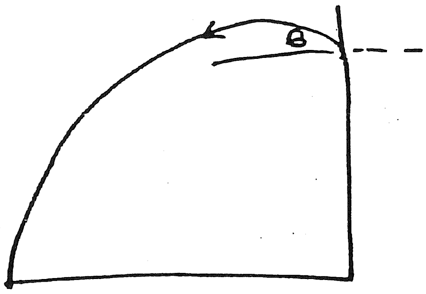
$t = 5$ s $\Rightarrow a_x = 0$ (c)

بس

$a_y = -g = -9.8$ m/s²

الحالة العامة للمقذوفات: الجسم لا يعود إلى مستوى القذف





* في الاتجاه الأفقي تكون السرعة ثابتة وهي

$$v_x = v_0 \cos\theta$$

x- component of v
المركبة الأفقية للسرعة

$$x = v_0(\cos\theta)t$$

x- component
الإزاحة الأفقية

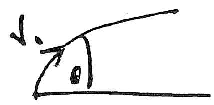
---

* في الاتجاه الرأسي يكون

$$a = -g = -9.8\ m/s^2$$

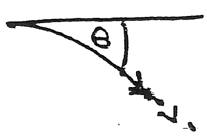
دائماً في المقذوفات

$$a = -g$$



السرعة الابتدائية في اتجاه y

v_{0y} =
- $+v_0 \sin\theta$ لو الجسم صاعد (above the horizontal)
- $-v_0 \sin\theta$ لو الجسم هابط (below the horizontal)



Ch 4 (29)

أما إذا ذكر في المسألة أن الجسم قذف أفقياً يكون

$\theta = 0 \Rightarrow v_y = 0$ thrown horizontally

$t = ✓$ $v_y = ?$ or $v_y = ✓$ $t = ?$

$$v_y = v_{oy} + at$$

(1) (y) y - component of v المركبة الرأسية للسرعة

$t = ✓$ $y = ?$ or $y = ✓$ $t = ?$

$$y = v_{oy} t + \frac{1}{2} a t^2$$

(2) (v_y) y - component الإزاحة الرأسية

$y = ✓$ $v_y = ?$ or $v_y = ✓$ $y = ?$

$$v_y^2 = v_{oy}^2 + 2ay$$

(3) (t)

$$\vec{r} = x\,i + y\,j$$

position vector

$$\vec{v} = v_x\,i + v_y\,j$$

مقدار السرعة / السرعة الكلية

$$v = \sqrt{v_x^2 + v_y^2}$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$

$$y = (\tan\theta)x - \frac{g x^2}{2(v_0 \cos\theta)^2}$$

(*)

$x = ✓$ $y = ?$ or $y = ✓$ $x = ?$

ملاحظة هامة

إذا أعطانا

$\vec{V_0} = \square i + \square j$

$V_{0x} = V_x = \square$ (السرعة الأفقية ثابتة)

$V_{0y} = \square$

وإذا أعطانا

$\vec{V} = \square i + \square j$

$V_x = \square$

$V_y = \square$

Ex A particle [جسم] is projected [قذف] with an initial velocity $\vec{V_0} = 5i + 4j$ (m/s). The horizontal [الأفقية] component [المركبة] of its velocity [للسرعة] at the maximum [أقصى] height [ارتفاع] is:

ⓐ zero ⓑ 4 m/s ⓒ 3 m/s ⓓ 5 m/s ⓔ 6 m/s

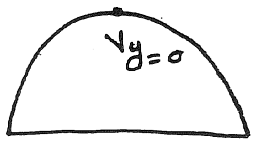
---

solution: $\vec{V_0} = 5i + 4j$

$V_{0x} = V_x = 5$ m/s

لكن السرعة الأفقية دائماً ثابتة

$V_x = 5$ m/s ⓓ



Ch 4

(31)

13. An object was fired with an angle 30° with the horizontal with a speed of 80 m/s . The vertical component of the velocity is:

A) 40 m/s B) 4.0 m/s C) 15 m/s D) 35 m/s

Solution

$\theta = 30^0$ $v_0 = 80\,m/s$

$v_{oy} = ??$

$v_{oy} = v_0 \sin\theta \Rightarrow v_{oy} = 80 \sin 30 = 40\,m/s$

(A)

20. A projectile is fired with a velocity of 80 m/s at an angle of θ to the horizontal. If the vertical component of the initial velocity was 60 m/s, the angle θ is:

A) 48.6⁰ B) 54.5⁰ C) 32.23⁰ D) 20⁰

Solution:

$v_0 = 80\,m/s$ $v_{oy} = 60\,m/s$

$\theta = ??$

$v_{oy} = v_0 \sin\theta \Rightarrow 60 = 80 \sin\theta$

$\sin\theta = \frac{60}{80} = 0.75$

$\theta = \sin^{-1}(0.75) = 48.6^0$ (A)

في حركة المقذوفات

Ex At the Projectile motion, the y-

مركبة y — للسرعة — عند أقصى

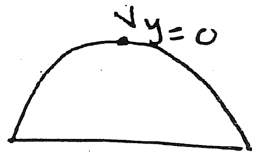
Component of the velocity at the maximum

ارتفاع

height is:

(a) Zero (b) Constant (d) Negative (d) Positive

Solution: at maximum height



$v_y = 0 \Rightarrow$ (a)

مقذوف — أطلق — بزاوية

Ex A Projectile is launched at an angle of

مع الأفقي

60° with the horizontal with a speed of

عندما — يصل لأقصى ارتفاع

100 m/s. When it reaches its maximum height

سرعته

its speed is:

(a) 30 m/s (b) 40 m/s (c) 50 m/s (d) 60 m/s (e) 20 m/s

Solution: at maximum height $\Rightarrow v_y = 0$

$v_0 = 100\ m/s \quad \theta = 60° \quad v = ?$

$v_x = v_0 \cos\theta = 100 \cos 60 = 50\ m/s$

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(50)^2 + (0)^2} = 50\ m/s$ (c)

Ch 4 (33)

21. A bullet is fired horizontally from the roof of a building with a velocity of 850 m/s. Its height in 3.0 s is:
A) 29.4 m B) - 44.1 m C) -100 m D) 19.60 m

22. Referring to Q21, If the building is 100 m height, the time for the bullet to reach the ground is:
A) 3.13 s B) 81.32 s C) 4.52 s D) 20.41 s

Solution:

Fired horizontally $\Rightarrow$ $\theta = 0$, $v_{oy} = 0$

$v_{oy} = 0$ v_y

$a = -9.8\ m/s^2$ $t = 3s$

$y = ?$

$y = v_{oy}t + \frac{1}{2}at^2 = 0(3) + \frac{1}{2}(-9.8)(3)^2$

$= -44.1\ m$ (B)

$v_{oy} = 0$ v_y

$a = -9.8\ m/s^2$ $t = ??$ $y = -100m$ ↓ تحت

$y = v_{oy}t + \frac{1}{2}at^2 \Rightarrow -100 = 0 + \frac{1}{2}(-9.8)t^2$

$t = 4.52\ s$ (C)

12. A man throws a stone horizontally off a cliff that is 40 m above the sea level. If the velocity of the stone is 30 m/s, the time it takes to hit the sea level is:

A) 3.49 s B) 4 s C) 2.85 s D) 6 s

Solution:

thrown horizontally $\Rightarrow \theta = 0$, $v_{oy} = 0$

$v_{oy} = 0$ | v_y | هابط

$a = -9.8\ m/s^2$ | $t = ?$ | $y = \downarrow -40m$

$y = v_{oy} t + \frac{1}{2} a t^2$

$-40 = 0 + \frac{1}{2}(-9.8) t^2 \Rightarrow t = 2.857\ s$ (C)

33. In the projectile motion, the vertical velocity component v_y

(a) changes continuously (b) remains constant (c) equals zero (d) v_y equals v_x

Solution:

استرجعي الاتجاه الرأسي (y - direction) في حركة المقذوفات هو (a = -g) وبالتالي فإن v_y تتغير باستمرار مع الزمن

(a)

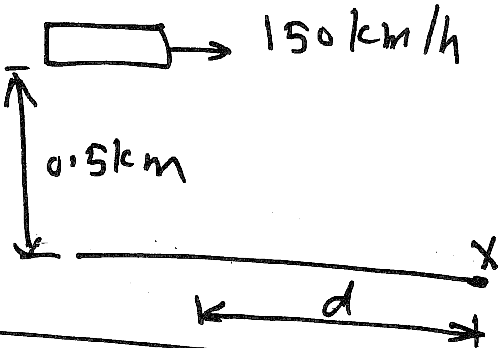
Ch 4

(35)

Ex) The airplane (طائرة) shown is at an altitude (ع ارتفاع) of 0.5 km and a speed of 150 km/h. At what distance d should it release (تترك) a heavy (ثقيلة) bomb (قنبلة) to hit (لتضرب) the target (الهدف) X? Take ($g = 10\ m/s^2$)

ⓐ 150 m ⓑ 295 m

ⓒ 417 m ⓓ 255 m



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solution

السرعة الابتدائية للقنبلة هي نفس سرعة الطائرة

$$V_o = 150\ km/h = 150 \times \frac{1000}{3600} = 41.67\ m/s$$

$\theta = 0 \Rightarrow V_{oy} = 0$ $y = -500\ m$ (هابط) $a = -10\ m/s^2$ $t = ??$

$$y = V_{oy} t + \frac{1}{2} a t^2 \Rightarrow -500 = 0 + \frac{1}{2}(-10) t^2$$

$$t = 10\ s$$

$$x = (V_o \cos\theta) t = (41.67 \cos 0)(10)$$

$$= 416.7\ m$$

ⓒ

حجر قذف مبنى

Ex) A stone is projected at builiding of

ارتفاعه بسرعة ابتدائية

height h with an initial speed of 42 m/s

تتجه الأفق كما موضح

directed 60° above the horizontal (as shown

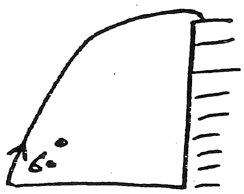
بالشكل هبط سطح

in the figure). The stone landed on the roof

المبنى بعد إطلاقه

of the building 7 seconds after launching. The

height h is:



ⓐ 59.4 m ⓑ 41.8 m

ⓒ 29.4 m ⓓ 14.5 m ⓔ 44.6 m

Solution:

$v_o = 42$ m/s $\quad t = 7$ s

$\theta = 60°$

$v_{oy} = v_o \sin\theta = 42 \sin 60° = 36.37$ m/s

$y = v_{oy} t + \frac{1}{2} a t^2$

$= (36.37)(7) + \frac{1}{2}(-9.8)(7)^2$

$= 14.49$ m ⓓ

$v_{oy} = ✓$

$t = ✓$

$a = ✓$

$y = ?$

(v_y) (2)

ch 4 (37)

Q.27 If a ball is projected with velocity 30 m/s at angle of 30° with the horizontal. The y-component of the velocity of the ball after one second is:

(A) 0.2 m/s (B) 20 m/s (C) 5.2 m/s (D) 10 m/s (E) 12 m/s

solution:

$v_0 = 30\ m/s$ $\theta = 30^\circ$

$v_{0y} = v_0 \sin 30 = 30 \sin 30 = 15\ m/s$

$v_{0y} = 15\ m/s$ $v_y = ?$

$a = -9.8\ m/s^2$ $t = 1s$

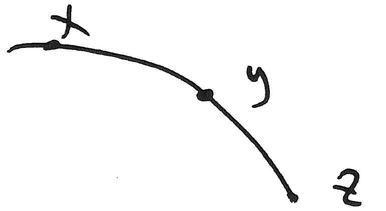
$v_y = v_{0y} + at = 15 - 9.8(1) = 5.2\ m/s$

(C)

Ex: A stone is thrown horizontally and follows the path xyz shown. The direction of the acceleration of the stone at y is:

(a) ↑ (b) →

(c) ↓ (d) ←



solution:

y لاحظ دائماً a رأسياً لأسفل ↓ (c)

toward the ground

Ch 4

(38)

حجر — قذف — أفقياً

Ex) A stone is thrown horizontally from the top of a building of height 75 m, with an initial speed of 15 m/s. Find the speed of the stone 2 s after it is thrown.

(قمة — مبنى — ارتفاعه — بسرعة ابتدائية — السرعة — بعد رميه)

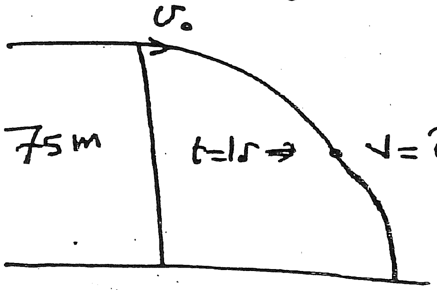
ⓐ 25 m/s ⓑ 38 m/s ⓒ 15 m/s ⓓ 10 m/s ⓔ 0 m/s

Solution: thrown horizontally ⇒ $\theta = 0$ $v_{0y} = 0$

$t = 2\,s$ $v = ?$ $v_0 = 15\,m/s$

م ، ب

$v_x = ...$ $v_y = ...$



$$v = \sqrt{v_x^2 + v_y^2}$$

$$v_x = v_0 \cos\theta = 15 \cos 0 = 15\,m/s$$

$v_{0y} = ...$ $a = ...$ $t = ...$ $v_y = ?$ (y) ⇒ (1)

$$v_y = v_{0y} + at = 0 - 9.8(2) = -19.6\,m/s$$

$$v = \sqrt{v_x^2 + v_y^2} = 24.7\,m/s \simeq 25\,m/s \quad (a)$$

ملاحظة هامة

إذا طلب المركبة الأفقية للسرعة v_x

horizontal component of the velocity $v_x = ?$

vertical component of the velocity $v_y = ?$

إذا طلب المركبة الرأسية للسرعة

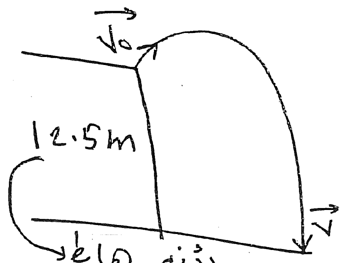
velocity (speed) $v = \sqrt{v_x^2 + v_y^2}$ أما إذا طلب السرعة

EX A ball is shot (قذفت) from the top (سطح) of a building (مبنى) of height (ارتفاعه) 12.5 m, with initial velocity $\vec{v}_0 = 5.8\hat{i} + 9.7\hat{j}$, in meters per second. What is the magnitude (مقدار) of the ball's velocity (سرعة الكرة) just before (قبل الارتطام بالأرض مباشرة) it hits the ground?

ⓐ 5 m/s ⓑ 6 m/s ⓒ 19.3 m/s ⓓ 10 m/s

<u>solution:</u> $\vec{v}_0 = 5.8\hat{i} + 9.7\hat{j}$ (m/s)

$v_x = 5.8$ m/s



$v_{0y} = 9.7$ m/s $\quad a = -9.8$ m/s^2 $\quad y = -12.5$ m

$v_y = ?$ $\Rightarrow$ $v_y^2 = v_{0y}^2 + 2ay$

$v_y^2 = (9.7)^2 + 2(-9.8)(-12.5) = 339.09$ "$\sqrt{\ }$"

$v_y = -18.4$ m/s لأنها هابطة

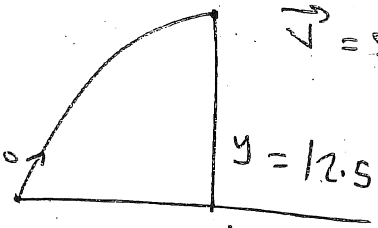
$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(5.8)^2 + (18.4)^2} = 19.3$ m/s ⓒ

v_{0y} = ✓
a = ✓
y = ✓
v_y = ?
(5) ⇒ (3)

Ex: A ball is shot from the ground into the air. At a height of 12.5 m, its velocity is observed to be $\vec{v} = 5.8\hat{i} + 9.7\hat{j}$ in m/s. The magnitude of the ball's initial velocity is:

ⓐ 19.3 m/s ⓑ 5.8 m/s ⓒ 18.4 m/s ⓓ 9.7 m/s

Solution:



$\vec{v} = 5.8\hat{i} + 9.7\hat{j}$ m/s

$v_x = 5.8$ m/s → $v_y = 9.7$ m/s

v_y = ✓, y = ✓, ⓣ ⇒ ③; a = ✓, v_{oy} = ?

$v_{oy} = ?$ $a = -9.8\ m/s^2$ $y = 12.5m$ $v_y = 9.7$ m/s

ⓣ ⇒ ③

$v_y^2 = v_{oy}^2 + 2ay \Rightarrow (9.7)^2 = v_{oy}^2 + 2(-9.8)(12.5)$

$v_{oy}^2 = (9.7)^2 + (2)(9.8)(12.5) = 339.1 \overset{\sqrt{}}{\Rightarrow} v_{oy} = 18.4\ m/s$

$v_o = \sqrt{v_x^2 + v_{oy}^2} = \sqrt{(5.8)^2 + (18.4)^2} = 19.3$ m/s ⓐ

Ch 4

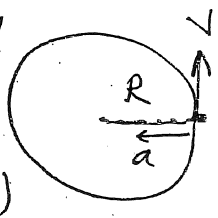
Uniform Circular Motion
الحركة الدائرية المنتظمة

عندما يتحرك جسم في دائرة نصف قطرها R (radius = R)
بسرعة ثابتة v فإنه

a = centripetal acceleration التسارع المركزي
or (radial acceleration)

$$a = \frac{v^2}{R}$$

toward the center and perpendicular on the velocity ($a \perp v$)



دائماً اتجاه التسارع المركزي **نحو المركز** وعمودي على السرعة الخطية للجسم

T = Period (or Time of one revolution)
الزمن الدوري (زمن اللفة الواحدة)

T = محيط الدائرة / السرعة

$2\pi R$ = circumference = محيط الدائرة = مسافة اللفة الواحدة

$$T = \frac{2\pi R}{v}$$ (أو) $$T = \frac{\text{الزمن الكلي}}{\text{عدد اللفات}}$$

f = frequency التردد (عدد اللفات في الثانية)

$$f = \frac{1}{T}$$

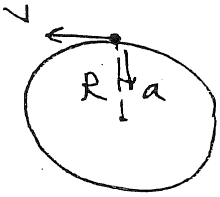
Ex. The velocity and acceleration of a body in a uniform circular motion (الحركة الدائرية المنتظمة) are:

ⓐ differed by 45° ⓑ differed by 135°

ⓒ perpendicular ⓓ parallel ⓔ none of these

Solution: $v \perp a$ ⟹ perpendicular (متعامدان)

ⓒ



Ex. A player runs in a circular track (مسار دائري) with constant speed (بسرعة ثابتة). The direction (اتجاه) of his centripetal acceleration (التسارع المركزي) is

ⓐ toward the center (نحو المركز) ⓑ outward the center (يبتعد عن المركز)

ⓒ in the positive x-axis (في اتجاه موجب x) ⓓ none of these

Solution: toward the center (نحو المركز) ⓐ

4. A particle is said to be in uniform circular motion if

a) its velocity has a constant magnitude
b) its velocity has a constant direction
c) its velocity is directed towards the center
d) its velocity equals zero

Solution

الحركة الدائرية المنتظمة

uniform circular motion

عندما يتحرك الجسم في دائرة بسرعة ثابتة

constant velocity (a)

3. A particle in uniform circular motion of radius r = 2m moved one period. **The distance that the particle travelled** in meters is:

a) 4π b) 2π c) π d) 3π

Solution: $R = 2m$

المسافة التي يتحركها جسم خلال لفة واحدة = محيط الدائرة

$S = 2\pi R = 2\pi(2) = 4\pi$ (a)

Ch 4

(44)

51. The period of an objects moving at a constant speed of 4 m/s on a circular path of radius 2 m is:

(a) π s (b) 2π s (c) 4π s (d) 8π s

52. Referring to question 51, the acceleration of the object is:

(a) 1 m/s^2 (b) 2 m/s^2 (c) 4 m/s^2 (d) 8 m/s^2

Solution:

$v = 4\, m/s \qquad R = 2\, m \qquad T = ??$

$$T = \frac{2\pi R}{v} = \frac{2\pi(2)}{4} = \pi\ s \quad (a)$$

$$a = \frac{v^2}{R} = \frac{(4)^2}{2} = \frac{16}{2} = 8\, m/s^2 \quad (d)$$

49. The speed of a car moving in a circular path of radius 20 m with a centripetal acceleration of 5 m/s^2 is:

(a) 10 m/s (b) 100 m/s (c) 4 m/s (d) 2000 m/s

solution:

$R = 20\, m \qquad a = 5\, m/s^2 \qquad v = ??$

$$a = \frac{v^2}{R} \Rightarrow 5 = \frac{v^2}{20}$$

$v = 10\, m/s$ (a)

Ch 4 (5)

Q.9 A particle moves at constant speed in a horizontal circle of radius 5 m, making a complete circle in 4 s. The acceleration is:

(A) 15 m/s^2 (B) 10 m/s^2 (C) 8 m/s^2 (D) 12.34 m/s^2 (E) Zero

Solution:

$R = 5\ m$

Complete circle in 4 s $\Rightarrow T = 4\ s$

$$T = \frac{2\pi R}{v} \Rightarrow 4 = \frac{2 \times 3.14 \times 5}{v}$$

$$v = 7.85\ m/s$$

$$a = \frac{v^2}{R} = \frac{(7.85)^2}{5} = 12.3\ m/s^2$$

(D)

Q.11 A 5 kg body is moving in a circular path of radius 0.5 m in radius with a constant speed makes five revolutions per second. Then its speed is:

(A) 15.71 m/s (B) 3.14 m/s (C) 7.5 m/s (D) 0.20 m/s (E) Zero

Solution:

$R = 0.5\ m$

5 revolutions per second

$$T = \frac{\text{الزمن الكلي}}{\text{عدد الدورات}} \Rightarrow T = \frac{1}{5} = 0.2\ s$$

$$T = \frac{2\pi R}{v} \Rightarrow 0.2 = \frac{2 \times 3.14 \times 0.5}{v}$$

$$v = 15.7\ m/s$$

(A)

Ch 4

(46)

47. A stone is tied to a 0.50-m string and whirled at a constant speed of 4. m/s in a vertical circle. Its acceleration at the bottom of the circle is:

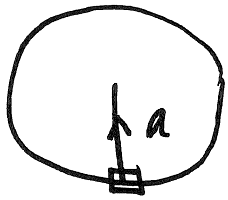
(a) 9.8 m/s², up (b) 9.8 m/s², down (c) 32 m/s², up (d) 32 m/s², down

solution:

$R = 0.5\,m$ طول الحبل

$v = 4\ m/s$

التسارع دائماً نحو المركز



$$a = \frac{v^2}{R} = \frac{(4)^2}{0.5} = 32\ m/s^2\ \text{up}\ (c)$$

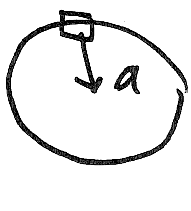
46. A stone is tied to a 0.50-m string and whirled at a constant speed of 4m/s in a vertical circle. Its acceleration at the top of the circle is:

(a) 9.8 m/s², up (b) 9.8 m/s², down (c) 32 m/s², up (d) 32 m/s², down

solution:

$R = 0.5\,m$ طول الحبل

$v = 4\ m/s$



$$a = \frac{v^2}{R} = \frac{(4)^2}{0.5}$$

$= 32\ m/s^2$ down (b)

45. For a biological sample in a 1:0-m radius centrifuge to have a centripetal acceleration of 25g, its speed must be:

(a) 11 m/s (b) 16 m/s (c) 50 m/s (d) 122 m/s

Solution:

$R = 1m$ $a = 25g = 25 \times 9.8$

$= 245 \ m/s^2$

$a = \frac{v^2}{R} \Rightarrow 245 = \frac{v^2}{1} \Rightarrow$

$v = 15.7 \ m/s$ (b)

18. A car travels in a circular track of 200 m in circumference at a constant velocity of 18 m/s . The radial acceleration of the car is:

A) 8.37 m/s^2 B) 12.8 m/s^2 C) 7.31 m/s^2 D) 10.2 m/s^2

Solution:

المحيط $v = 18 \ m/s$

Circumference $= 2\pi R = 200 \ m$

$R = \frac{200}{2\pi} = \frac{200}{2(3.14)} = 31.84 m$

$a = \frac{v^2}{R} = \frac{(18)^2}{31.84} = 10.17 \ m/s$

(D)

قمر صناعي يتحرك

Ex: A space satellite moves in a

في مسار دائري حول الأرض

circular orbit around the earth, at

على ارتفاع وبسرعة

altitude of 530 km and with speed

التسارع

of 8 km/s. The acceleration of the

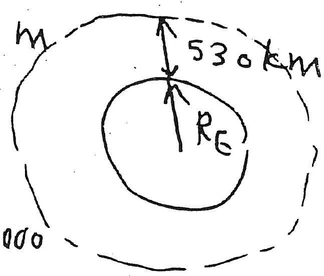
نصف قطر الأرض

satellite is: (the earth radius 6.37×10^6 m)

(a) $9.27\ m/s^2$ (b) $9.74\ m/s^2$ (c) $0.927\ m/s^2$ (d) 0

نصف قطر الأرض

Solution: $R_E = 6.37 \times 10^6\ m$



$R = R_E + 530 \times 1000$ ← km

$= 6.37 \times 10^6 + 530 \times 1000$

$= 6.9 \times 10^6\ m$

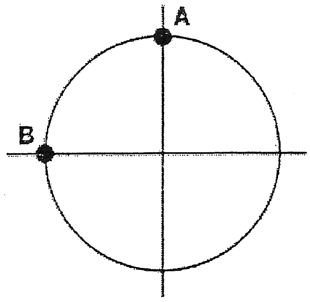
$v = 8\ km/s = 8000\ m/s$

$$a = \frac{v^2}{R} = \frac{(8000)^2}{6.9 \times 10^6} = 9.275\ m/s^2$$

(a)

Ch 4 (49)

14. In the figure, a car moves at constant speed around the circle path in a horizontal xy plane, with the center at the origin. When it is at point A its coordinates are $x=0$, $y=3$m and its velocity is (6 m/s) $\hat{i}$. When it is **at point B its velocity and acceleration** are:



A) $\vec{v}=+6\hat{j}$ and $\vec{a}=+12\hat{i}$, respectively
B) $\vec{v}=-6\hat{j}$ and $\vec{a}=+12\hat{j}$, respectively
C) $\vec{v}=+6\hat{i}$ and $\vec{a}=-12\hat{i}$, respectively
D) $\vec{v}=+4\hat{j}$ and $\vec{a}=+12\hat{i}$, respectively

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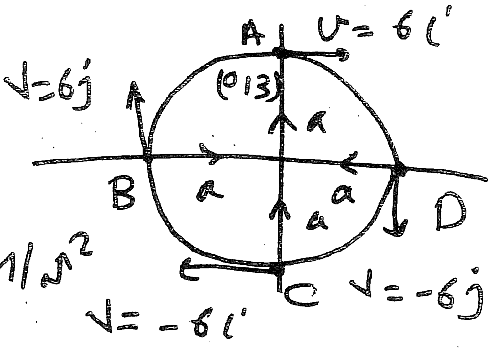
Solution: at A $v = 6i$ m/s

$R = 3$ m $\quad v = 6$ m/s



$$a = \frac{v^2}{R} = \frac{(6)^2}{3} = 12 \text{ m/s}^2$$

لاحظ دائماً $\vec{a}$ نحو المركز ملازم

at B $\quad \vec{v} = 6j$ m/s $\quad \vec{a} = 12i$ m/s^2 (a)

لاحظ

at C $\quad \vec{v} = -6i \quad \vec{a} = 12j$

at D $\quad \vec{v} = -6j \quad \vec{a} = -12i$

50. The period of a plane that enters a horizontal circular turn with $\bar{v}_i = 200\hat{i} + 600\hat{j}$ m/s and 32 s later leaves the turn with $\bar{v}_f = 200\hat{i} + 600\hat{j}$ is:

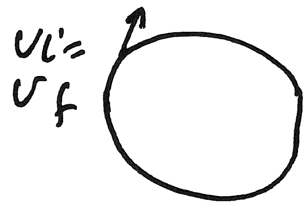
(a) 12 (b) 16 (c) 32 (d) 64

solution :

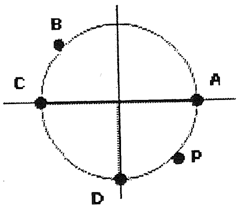
$v_i = v_f = 200\hat{i} + 600\hat{j}$ m/s

معنى ذلك أن الكوكب عمل دورة كاملة

$\therefore T = 32$ s (c)



53. A particle is moving in circular path, at point P the particles velocity is: $\bar{v} = 3\hat{i} + 4\hat{j}$ at which point the velocity is $\bar{v} = -3\hat{i} - 4\hat{j}$

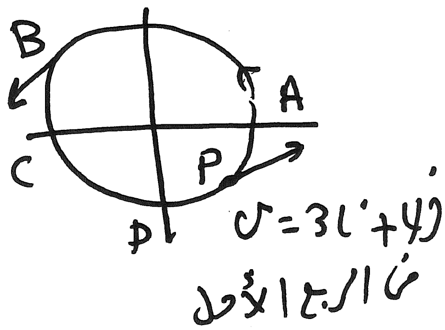


(a) A (b) B (c) C (d) D

solution

$v = -3\hat{i} - 4\hat{j}$ في الربع الثالث

أي عند النقطة B



Ch 4 (51)

31. Two objects having masses of 1Kg and 2Kg moving around a circle of radius r = 1 m and with v = 1 m/s. Their **accelerations** are related by:

A) $\frac{a_1}{a_2}=\frac{1}{2}$ B) $\frac{a_1}{a_2}=2$ C) $a_1=a_2$ D) $a_1=a_2=0$

Solution :

$m_1 = 1\ kg$ $m_2 = 2\ kg$

$r = 1m$ $v = 1\ m/s$

$$a = \frac{v^2}{R}$$

ثابتة R ، ثابتة v

$a_1 = a_2$ (C)

لاحظ الكتلة فقط هي التي تغيرت والتسارع المركزي لا يتأثر بتغير الكتلة ولذلك ظل التسارع المركزي هو نفسه بالنسبة للكتلتين

Ch 5 (1)

Force and Motion

Newton's first law: قانون نيوتن الأول

If no net force acts on the body, then the body is at rest (ساكن) or moving with constant velocity (يتحرك بسرعة ثابتة) (acceleration = 0)

in equilibrium

إذا تحرك جسم بسرعة ثابتة أو ساكن (الجسم متزن) فإنه

$$\text{net force} = \sum \vec{F} = 0 \Rightarrow \sum F_x = 0 \quad \sum F_y = 0$$

or net force = 0 $\Leftrightarrow$ Constant speed
(resultant المحصلة)

		الوحدة
m = mass	الكتلة	(kg)
W = weight	الوزن	نيوتن (N)

$g = 9.8\ m/s^2$

الوزن هو قوة الجاذبية بين الجسم والأرض

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

$N = kg \cdot m/s^2$

لاحظ الكتلة mass ثابتة لا تتغير (كتلة جسم على سطح القمر هي نفسها على سطح الأرض) لكن الوزن weight يتغير بتغير تسارع الجاذبية

Ch 5 (2)

25. The gravitational force of earth acting on a 1 kg is

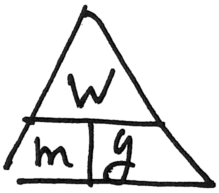
a) 1N b) 8.9 N c) 9.8 N d) 980 N

Solution:

$m = 1\ kg$

$W = mg = 1 \times 9.8$

$= 9.8\ N$ (c)



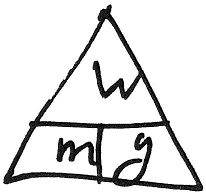
32. A girl weighs 489 N on Earth. Her mass is;

a) 50 kg b) 489 kg c) 9.8 kg d) 0kg

Solution

$W = 489\ N$ $m = ??$

$W = mg \Rightarrow 489 = m(9.8)$



$m = \frac{489}{9.8} = 49.9\ kg \simeq 50\ kg$ (a)

22. A particle has a **weight of 22 N** at a point where **g = 9.8 m/s²**, what are its **mass and weight** at a point where **g = 0** ?

