Jeddah University

PHYSICS (101)

Chapter (1)
Units , and Vectors

Mahmoud Al-Zamil

0508601922

Standards and Units

Example 1:

A car is traveling at 20 m/s. The speed of this car is equivalent to:

Solution:

(C) ✓

(A) 23 km/h
(B) 56 km/h
(C) 72 km/h
(D) 97 km/h

$$\text{km/h} \underset{\times \frac{3600}{1000}}{\overset{\times \frac{1000}{3600}}{\rightleftarrows}} \text{m/s}$$

$$S = 20 \times \frac{3600}{1000} = 72 \text{ km/h}$$

Standards and Units

Example 2:

مكعب طول ضلع الحجم

A cube of edge 47.5 mm, its volume is:

$mm \xrightarrow{\div 1000} m$

Solution:

(A) 43 m^3
(B) 0.473 m^3
(C) 47.3 m^3
(D) 1.072×10^{-4} m^3

~~(D)~~

$L = \frac{47.5}{1000} = 0.0475\ m$

$V = (0.0475)^3 = 1.072\times10^{-4}\ m^3$

Using and Converting Units

Example 3:

قطار

A train moves with a speed of 65 mile per hour. The speed in SI units is: (Hint: 1 mile = 1610 m)

Solution:

(B)

(A) 24
(B) 29
(C) 32
(D) 37

$$mile/h \xrightarrow{\times \frac{1610}{3600}} m/s$$

$$S = 65 \times \frac{1610}{3600} = 29 \quad m/s$$

B

Vectors and Vector Addition

Example 4:

كمية متجهة

Which of the following quantities is not a vector quantity?

Solution:

(B) mass الكتلة

(A) Velocity
(B) Mass
(C) Acceleration
(D) Force

Component of Vectors

Example 5:

The component of vector $\vec{A}$ are given as $A_x = 5.5\,m$ and $A_y = -5.3\,m$. The magnitude of vector $\vec{A}$ is:

Solution:

(C)

(A) 6.1 m
(B) 6.9 m
(C) 7.6 m
(D) 8.4 m

$$|A| = \sqrt{Ax^2 + Ay^2}$$

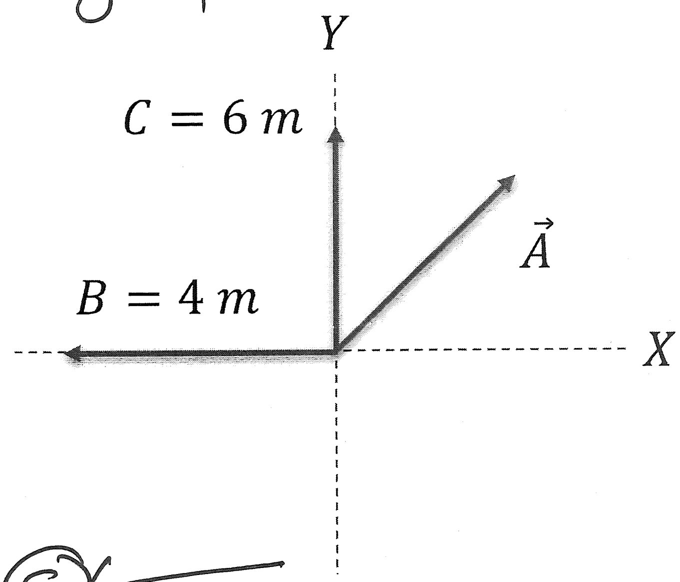
$$|A| = \sqrt{(5.5)^2 + (-5.3)^2}$$

$$|A| = 7.638\ m$$

Unit Vectors

Example 6:

In figure, if $\vec{A}+\vec{B}-\vec{C}=4\hat{\imath}$ then the vector $\vec{A}$ in unit vector notation is:



Solution:

من الشكل

$\vec{C} = 6\hat{j}$ شمال

$\vec{B} = -4\hat{i}$

$\boxed{A + B - C = 4\hat{i}}$

$A - 4\hat{i} - 6\hat{j} = 4\hat{i}$

$A = 4\hat{i} + 4\hat{i} + 6\hat{j}$

$= 8\hat{i} + 6\hat{j}$

(A) $4\hat{\imath} + 2\hat{\jmath}$
(B) $9\hat{\imath} + 4\hat{\jmath}$
(C) $8\hat{\imath} + 6\hat{\jmath}$
(D) $5\hat{\imath} + 4\hat{\jmath}$

C

Products of Vectors

Example 6:

Given $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{B} = 2\hat{i} - 3\hat{j} + 4\hat{k}$, then $(\vec{A} \cdot \vec{B})$ is:

Solution:

(C)

(A) $3\hat{i} + 4\hat{j} - 5\hat{k}$
(B) 40
(C) 8
(D) $\hat{i} + \hat{j} - 5\hat{k}$

$A = i + 2\hat{j} + 3k$

$B = 2i - 3\hat{j} + 4k$

$A \cdot B = 1 \times 2 + 2 \times -3 + 3 \times 4$

$= 2 - 6 + 12 = 8$

Products of Vectors

Example 7:

Given $\vec{A} = 2\hat{i} + \hat{j} + 3\hat{k}$, $\vec{B} = 2\hat{i} - 6\hat{j} + 7\hat{k}$, $\vec{C} = 2\hat{i} - \hat{j} + 4\hat{k}$ then the vector $\vec{D} = 2\vec{A} + \vec{B} - \vec{C}$ is:

$2A + B - C = ?$

Solution:

(D)

(A) $-\hat{i} - 2\hat{j} + 3\hat{k}$
(B) $3\hat{i} + 2\hat{j} - 5\hat{k}$
(C) $3.5\hat{i}$
(D) $4\hat{i} - 3\hat{j} + 9\hat{k}$

$2(2i + j + 3k) + 2i - 6j + 7k - (2i - j + 4k)$

$= 4i + 2j + 6k + 2i - 6j + 7k - 2i + j - 4k$

$= 4i - 3j + 9k$ D

Products of Vectors

Example 8:

Refer to Example 7, the angle between the vector $\vec{A}$ and the positive z-axis is:

$$|A| = \sqrt{2^2 + 1^2 + 3^2} = \sqrt{14}$$

Solution:

(B)

(A) Zero
(B) 36.7°
(C) 180°
(D) 315°

$$\theta = \cos^{-1}\left(\frac{A_z}{|A|}\right)$$

$$\theta = \cos^{-1}\left(\frac{3}{\sqrt{14}}\right) \qquad \theta = 36.7^\circ$$

Products of Vectors

Example 9:

The result of $\hat{i} \cdot \hat{j}$ is:

Solution:

(A)

$\hat{i} \cdot \hat{i} = 1$
$\hat{j} \cdot \hat{j} = 1$ متشابهين
$k \cdot k = 1$

$\hat{i} \cdot \hat{j} = 0$ مختلفين

(A) Zero
(B) $\hat{i}$
(C) $\hat{k}$
(D) $\hat{j}$

Products of Vectors

Example 10:

If $\vec{A}$ and $\vec{B}$ are vectors with magnitudes 5 and 4 respectively, and the magnitude of their cross product is 17.32, then the angle between $\vec{A}$ and $\vec{B}$ is:

Solution:

(A) 180°
(B) 90°
(C) 60°
(D) 45°

(C) $\theta = \sin^{-1}\left(\frac{A \times B}{|A||B|}\right)$

$\theta = \sin^{-1}\left(\frac{17.32}{5 \times 4}\right)$

$\theta = 60^\circ$ C

Products of Vectors

Example 12:