(a) m = 2.2 kg, W = 0 (b) m = 0, W = 2.2 N (c) m = 0.45 kg, W = 0 (d) m = 0, W = 45 N

Solution:

$W = 22\ N$ $g = 9.8\ m/s^2$

$m = \frac{W}{g} = \frac{22}{9.8} = 2.245\ kg$

$g = 0 \Rightarrow m = 2.245\ kg$ الكتلة ثابتة لا تتغير

$W = mg = 2.245(0) = 0$ (a)

Ch 5 (3)

8. The ratio between the mass and weight (mass/weight) of any body at any point on Earth is

a) 1 (b) 1/9.8 c) 9.8 d) 0.5

solution:

$$W = mg$$

$$\frac{m}{W} = \frac{m}{mg} = \frac{1}{g} = \frac{1}{9.8} \quad (b)$$

18. For any object the mass and weight are:
(a) weight is force and mass is not
b) mass is always more than weight
c) weight and mass are vectors
d) weight and mass are equal

solution الوزن هو قوة الجذب بين الأرض والجسم

weight is force and mass is not (a)

16. The unit of force called the Newton is

a) 9.8 $kg.m/s^2$ (b) 1 $kg.m/s^2$ c) 1 kg of mass d) 1 kg of force

solution

$$W = mg$$

$$N = kg.m/s^2 \quad (b)$$

23. The two quantities are measured in the same units are
a) velocity and acceleration
(b) weight and force
c) mass and weight
d) force and mass

solution القوة دا لوزن وحدة كل منهما نيوتن

(b)

Ch 5 (4)

24. A car travels east at constant velocity. The net force on the car is;
a) zero b) east c) west d) up

Solution: Constant velocity ⇒ قانون نيوتن الأول

net force = 0 $\sum \vec{F} = 0$ (a)

6. Two forces act on a particle that moves with **constantvelocity** $\vec{v} = 3\hat{i} - 4\hat{j}$ **m/s**, one of the forces is $\vec{F}_1 = 2\hat{i} - 6\hat{j}$ **N**,what is the other force?

(a) $\vec{F}_2 = 2\hat{i} - 6\hat{j}$ (b) $\vec{F}_2 = 6\hat{i} - 10\hat{j}$ (c) $\vec{F}_2 = -2\hat{i} + 6\hat{j}$ (d) $\vec{F}_2 = -6\hat{i} + 10\hat{j}$

Solution: Constant velocity ⇒ قانون نيوتن الأول

$\sum \vec{F} = 0$

$\vec{F}_1 + \vec{F}_2 = 0 \Rightarrow 2\hat{i} - 6\hat{j} + \vec{F}_2 = 0$

$\vec{F}_2 = -2\hat{i} + 6\hat{j}$ (c)

25. Three forces act on a particle that moves with **unchanging** velocity $\vec{v} = 2\hat{i} - 7\hat{j}$, two of the forces are $\vec{F}_1 = 2\hat{i} + 3\hat{j} - 2\hat{k}$ and $\vec{F}_2 = -5\hat{i} + 8\hat{j} - 2\hat{k}$. what is the **third force** ?

(a) $3\hat{i} - 11\hat{j} + 4\hat{k}$ (b) $7\hat{i} - 5\hat{j}$ (c) $-3\hat{i} + 11\hat{j} - 4\hat{k}$ (d) $-7\hat{i} + 5\hat{j}$

Solution unchanging velocity السرعة غير متغيرة (ثابتة) ← قانون نيوتن الأول

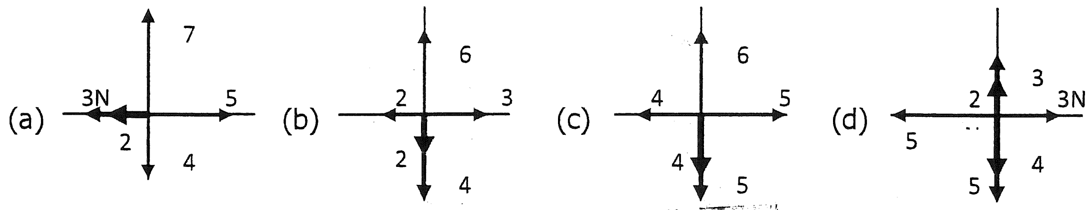
$\sum \vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$

$2\hat{i} + 3\hat{j} - 2k - 5\hat{i} + 8\hat{j} - 2k + \vec{F}_3 = 0$

$\vec{F}_3 = 3\hat{i} - 11\hat{j} + 4k$ (a)

Ch 5 (5)

8. In which figure of the following the **y-component of the net force is zero**?



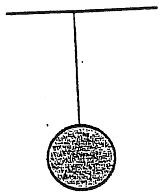
Solution:

في الشكل (b)

$\Sigma F_y = 6 - (2+4) = 0$

17. A rope from the ceiling suspends (معلق به) a ball of weight 5 N. The tension in the rope is:

(a) 5 N b) 49 N c) 500 N d) 0 N



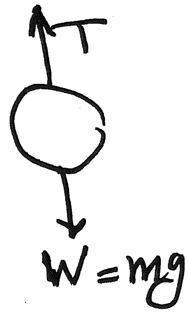
Solution:

الكرة ساكنة ⇐ قانون نيوتن الأول

$W = 5N$

$\Sigma F_y = 0$

$T = W = 5 N$

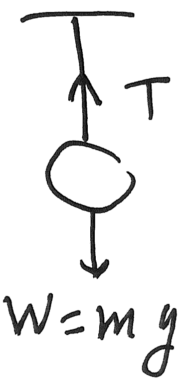


Q.17 A string from the ceiling suspends a mass of 3.5 kg. The tension in the string is:

(A) 49 N (B) 34.3 N (C) 3.5 N (D) zero

Solution: $m = 3.5\ kg$

الكرة ساكنة ⇐ قانون نيوتن الأول

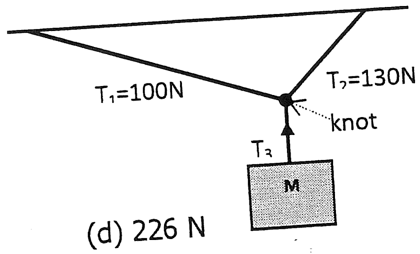


$T = W = mg = 3.5 \times 9.8$

$= 34.3 N$ (B)

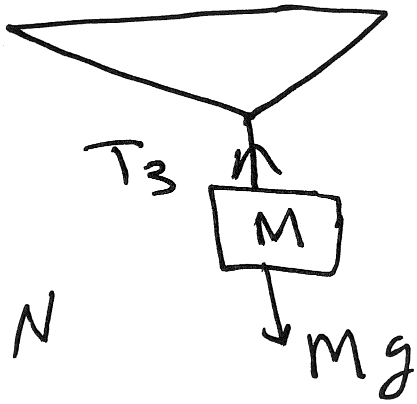
Ch 5 (6)

12. A block of mass **M= 20 kg** hangs from three cords by means of a knot, **(**the mass M does not move**), what is the value of tensionT_3**?



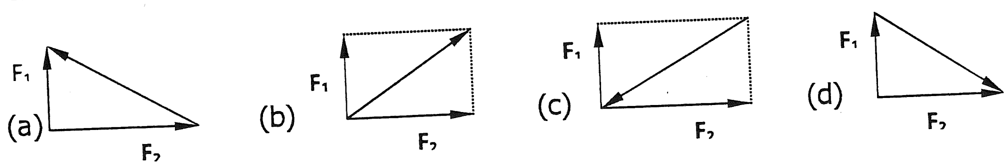
(a) 230 N (b) 196 N (c) 426 N (d) 226 N

Solution: $M = 20\,kg$

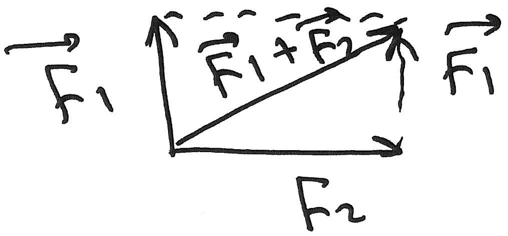


$T_3 = Mg = 20 \times 9.8 = 196\,N$

4. Which of the following figures correctly show the vector **addition of forces F_1 and F_2** ?



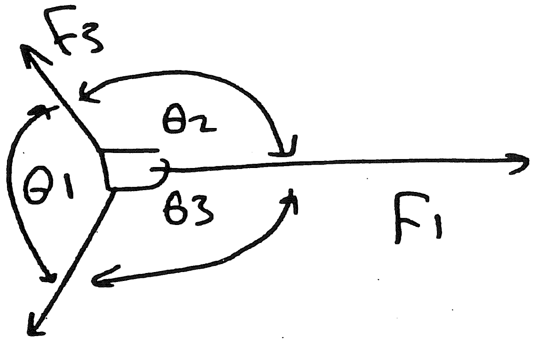
Solution:



(c)

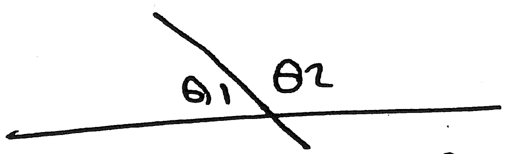
حالة خاصة: إذا اتزن جسم تحت تأثير ثلاث قوى فقط

(الجسم ساكن أو يتحرك بسرعة ثابتة)



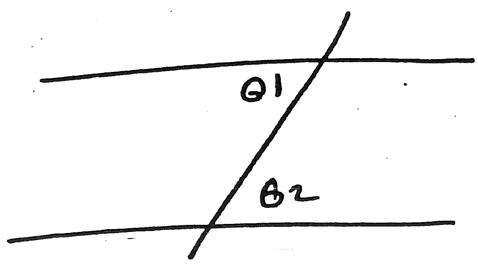
$$\theta_1 + \theta_2 + \theta_3 = 360^\circ$$

$$\frac{F_1}{\sin\theta_1} = \frac{F_2}{\sin\theta_2} = \frac{F_3}{\sin\theta_3}$$



$$\theta_1 + \theta_2 = 180^\circ$$

الزاويتان المتكاملتان مجموعهم = 180°

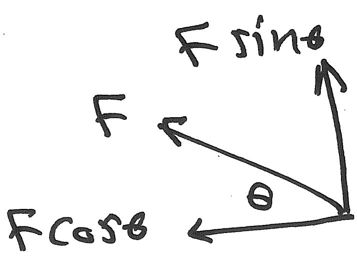


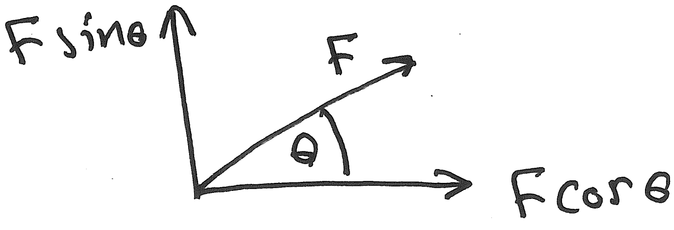
$$\theta_1 = \theta_2$$

في وضع تبادل

مجموع زوايا المثلث = 180°

تذكر

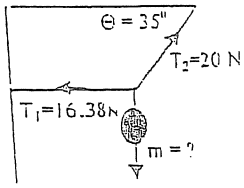




Ch 5 (8)

11- A boy stand on the ground level, if his mass is 40 kg, his weight is:
(a) 3.92 N (b)392 N (c) 39.2 N (d)3920 N

12- A body of mass m, is hung by the ropes at equilibrium as shown in the figure. The value of the mass is:
(a) 1.17 kg (b) 11.7 kg (c) 117 kg (d) 0.117 kg

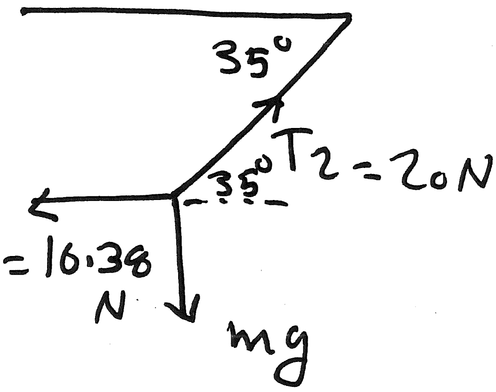


solution :

(11) $m = 40\ kg \Rightarrow W = mg = 40 \times 9.8 = 392\ N$ (b)

(12)

الجسم متزن

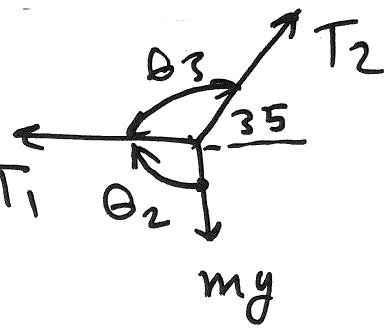


$\Sigma F_x = 0$

$T_2 \sin 35° = mg$

$20 \sin 35° = m \times 9.8 \Rightarrow m = 1.17\ kg$ (a)

حل آخر



$T_2 = 20N$ $\theta_2 = 90°$

$T_3 = mg$ $\theta_3 = 180° - 35° = 135°$

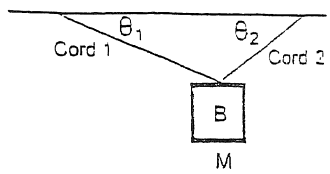
$$\frac{T_2}{\sin 90°} = \frac{mg}{\sin 135°} \Rightarrow \frac{20}{\sin 90} = \frac{m \times 9.8}{\sin 135°}$$

$m = 1.17\ kg$ (a)

Ch 5 (9)

Q.14

In the figure a block B of unknown mass M hangs by a cord from the ceiling by means of two cords. The angle $\theta_1 = 20°$ and $\theta_2 = 40°$. The tension in cord 1 is 90 N. The tension in cord 2 is:

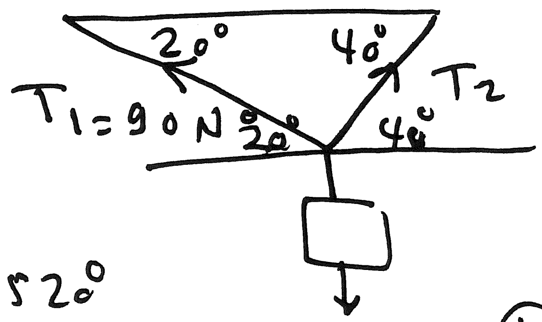


(a) 122.7 N (b) 110.4 N (c) 85.9 N (d) 98.1 N (e) 9.2 N (f) Zero

---

Solution

$T_1 = 90\,N \qquad T_2 = ??$



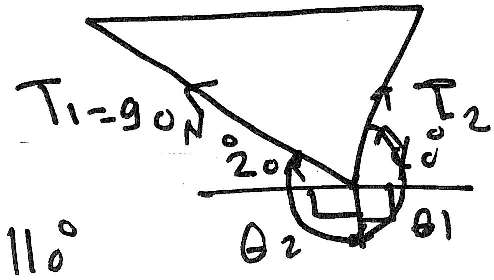
$\Sigma F_x = 0$

$T_2 \cos 40° = T_1 \cos 20°$

$T_2 = \frac{T_1 \cos 20°}{\cos 40°} = \frac{90 \cos 20°}{\cos 40°} = 110.4N$ (b)

حل آخر

$T_1 = 90\,N \qquad \theta_1 = 90° + 40° = 130°$



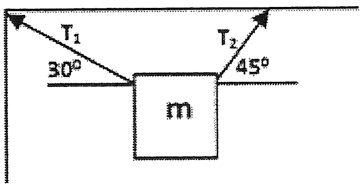
$T_2 = ? \qquad \theta_2 = 90° + 20° = 110°$

$\frac{T_1}{\sin \theta_1} = \frac{T_2}{\sin \theta_2} \Rightarrow \frac{90}{\sin 130} = \frac{T_2}{\sin 110}$

$T_2 = 110.4\,N$

Ch 5 (10)

A block of mass m = 5 kg is hanging by two ropes as shown in the figure:



7. From the figure, $F_{net,x}$ on the block is:

A) $T_1 \cos 45 - T_2 \cos 30 = 0$

B) $-T_1 \cos 30 + T_2 \cos 45 = 0$

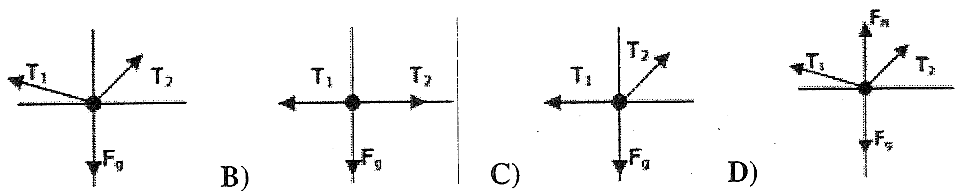
C) $T_1 \cos 45 - T_2 \cos 30 = m a_x$

D) $T_1 \cos 30 - T_2 \cos 45 = m a_x$

8. The **magnitude of weight (W)** in Newtons is equal to:

A) 9.8 N B) - 9.8 N C) - 49 N D) 49 N

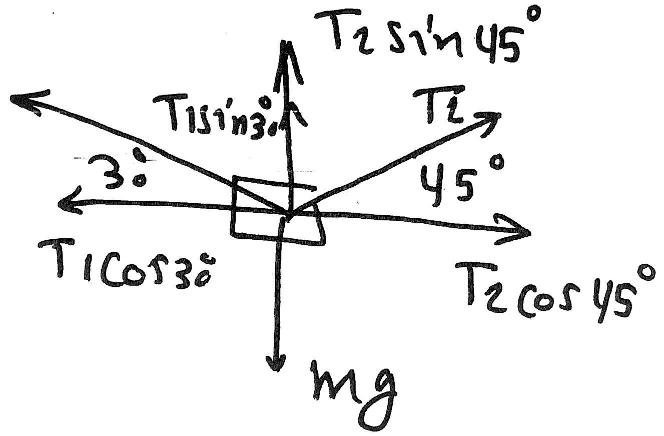
9. The **free body diagram** representing the forces on m is:



Solution:

(7) m = 5 kg

$\Sigma F_{net} = 0 \Leftarrow$ الجسم متزن



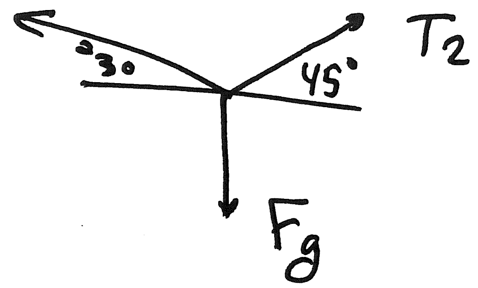
$\Sigma F_x = T_2 \cos 45° - T_1 \cos 30° = 0$

or $\Sigma F_x = -T_1 \cos 30 + T_2 \cos 45°$ (B)

Ch 5 ⑪

(8) $W = mg = 5 \times 9.8 = 49\ N$ (D)

(9) Free body diagram



(A)

Q17- Weight of 50 N is supported by a rod and a cable as shown in figure (4). The tension (T_1) is:
A) 45.77 N B) 138.59 N C) 77.78 N D) 87.77 N

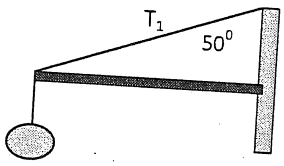


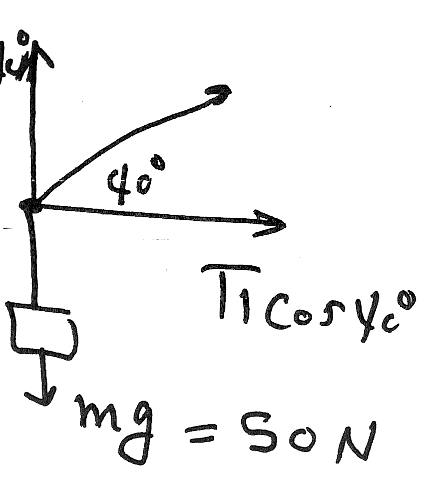
Fig. (4)

Solution:

$mg = 50\ N$

الجسم متزن

$\Sigma F_y = 0$



$T_1 \sin 40 = mg$

$$T_1 = \frac{mg}{\sin 40} = \frac{50}{\sin 40}$$

$T_1 = 77.786\ N$ (C)

Ch 5

Newton's second law   قانون نيوتن الثاني

إذا تحرك جسم بتسارع a فإن

القوة المحصلة

net force = $\Sigma \vec{F} = m\vec{a}$

resultant

m = mass الكتلة $\vec{a}$ = acceleration التسارع

ملاحظة هامة

The direction of the acceleration of the object is always the same of the net force.

اتجاه تسارع الجسم دائماً في اتجاه القوة المحصلة

Force = mass × acceleration

النيوتن N = kg . m/s²

Ch 5 (13)

Which law says that force is equal to mass times acceleration (F=MA)?
a) Newton's second law of motion
b) Newton's first law of motion
c) Newton's third law of motion
d) none

Solution :

قانون نيوتن الثاني

(a) $F = MA$

22. As in Newton's second law, acceleration is always in the direction:
a) of the initial velocity
b) of the displacement
c) of the net force
d) of the final velocity

solution

$F = ma$

a = acceleration دائماً التسارع في اتجاه

net force (resultant) القوة المحصلة

13. **What is the net force** acting on a body of a **mass of 48 kg** , when its **acceleration is 6 m/s^2** ?

(a) 758 N
(b) 182 N
(c) 288 N
(d) 470 N

Solution :

$m = 48$ kg

$a = 6\ m/s^2$

$F = ma = (48)(6) = 288\ N$

(c)

Ch 5 (14)

2. A force of **0.2 N** acts on a mass of **100 g**, what is its **acceleration**?

(a) 2×10^{-2} m/s² (b) 2×10^{-6} m/s² (c) 2×10^{-3} m/s² (d) 2 m/s²

Solution

$F = 0.2\ N$ $m = 100g = \frac{100}{1000} = 0.1 kg$

$F = ma \Rightarrow a = \frac{F}{m}$

$a = \frac{0.2}{0.1} = 2 m/s^2$ (d)

17- When a certain force is applied to 1 kg mass its acceleration is 8.0m/s². When the same force is applied to another mass its acceleration is 2.0m/s². The mass of the object is

a) 0.25 kg b) 0.5 kg c) 16.0 kg (d) 4.0 kg

Solution: $m_1 = 1 kg$ $a_1 = 8 m/s^2$

$F = m_1 a_1 = (1)(8) = 8 N$

$m_2 = ?$ $a_2 = 2 m/s^2$

$F = m_2 a_2 \Rightarrow 8 = m_2 (2) \Rightarrow m_2 = 4 kg$

(d)

$F = m_1 a_1 = m_2 a_2 \Rightarrow (1)(8) = m_2 (2)$

$m_2 = 4 kg$ (d)

Ch 5 (15)

16. If m_1= **2 kg** and m_2= **4 kg** and the **same force is applied to both masses**, then the **ratio of their accelerations is**:

(a) $\frac{a_2}{a_1}=\frac{1}{2}$ (b) $\frac{a_2}{a_1}=2$ (c) $\frac{a_2}{a_1}=\frac{1}{4}$ (d) $\frac{a_2}{a_1}=4$

Solution

$$F = m_1 a_1 = m_2 a_2$$

$$2a_1 = 4a_2 \xrightarrow{\div a_1} 2 = \frac{4a_2}{a_1} \xrightarrow{\div(4)}$$

$$\frac{a_2}{a_1} = \frac{2}{4} = \frac{1}{2}$$ (a)

17. A force **F** applied to a body of mass $\mathbf{m_0}$ giving it an acceleration $\mathbf{a_0}$, what is the mass of a body **x** if the same force is applied to it and accelerate it by $\mathbf{a_x}$?

(a) $m_x = m_0 \frac{a_x}{a_0}$ (b) $m_x = m_0 \frac{a_0}{a_x}$ (c) $m_x = \frac{a_x}{a_0}$ (d) $m_x = \frac{a_0}{a_x}$

Solution :

$$F = ma$$

$$F = m_0 a_0 = m_x a_x$$

$$\boxed{m_x = m_0 \frac{a_0}{a_x}}$$ (b)

Ch 5 (16)

21. A 9000-N automobile is pushed along a level road by four students who apply a total forward force of 500 N. Neglecting friction, the acceleration of the automobile is

a) $0.055 m/s^2$ (b) $0.54 m/s^2$ c) $1.8 m/s^2$ d) $9.8 m/s^2$

Solution:

$$W = mg = 9000\ N$$

$$m = \frac{W}{g} = \frac{9000}{9.8} = 918.4\ kg$$

$F = 500\ N$ $a = ?$

$$F = ma \Longrightarrow 500 = 918.4\, a \Longrightarrow$$

$$a = 0.54\ m/s^2 \quad (b)$$

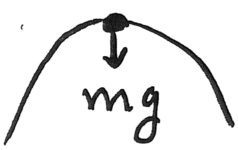
24. A ball with a weight of 1.5N is thrown at an angle of 30° above the horizontal with an initial speed of 12m/s. At its highest point, the net force on the ball is

a) 9.8 N, 30° below horizontal b) Zero c) 9.8 N, up (d) 1.5 N, down

Solution:

$$W = mg = 1.5\ N$$

تسارع المقذوف دائماً $a = -9.8\ m/s^2 \downarrow$



net force = $ma = mg = 1.5\ N \downarrow$ down

↓ عند أي نقطة

(d)

Ch 5 (17)

1. What is the **gravitational force** on a man of mass **m** when he is sitting in a car that accelerates at **a** ?

(a) $F_g = m a$ (b) $F_g = m (g - a)$ (c) $F_g = m g$ (d) $F_g = m (a - g)$

solution

قوة اجاذبية — gravitational force = mg (الوزن)

$W = F_g = mg$ (c)

19. A constant force of 8.0 N is exerted for 4.0 s on a 16 kg object initially at rest. The change in speed of this object will be

a) 0.5 m/s (b) 2 m/s c) 4 m/s d) 8 m/s

solution:

$F = 8\ N$ $m = 16\ kg$

$F = ma \Rightarrow 8 = 16a \Rightarrow a = 0.5\ m/s^2$

initially at rest $\Rightarrow v_0 = 0$

$v_0 = 0$ $v = ??$ $a = 0.5\ m/s^2$ $t = 4\ s$

$v = v_0 + at = 0 + 0.5(4) = 2\ m/s$

The change in speed $= v - v_0$

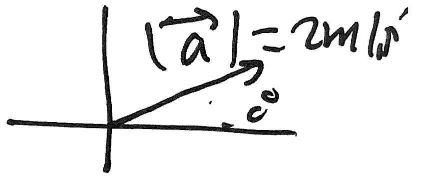
$= 2 - 0 = 2\ m/s$ (b)

Ch 5 (18)

30. If the **1 kg** body has an **acceleration of 2 m/s²** at an angle of **20°** above the positive direction of the x-axis. What is the **net force** in unit vctor notation?

(a) $\vec{F} = 0.34\hat{i} + 0.94\hat{j}$ (b) $\vec{F} = 1.88\hat{i} + 0.68\hat{j}$ (c) $\vec{F} = 0.68\hat{i} + 1.88\hat{j}$ (d) $\vec{F} = 0.94\hat{i} + 0.34\hat{j}$

solution: $m = 1\,kg$



$$\vec{a} = 2\cos 20°\,\hat{i} + 2\sin 20°\,\hat{j} = 1.88\hat{i} + 0.684\hat{j}$$

$$\Sigma\vec{F} = m\vec{a} = (1)(1.88\hat{i} + 0.684\hat{j})$$

$$= 1.88\hat{i} + 0.684\hat{j}\ (N)$$ (b)

16. A Newton is the force:

a) of gravity on a 1 kg body
b) of gravity on a 1 g body
c) that gives a 1 kg body an acceleration of $1\,m/s^2$
d) that gives a 1 kg body an acceleration of $9.8\,m/s^2$

solution:

$F = m\,a$

$1N = 1kg \cdot 1m/s^2$

Newton is the force that gives a 1kg body an acceleration of $1m/s^2$

(c)

Ch 5 (19)

Q.11 Two forces act on a particle of mass 2 kg. $\bar{F}_1 = (80\hat{i} + 60\hat{j})$ N and $\bar{F}_2 = (40\hat{i} + 100\hat{j})$ N The magnitude of the acceleration is:
(a) 25 m/s^2 (b) 50 m/s^2 (c) 100 m/s^2 (d) 200 m/s^2 (e) 400 m/s^2 (f) 10 m/s^2

solution: $m = 2 kg$ $|\vec{a}| = ??$

$\vec{F_1} = (80i + 60j)\ N$ $\vec{F_2} = (40i + 100j)\ N$

$\sum \vec{F} = m\vec{a} \Rightarrow \vec{F_1} + \vec{F_2} = m\vec{a}$

$80i + 60j + 40i + 100j = 2\vec{a}$

$120i + 160j = 2\vec{a} \xrightarrow{\div 2} \vec{a} = 60i + 80j\ m/s^2$

$|\vec{a}| = \sqrt{(60)^2 + (80)^2} = 100\ m/s^2$ (c)

20. A 6-kg object is moving with a net force of 12N north on it. The object having an acceleration of
(a) 2m/s^2, north b) 2m/s^2, south c) 6m/s^2, north d) 18m/s^2, north

solution: $m = 6 kg$ $F = 12\ N$ ↑ north

$\vec{F} = 12j\ (N)$ $\sum \vec{F} = m\vec{a}$

$12j = 6\vec{a} \Rightarrow \vec{a} = 2j\ (m/s^2)$

$a = 2\ m/s^2$ ↑ north (a)

Ch 5 (21)

Ex: A Particle (جسيم) of mass (كتلة) 2kg is moving (يتحرك) with (بسرعة) Velocity $\vec{v}(t) = (13\hat{i} + 25t^2\hat{j})$ m/s where t is the time. The net force (القوة المحصلة) on the particle in SI units is:

(a) $26\hat{i}$ (b) $78t\hat{i}$ (c) $15\hat{j}$ (d) $100t\hat{j}$

Solution:

$m = 2$ kg

$\vec{v}(t) = 13\hat{i} + 25t^2\hat{j}$ (m/s)

أشتقنا

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

$\vec{a} = \frac{d\vec{v}}{dt} = 0 + 50t\hat{j} = 50t\hat{j}$ m/s²

$\sum F = m\vec{a} = 2(50t\hat{j}) = 100t\hat{j}$ (N)

(d)

Ch 5 (20)

Ex) Two forces are applied to an object of mass 9. kg. One force is 30 N to the north and the other is 24N to the west. The magnitude of the object is:

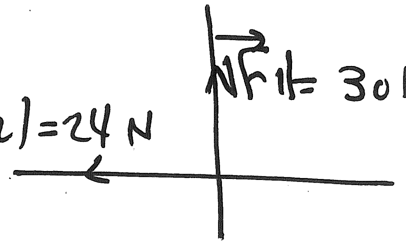
ⓐ $2 m/s^2$ ⓑ $3 m/s^2$ ⓒ $4 m/s^2$ ⓓ $5 m/s^2$

Solution

$m = 9.61 kg$

$\vec{F_1} = 30\hat{j}$ (north)

$\vec{F_2} = -24\hat{i}$ (west)



$\sum\vec{F} = m\vec{a} \Rightarrow \vec{F_1} + \vec{F_2} = m\vec{a}$

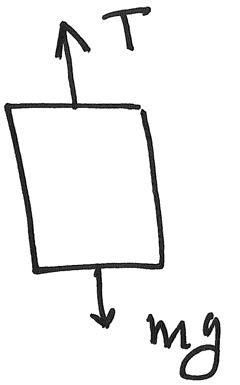
$30\hat{j} - 24\hat{i} = 9.61\vec{a}$ $\div (9.61)$

$\vec{a} = 3.122\hat{j} - 2.497\hat{i}$

$|\vec{a}| = \sqrt{(3.122)^2 + (-2.497)^2} = 4 m/s^2$

ⓒ

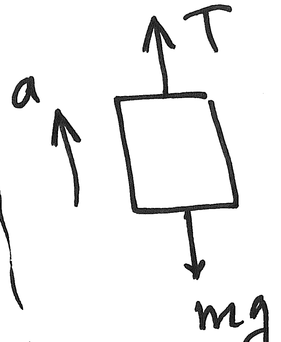
Elevator المصعد



المصعد ساكن أو يتحرك بسرعة ثابتة

فقانون نيوتن الأول

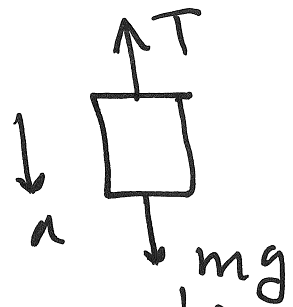
$T = mg$



يصعد
(up) assend

$T > mg$

$T - mg = ma$



يهبط
down (dessend)

$mg > T$

$mg - T = ma$

or

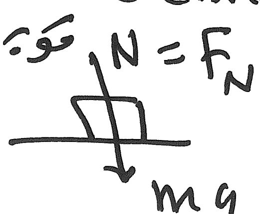
$T - mg = -ma$

سالب

الشد

T = tension or the normal force on the man, scale reading قراءة الميزان

the force exerted by the elevator on the man



Ch 5 (23)

25. An 800 N person is standing in an elevator. If the upward force of the elevator on the person is 600 N, the net force on the person is:

a) 1400 N b)800 N (c) – 200 N d) – 600 N

Solution: $W = mg = 800\ N$ $T = 600\ N$

$mg > T$

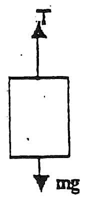
net force $= 800 - 600 = 200\ N \downarrow$

[illegible]

net force $= -200\ N$ (c)

---

26. A 1000-kg elevator is rising and its speed is increasing at 3 m/s². The tension force of the cable on the elevator is



$\vec{a} = 3\ m/s^2$ ↑

a) 6800N b) 1000N c) 3000N (d) 12800N

Solution: $m = 1000\ kg$ $T = ??$

$a = 3\ m/s^2$

rising يعني ↑

$T - mg = ma \Rightarrow T - 1000 \times 9.8 = 1000(3)$

$T = 12800\ N$ (d)

Ch 5 (24)

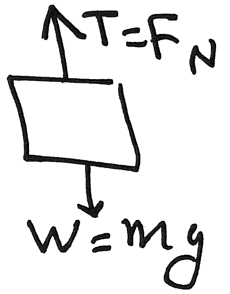
11. An 800 N person is standing in an elevator. If the normal force on the person is 600 N, the person is;
a) moving up at a constant speed b) at rest c) accelerating upward
d) accelerating downward

Solution:

$W = mg = 600\,N$

$F_N = T = 600\,N < W = mg$

المصعد يتحرك لأسفل

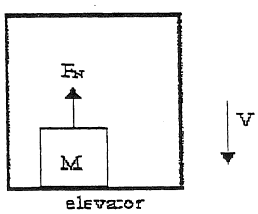


accelerating downward (d)

---

24. A box of mass M sits on the floor of an elevator (مصعد) that is accelerating downward, the magnitude of the normal force F_N :
(a) $F_N < Mg$ b) $F_N = Mg$ c) $F_N > Mg$ d) $F_N = 0$

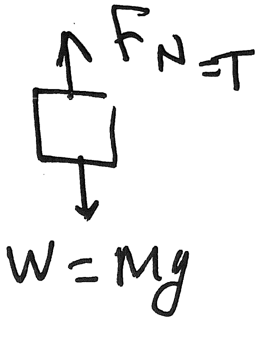
(3)



Solution

المصعد يتسارع لأسفل

a ↓



$\therefore$ $W > T$

$Mg > F_N$ (a)

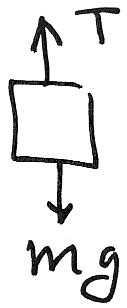
26. A 72-kg man stands on a scale in an elevator, before the elevator starts to move, the scale reading is: :

a) 165 N (b) 706 N c) 814 N d) 648 N

Solution:

$m = 72\ kg$

المصعد ثابت



$\therefore T = mg = 72 \times 9.8$

$= 705.6\ N$

قراءة الميزان $= T = 705.6\ N$ (b)

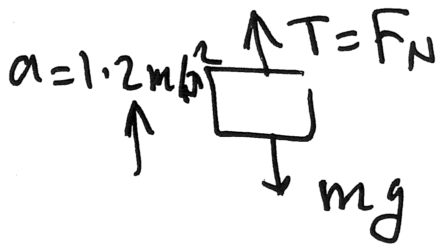
---

26. An 80 kg man stands on a scale in an elevator cab, if the cab accelerate upward with 1.2 m/s^2, the normal force (F_N) is;

a) 680 N b) 80N c) 880N d) zero

Solution

$m = 80\ kg$



$T - mg = ma \Rightarrow$

$T - 80 \times 9.8 = 80\,(1.2)$

$T = F_N = 880\,N$ (c)

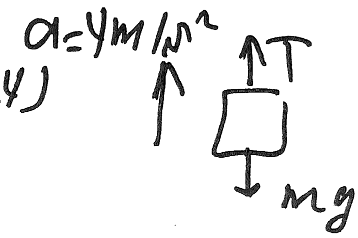
Q.17 A man weighing 700 N is in an elevator that is accelerating upward at 4 m/s^2. The magnitude of the force exerted on him by the elevator's floor is:

(A) 985.70 N (B) 290 N (C) Zero (D) 410 N (E) 71 N

Solution

$W = mg = 700\,N \Rightarrow m = \frac{700}{9.8} = 71.4\ kg$

$T - mg = ma \Rightarrow T - 700 = 71.4\,(4)$



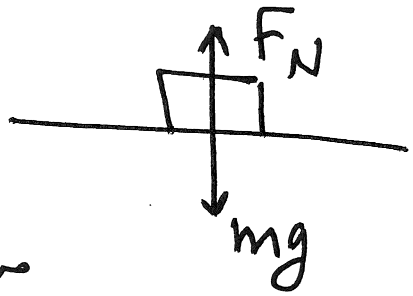
$F = T = 985.6\ N$ (A)

Ch 5 (26)

10. A bag rests on a table, exerting a downward force on the table. The **reaction to this force is:**

a) The force of Earth on the bag
b) The force of the table on the bag
c) The force of the Earth on the table
d) The force of the bag on Earth

Solution



قوة رد الفعل العمودي هي قوة
من الطاولة ع الجسم

(b)

---

28. When a person is standing on a scale in an elevator, the scale reads higher than the normal weight of the person if the elevator is :

A) accelerating upward
B) accelerating downward
C) moving up with constant velocity.
D) stationary

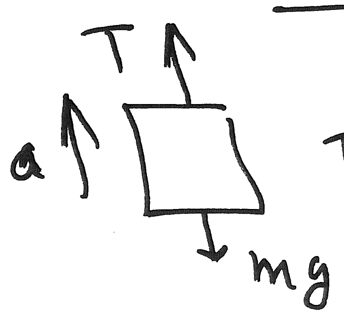
Solution

قراءة الميزان هي الشد في الخيط

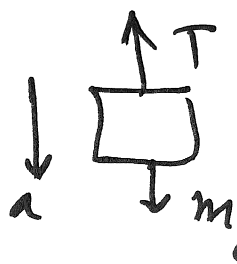
$T > mg \Rightarrow$ المصعد يتحرك بتسارع a لأعلى

(A)

لاحظ



$T > mg$
الشد أكبر من الوزن



$mg > T$
الوزن أكبر من الشد

Newton's third law قانون نيوتن الثالث

To every action there is always an equal and opposite reaction

لكل فعل رد فعل مساوي له في المقدار ومعاكس له في الاتجاه.

Ex9 In Newton's third law the action (الفعل) and reaction (ورد الفعل) forces are:

ⓐ Both are in the same direction

ⓑ Both are equal and opposite in direction

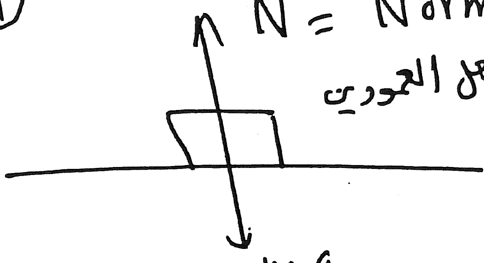
ⓒ The reaction force is greater than the action force

Solution Both are equal and opposite in direction ⓑ

المستوي الأفقي

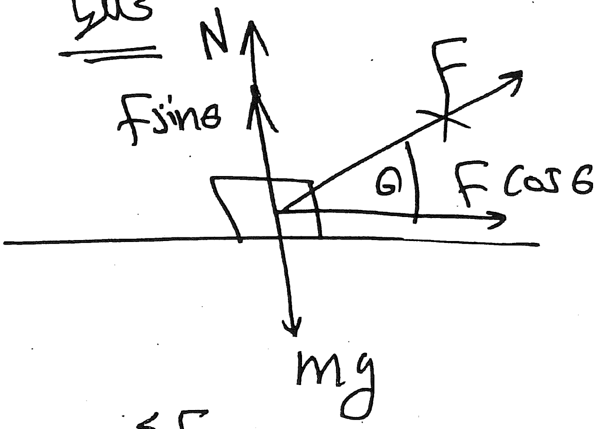
① N = Normal force

قوة رد الفعل العمودي



$$N = mg$$

② القوة المائلة على المستوى دائماً نحللها



المركبة المجاورة للزاوية تأخذ cosθ

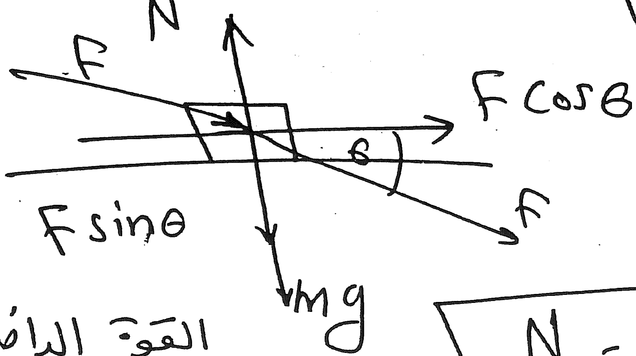
المركبة البعيدة عن الزاوية تأخذ sinθ

$\Sigma F_y = 0$

$$N + F\sin\theta = mg$$

$$N = mg - F\sin\theta$$

③

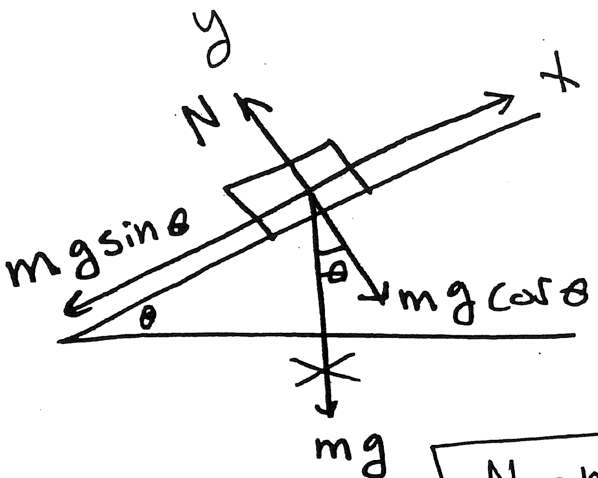


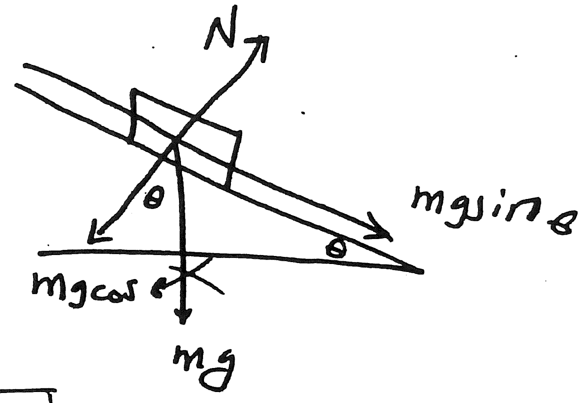
القوة الداخلة دائماً نمدها

$\Sigma F_y = 0$

$$N = mg + F\sin\theta$$

ch 5

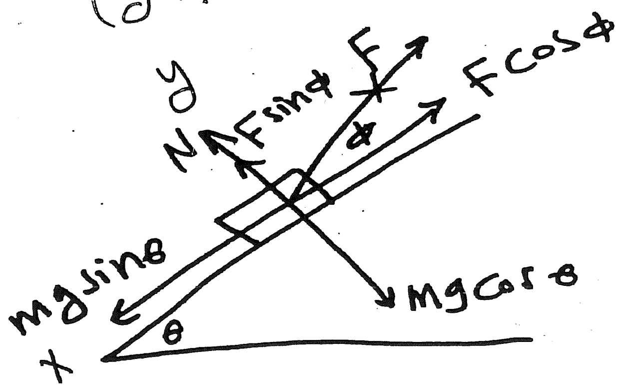




$$N = mg\cos\theta$$

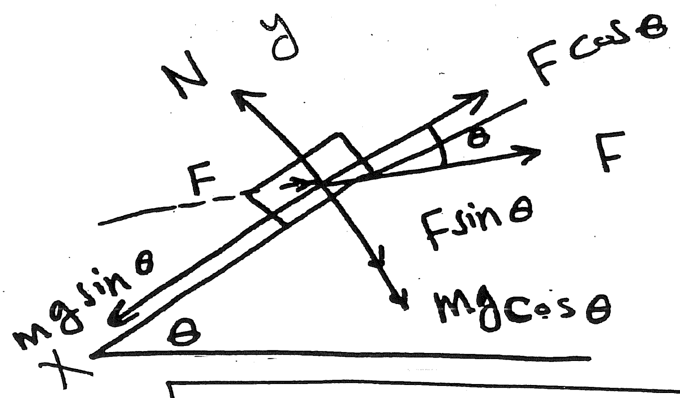
بالنسبة للوزن mg ع المستوى المائل دائماً

* المركبة الموازية للمستوى لأسفل $mg\sin\theta$ (المركبة X)
* المركبة العمودية على المستوى لأسفل $mg\cos\theta$ (المركبة y)



$$N + F\sin\phi = mg\cos\theta$$

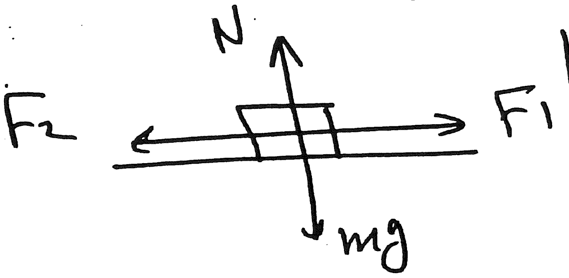
$$N = mg\cos\theta - F\sin\phi$$



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

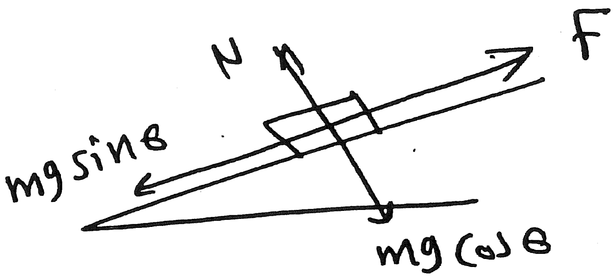
Ch 5

* الجسم يتحرك بسرعة ثابتة ⇐ نيوتن الأول



$N = mg$

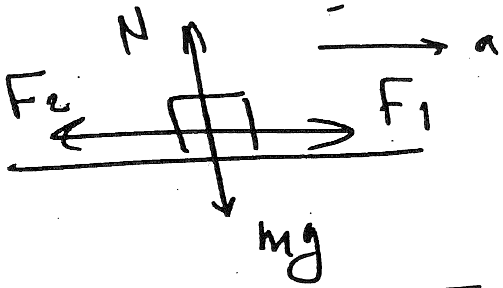
$F_1 = F_2$



$F = mg\sin\theta$

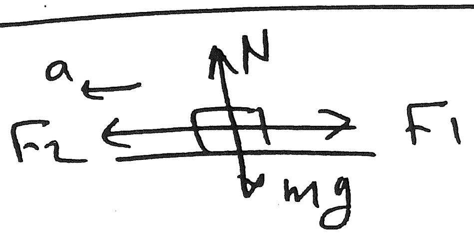
$N = mg\cos\theta$

* الجسم يتحرك بتسارع a ⇐ نيوتن الثاني



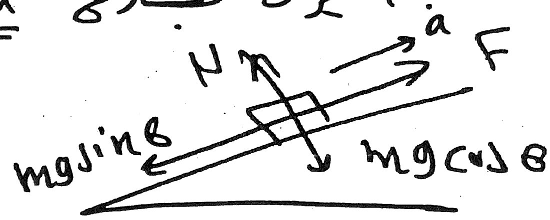
$F_1 - F_2 = ma$

$N = mg$



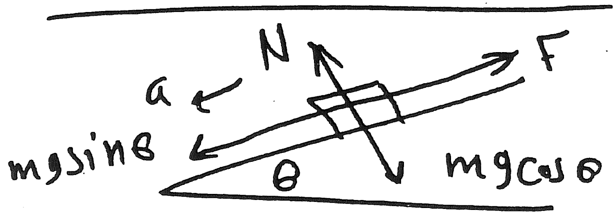
$F_2 - F_1 = ma$

$N = mg$



$F - mg\sin\theta = ma$

$N = mg\cos\theta$

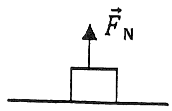


$mg\sin\theta - F = ma$

$N = mg\cos\theta$

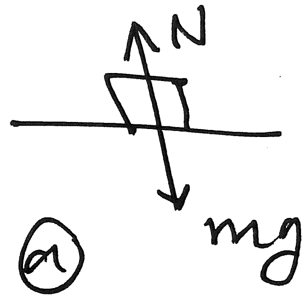
20. A 3 kg mass is sliding horizontally on a frictionless surface, the normal force F_N is

a) 29.4 N b) 1 N c) 0 d) 24.8 N



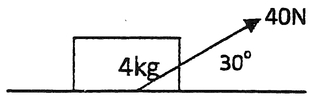
Solution: $m = 3kg$

$F_N = N = mg = 3 \times 9.8 = 29.4 N$ (a)



16. A box, has mass of 4 kg, is pulled over a frictionless floor with a force of magnitude 40 N making an angle of 30° above the horizontal. The normal force is:

a) 19.2 N b) 40N
c) 39.2 N d) 59.2 N



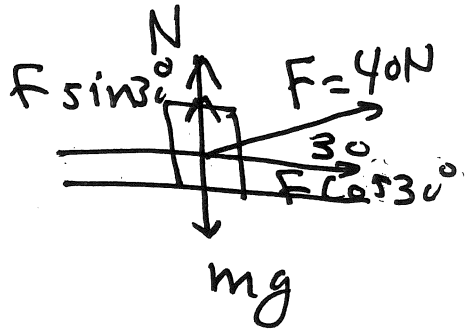
Solution: $m = 4kg$

$\sum F_y = 0$

$N + F \sin 30° = mg$

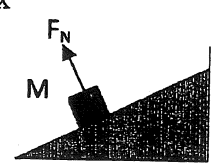
$N + 40 \sin 30° = 4 \times 9.8$

$N = F_N = 19.2 N$ (a)



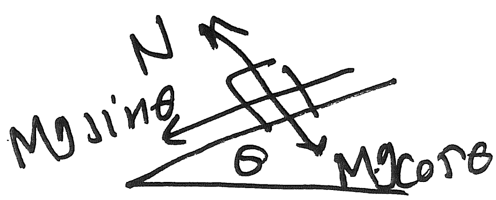
23. From the diagram; the magnitude of the normal force F_N acting on the box

a) Mg sinθ b) Mg tanθ
c) Mg d) Mg cosθ



Solution: $\sum F_y = 0$

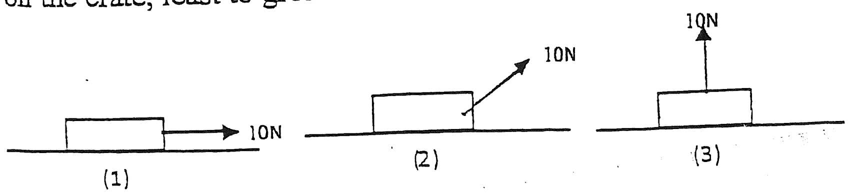
$N = Mg\cos\theta$ (d)



Ch 5 (32)

صح.

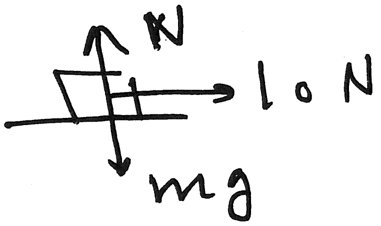
A crate rests on a horizontal surface and a woman pulls on it with a 10-N force. Rank the situations shown below according to the magnitude of the normal force exerted by the surface on the crate, least to greatest



a) 1, 2, 3 b) 2, 1, 3 c) 2, 3, 1 (d) 3, 2, 1

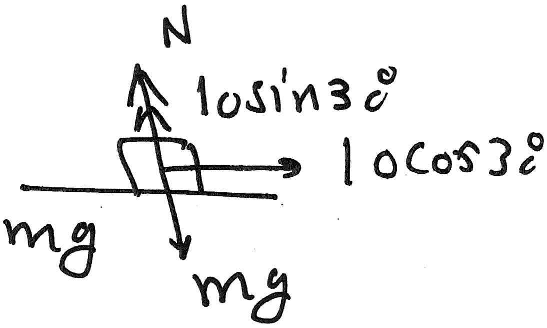
Solution:

(1)



$N = mg$

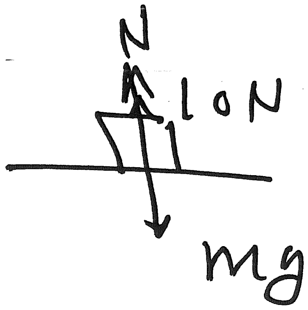
(2)



$N + 10\sin 30 = mg$

$N = mg - 10\sin 30 = mg - 5$

(3)



$N + 10 = mg$

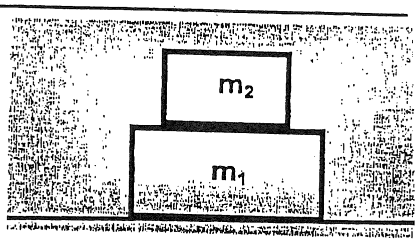
$N = mg - 10$

(1) > (2) > (3) لأن N أصغر

3, 2, 1 (d)

Q.16 In the figure m_1=10 kg and m_2=5 kg, the gravitational force on m_1 is:

(A) 30 N (B) 147 N (C) 9.8 N (D)Zero (E) 75 J



solution

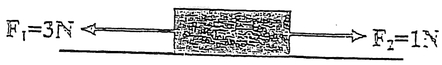
$$F_{g_1} = (m_1+m_2)g = (10+5)(9.8)$$
$$= 147\ N \quad \text{(B)}$$

$$F_{g_2} = m_2 g = 5\times 9.8 = 49\ N$$ ملاحظة

$$N_{floor} = (m_1+m_2)g = 147\ N$$

$$N_{m_1} = m_2 g = 49\ N$$

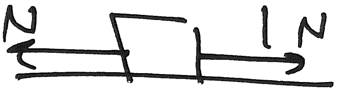
19. From the figure the acceleration of the block of mass m= 0.5 kg moving along the x-axis on a frictionless table is:



(a) – 2m/s^2 (b) – 4 m/s^2 (c) – 6 m/s^2 (d) – 8 m/s^2

Solution:

$m = 0.5\ kg$



$$\Sigma F = ma$$

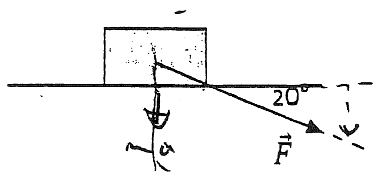
$$3-1 = 0.5\,a \Rightarrow a = 4\ m/s^2$$

$$a = -4\ m/s^2 \quad \text{(b)}$$

← سالب اتجاه (−x)

Ch 5 (34)

19. When a 25-kg box is pushed across a frictionless horizontal floor with a force of 200 N, directed 20° below the horizontal, the magnitude of the normal force F_N of the floor on the box is:
a) 68.4 N b) 176.5 N c) 245 N d) 313.4 N



Solution:

$m = 25\,kg$

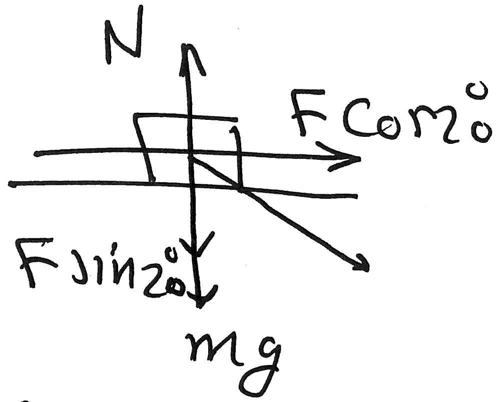
$F = 200\,N$

$\Sigma F_y = 0$

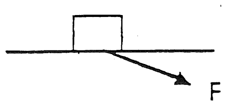
$N = mg + F\sin 20°$

$= 25 \times 9.8 + 200 \sin 20$

$= 313.4\,N$



22. A 25-kg crate is pushed across a frictionless horizontal floor with a force of 20N, directed 20° below the horizontal. The acceleration of the crate is



a) 0.27m/s²
b) 0.75m/s²
c) 0.80m/s²
d) 170m/s²

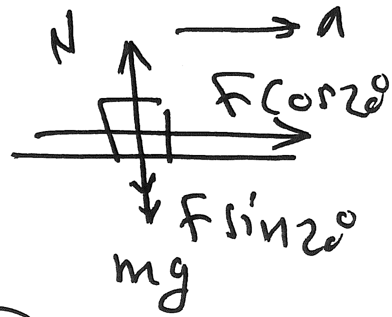
Solution: $m = 25\,kg$ $F = 20\,N$

$\Sigma F_x = ma$

$F\cos 20 = ma$

$20 \cos 20° = 25\,a$

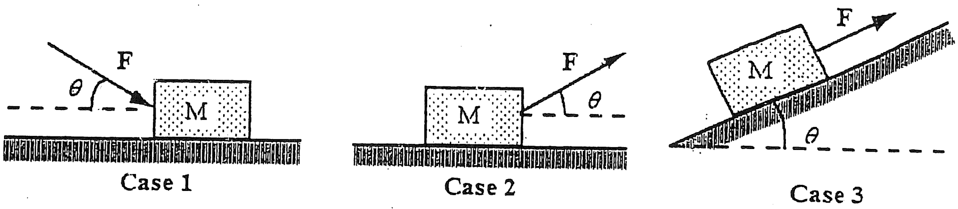
$a = 0.75\,m/s^2$ (b)



Ch 5 (35)

Q.4 In which case will the magnitude of the normal force on the block be equal to ($Mg\cos\theta$)?

(A) case 1only
(B) case 2 only
(C) case 1 and 2
(D) case 3 only
(E) cases 1, 2, and 3



Q.5 Referring to question 4, in which case will the x-component of the weight of the block be equal to (Mg sinθ)?

(A) cases 1 and 2 (B) case 2 only (C) case 3 only (D) cases 2 and 3 (E) case 1 only

Solution :

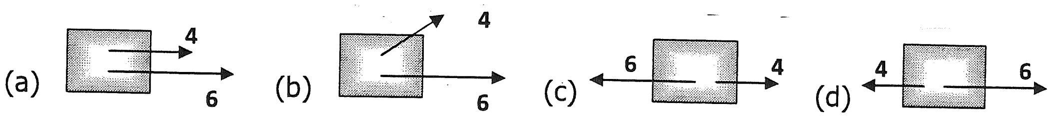
الشكل الوحيد الذي يحتوي ع $Mg\cos\theta$ هو case 3

(D)

الشكل الوحيد الذي يحتوي ع $Mg\sin\theta$ هو case 3

(C)

1. The figures below shows four situation in which forces act on a block that lies on a frictionless floor. In which figure the block has the **greatest acceleration**?



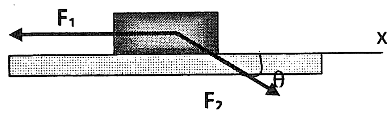
Solution $\sum F = ma$

أكبر محصلة عندما تكون القوتان في نفس الاتجاه

أي الشكل (a)

Ch 5 (36)

15. Two forces act on a block of mass **m= 0.5 kg** that Moves along the x-axis on a frictionless table, **F_1= 3 N** and **F_2= 1 N** directed at angle **θ=30°** as shown,
What is the acceleration of the block?

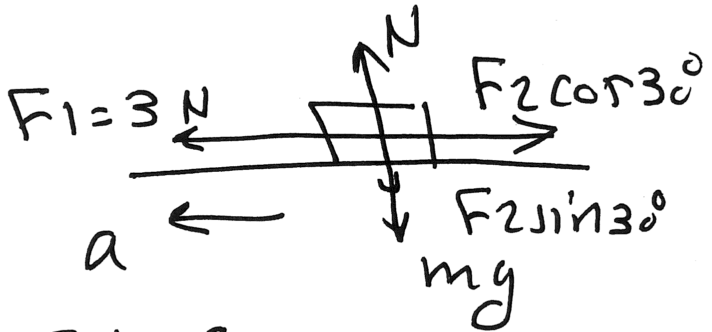


(a) – 4.3 m/s² (b) – 7.7 m/s² (c) - 5 m/s² (d) - 7 m/s²

solution:

m = 0.5 kg   F1 = 3N   F2 = 1N

$\Sigma F_x = ma$

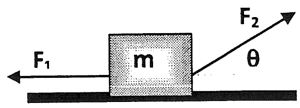


$F_1 - F_2\cos 30° = ma$

$3 - 1\cos 30 = 0.5a \Rightarrow a = 4.3\ m/s^2$

$a = -4.3\ m/s^2$ ← سالب - باتجاه (−x)

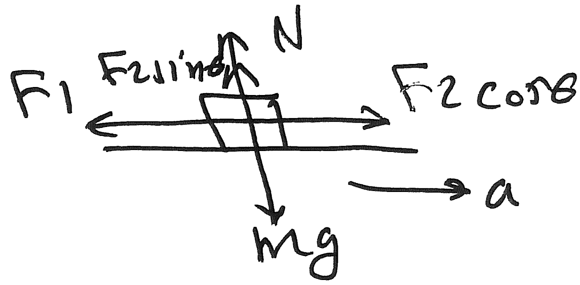
18. In the figure, two forces acting on a box of mass **m** moving over a **frictionless** ice along the **x-axis** .
What is the **acceleration** of the box?



(a) $a_x = \frac{F_1 + F_2\cos\theta}{m}$ (b) $a_x = \frac{F_2\cos\theta - F_1}{m}$ (c) $a_x = \frac{F_2\cos\theta}{m}$ (d) $a_x = \frac{F_1 - F_2}{m}$

Solution:

$\Sigma F_x = ma$

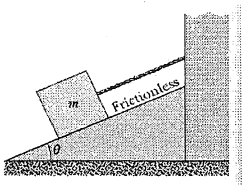


$F_2\cos\theta - F_1 = ma$

$a = \frac{F_2\cos\theta - F_1}{m}$ (b)

Ch 5 (37)

9. In the figure a cord holds stationary a block of mass **m = 8.5 kg** on a frictionless plane that is inclined at An angle **θ = 30°, the tension in the cord T** equals:



(a) 72.14 N (b) 83.3 N (c) 53.14 N (d) 41.65 N

10. In question9, the **Normal forceN** acting on the block is:

(a) N= F_g – mg cosθ (b) N= $F_g$cosθ (c) N= F_g+mgcosθ (d) N= F_g

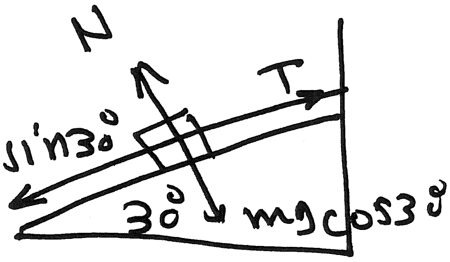
11. In question9, if the cord is **cut** then the mass will slide with **acceleration equals**:

(a) a = - 4.9 m/s² (b) a = - 9.8 m/s² (c) a = - 8.5 m/s² (d) a = - 3.4 m/s²

Solution

m = 8.5 kg

الجسم ساكن ⇐



$\Sigma F_x = 0 \Rightarrow T = mg\sin 30$

$= 8.5 \times 9.8 \sin 30$

$= 41.65$ N (d)

$\Sigma F_y = 0 \Rightarrow N = mg\cos 30$

$= 8.5 \times 9.8 \cos 30$

$= 72.14$ N

$N = mg\cos\theta$

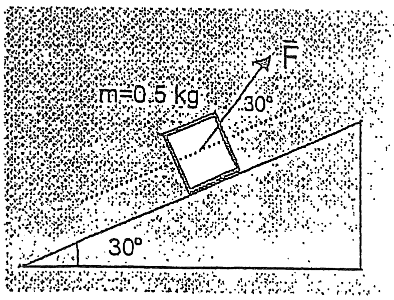
$= F_g\cos\theta$ (b)

الجسم يتحرك على مستوى مائل أملس تحت تأثير وزنه فقط

$a = g\sin\theta = 9.8\sin 30 = 4.9\ m/s^2$ $a = -4.9\ m/s^2$ (a)

Ch 5 (38)

Q.13 As shown in the figure a box on frictionless inclined plane. The magnitude of $\bar{F}$ Which prevents the box from slipping down the plane is:
The magnitude of $\bar{F}$ is:
(A) 2.83 N (B) 9.8 N (C) 4.9 N (D) 8.3 N (E) Zero



Q.14 In the figure, if F=4 N then the value of box acceleration is:
(A) 1 m/s^2 (B) 4 m/s^2 (C) 9.8 m/s^2 (D) 6 m/s^2 (E) 2.03 m/s^2

Q.15 In the figure, if F=4 N then the normal force on the box is:
(A) 2 N (B) 2.24 N (C) 6.24 N (D) 4.24 N (E) Zero

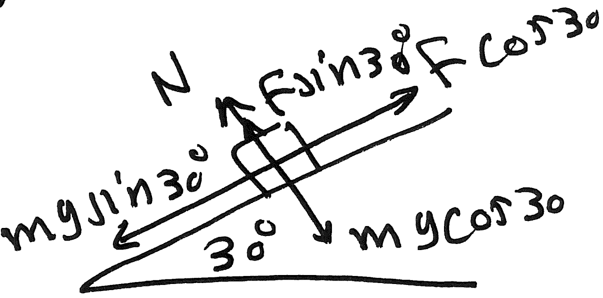
solution:

$m = 0.5$ kg مسألة مهمة

(13)

القوة F تمنع الصندوق من الانزلاق

الجسم ساكن ⇐



$\Sigma F_x = 0$

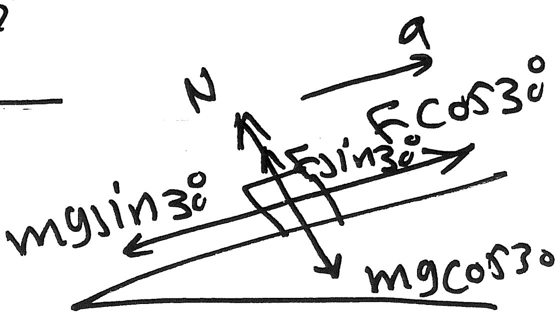
$F \cos 30 = mg \sin 30°$

$F \cos 30 = 0.5 \times 9.8 \sin 30$

$F = 2.83$ N (a)

(14) $F = 4$ N

بفرض a لإيجاد التسارع



$\Sigma F_x = ma \Rightarrow F \cos 30 - mg \sin 30 = ma$

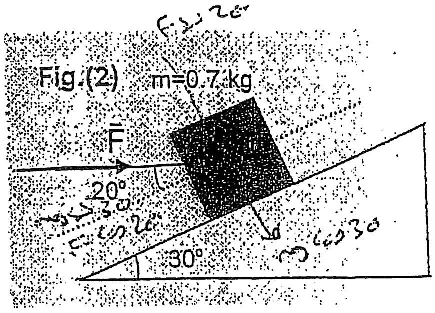
$4 \cos 30 - 0.5 \times 9.8 \sin 30 = 0.5\, a \Rightarrow a = 2.03$ m/s^2 (E)

(15) $\Sigma F_y = 0$ $N + F \sin 30 = mg \cos 30$

$N + 4 \sin 30° = 0.5 \times 9.8 \cos 30° \Rightarrow N = 2.24$ N (B)

Ch 5 (39)

Q.25 As shown in the figure (2), a box on frictionless inclined plane. The horizontal force, which prevents the box from slipping down the plane, then the magnitude of $\bar{F}$ is:
(A) 2.45 N (B) 9.8 N (C) 3.65 N (D) 2.83 N (E) Zero



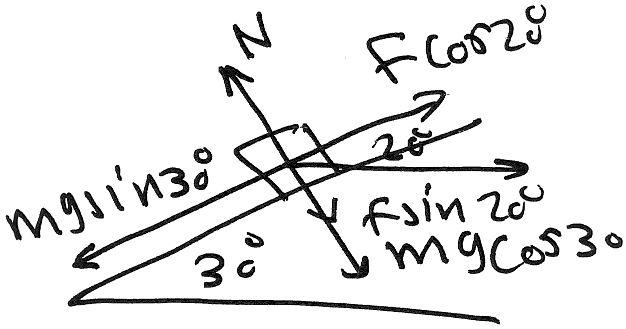
Q.26 In the figure (2), if F=4 N then the value of box acceleration is:
(A) 1 m/s^2 (B) 6 m/s^2 (C) 9.8 m/s^2 (D) 0.50 m/s^2 (E) 2.03 m/s^2

Q.27 In the figure (2), if F=4 N then the normal force on the box is:
(A) 7.31 N (B) 3.1 N (C) 2 N (D) 5.94 N (E) Zero

Solution:

$m = 0.7\,kg$

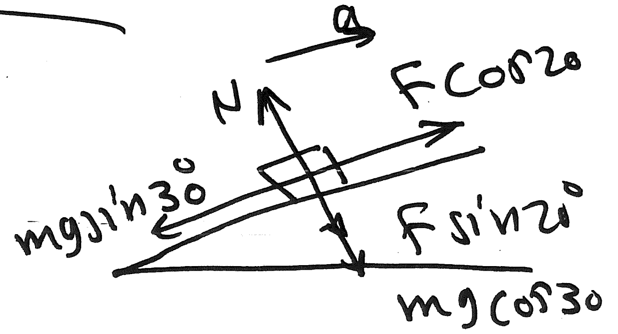
(25) $\Sigma F_x = 0$ الجسم ساكن



$F\cos 20° = mg\sin 30°$

$F\cos 20 = 0.7 \times 9.8 \sin 30 \Rightarrow F = 3.65\,N$ (C)

(26) بفرض الجسم يتحرك لأعلى بتسارع a



$\Sigma F_x = ma$

$F\cos 20 - mg\sin 30 = ma$

$4\cos 20 - 0.7 \times 9.8\sin 30 = 0.7a \Rightarrow a = 0.47\ m/s^2$ (D)

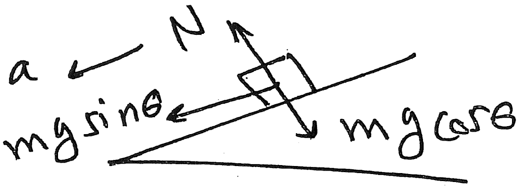
$\Sigma F_y = 0$

$N = F\sin 20° + mg\cos 30° = 4\sin 20° + 0.7 \times 9.8\cos 30°$

$N = 7.31\,N$ (A)

ملاحظة هامة جداً في الاختبار

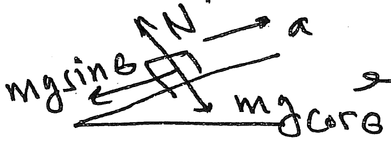
① إذا وضع جسم على مستوى مائل أملس لا تؤثر عليه قوة خارجية F ولا T (تحت تأثير وزنه فقط) فإنه يتحرك لأسفل بتسارع a



$$a = g \sin\theta$$

$$\text{net force (القوة المحصلة)} = \Sigma F = mg \sin\theta$$

② وإذا قذف هذا الجسم لأعلى المستوى المائل الأملس ولا تؤثر عليه قوة خارجية F ولا T (تحت تأثير وزنه فقط) فإن تسارعه هو



$$a = -g \sin\theta$$

$$\text{net force (القوة المحصلة)} = \Sigma F = -mg \sin\theta$$

Ex: A block (جسم) slides (ينزلق) down (لأسفل) on a frictionless inclined plane (مستوى مائل أملس) at an angle of 30°. What is its acceleration?

---

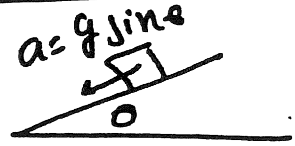
solution: $a = g\sin\theta = 9.8 \sin 30^\circ = 4.9 \ m/s^2$

أملس

Ex A block slides (ينزلق) down a frictionless (أملس) inclined plane (مستوى مائل) with acceleration of magnitude $3.6\ m/s^2$. The angle (الزاوية) between the plane (المستوى) and the horizontal (الأفقي) is:

ⓐ 30° ⓑ 26° ⓒ 21.55° ⓓ 14.32° ⓔ 60.15°

solution



$$a = g\sin\theta$$

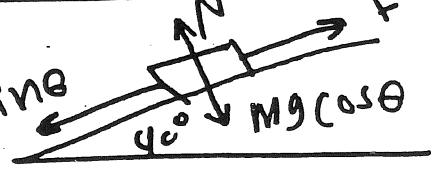
$$\sin\theta = \frac{a}{g} = \frac{3.6}{9.8} = 0.367$$

$$\theta = \sin^{-1}(0.367) = 21.55^\circ \quad \text{ⓒ}$$

Ex A 25-N crate (صندوق، الوزن $mg =$) is held (يبقى) at rest (ساكناً) on a frictionless incline (مستوى مائل أملس) by a force parallel (موازية) to the incline. If the incline is 40° above the horizontal, what is the magnitude (مقدار) of the applied force (القوة المؤثرة)?

solution $mg = 25\ N$

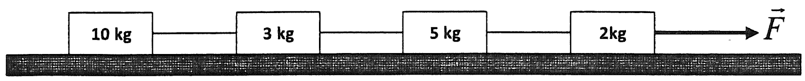
الجسم ساكن



$$F = mg\sin\theta = 25\sin 40^\circ = 16.07\ N$$

Ch 5 (42)

24. The figure shows a train of four blocks being pulled across a frictionless floor by force $\vec{F}$, what total mass is accelerated to the right by force $\vec{F}$?



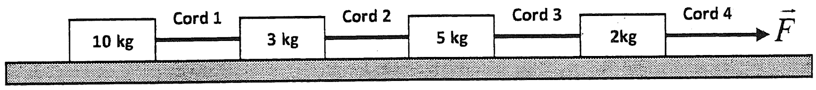
(a) 20 kg (b) 18 kg (c) 13 kg (d) 245 m/s

Solution:

the total mass accelerated to the right by force $\vec{F}$ = 10+3+5+2

= 20 kg (a)

21. The figure shows a train of four blocks being pulled across a frictionless floor by force $\vec{F}$, what **total mass is accelerated to the right byCord 2**?

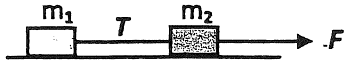


Solution

total mass is accelerated to the right by Cord 2 = 10+3

= 13 kg

14. Two masses m_1=2 kg, m_2= 4 kg situated on a frictionless horizontal surface are connected by a string. A force F = 12 N is exerted on m_2 as shown in fig. The acceleration of the system is



a) 2 m/s^2 b) 1 m/s^2

c) 4m/s^2 d) 3 m/s^2

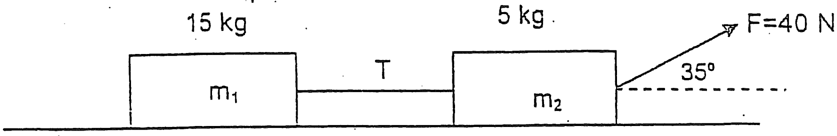
Solution: $m_1 = 2\,kg$ $m_2 = 4\,kg$

$F = 12\,N$

$\Sigma F = ma \Rightarrow 12 = (2+4)a \Rightarrow a = 2\,m/s^2$ (a)

$T = m_1 a = 2(2) = 4N$ يعني

Q.18 As shown in the figure, if the two blocks are moving on frictionless surface and connected with a rope of negligible mass. The tension T in that rope is:



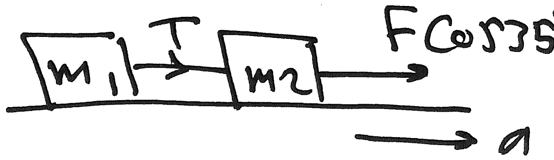
(A) 2.5 N (B) 9.98 N (C) 23 N (D) Zero (E) 24.57 N

Q.19 Referring to question 18, the normal force on the block m_1 is:

(A) 147 N (B) 5 N (C) Zero (D) 15 N (E) 49 N

Solution: $m_1 = 15\,kg$ $m_2 = 5\,kg$ $F = 40\,N$

$\Sigma F = ma$

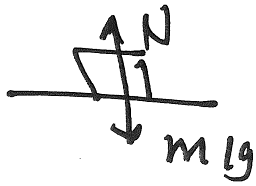


$F\cos 35 = (m_1 + m_2)a$

$40\cos 35° = (15+5)a \Rightarrow a = 1.64\,m/s^2$

$T = m_1 a = 15(1.64) = 24.57\,N$ (E)

$N = m_1 g = 15 \times 9.8 = 147\,N$ (A)

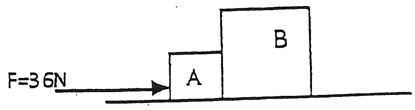


Ch 5

(44)

Two blocks (A and B) are in contact on a horizontal frictionless surface. A 36 N constant force is applied to A as shown.

m_A=4 kg
m_B=20 kg



32. From the diagram above the force on B from A (F_{BA}) is equal to

(a) $m_B a$ b) $m_A a$ c) $a/(m_B+m_A)$ d) $a(m_B+m_A)$

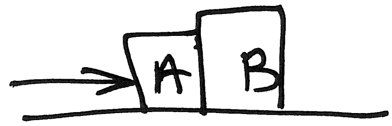
33. The acceleration of the system of the two blocks is

(a) 1.5 m/s² b) 9 m/s² c) 5 m/s² d) 8 m/s²

Solution $m_A = 4$ kg $m_B = 20$ kg $F = 36N$

(33)

$\Sigma F = ma$



$F = (m_A + m_B)\, a \Rightarrow 36 = (4+20)\, a$

$a = 1.5\ m/s^2$ (a)

(32) $F_{BA} = m_B\, a = 20(1.5)$

$= 30N$

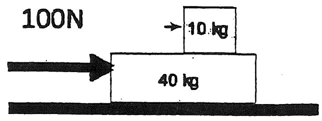
$F_{BA} = m_B\, a$ (a)

Ch 5 (45)

12. From the diagram; the acceleration of the two blocks is;

a) $30\ m/s^2$ c) $50\ m/s^2$

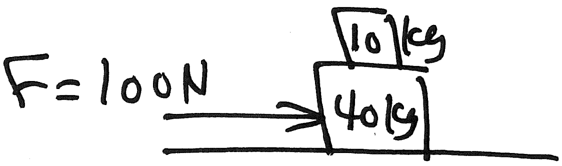
b) $1 m/s^2$ d) $2\ m/s^2$



Solution:

$m1 = 10\ kg$

$m2 = 40\ kg$



$\Sigma F = ma$

$F = (m1 + m2)\, a$

$100 = (10 + 40)\, a \Rightarrow a = 2\ m/s^2$

(d)

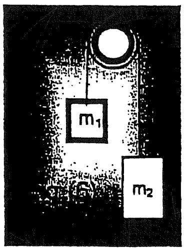
لاحظ

The horizontal force exerted by the bottom box on the upper box is

$F' = m1 a = 10(2) = 20\ N$

Q.28 In the figure (6) if m_1=5 kg and m_2=10 kg. Are connected by a string through the pulley. The acceleration is:

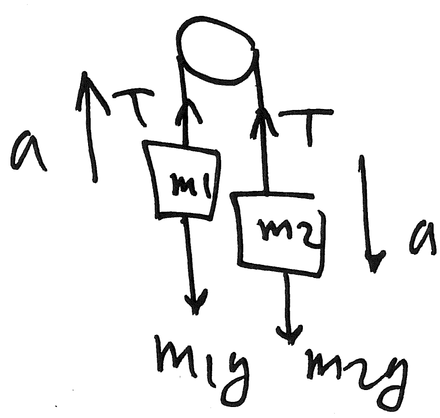
(A) 14 m/s² (B) 12 m/s² (C) 9.17 m/s² (D) 3.33 m/s² (E) Zero



Solution

دائماً T تتجه نحو البكرة

الكتلة الأكبر تتحرك لأسفل



$m_1 = 5\,kg < m_2 = 10\,kg$

for m_2 $\quad m_2 g - T = m_2 a$ ①

for m_1 $\quad T - m_1 g = m_1 a$ ②

بالجمع

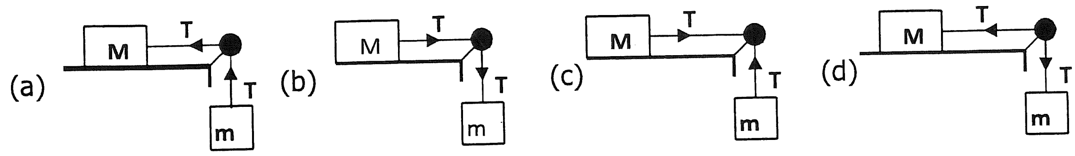
$m_2 g - m_1 g = m_2 a + m_1 a$

$10 \times 9.8 - 5 \times 9.8 = 10a + 5a$

$a = 3.3\ m/s^2$ (D)

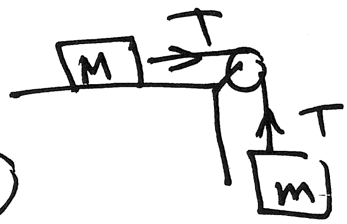
$T - 5 \times 9.8 = 5(3.3) \Rightarrow \boxed{T = 65.5\,N}$ إذا طلب

14. Which figure of the following shows **the right direction of the tension T**? (the two masses are stationary).



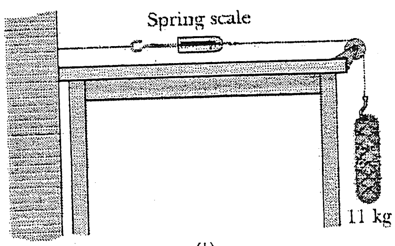
Solution

دائماً في البكرات الشد T يتجه نحو البكرة



(c)

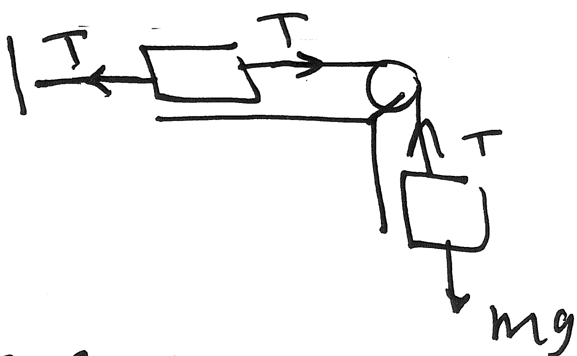
26. An **11 kg** object is supported by a cord that Runs around a pulley and to a scale. The opposite end of the scale is attached by a cord to a wall.
What is the reading on the scale?



(b)

(a) 11 N (b) 9.8 N (c) 107.8 N (d) 215.6 N

Solution



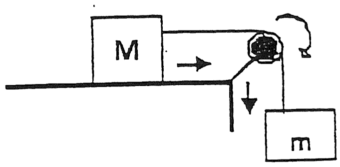
$m = 11\ kg$

$T = mg = 11 \times 9.8 = 107.8\ N$

(c)

Ch 5 (48)

A block of mass M is connected to a block of mass m as shown.



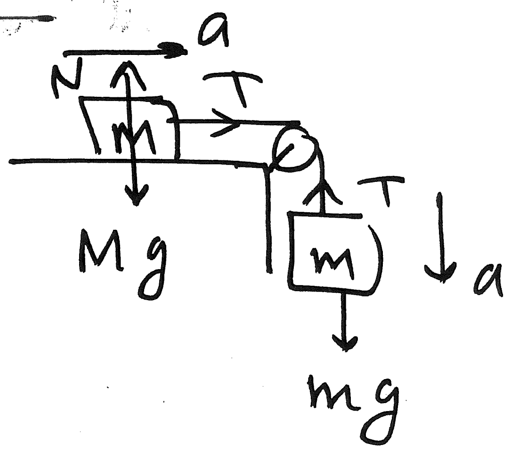
27. The normal force on block M is

a) $F_N = mg$ b) $F_N = Mg - T$ c) $F_N = mg - T$ (d) $F_N = Mg$

28. block m is moving downward, the net force acting on it is

a) $ma - T = mg$ b) $T = ma$ c) $T = mg$ (d) $T - mg = -ma$

Solution:



(27) $N = Mg$ (d)

---

(28) $\Sigma F = ma$

لأن الجسم يتسارع لأسفل

$T - mg = -ma$ (d)

If we cut the string, the acceleration of the block m is $a = -g = -9.8\ m/s^2$

سقوط حر

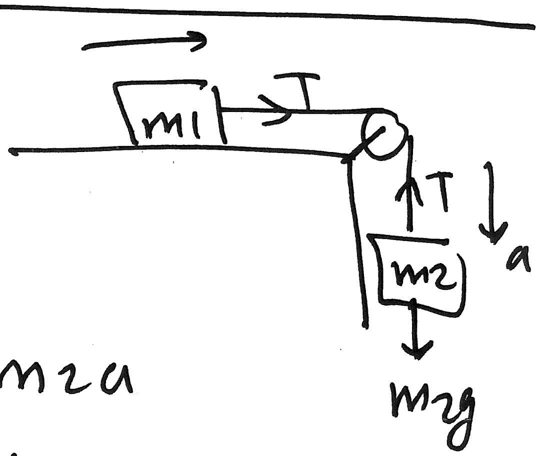
Ex If $m_1 = 5\,kg$, $m_2 = 10\,kg$

① Find the acceleration of the system

ⓐ $2\,m/s^2$ ⓑ $3.4\,m/s^2$ ⓒ $6.53\,m/s^2$ ⓓ $1\,m/s^2$

② The tension in the string is:

ⓐ $32.7\,N$ ⓑ $22.5\,N$ ⓒ $33.45\,N$ ⓓ $15.6\,N$



Solution:

$m_1 = 5\,kg$

$m_2 = 10\,kg$

For m_2:

$m_2 g - T = m_2 a$

$T = m_1 a$

طرح

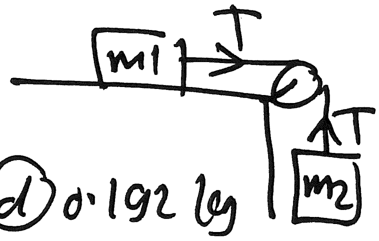
$m_2 g = m_2 a + m_1 a$

$10 \times 9.8 = 10a + 5a$

$a = 6.53\,m/s^2$ ⓒ

$T = m_1 a = 5(6.53) = 32.7\,N$ ⓐ

Ex. If $m_1 = 7.5\,kg$ and the system move with acceleration of $2\,m/s^2$ and the tension in the rope was 15 N. The value of m_2 is.

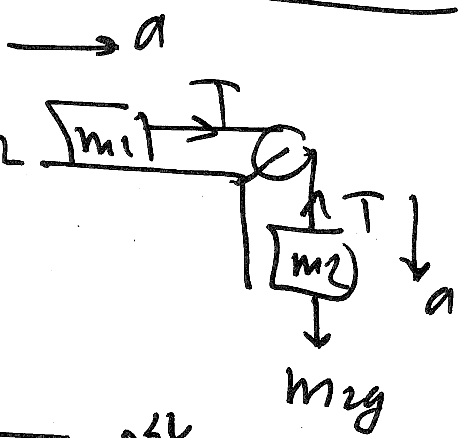


ⓐ 1.92 kg ⓑ 19.2 kg ⓒ 192 kg ⓓ 0.192 kg

---

solution: $m_1 = 7.5\,kg$

$m_2 = ??$ $a = 2\,m/s^2$



for m_2: $m_2 g - T = m_2 a$

for m_1: $T = m_1 a$

$$m_2 g = m_2 a + m_1 a$$

$$9.8 m_2 = 2 m_2 + 7.5(2)$$

$$m_2 = 1.923\,kg \quad ⓐ$$

---

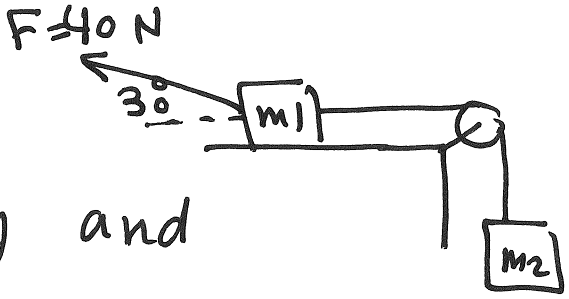
or for m_2: $m_2 g - T = m_2 a$

$$9.8 m_2 - 15 = 2 m_2$$

$$m_2 = 1.923\,kg$$

Ch 5 (51)

Ex 9 In the shown figure, if $m_1 = 5\,kg$ and $m_2 = 2\,kg$, then the acceleration of the system and the tension in the string are :

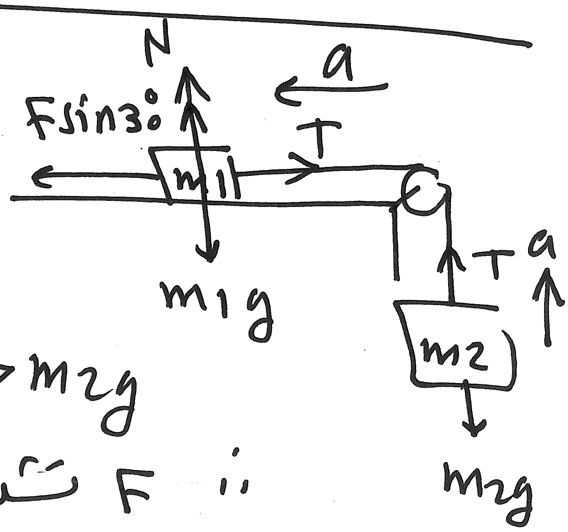


ⓐ $1\,m/s^2$, 20 N ⓑ $3\,m/s^2$, 45 N

ⓒ $2.15\,m/s^2$, 23.9 N ⓓ $1.25\,m/s^2$, 17 N

---

solution:



$m_2 g = 2 \times 9.8 = 19.6\,N$, $F\cos 30°$

$F\cos 30° = 40\cos 30°$

$= 34.64\,N > m_2 g$

∴ F تشد m1 لليسار

$\underline{m_1}$ $F\cos 30 - T = m_1 a$

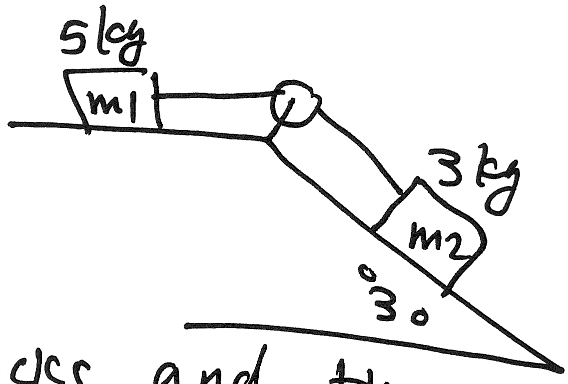
m_2 $T - m_2 g = m_2 a$

$F\cos 30 - m_2 g = m_1 a + m_2 a$

$34.64 - 19.6 = 5a + 2a \Rightarrow a = 2.15\,m/s^2$

$T - 19.6 = 2(2.15) \Rightarrow T = 23.9\,N$ ⓒ

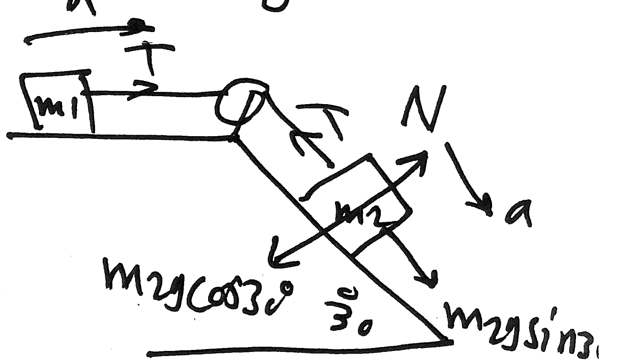
Ex: If the surface is frictionless, find the acceleration of the blocks and the tension in the string.



---

solution

$m_1 = 5\,kg$ $m_2 = 3\,kg$



for m_2

$m_2 g \sin 30 - T = m_2 a$

for m_1

$T = m_1 a$

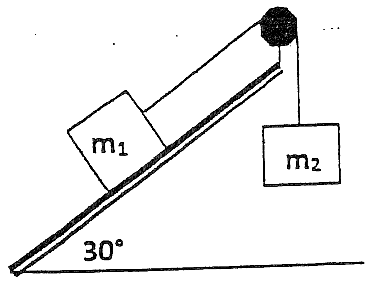
$m_2 g \sin 30 = m_2 a + m_1 a$

$3 \times 9.8 \sin 30 = 3a + 5a$

$a = 1.84\ m/s^2$

$T = m_1 a = 5(1.84) = 9.19\ N$

31. From the figure, if m_1 and m_2 are stationary and the surface and pulley are frictionless. If m_1=4 kg, the mass m_2 equals :



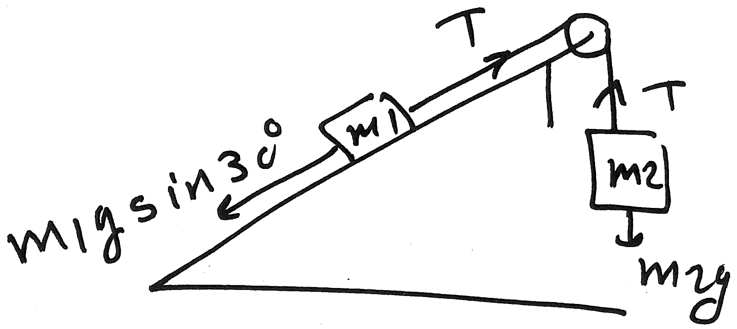
a) 3.5 kg b) 8 kg c) 2 kg d) 0.5 kg

Solution

$m_1 = 4$ kg $m_2 = ??$

الكتل ساكنة

$\Sigma F = 0$



For m1

$T = m_1 g \sin 30 = 4 \times 9.8 \sin 30$

$= 19.6\ N$

$T = m_2 g \Rightarrow 19.6 = m_2 (9.8)$

$m_2 = 2$ kg (c)

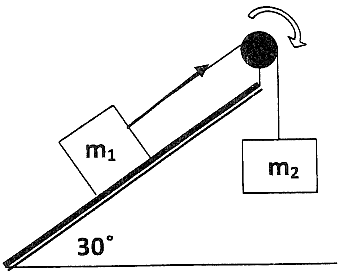
The normal force acting on m1 is

$N = m_1 g \cos 30 = 4 \times 9.8 \cos 30 = 33.95\ N$

Ch 5 (54)

27. A block of mass $\mathbf{m_1=3.7\ kg}$ on frictionless inclined plane of angle **30°** is connected by a cord over a massless frictionless pulley to a second block of mass $\mathbf{m_2=2.3\ kg}$ hanging vertically **as shown.**

If the magnitude of the **acceleration** of each block is $\mathbf{0.735\ m/s^2}$, what is the **tension in the cord** ?



(a) 36.3 N (b) 22.5 N (c) 20.8 N (d) 18.1 N

---

28. In question 27, what is the **normal force** acting on the block $\mathbf{m_1}$?

(a) $N=F_g \cos\theta - m_1 g$ (b) $N=F_g\cos\theta$ (c) $N=F_g \cos\theta + m_1 g$ (d) $N=F_g$

---

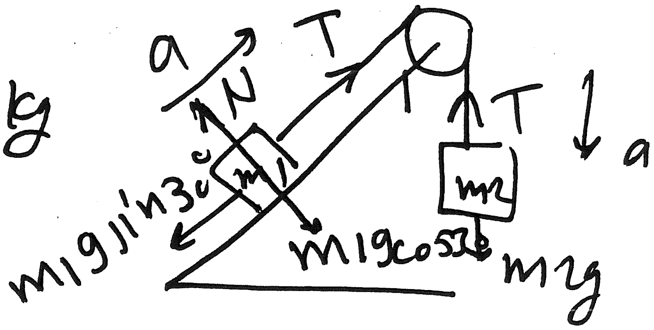
29. In question 27, if the cord is cut what is the **acceleration** of mass $\mathbf{m_2}$?

(a) $a = -4.9\ m/s^2$ (b) $a = -9.8\ m/s^2$ (c) $a = -0.735\ m/s^2$ (d) $a =$ zero

solution

$m_1 = 3.7\ kg$ $m_2 = 2.3\ kg$

$a = 0.735\ m/s^2$



for m2

$m_2 g - T = m_2 a$

$2.3 \times 9.8 - T = 2.3(0.735) \Rightarrow T = 20.8\ N$ (c)

for m1

$N = m_1 g \cos 30 = 3.7 \times 9.8 \cos 30$

$= 31.4\ N$

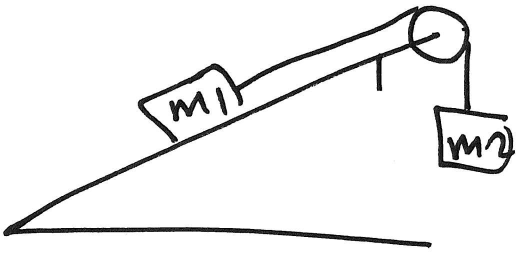
$N = F_g \cos\theta$ (b)

for m2 اذا قطع الحبل

$a = -g = -9.8\ m/s^2$ (b)

Ex If the inclined plane is frictionless and

$m_1 = 10\,kg$, $m_2 = 6\,kg$



the acceleration of the system and the tension in the string are

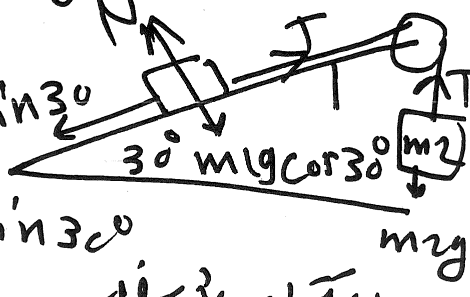
ⓐ $0.61\,m/s^2$, $100\,N$ ⓑ $0.45\,m/s^2$, $55\,N$

ⓒ $0.61\,m/s^2$, $55\,N$ ⓓ $0.45\,m/s^2$, $100\,N$

Solution $m_1 = 10\,kg$ $m_2 = 6\,kg$

$m_1 g \sin 30 = 10 \times 9.8 \sin 30 = 49\,N$

$m_2 g = 6 \times 9.8 = 58.8\,N > m_1 g \sin 30°$



m2 يتحرك لأسفل

$\underline{m_2}$ $m_2 g - T = m_2 a$

$T - m_1 g \sin 30 = m_1 a$

بالجمع

$m_2 g - m_1 g \sin 30 = m_2 a + m_1 a$

$58.8 - 49 = 6a + 10a \Rightarrow a = 0.61\,m/s^2$

$T - 49 = 10(0.61) \Rightarrow T = 55.1\,N$ ⓒ

Ch 6 (1)

Friction الاحتكاك

عندما يتحرك جسم على مستوى خشن فإن قوة الاحتكاك دائماً اتجاهها عكس اتجاه الحركة

قوة الاحتكاك عكس اتجاه الحركة

The direction of friction is always opposite to the direction in which the object is moving.

يوجد نوعان من قوة الاحتكاك

(1) Static frictional force قوة الاحتكاك الساكنة

عندما يكون الجسم على وشك الحركة

will start to move - Just before starting to move -

Ch 6 ②

$$F_{s,max} = \mu_s N$$

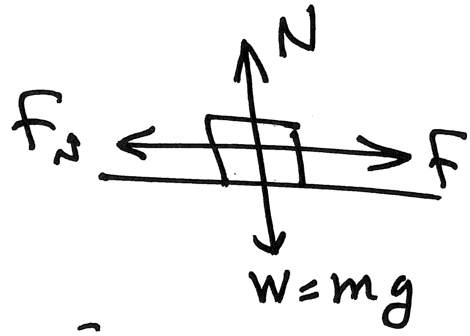
$$\mu_s = \frac{f_{s,max}}{N}$$

μ_s = coefficient of static friction
معامل الاحتكاك الساكن

N = Normal force قوة رد الفعل العمودي

الجسم ساكن ⇐ من قانون نيوتن الأول

$$F_s = F$$



متى تصل قوة الاحتكاك الساكن إلى أكبر قيمة لها

$$f_{s,max} = \mu_s N$$

② Kinetic frictional force قوة الاحتكاك الحركي
(or Dynamic frictional force)

عندما يكون الجسم متحرك (متحرك بسرعة ثابتة أو متحرك بتسارع)

$$F_k = \mu_k N$$

$$\mu_k = \frac{F_k}{N}$$

μ_k = coefficient of kinetic friction معامل الاحتكاك الحركي

Ch 6 (3)

Ex The direction (اتجاه) of friction (الاحتكاك) is always ----- to the direction in which the object is moving

ⓐ Perpendicular (عمودي) ⓑ opposite (معاكس) ⓒ normal (عمودي) ⓓ similar (مماثل)

Solution:

دائماً قوة الاحتكاك تكون عكس اتجاه حركة الجسم

opposite ⓑ

Ex The formula (قانون) of the friction force is:

ⓐ $f = \mu N$ ⓑ $F = ma$ ⓒ $W = mg$ ⓓ $F = N$

Solution: $f = \mu N$ ⓐ

Ex The frictional force on a moving body is proportional (تتناسب مع) to the:

ⓐ force causing the motion ⓑ weight of the body
ⓒ normal force on the body ⓓ acceleration of the body

Solution: $f = \mu N \rightarrow f \propto N$ normal force ⓒ

Ch 6 (4)

10. The **coefficient of static friction** (μ_s):

A) has a magnitude of exactly 1
B) is dimensionless
C) is in the direction of the normal force
D) is in the direction of motion

Solution:

$$F_s = \mu_s N$$

$$\mu_s = \frac{F_s}{N}$$

ليس له وحدة

(B) dimensionless

---

30. The **force that always perpendicular to the surface** is called

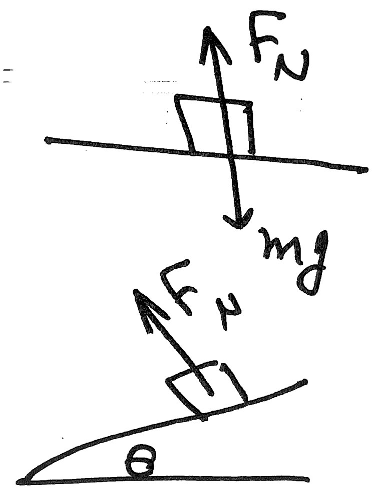
A) Gravitational force B) Tension C) Friction D) Normal force

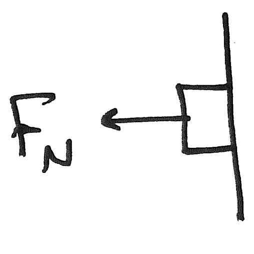
Solution

القوة التي دائماً عمودية على السطح

هي قوة رد الفعل العمودي Normal force

(D)





Ch 6 (5)

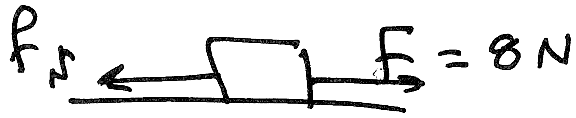
6. A block lies on a floor. If the maximum value $f_{x,max}$ of the static frictional force on the block is **10 N**, what is the magnitude of the **frictional force** if the magnitude of the horizontally applied force is **8 N**?

(a) 10 N (b) 8 N (c) 2 N (d) 18 N

Solution

$f_{x,max} = 10\ N$

أقل من



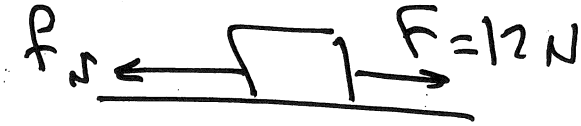
$\Sigma F_x = 0$

$f_s = F = 8N$ (b)

8. A block lies on a floor. If the maximum value $f_{x,max}$ of the static frictional force on the block is **10 N**, what is the magnitude of the frictional force if the magnitude of the horizontally applied force is **12 N**?

(a) 10 N (b) 12 N (c) 2 N (d) 22 N

Solution



$f_{x,max} = 10\ N > F = 12\ N$

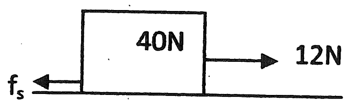
$\therefore f_s = f_{x,max} = 10\ N$

(a)

Ch 6 (6)

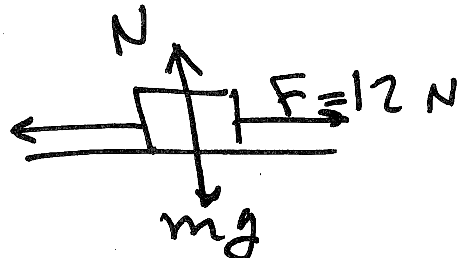
A 40-N box rests on a rough horizontal floor. A 12 N horizontal force is then applied to it but the box does not move. What is the magnitude of the frictional force on the box?

a) 3.3 N
b) 28 N
c) 12 N
d) 52 N



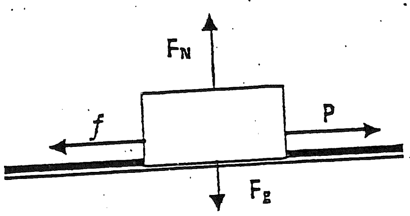
Solution:

الجسم ساكن



$\Sigma F_x = 0 \Rightarrow F_r = F = 12\ N$ (c)

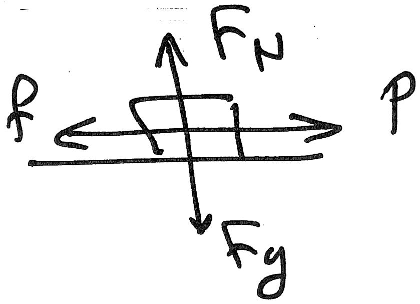
30. A boy pulls a wooden box along a rough horizontal floor at **constant speed** by means of a force $\bar{P}$ as shown. Which of the following must be **true**



(a) $P = f$ and $F_N = F_g$ b) $P = f$ and $F_N > F_g$ c) $P > f$ and $F_N < F_g$ d) $P < f$ and $F_N > F_g$

Solution:

الجسم يتحرك بسرعة ثابتة



$\Sigma F_x = 0$

$P = f$

$\Sigma F_y = 0$

$F_N = F_g$ (a)

Ch 6 (7)

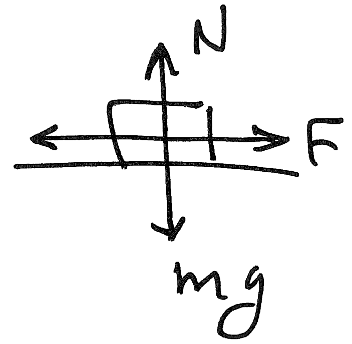
The coefficient of static friction μ_s = 0.4 between a 5 kg block and horizontal surface. The maximum horizontal force that can be applied to the block before it slips is:

a) 8.7 N b) 10 N c) 19.6 N d) 5.5 N

---

solution

$m = 5\ kg$ $\mu_s = 0.4$



$N = mg = 5 \times 9.8 = 49\ N$

$f_s = \mu_s N = 0.4\,(49) = 19.6\ N$

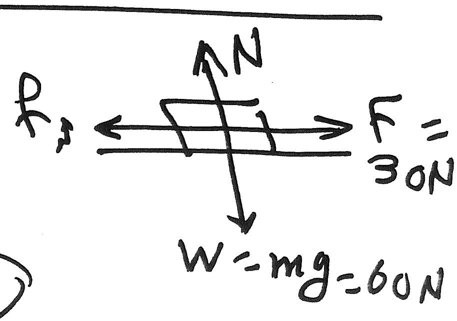
$\therefore F = f_s = 19.6\ N$ ⓒ اكيم ماتس

Ex A block slides on a rough surface.

The block will start to slide when parallel force of 30 N is applied. The coefficient of static friction μ_s is:

ⓐ 0.5 ⓑ 0.4 ⓒ 0.33 ⓓ 0.67

Solution: اكم ماتس



$N = mg = 60\ N$ $f_s = F = 30\ N$

$\mu_s = \frac{f_s}{N} = \frac{30}{60} = 0.5$ ⓐ

Ch 6 (8)

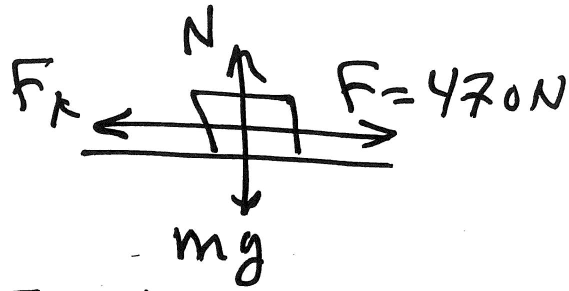
7. A **470 N** horizontal force pushes a block of **mass 79 kg** to make it move with **constant speed**, what is the value of the **coefficient of friction** μ_k ?

(a) 0.61 (b) 6 (c) 1.6 (d) 0.06

Solution:

$m = 79\ kg$

$F = 470\ N$



الجسم يتحرك بسرعة ثابتة

$N = mg = 79 \times 9.8 = 774.2\ N$

$F_k = F = 470\ N$

$\mu_k = \frac{F_k}{N} = \frac{470}{774.2} = 0.61$ (a)

3. A **12 N** horizontal force pushes a block of **weight 5 N** to make it move with **constant speed,** the value of the **coefficient of friction** μ_k is:

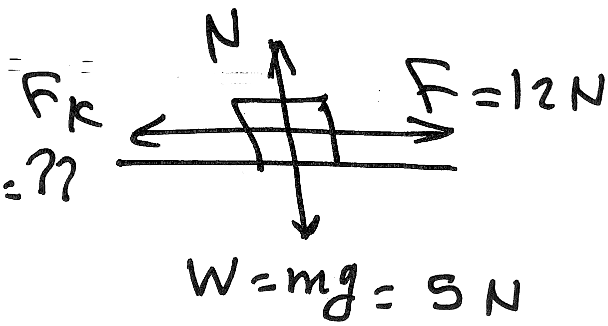
(a) 2.4 (b) 0.24 (c) 4.1 (d) 0.41

Solution:

$F = 12\ N$

$W = mg = 5\ N$

$\mu_k = ??$



الجسم يتحرك بسرعة ثابتة

$N = W = mg = 5\ N$

$F_k = F = 12\ N$

$\mu_k = \frac{F_k}{N} = \frac{12}{5} = 2.4$ (a)

Ch 6 (9)

Q.17 A block of mass m is pulled at constant velocity along a rough horizontal floor by an applied force F as shown. The magnitude of the frictional force is:
(A) mg cosθ (B) T sinθ (C) Ttanθ (D) T cosθ (E) zero

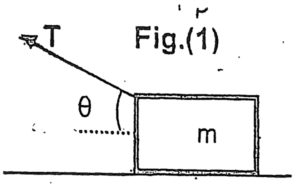
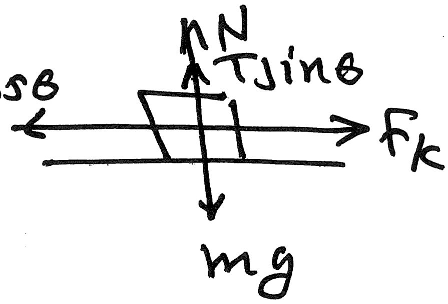


Fig.(1)

solution

السرعة ثابتة

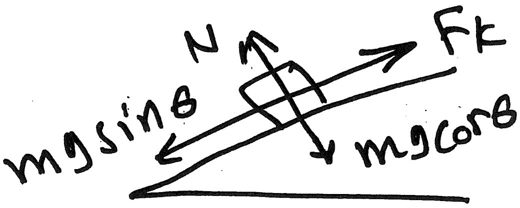


$\Sigma F_x = 0 \Rightarrow F_k = T\cos\theta$ (D)

Q.28 A box stands on a rough incline plane. The plane is inclined at an angle of θ. If the box moves with constant speed, the friction force is:
(A) mg cosθ (B) mg sinθ (C) mg tanθ (D) mg

solution:

الجسم يتحرك بسرعة ثابتة $\Sigma F_x = 0$



$F_k = mg\sin\theta$ (B)

$a = 0$

12. A 1100 Kg airplane moves in a straight line at constant speed, the force of air friction is 2000N, the net force on the plane is

(a) 0 b) 2780 N c) 10000 N d) 12780 N

solution

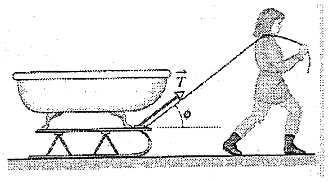
الطائرة تتحرك بسرعة ثابتة ⇐

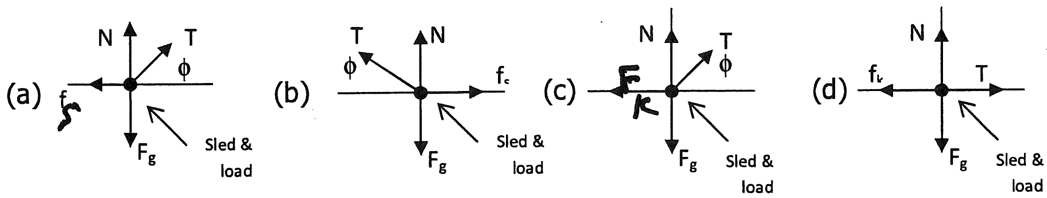
net force on the plane = 0

(a)

Ch 6 (10)

1. In the figure a woman **pulls** a loaded sled of mass **m** along a horizontal surface at **constant velocity**. The coefficient of kinetic friction between the runners and the snow is μ_k .
Which figure shows the correct **free body diagram** for the sled and load?





2. In question 2, The **equation of the forces acting on the load and sled** (from Newton's second law) is:

(a) $\vec{T}+\vec{N}+\vec{F}_g+\vec{f}_k=0$

(b) $\vec{T}+\vec{N}+\vec{F}_g+\vec{f}_s=0$

(c) $\vec{T}+\vec{N}+\vec{F}_g+\vec{f}_k=m\vec{a}$

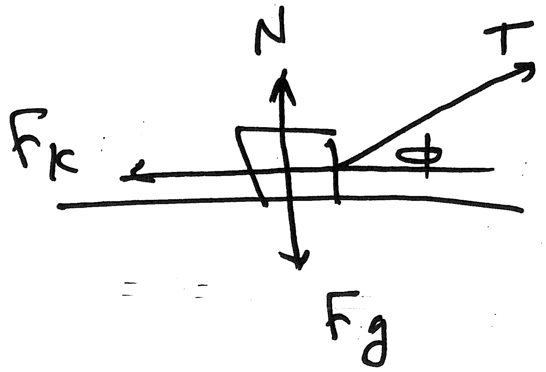
(d) $\vec{T}+\vec{N}+\vec{F}_g+\vec{f}_s=m\vec{a}$

Solution:

الجسم يتحرك بسرعة ثابتة

قوة الاحتكاك F_k

(c)

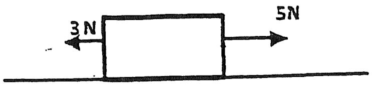


الجسم يتحرك بتسارع ثابت $\Leftarrow$ $\Sigma\vec{F}=0$

$\vec{T}+\vec{N}+\vec{F}_g+\vec{F}_k=0$ (a)

Ch 6 (11)

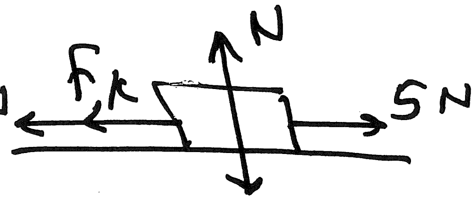
18. The block shown moves with constant velocity on a horizontal surface. Two of the forces on it are shown. A frictional force exerted by the surface is the only other horizontal force on the block. The frictional force is



a) 0 (b) 2N, leftward c) 2N, rightward d) slightly more than 2N, leftward

Solution

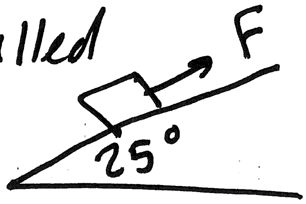
الجسم يتحرك بسرعة ثابتة



$\Sigma F_x = 0 \Rightarrow 3 + f_k = 5$

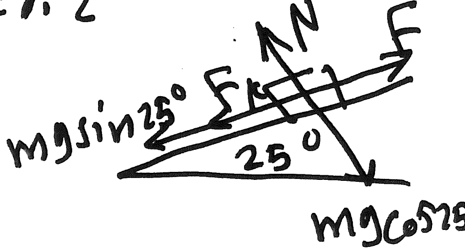
$f_k = 5 - 3 = 2N \leftarrow$ leftward (b)

Ex A body of mass 4 kg pulled by a force F parallel to the inclined surface at constant speed. If $\mu_k = 0.2$, then the force F is



(a) 2.75 N (b) 281.7 N (c) 9.437N (d) 23.64N

Solution: $m = 4$ kg $\mu_k = 0.2$



$N = mg\cos 25° = 4 \times 9.8 \cos 25°$
$= 35.53$ N

لا يوجد تسارع لأن الجسم يتحرك بسرعة ثابتة

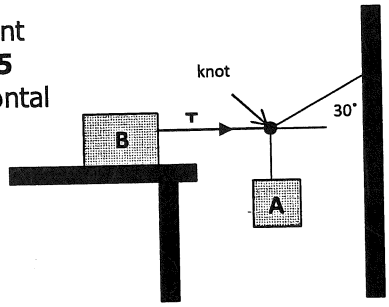
$f_k = \mu_k N = (0.2)(35.53) = 7.106N$

$F = f_k + mg\sin 25 = 7.106 + 4 \times 9.8 \sin 25$
$= 23.67$ N (d)

Ch 6 (12)

9. In the figure, **block B weighs 711 N**. The coefficient of static friction between the block and the table is **0.25** assume that the cord between **B** and the **knot** is horizontal

What is the magnitude of the tension T?

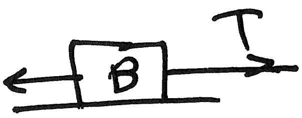


(a) 205.2 N (b) 355.5 N (c) 820.1 N (d) 1422 N

10. **In question 9**, the weight of block **A** is :

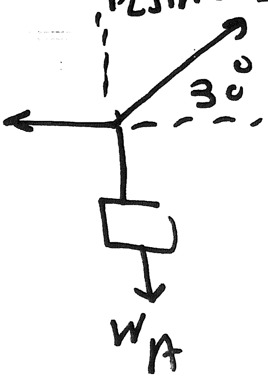
(a) T cos 30 (b) T sin 30 (c) $F_g - T\cos 30$ (d) $F_g - T\sin 30$

Solution :



$W_B = 711\ N$ $\mu_s = 0.25$

$T = F_s = \mu_s m_B g = \mu_s W_B = (0.25)(711)$
$= 177.75\ N$



$\Sigma F_y = 0$

$W_A = T_2 \sin 30°$

$T_2 \cos 30 = T \Rightarrow T_2 = \dfrac{177.75}{\cos 30°} = 205.25\ N$

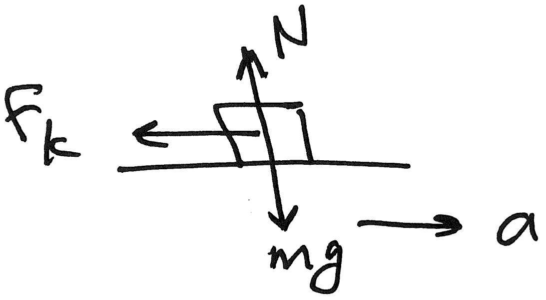
$W_A = T_2 \sin 30 = 205.25 \sin 30° = 102.62\ N$

Ch 6 (13)

4. A car has a **weight of 1.1 N** slides on the road with acceleration **a=1.24 m/s²**, what **is the force of friction** between the car and the road?

(a) - 1.13 N (b) - 11 N (c) - 1.4 N (d) - 0.14 N

Solution:



$$W = mg = 1.1 \text{ N}$$

$$m = \frac{W}{g} = \frac{1.1}{9.8} = 0.1122 \text{ kg}$$

$$\Sigma F = ma \Rightarrow 0 - F_k = ma$$

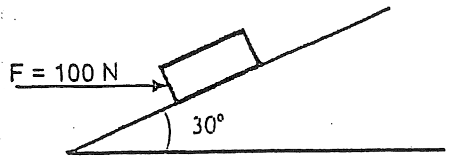
$$-F_k = 0.1122\,(1.24) \Rightarrow F_k = -0.14 \text{ N}$$

(d)

لاحظ أن قوة الاحتكاك دائماً عكس اتجاه الحركة
فرضنا a إلى اليمين وبالتالي نعوض F_k إلى اليسار

ch 8 (14)

Q.1
A 5 kg box is pushed up a rough surface μ_k=0.5 inclined at 30° to the horizontal by a horizontal force of magnitude of 100 N.



a) The Normal force is:
(a) 42.4 N (b) 92.4 N (c) 86.6 N (d) Zero (e) 100 N

b) The frictional force is:
(a) 50 N (b) 100 N (c) Zero (d) 109.87 N (e) 46.2 N

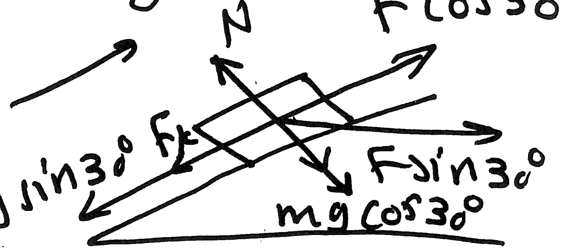
c) The acceleration of the box is:
(a) 3.18 m/s^2 (b) 9.8 m/s^2 (c) 1.58 m/s^2 (d) Zero (e) 8 m/s^2

d) If the acceleration is equal to zero, the pushing force is:
(a) 100 N (b) 81.6 N (c) Zero (d) 50 N (e) 86.6 N

---

solution: $\mu_k = 0.5$ $m = 5\,kg$

الجسم يتحرك لأعلى ⇐ F_k لأسفل



$N = F\sin 30 + mg\cos 30°$

$= 100\sin 30 + 5\times 9.8\cos 30 = 92.44N$ (b)

$F_k = \mu_k N = (0.5)(92.44) = 46.22\,N$ (e)

$\Sigma F_x = ma \Rightarrow F\cos 30° - (F_k + mg\sin 30°) = ma$

$100\cos 30° - (46.22 + 5\times 9.8\sin 30) = 5a$

$a = 3.18\,m/s^2$ (a)

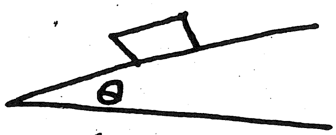
$a -= 0 \Rightarrow \Sigma F_x = 0 \Rightarrow F\cos 30 = F_k + mg\sin 30°$

$F\cos 30° = 46.22 + 5\times 9.8\sin 30° \Rightarrow F = 81.66N$ (b)

Ch 6 (15)

ملاحظة هامة جداً

① إذا كان الجسم على وشك الحركة لأسفل المستوى المائل الخشن تحت تأثير وزنه فقط (لا توجد قوة F ولا قوة T تؤثر على الجسم)

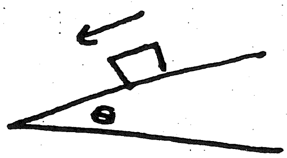


$$\mu_s = \tan\theta$$ مهم جداً جداً

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

لاحظ معامل الاحتكاك μ_s يعتمد على الزاوية (θ)

② إذا كان الجسم يتحرك لأسفل المستوى المائل الخشن بسرعة ثابتة تحت تأثير وزنه فقط (لا توجد قوة F ولا قوة T تؤثر على الجسم)



$$\mu_k = \tan\theta$$

لاحظ μ_k يعتمد على الزاوية θ

Ex: A coin (قطعة عملة معدنية) is placed (وضعت) on a flat (مستوي) surface (سطح), when the surface is tilted (أميل) 10° to the horizontal (الأفقي) the coin will start to move (سوف تبدأ في الحركة). The Coefficient (معامل) of static friction (الاحتكاك السكوني) between the coin and the surface is:

ⓐ 0.286 ⓑ 0.325 ⓒ 0.176 ⓓ 0.212 ⓔ 0.422

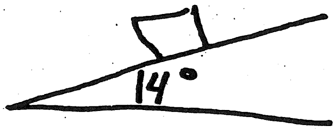
Solution: $\mu_s = \tan\theta = \tan 10 = 0.176$ ⓒ $\theta = 10°$

Ex A block is sliding (يتزلق) down at constant speed on a rough (خشن) inclined (مستوى مائل) angled (على) at 14° to the horizontal. The coefficient (معامل) of kinetic (الحركة) friction (الاحتكاك) of the block with the plane is:

ⓐ 0.4 ⓑ 0.53 ⓒ 0.13 ⓓ 0.25 ⓔ 0.35

Solution: الجسم يتحرك بسرعة ثابتة أسفل المستوى

$$\mu_k = \tan\theta = \tan 14^\circ$$
$$= 0.249$$



ⓓ

Ex A block is placed (وضع) on an inclined (مائل) rough (خشن) plane (سطح). If $\mu_s = 0.4$, $\mu_k = 0.3$. What is the angle (الزاوية) between the inclined plane and the horizonal if the block will start to slide (على وشك الانزلاق) down the inclined plane (المستوى المائل).

ⓐ 33.4° ⓑ 26.2° ⓒ 44.3° ⓓ 55.4° ⓔ 21.8°

Solution: الجسم على وشك الحركة لأسفل المستوى المائل

$$\theta = \tan^{-1}(\mu_s) = \tan^{-1}(0.4) = 21.8^\circ$$

ⓔ

ch ٦ (١٧)

ملاحظات هامة

١) إذا تحرك جسم على سطح أفقي خشن ولا تؤثر على الجسم قوى خارجية غير الاحتكاك (قوة الاحتكاك هي التي توقف حركته)

فإنه

$$a = -\mu_k g$$

---

٢) إذا تحرك جسم على سطح مائل خشن لأسفل ولا تؤثر عليه قوى خارجية غير قوة الاحتكاك

فإنه

$$a = g\sin\theta - \mu_k g\cos\theta$$

---

٣) إذا تحرك جسم على مائل خشن لأعلى ولا تؤثر عليه قوى خارجية غير قوة الاحتكاك

فإنه

$$a = -g\sin\theta - \mu_k g\cos\theta$$

---

٤) لاحظ إذا كانت μ_k غير معلومة وطلب قوة الاحتكاك الحركي F_k لا نستخدم القانون

$$F_k = \mu_k N$$

ولكن نوجد F_k من معادلة الحركة

$$\Sigma F = ma$$

Ex 5 kg block moves on a horizontal rough plane ($\mu_k = 0.2$). What is the acceleration of the block and what is the net force on the block?

(مستوى — أفقي — خشن — التسارع — الجسم — القوة المحصلة)

Solution:

$m = 5\,kg \qquad \mu_k = 0.2$

الجسم يتحرك على سطح أفقي خشن ولا تؤثر عليه قوة خارجية غير الاحتكاك

$a = -\mu_k g = -0.2 \times 9.8 = -1.96\ m/s^2$

net force $= \sum F = ma = 5 \times -1.96 = -9.8\,N$

Ex A block is given an initial speed of 10 m/s on a horizontal surface. If $\mu_k = 0.15$ between the block and the surface, how far will the block slide before coming to rest?

(سرعة ابتدائية — أفقي — سطح — السطح — كم المسافة — ينزلق — يسكن)

solution:

الجسم يتحرك على سطح أفقي خشن ولا تؤثر عليه قوة خارجية
غير الاحتكاك (أي لا تؤثر عليه قوة خارجية F ولا قوة T)

$a = -\mu_k g = -0.15 \times 9.8 = -1.47\ m/s^2$

$V_0 = 10\,m/s \qquad a = -1.47\,m/s^2 \qquad V = 0 \qquad X = ?$

$V^2 = V_0^2 + 2aX \Rightarrow 0 = (10)^2 + 2(-1.47)X$

$2.94X = 100 \Rightarrow X = \frac{100}{2.94} = 34\,m$

Ch 6 (19)

بداية

Ex: A box is initially at a speed of 9.8 m/s on a rough horizontal surface. If it come to rest in a distance of 49 m, the coefficient of friction between the box and the surface is:

سطح أفقي خشن — تسكن — $\mu_k = ?$

ⓐ 1 ⓑ 0.5 ⓒ 2.3 ⓓ 0.3 ⓔ 0.1

Solution:

$v_0 = 9.8\ m/s$ $v = 0$

$x = 49\ m$ $a = ?$

$v^2 = v_0^2 + 2ax \Rightarrow (0)^2 = (9.8)^2 + 2a(49)$

$0 = (9.8)^2 + 98a \Rightarrow -98a = (9.8)^2$

$a = \frac{(9.8)^2}{-98} = -0.98\ m/s^2$

الجسم يتحرك على مستوى أفقي خشن ولا تؤثر عليه قوة F ولا T

$\therefore a = -\mu_k g \Rightarrow \mu_k = \frac{a}{-g} = \frac{-0.98}{-9.8} = 0.1$ ⓔ

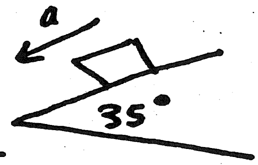
Ex A crate is sliding **down** on an inclined plane that is 35° above the horizontal. If the coefficient of kinetic friction is 0.4, the acceleration of the crate is:

(صندوق — ينزلق — مستوى مائل — معامل — الاحتكاك الحركي — تسارع)

(a) zero (b) $2.4\ m/s^2$ (c) $5.8\ m/s^2$ (d) $10.3\ m/s^2$ (e) $8.8\ m/s^2$

solution

الجسم يتحرك أسفل المستوى المائل ولا تؤثر على الجسم قوى خارجية غير قوة الاحتكاك (لا تؤثر عليه قوة F ولا قوة T) ⇐



$\theta = 35°$

$\mu_k = 0.4$

$a = g\sin\theta - \mu_k g\cos\theta$ ← لأسفل

$a = 9.8\sin 35 - 0.4 \times 9.8\cos 35 = 2.41\ m/s^2$ (b)

Ex In the previous question, if the crate moves **up** on the inclined plane, the acceleration of the crate is:

(في السؤال السابق — المستوى المائل)

(a) $1.4\ m/s^2$ (b) $2.4\ m/s^2$ (c) $8.8\ m/s^2$ (d) zero (e) $4.8\ m/s^2$

solution:

الجسم يتحرك أعلى المستوى المائل ولا يؤثر على الجسم قوى خارجية غير قوة الاحتكاك

$a = -g\sin\theta - \mu_k g\cos\theta$

$= -9.8\sin 35° - 0.4 \times 9.8\cos 35° = -8.83\ m/s^2$ (c)

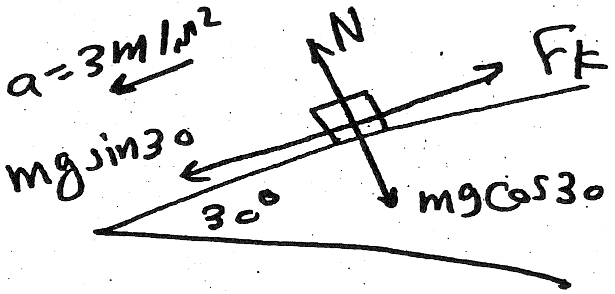
ch 6

(21)

Ex: A 1.8 kg block is released from rest at the top of a rough 30° inclined plane. As the block slides down the incline, its acceleration is 3 m/s² down the incline. Determine the magnitude of the force of friction acting on the block.

(a) 3.8 N (b) 2.3 N (c) 4.2 N (d) 3.4 N (e) 3 N

Solution: $m = 1.8 kg$



لاحظ μ_k غير معلوم

ولذلك لا نوجد $F_k = \mu_k N$

ولكن نوجد F_k من معادلة الحركة

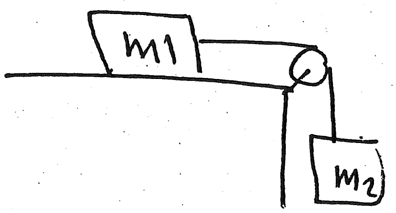
$$mg\sin 30 - F_k = ma$$

$$1.8 \times 9.8 \sin 30 - F_k = 1.8(3)$$

$$8.82 - F_k = 5.4$$

$$F_k = 8.82 - 5.4 = 3.42 \text{ N} \quad (d)$$

Ex In the shown figure, (في الشكل الموضح)

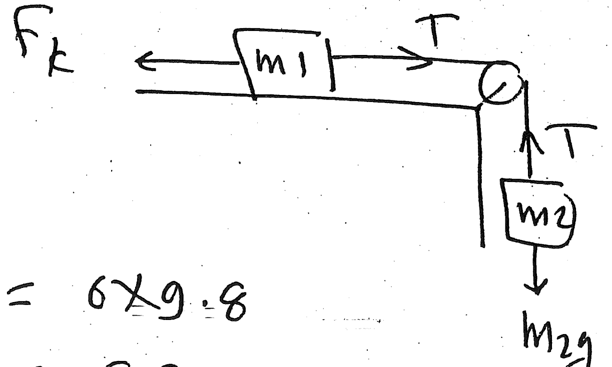


$m_1 = 12\,kg$ and $m_2 = 6\,kg$. The hang crate (الجسم المعلق) descends (يهبط) with constant velocity (سرعة ثابتة). The magnitude of the frictional force between the surface and m_1 is:

ⓐ 1.5 N ⓑ 58.8 N ⓒ 29.7 N ⓓ 3.0 N

Solution: $m_1 = 12\,kg$
$m_2 = 6\,kg$

المجموعة تتحرك بسرعة ثابتة



for m_2

$T = m_2 g = 6 \times 9.8$
$= 58.8\,N$

for m_1

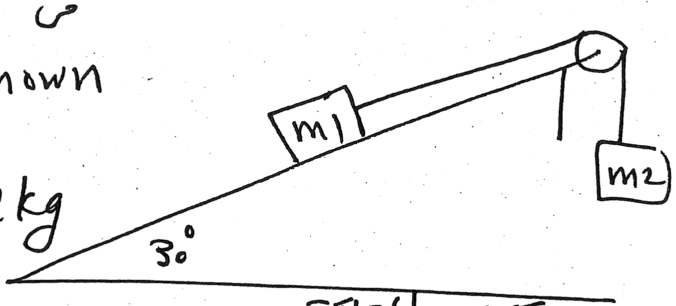
$T = F_k \Rightarrow \boxed{F_k = 58.8\,N}$

ⓑ

Ch 6 (23)

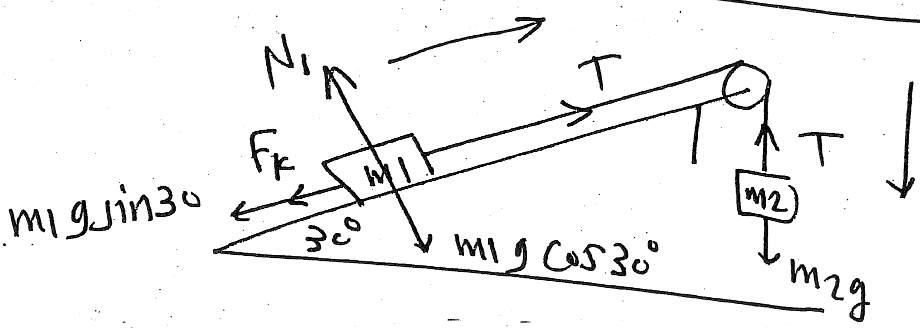
من الشكل الموضح

Ex In the shown figure, if $m_1 = 12kg$ and $m_2 = 12kg$. If the hang crate (الكتلة المعلقة) descends (يهبط) with constant velocity. The magnitude of the frictional force exerted (المبذولة) on m_1 by the plane (من المستوى) is:



ⓐ 58.8N ⓑ 12 N ⓒ 29.7 N ⓓ 117.0N

solution:



$m_1 = 12kg$ $M_2 = 12kg$

الكتلة المعلقة تتحرك لأسفل ⇐ قوة الاحتكاك بين m_1 والمستوى لأسفل

المجموعة تتحرك بسرعة ثابتة

For m_2

$$T = m_2 g = 12 \times 9.8 = 117.6\ N$$

For m_1

$$T = m_1 g \sin 30 + F_k$$

$$F_k = T - m_1 g \sin 30$$

$$= 117.6 - 12 \times 9.8 \times 0.5 = 58.8\ N \quad (a)$$

في السؤال السابق

Ex In the previous question, the coefficient of kinetic friction μ_k is:

(a) 0.3 (b) 0.12 (c) 0.58 (d) 1.7

Solution: $N_1 = m_1 g \cos 30 = 12 \times 9.8 \cos 30 = 101.84\ N$

$$\mu_k = \frac{F_k}{N_1} = \frac{58.8}{101.84} = 0.577 \quad (c)$$

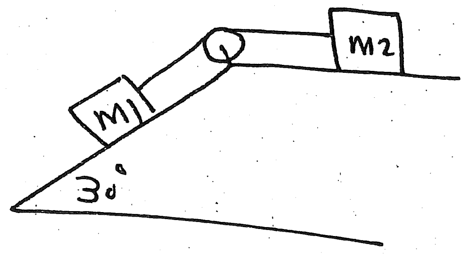
Ch 6

(25)

في الشكل الموضح

Ex In the shown figure $m_1 = 3$ kg and $m_2 = 2$ kg the coefficient of kinetic friction (μ_k) between m_2 and the horizontal plane is 0.4. The inclined plane is frictionless. (أملس) (المستوى المائل)

① The frictional force exerted on m_2 by the plane is



(a) 0 (b) 9.8 N (c) 2 N (d) 7.84 N (e) 6 N

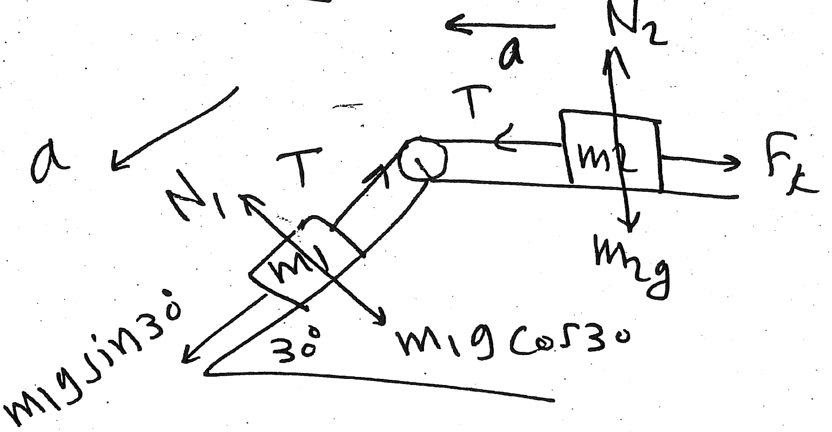
② The normal force (N) between m1 and the inclined plane (المستوى المائل) is:

(a) 0 (b) 25.46 N (c) 9.8 N (d) 33.9 N

③ If the acceleration of the blocks is $1.37\ m/s^2$ down the inclined plane, then the tension on (على) the cord (في الحبل) is:

(a) 32 N (b) 13.2 N (c) 4 N (d) 10.59 N

Ch 6 (26)



solution:

$m_1 = 3\,kg$

$m_2 = 2\,kg$

$\mu_k = 0.4$

(1) $N_2 = m_2 g = 2 \times 9.8 = 19.6\,N$

$f_{k_2} = \mu_k N_2 = 0.4 \times 19.6 = 7.84\,N$ (d)

---

(2) $N_1 = m_1 g \cos 30$

$= 3 \times 9.8 \cos 30 = 25.46\,N$ (b)

---

(3) $\Sigma F = ma$ $\qquad a = 1.37\,m/s^2$

$m_1 g \sin 30 - T = m_1 a$

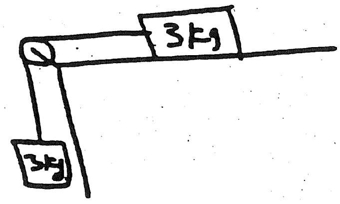
$3 \times 9.8 \sin 30 - T = 3\,(1.37)$

$14.7 - T = 4.11 \Rightarrow T = 14.7 - 4.11$

$= 10.59\,N$ (d)

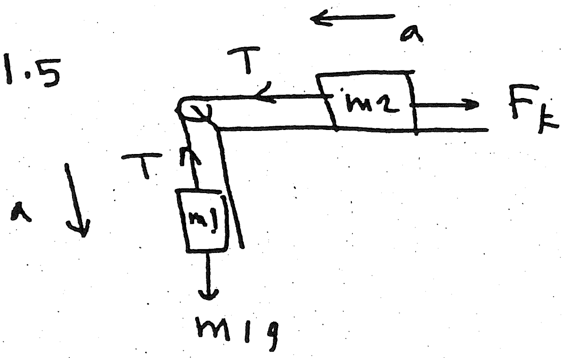
ch 6 (27)

Ex 5: The two blocks are released (تحرك) from rest (من السكون) and observed (لوحظ) to move with acceleration $a = 1.5\ m/s^2$. What is the magnitude of the frictional force (قوة الاحتكاك) on the block that slides (ينزلق) horizontally (أفقيا)?



(a) 20.4 N (b) 30.6 N (c) 24 N (d) 35 N (e) 18 N

$a = 1.5$



$m_1 = 3\ kg$

$m_2 = 3\ kg$

لاحظ

μ_k غير معلومة ولذلك نوجد F_k من معادلات الحركة

$\underline{m_1}$ $\quad m_1 g - \cancel{T} = m_1 a$

$\underline{m_2}$ $\quad \cancel{T} - F_k = m_2 a$

بالجمع

$m_1 g - F_k = m_1 a + m_2 a$

$3 \times 9.8 - F_k = 3(1.5) + 3(1.5)$

$29.4 - F_k = 9 \Rightarrow F_k = 29.4 - 9$

$= 20.4\ N$

(a)

عندما يتحرك جسم في مسار دائري أفقي مثل بسرعة ثابتة جداً

* التسارع المركزي

the centripetal acceleration

$$a_\perp = \frac{v^2}{R}$$

toward the center نحو المركز

$a \perp v$

R = radius نصف القطر

v = velocity السرعة

* القوة الطاردة المركزية

the centripetal force

$$F_\perp = m a_\perp = m\frac{v^2}{R}$$

في اتجاه التسارع $a_\perp$ نحو المركز

* قوة الاحتكاك = القوة الطاردة المركزية

$F_s = F_\perp$

$F_s = \mu_s N = \mu_s mg$ $\qquad$ $F_\perp = m\frac{v^2}{R}$

$F_s = F_\perp \Longrightarrow$

$$\mu_s \cancel{m} g = \cancel{m}\frac{v^2}{R}$$

مهم جداً

معامل الاحتكاك الساكن

μ_s = the Coefficient of static friction

تخضع

القوة الطاردة المركزية

Ex The formula for the centripetal force is:

(a) $a = \frac{v^2}{R}$ (b) $F = ma$ (c) $F = mg$ (d) $F = m\frac{v^2}{R}$

---

solution:

$$F = m\frac{v^2}{R} \quad (d)$$

Ex A 900 kg car is travelling at constant speed of 18 m/s around circular track of radius R = 200 m. What is the magnitude of the frictional force on the car?

سار دائري حول

قوة الاحتكاك

(a) 1645 N (b) 1539 N (c) 1458 N (d) 1377 N

Solution:

$m = 900\ kg$ — $v = 18\ m/s$

$R = 200 m$

لاحظ طلب F_s و μ_s غير معلومة

$$F_s = F_\perp = m\frac{v^2}{R}$$

$$= 900\frac{(18)^2}{200} = 1458 N \quad (c)$$

Ex: A 1000kg car moves in a curve rounds
منعطف
a 50m radius at 10 m/s. The magnitude
القوة الطاردة المركزية   المؤثرة
of the centriptal force exerted on the car
is :

ⓐ 1kN ⓑ 2.5kN ⓒ 2kN ⓓ 4kN

Solution: $m = 1000\,kg$ $R = 50m$ $v = 10m/s$

$$F_{\perp} = m\frac{v^2}{R} = 1000 \times \frac{(10)^2}{50} = 2000\,N = 2kN \text{ ⓒ}$$

Ex: A truck is moving in a circular path
مسار دائري
on a rough horizontal road with a
أفقي خشن
constant speed of 10m/s. If the coefficient
of static friction is 0.4, what is the
μ_s
radius of the path which prevent the
تمنع
truk from sliding?
من الانزلاق

Solution: $v = 10m/s$ $\mu_s = 0.4$

$$F_s = F_{\perp} \Rightarrow \mu_s m g = \frac{m v^2}{R} \Rightarrow 0.4 \times 9.8 = \frac{(10)^2}{R} \Rightarrow \boxed{R = 25.5m}$$

Ex A truck (شاحنة) is moving in a circular path (مسار دائري) on a rough (أرض خشنة) horizontal road of radius (نصف قطر) 25 m with a <u>constant speed</u> of 10 m/s. The coefficient of static friction (معامل الاحتكاك الساكن) which prevent (منع) the truck from sliding (من الانزلاق) off the road is:

(a) 0.36 (b) 0.15 (c) 0.3 (d) 0.4 (e) 0.5

Solution: $R = 25\,m$ $\quad v = 10\,m/s$ $\quad \mu_s = ?$

$$F_s = F_\perp \Rightarrow \mu_s m g = \frac{m v^2}{R} \Rightarrow \mu_s \times 9.8 = \frac{(10)^2}{25} \Rightarrow \mu_s = 0.4$$

(d)

Ex A truck (شاحنة) is moving in a circular road (مسار دائري) of radius 20 m. The friction coefficient (معامل الاحتكاك) between the road and the tires (الكفرات) is 0.6. What is the maximum speed (أقصى سرعة) for the car without (بدون) sliding (انزلاق) off the road?

(a) 5 m/s (b) 10.8 m/s (c) 5.4 m/s (d) 4.2 m/s

Solution $R = 20\,m$ $\quad \mu_s = 0.6$ $\quad v = ?$

$$F_s = F_\perp \Rightarrow \mu_s m g = \frac{m v^2}{R}$$

$$0.6 \times 9.8 = \frac{v^2}{20} \Rightarrow v = 10.8\,m/s$$

(b)

ملخص قوانين

Ph110 — Ch 4 — (1)

$$\vec{r} = x(t)\,i + y(t)\,j$$

$$\vec{v} = v_x(t)\,i + v_y(t)\,j$$

$$\vec{a} = a_x(t)\,i + a_y(t)\,j$$

$\vec{r}$ —اشتقاق→ $\vec{v}$ —اشتقاق→ $\vec{a}$

$$v = \frac{d\vec{r}}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{d}{dt}\left(\frac{dr}{dt}\right)$$

$\vec{a}$ is constant

$$\vec{v} = \vec{v}_0 + at$$

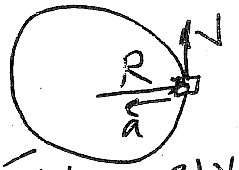
Circular motion الحركة الدائرية

centriptal acceleration

التسارع المركزي اتجاهه دائماً نحو المركز

toward the center

$$a = \frac{v^2}{R}$$



$a \perp V$

$$\text{Period} = T = \frac{\text{المحيط}}{\text{السرعة}} = \frac{2\pi R}{v}$$

$$T = \frac{\text{الزمن الكلي}}{\text{عدد اللفات}}$$

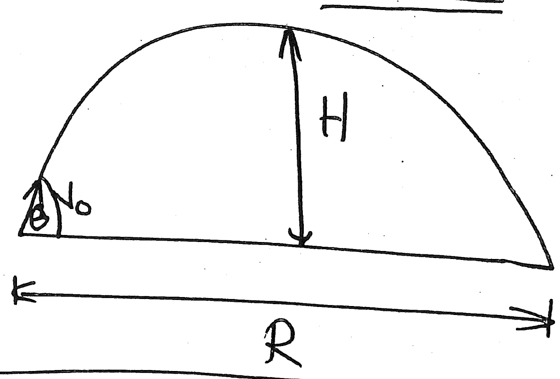
Ch 4 (2)

الحالة الخاصة :

$$R = \frac{v_0^2 \sin 2\theta}{g}$$

$$H = \frac{v_0^2 (\sin\theta)^2}{2g}$$

$$t = \frac{2 v_0 \sin\theta}{g}$$



$$\tan\theta = \frac{4H}{R}$$

for maximum range $\theta = 45°$

$$R_{max} = \frac{v_0^2}{g}$$

$a_y = -g$

$a_x = 0$

لأن V_x ثابتة

If $\vec{V_0} = V_{0x}\,i + V_{0y}\,j$ ⟹

$V_0 = \sqrt{V_{0x}^2 + V_{0y}^2}$ $\theta = \tan^{-1}\left(\frac{V_{0y}}{V_{0x}}\right)$

at the highest Point: عند أعلى نقطة

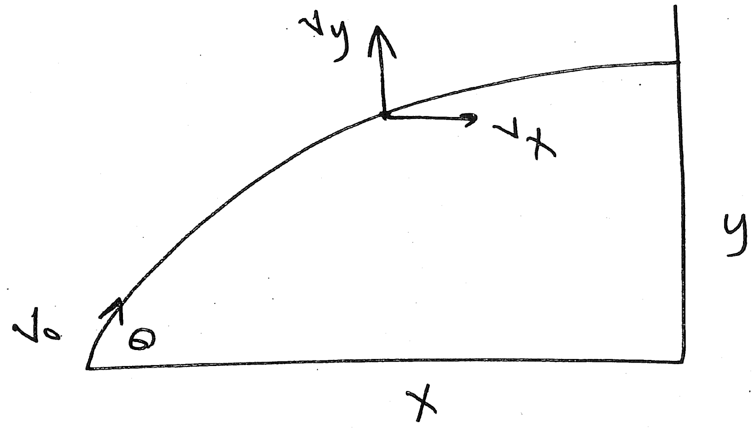
$V_y = 0$ $V_x = V_0 \cos\theta$

$y = H$ $x = \frac{1}{2} R$

$t_{أقصى ارتفاع} = \frac{1}{2} t_{الكلي}$

ch 4 (3)

الحالة العامة



$$v_x = v_0 \cos\theta$$

$$a_x = 0$$

$$x = v_0 \cos\theta \, t$$

$$a_y = -g = -9.8 \ m/s^2$$

$$v_{0y} = \begin{cases} v_0 \sin\theta & \text{above the horizontal} \\ -v_0 \sin\theta & \text{below the horizontal} \end{cases}$$

$$v_y = v_{0y} + at$$ ⟹ v_y = vertical component (y-component of the velocity)

$$y = v_{0y} t + \frac{1}{2} a t^2$$

v = speed = velocity → $v = \sqrt{v_x^2 + v_y^2}$

$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

thrown horizontally ⟹

$\theta = 0$ $v_{0y} = 0$

Ch 5

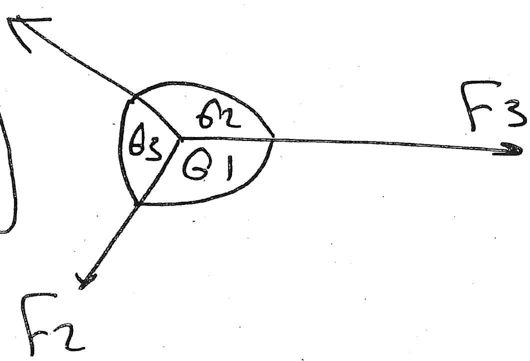
(*) If the block is at rest or moving at constant speed

إذا كان الجسم يتحرك بسرعة ثابتة أو ساكن

$$\sum \vec{F} = \vec{0}$$

في حالة اتزان الجسم تحت تأثير ٣ قوى فقط

$$\frac{F_1}{\sin\theta_1} = \frac{F_2}{\sin\theta_2} = \frac{F_3}{\sin\theta_3}$$



$$\sum \vec{F} = m\vec{a}$$ ⇐ $\vec{a}$ إذا تحرك الجسم بتسارع

النيوتن $N = kg \cdot m/s^2$

وحدة

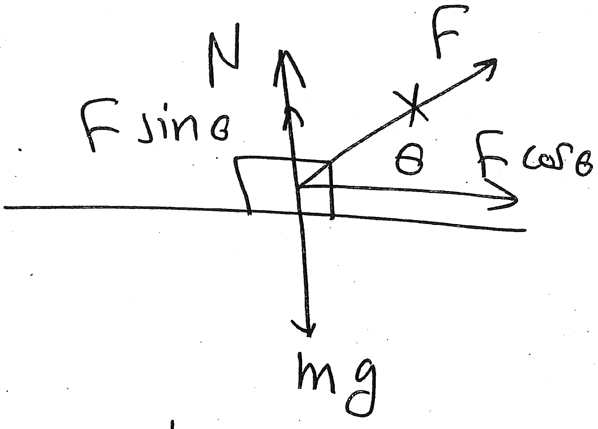
الكتلة m ⟶ kg

الوزن W ⟶ النيوتن N

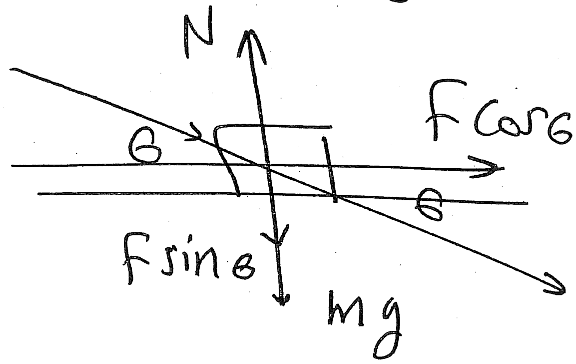
$W = mg$ ⟹ $m = \frac{W}{g} = \frac{W}{9.8}$

$N + F\sin\theta = mg$

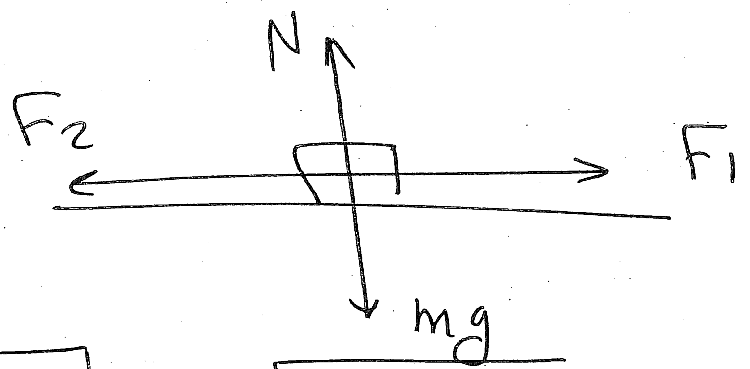
$$N = mg - F\sin\theta$$



$$N = mg + F\sin\theta$$



وإذا تحرك الجسم بسرعة ثابتة

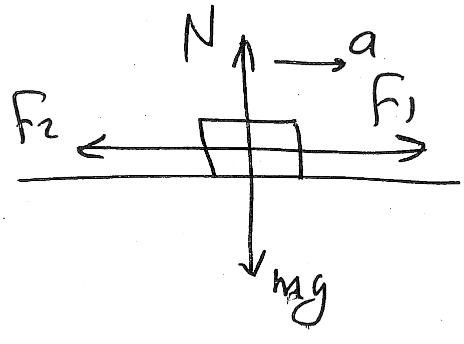


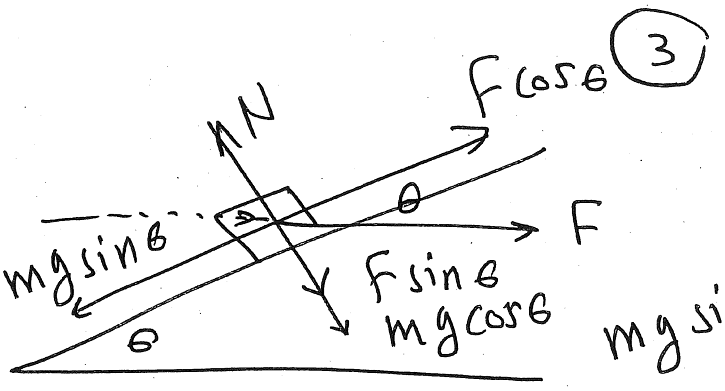
$$N = mg$$ $$F_1 = F_2$$

وإذا تحرك الجسم بتسارع ثابت a

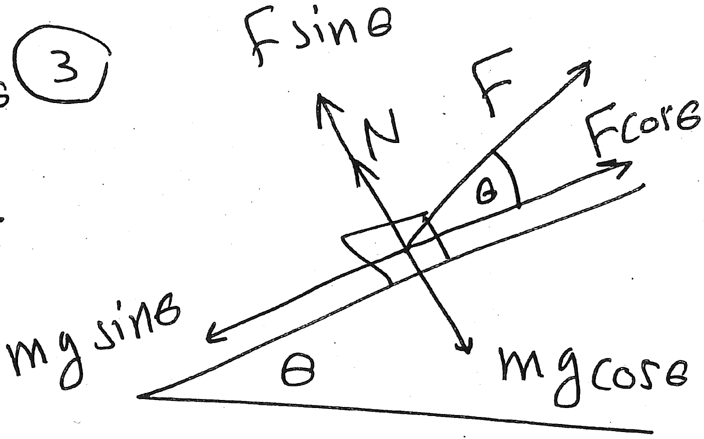
$$F_1 - F_2 = ma$$

$$N = mg$$





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



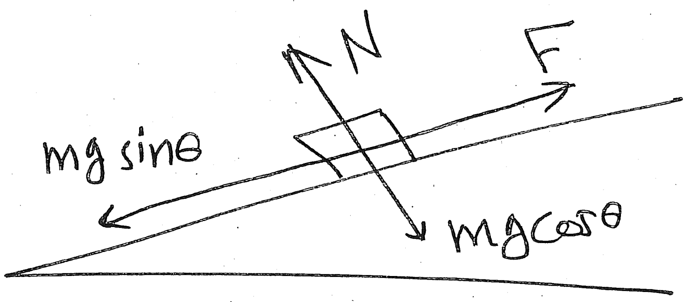
$$F\sin\theta + N = mg\cos\theta$$

$$N = mg\cos\theta - F\sin\theta$$

إذا تحرك الجسم بسرعة ثابتة أو الجسم ساكن (متزن at equilibrium)

$$N = mg\cos\theta$$

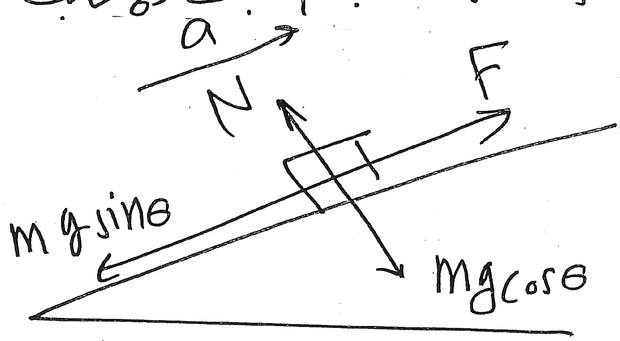
$$F = mg\sin\theta$$



إذا تحرك الجسم بتسارع ثابت a

$$F - mg\sin\theta = ma$$

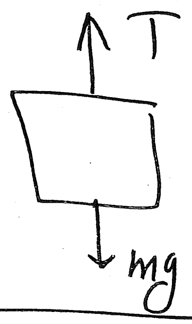
$$N = mg\cos\theta$$



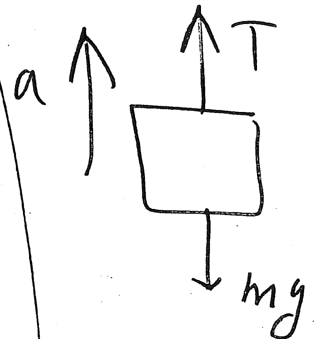
ملاحظات هامة

1. Elevator

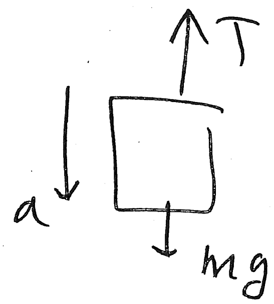
السرعة ثابتة أو ساكنة



$T = mg$



$T - mg = ma$

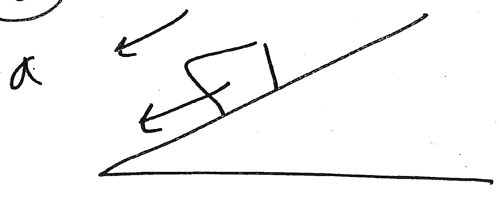


$mg - T = ma$

T = apperent weight الوزن الظاهري (قراءة الميزان)

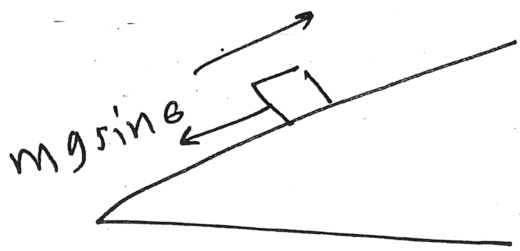
2.

الجسم يتحرك تحت تأثير وزنه فقط ولا تؤثر عليه قوة f و لا T



$a = g\sin\theta$

$\Sigma F = mg\sin\theta$



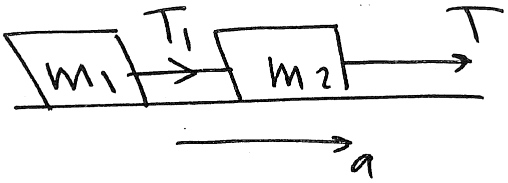
$a = -g\sin\theta$

$\Sigma F = -mg\sin\theta$

5

3

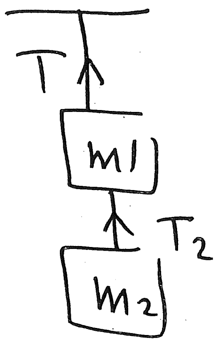
الجسم يتحرك بتسارع a



$$T = (m_1 + m_2)a$$

$$T_1 = m_1 a$$

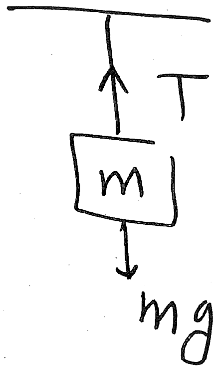
الجسم ساكن



$$T = (m_1 + m_2)g$$

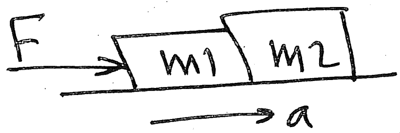
$$T_2 = m_2 g$$

الجسم ساكن



$$T = mg$$

الجسم يتحرك بتسارع a

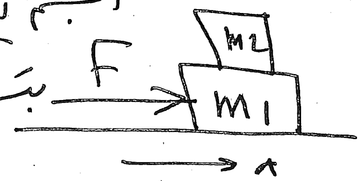


$$F = (m_1 + m_2)a$$

قوة دفع m_1 لـ m_2

$$F' = m_2 a$$

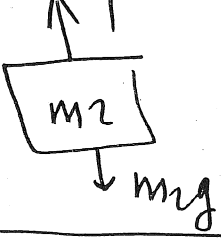
الجسم يتحرك بتسارع a



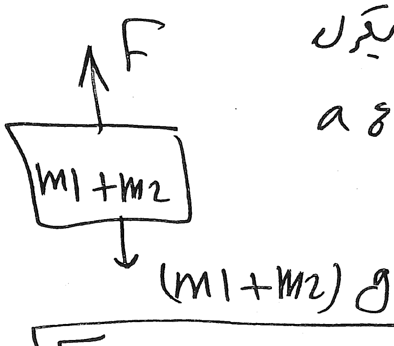
$$F = (m_1 + m_2)a$$

قوة دفع m_1 لـ m_2

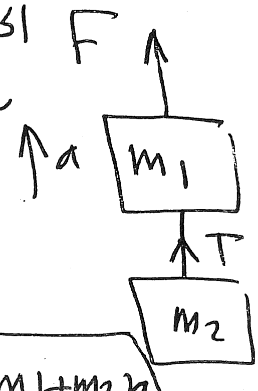
$$F' = m_2 a$$



$$T - m_2 g = m_2 a$$



الجسم يتحرك بتسارع a



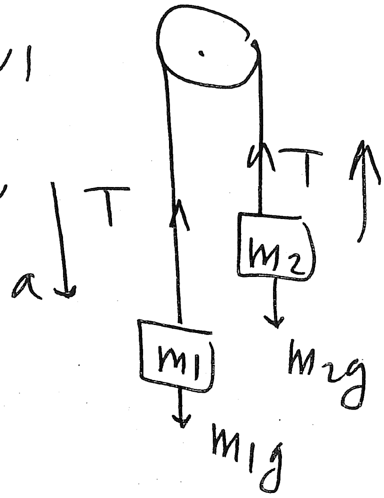
$$F - (m_1 + m_2)g = (m_1 + m_2)a$$

البكرات

الكتلة الأكبر تتحرك لأسفل

الشد T دائماً نحو البكرة

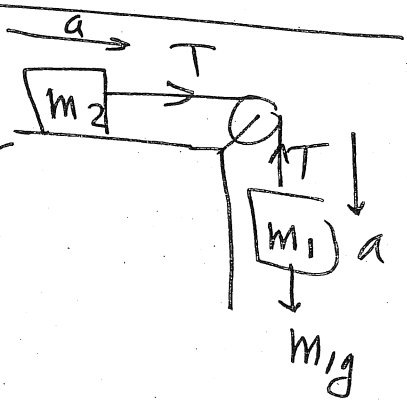
بفرض $m_1 > m_2$



$$m_1 g - T = m_1 a$$

$$T - m_2 g = m_2 a$$

الجسم المعلق يتحرك لأسفل حتى لو كانت كتلته أقل

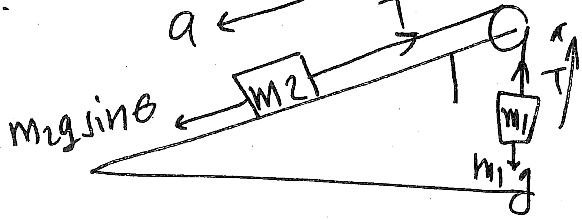


$$m_1 g - T = m_1 a$$

$$T = m_2 a$$

حسب $m_1 g$ ($m_2 g \sin\theta$ الكبير يتحرك لأسفل

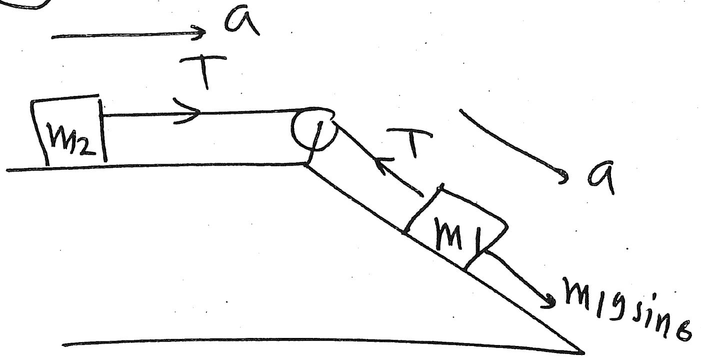
بفرض $m_2 g \sin\theta > m_1 g$



$$m_2 g \sin\theta - T = m_2 a$$

$$T - m_1 g = m_1 a$$

7



الكتلة الموضوعة ع
المستوى المائل تتحرك لأسفل
حتى لو كانت كتلتها أقل لأنه
المستوى أملس

$$m_1 g \sin\theta - T = m_1 a$$

$$T = m_2 a$$

Ch 6 ①

دائماً قوة الاحتكاك اتجاهها عكس اتجاه الحركة

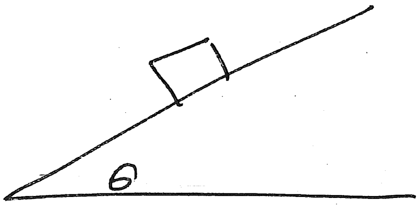
① f_s = static frictional force
قوة الاحتكاك الساكن

$$f_s = \mu_s N$$

② kinetic frictional force قوة الاحتكاك الحركي

$$f_k = \mu_k N$$

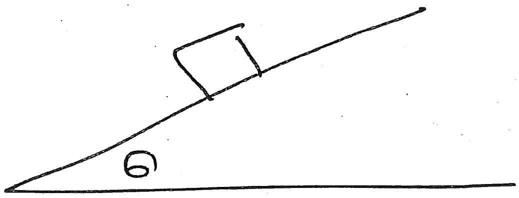
إذا كان الجسم لا تؤثر عليه قوة F ولا T



إذا كان الجسم على وشك الحركة لأسفل

$$\mu_s = \tan\theta$$

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



إذا كان الجسم يتحرك بسرعة ثابتة لأسفل

$$\mu_k = \tan\theta$$

$$\theta = \tan^{-1}(\mu_k)$$

Ch 6 (17)

ملاحظات هامة

① إذا تحرك جسم على سطح أفقي خشن ولا تؤثر على الجسم قوى خارجية غير الاحتكاك (قوة الاحتكاك هي التي توقف حركته)

فإنه $$a = -\mu_k g$$

② إذا تحرك جسم على سطح مائل خشن لأسفل ولا تؤثر عليه قوى خارجية غير قوة الاحتكاك

فإنه $$a = g\sin\theta - \mu_k g\cos\theta$$

③ إذا تحرك جسم على مائل خشن لأعلى ولا تؤثر عليه قوى خارجية غير قوة الاحتكاك

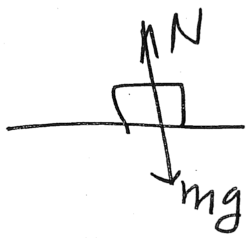
فإنه $$a = -g\sin\theta - \mu_k g\cos\theta$$

④ لاحظ إذا كانت μ_k غير معلومة وطلب قوة الاحتكاك الحركي F_k لا نستخدم القانون $F_k = \mu_k N$ ولكن نوجد F_k من معادلة الحركة $\Sigma F = ma$

عندما يتحرك جسم بسرعة ثابتة في مسار دائري أفقي
فشكله يكون

$$F_s = F_\perp$$

$$\mu_s N = m\frac{v^2}{R}$$



$$N = mg$$

$$\mu_s mg = \frac{mv^2}{R}$$

① إذا طلب قوة الاحتكاك و μ_s غير معلومة

$$F_s = F_\perp = \frac{mv^2}{R}$$

$$f_\perp = \frac{mv^2}{R}$$

② إذا طلب معامل الاحتكاك الساكن μ_s للمستوى الدائري
الذي يجعل الجسم يتحرك بسرعة ثابتة

$$\mu_s = \frac{v^2}{Rg}$$

③ إذا طلب أكبر سرعة يتحرك بها الجسم دون أن ينزلق من
المستوى الدائري

$$v = \sqrt{Rg\mu_s}$$

King Abdulaziz University
Faculty of Sciences
Physics Department

Second Exam - Phys 110

First Term
1432-1433 H

Date: 10/ 1/ 1433H

A

Name:	ID No:	Section:

CHOOSE THE CORRECT ANSWER

1. A girl of mass 50 kg standing in a stationary elevator, her **weight** is:

   a) 490 N b) 550 N c) 245 N d) 392 N

2. Three forces act on a 2 kg object give it an acceleration $\vec{a} = -8\hat{i} + 6\hat{j}$. if $\vec{F}_1 = 30\hat{i} + 16\hat{j}$ and $\vec{F}_2 = -12\hat{i} + 8\hat{j}$ the **third force** is

   a) $\vec{F}_3 = 34\hat{i} + 12\hat{j}$
   b) $\vec{F}_3 = -34\hat{i} - 12\hat{j}$
   c) $\vec{F}_3 = -30\hat{i} - 6\hat{j}$
   d) $\vec{F}_3 = 8\hat{i} - 16\hat{j}$

3. A particle in uniform circular motion of radius r = 2m moved one period. **The distance that the particle travelled** in meters is:

   a) 4π b) 2π c) π d) 3π

4. A particle is said to be in uniform circular motion if

   a) its velocity has a constant magnitude
   b) its velocity has a constant direction
   c) its velocity is directed towards the center
   d) its velocity equals zero

5. 10.3 N is **equal to**

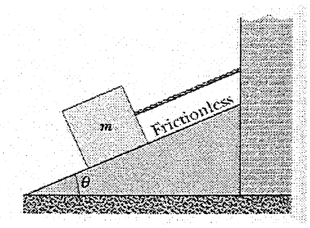
   a) $10.3\frac{kg.m}{s^2}$ b) $10.3\frac{kg.m^2}{s^2}$ c) $10.3\frac{kg^2.m^2}{s^2}$ d) $10.3\frac{kg.m}{s}$

6. At the maximum height of a projectile, **what of the following is correct**?

a) Its velocity is zero
b) Its y-component velocity is zero
c) Its x-component velocity is zero
d) Its acceleration is zero

Use the following to answer questions 7-9:

In the figure, a cord holds stationary a block of mass m = 8.5 kg on a frictionless plane that is inclined at an angle $\theta = 30^0$.



7. The **tension in the cord T equals:**

a) 72.14 N b) 83.3 N c) 53.14 N d) 41.65 N

8. The **normal Force F_N** acting on the block is

a) 53.14 N b) 41.65 N c) 83.3 N d) 72.14 N

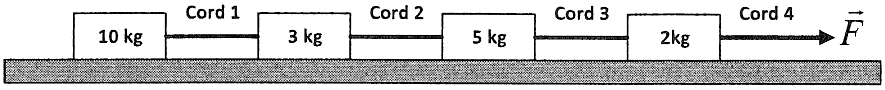
9. If the cord is cut, the magnitude of the **acceleration** of the block is

a) zero b) 4.9 m/s^2 c) 6 m/s^2 d) 4 m/s^2

10. A bag rests on a table, exerting a downward force on the table. The **reaction to this force is:**

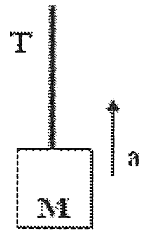
a) The force of Earth on the bag
b) The force of the table on the bag
c) The force of the Earth on the table
d) The force of the bag on Earth

11. The figure shows a train of four blocks being pulled across a frictionless floor by force $\vec{F} = 60N$, what is the **magnitude** of the system's **acceleration?**



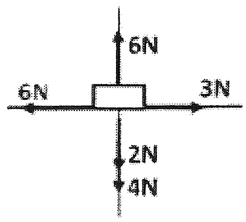
a) 3 m/s^2 b) 6 m/s^2 c) 12 m/s^2 d) 20 m/s^2

12. The cable in the figure is raising a box of mass M = 250 kg with an upward acceleration of 4 m/s^2. **The tension T** in the cable is



a) 863 N b) 1725 N c) 3450 N d) 6900

13. In the figure the **net force** on the block is:



a) 1 N -right b) 6 N -up c) 3 N -left d) 4 N -down

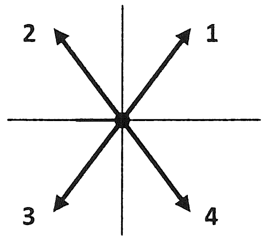
14. Ignoring air resistance, the **acceleration** of any projectile along the x-direction a_x in (SI units) is

a) 9.8 m/s^2 b) zero c) not constant d) less than zero

15. Three forces $\vec{F}_1 = 3\hat{i} - 4\hat{j}$, $\vec{F}_2 = -3\hat{i} + 4\hat{j}$ and $\vec{F}_3 = -6\hat{j}$ acting on a body, **the value of $F_{net,x}$** and **$F_{net,y}$** are:

a) $F_{net,x}$= 6 N and $F_{net,y}$ = -8 N
b) $F_{net,x}$= -6 N and $F_{net,y}$ = 8 N
c) $F_{net,x}$= 0 and $F_{net,y}$ = -6 N
d) $F_{net,x}$= 9 N and $F_{net,y}$ = 16 N

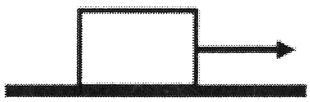
16. Two forces $\vec{F}_1 = 3\hat{i} - 4\hat{j}$ and $\vec{F}_2 = -3\hat{i} + 4\hat{j}$ acting on a body, from the free body diagram the vectors that represent $\vec{F}_1$ and $\vec{F}_2$ are



a) $\vec{F}_1$ is vector **1** , $\vec{F}_2$ is vector **3**
b) $\vec{F}_1$ is vector **2** , $\vec{F}_2$ is vector **4**
c) $\vec{F}_1$ is vector **3** , $\vec{F}_2$ is vector **1**
d) $\vec{F}_1$ is vector **4** , $\vec{F}_2$ is vector **2**

Use the following to answer questions 17-20:

A block lies on a floor as shown in the figure



17. The **magnitude of the frictional force** on it from the floor when **F = 0**

a) 0 b) 5 N c) 20 N d) 8 N

18. When F pulls the block to the right with an acceleration a_x , **The coefficient of Kinetic friction** μ_K is:

a) $\mu_k = \frac{F - ma_x}{F_N}$ b) $\mu_k = \frac{F_N}{F - ma_x}$ c) $\mu_k = \frac{ma_x}{F_N}$ d) $\mu_k = \frac{ma_x - F}{F_N}$

19. The **magnitude of the frictional force** on it from the floor when **F = 8 N** ,but the block does not move

a) 0 b) 5 N c) 20 N d) 8 N

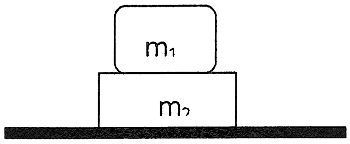
20. If the maximum static frictional force $f_{s,max}$= 20 N ,**the block will move to the right when F is equal to**

a) 21 N b) 15 N c) 19 N d) 12 N

21. A car moves in a circular road of radius r = 7.6 m with a speed 96.6 km/h, the car's **acceleration** is:

a) 18.4×10^3 km/h^2
b) 12.3×10^5 km/h^2
c) 20.7×10^3 km/h^2
d) 15.8×10^2 km/h^2

22. Two boxes m_1=10 kg and m_2=15 kg, **the gravitational force (Fg) on m_2** is



a) 25 N b) 245 N c) 2450 N d) 5 N

23. The position vector of a moving car in meters is: $\vec{r} = (3t^3)\hat{i} + (4t^2+3)\hat{j}$, its **acceleration** at **t = 1** s is:

a) $\vec{a} = 18\hat{i} + 8\hat{j}$ b) $\vec{a} = 8\hat{i} + 18\hat{j}$ c) $\vec{a} = 9\hat{i} + 18\hat{j}$ d) $\vec{a} = 9\hat{i} + 8\hat{j}$

24. The position of a moving particle is $\vec{r} = \hat{i} + 4t^2\,\hat{j} + t\,\hat{k}$, its **velocity** as a function of time is;

a) $\vec{v} = 8\hat{j}$ b) $\vec{v} = 8t\,\hat{j} + \hat{k}$ c) $\vec{v} = \hat{i} + 8t\,\hat{j} + \hat{k}$ d) $\vec{v} = 8t\,\hat{j}$

25. According to Newton's second law, the **force and acceleration** are:

a) in the opposite direction.
b) in the same direction.
c) perpendicular to each other.
d) scalar quantities.

26. The position of a particle was initially at $\vec{r} = 5\hat{i} - 6\hat{j} + 2\hat{k}$ and later at $\vec{r} = -2\hat{i} + 6\hat{j} + 2\hat{k}$. The particle's **displacement vector** is:

a) $\Delta\vec{r} = -7\hat{i} + 12\hat{j}$
b) $\Delta\vec{r} = 3\hat{i} + 4\hat{j}$
c) $\Delta\vec{r} = 7\hat{i} - 12\hat{j}$
d) $\Delta\vec{r} = 3\hat{i} + 12\hat{j} + 4\hat{k}$

27. A rabbit runs across a field. The coordinates of the rabbits position as a function of time are given by: $x = -2t^2 + 10t + 30$, and $y = t^2 - 5t + 10$ **at t = 10 s** the **position vector** $\vec{r}$ is:

a) $\vec{r} = 70\hat{i} - 60\hat{j}$
b) $\vec{r} = 60\hat{i} - 70\hat{j}$
c) $\vec{r} = -60\hat{i} + 70\hat{j}$
d) $\vec{r} = -70\hat{i} + 60\hat{j}$

Use the following to answer questions 28-30:

A ball rolls horizontally off the top of a building with a speed of 30 m/s. If the ball landed on the ground in a time t = 3.03 s

28. The **height of the building** from the ground is

a) 45 m b) 14.8 m c) 90 m d) 22 m

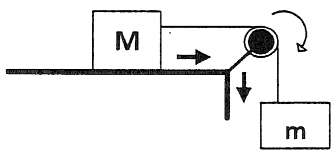
29. At what **horizontal distance** from the rolling point does the projectile strikes the ground

a) 9.9 m b) 90.9 m c) 0.9 m d) 99 m

30. What is the magnitude of **the vertical component of its velocity** as it strikes the ground

a) 2.9 m/s b) 0.31 m/s c) 3.2 m/s d) 29.7 m/s

31. A block of mass M is connected to a block of mass m as shown. The **normal force on block M** is:



a) $F_N = M g$ b) $F_N = M g - T$ c) $F_N = m g - T$ d) $F_N = m g$

32. A particle moves from $\vec{r}_1 = (-10m)\hat{k}$ to $\vec{r}_2 = (24m)\hat{i}$ in 2 s. Its **average velocity** is:

a) $\vec{v}_{avg} = \left(24\frac{m}{s}\right)\hat{i} + \left(10\frac{m}{s}\right)\hat{k}$

b) $\vec{v}_{avg} = \left(12\frac{m}{s}\right)\hat{i} + \left(5\frac{m}{s}\right)\hat{k}$

c) $\vec{v}_{avg} = \left(-10\frac{m}{s}\right)\hat{i} + \left(24\frac{m}{s}\right)\hat{k}$

d) $\vec{v}_{avg} = \left(-5\frac{m}{s}\right)\hat{i} + \left(12\frac{m}{s}\right)\hat{k}$

33. A force F is applied to an object of mass m_1= 45 kg produces an acceleration of 2 m/s^2. The same force is applied to a second object of mass m_2 produces an acceleration of 1.5 m/s^2. **The value of m_2** is

a) 45 kg b) 60 kg c) 30 kg d) 67 kg

Answer Key

1. a
2. b
3. a
4. a
5. a
6. b
7. d
8. d
9. b
10. b
11. a
12. c
13. c
14. b
15. c
16. d
17. a
18. a
19. d
20. a
21. b
22. b
23. a
24. b
25. b
26. a
27. d
28. a
29. b
30. d
31. a
32. b
33. b

(1)

(1) $m = 50\ kg$

$W = mg = 50 \times 9.8 = 490\ N$ (a)

---

(2) $m = 2\ kg \qquad \vec{a} = -8i + 6j$

$\vec{F_1} = 30i + 16j \qquad \vec{F_2} = -12i + 8j$

$\Sigma \vec{F} = m\vec{a} \Rightarrow \vec{F_1} + \vec{F_2} + \vec{F_3} = m\vec{a}$

$30i + 16j - 12i + 8j + \vec{F_2} = 2(-8i + 6j)$

$18i + 24j + \vec{F_2} = -16i + 12j$

$\vec{F_2} = -16i + 12j - 18i - 24j$

$\vec{F_2} = -34i - 12j$ (b)

(2)

(3) $r = 2m$

المسافة تساوي محيط الدائرة $d = 2\pi r = 2\pi(2) = 4\pi$ (a)

---

(4) (a)

---

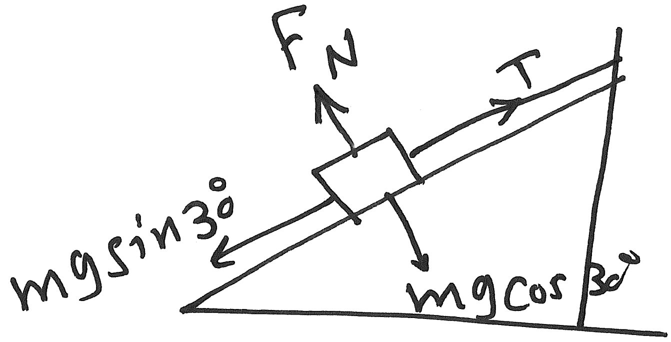
(5) $10.3\ N = 10.3\ kg \cdot m/s^2$

$1\ N = 1\ kg \cdot m/s^2$ (a)

---

(6) at the maximum height of the projectile, the y-component velocity is zero. (b)

(7) $m = 8.5\ kg$ $\theta = 30^\circ$



stationary block الجسم ساكن

$\Sigma F_x = 0$ قانون نيوتن الأول

$T = mg\sin 30 = 8.5 \times 9.8 \sin 30$

$= 41.65\ N$ (d)

---

(8) $\Sigma F_y = 0$

$F_N = mg\cos 30^\circ$

$= 8.5 \times 9.8 \cos 30^\circ$

$= 72.14\ N$ (d)

---

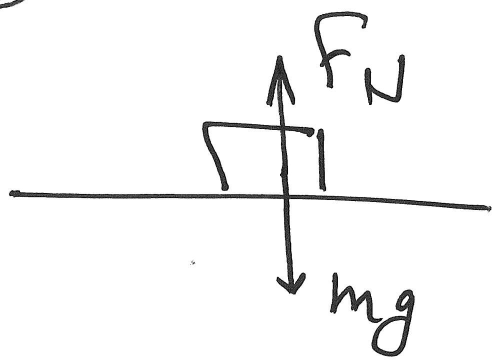
(9) If the cord is cut

يتحرك الجسم لأسفل المستوى المائل بتسارع

$a = g\sin 30 = 9.8 \sin 30 = 4.9\ m/s^2$ (b)

(4)

(10)

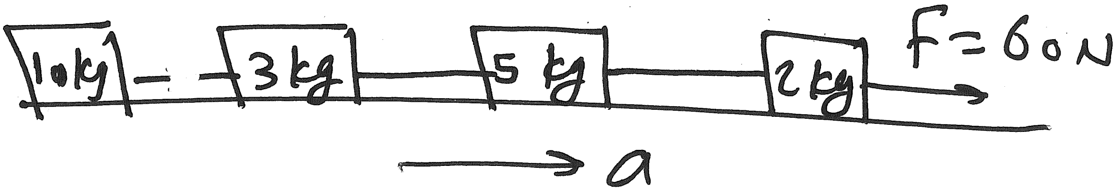


F_N = The earth of the table on the bag (b)

قوة رد الفعل من قوة الطاولة على الجسم (bag)

---

(11)



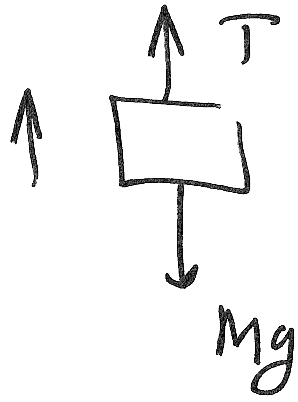
$\Sigma F = m\vec{a}$

$60 = (10+3+5+2)a$

$60 = 20a \Rightarrow a = \frac{60}{20} = 3\,m/s^2$ (a)

(12)

$M = 250\ kg$
$a = 4\ m/s^2$



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

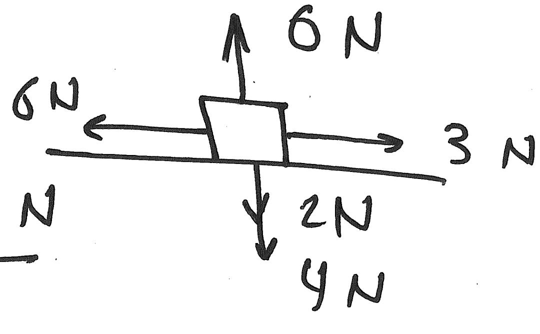
$T - Mg = Ma$

$T = Mg + Ma$

$= 250 \times 9.8 + 250 \times 4 = 3450\ N$ (c)

---

(13)



$\sum F_x = 3N - 6N = -3\ N$ ←

$\sum F_y = 6 - 2 - 4 = 0$

the net force is 3 N - left (c)

---

(14)

في المقذوفات دائماً

$a_x = 0$ ⇐ لأنه السرعة ثابتة في اتجاه x

(b)

(6)

(15) $\vec{F_1} = 3i - 4j$

$\vec{F_2} = -3i + 4j$

$\vec{F_3} = \quad -6j$

$\Sigma\vec{f} = \vec{f_1} + \vec{f_2} + \vec{f_3} = 0 - 6j$

$F_{net,x} = 0$ $\quad$ $F_{net,y} = -6\ N$

(c)

---

(16) $\vec{F_1} = 3i - 4j$ $\quad$ $\vec{F_2} = -3i + 4j$

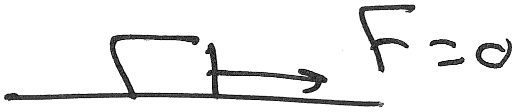
x (+) $\quad$ y (−) $\quad$ x (−) $\quad$ y (+)

في الربع الرابع $\quad$ في الربع الثاني

$\vec{F_1}$ is vector 4 $\quad$ $\vec{F_2}$ is vector 2

(d)

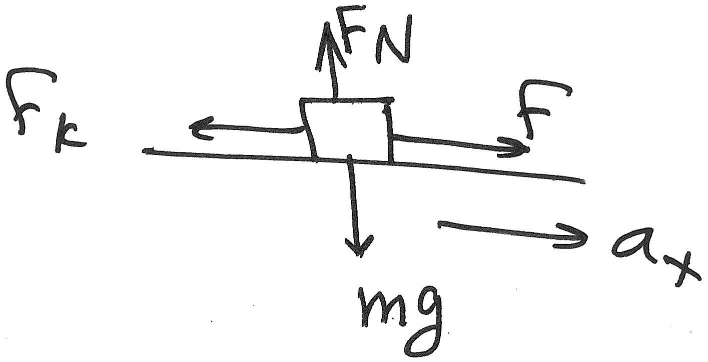
(17)



the frictional force $= 0$ (a) الجسم ساكن
لا تؤثر عليه قوة تحاول تحريكه

---

(18)



$F_N = mg$

$F_k = \mu_k F_N$

$\Sigma F = ma \Longrightarrow F - F_k = m a_x$

$F_k = F - m a_x$

$\mu_k F_N = F - m a_x$

$$\mu_k = \frac{F - m a_x}{F_N}$$ (a)

(8)

(19) The block does not move

$\sum F = 0$

The frictional force = $F = 8\,N$ (d)

---

(20) $f_{s,max} = 20N$

حتى يتحرك الجسم لابد أن تكون

$F > f_{s,max}$

$F = 21\,N$ (a)

هي الجواب المناسب

(الوحيد الذي أكبر من 20N)

---

(21) $r = 7.6\,m$ $\quad v = 96.6\ km/h$

$= 0.0076\ km$

لاحظ الاختيارات km/h^2

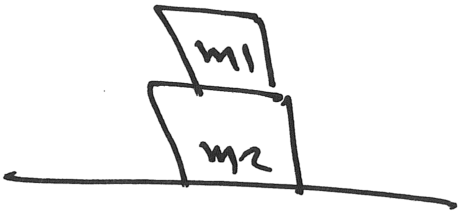
نحول ر إلى ($\div 1000$) km

$a = \frac{v^2}{r} = \frac{(96.6)^2}{0.0076} = 1.23 \times 10^6\ km/h^2$

$= 12.3 \times 10^5\ km/h$ (b)

(9)

(22) $m_1 = 10\ kg$



$m_2 = 15\ kg$

$$F_{g2} = (m_1 + m_2)\, g = (10+15)(9.8)$$

$$= 245\ N \quad \text{(b)}$$

---

(23) $$\vec{r} = (3t^3)\,i + (4t^2 + 3)\,j \quad (m)$$

$$\vec{v} = \frac{d\vec{r}}{dt} = (9t^2)\,i + (8t)\,j \quad m/s$$

ثانية

ثانية

$$\vec{a} = \frac{d\vec{v}}{dt} = (18t)\,i + 8j$$

$$t = 1\,s \Rightarrow \vec{a} = (18\,i + 8j)\ m/s^2$$

(a)

(10)

(24) $\vec{r} = i + 4t^2 j + tk$

$\vec{v} = \frac{d\vec{r}}{dt} = (8tj + k)$ m/s

(b)

---

(25) The force and the acceleration are in the same direction (b)

---

(26) $r_1 = 5i - 6j + 2k$

$r_2 = -2i + 6j + 2k$

$\vec{\Delta r} = \vec{r_2} - \vec{r_1} = -7i + 12j$ (a)

(11)

(27) $x = -2t^2 + 10t + 30$

$y = t^2 - 5t + 10$

$\vec{r} = x\hat{i} + y\hat{j}$

$\vec{r} = (-2t^2 + 10t + 30)\hat{i} + (t^2 - 5t + 10)\hat{j}$

$t = 10\,s \Rightarrow \vec{r} = (-2(10)^2 + 10(10) + 30)\hat{i}$

$+ ((10)^2 - 5(10) + 10)\hat{j}$

$\vec{r} = (-200 + 100 + 30)\hat{i} + (100 - 50 + 10)\hat{j}$

$\vec{r} = -70\hat{i} + 60\hat{j}$ (d)

(12)

$v_0 = 30\ m/s$

horizontally
$\theta = 0$
$v_{0y} = 0$

$t = 3.03\ s$

(28) $v_{0y} = 0$ $a = -9.8\ m/s^2$

$t = 3.03\ s$ $y = ?$

$y = v_{0y} t + \frac{1}{2} a t^2 = 0 + \frac{1}{2}(-9.8)(3.03)^2$

$y = -44.99 m \simeq -45 m$

height $= |y| = 45\ m$ (a)

---

(29) $x = v_0 \cos\theta t = 30 \cos 0 (3.03)$
$= 90.9\ m$ (b)

(30) $v_{oy} = 0$ $\quad a = -9.8\ m/s^2$

$t = 3.03\ s$ $\quad v_y = ?$

$v_y = v_{oy} + at = 0 - 9.8(3.03)$

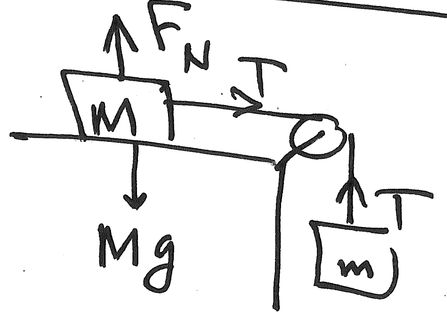
$= -29.694\ m/s$

$|v_y| = 29.694\ m/s$ (d)

---

(31)

$F_N = Mg$ (a)



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(32) $\vec{r_1} = (-10m)\,k$ $\quad \vec{r_2} = (24m)\,i$

$\Delta t = 2s$

$$v_{ave} = \frac{\Delta r}{\Delta t} = \frac{\vec{r_2} - \vec{r_1}}{\Delta t} = \frac{24i - (-10k)}{2}$$

$= (12i + 5k)\ m/s$ (b)

(14)

(a) $m1 = 45 kg$ $a_1 = 2 m/s$

$F = m1\, a_1 = (45)(2) = 90\ N$

$F = 90 N$ $m_2 = ?$ $a_2 = 1.5 m/s^2$

$F = m_2 a_2$

$$m_2 = \frac{F}{a_2} = \frac{90}{1.5}$$

$= 60\ kg$ (b)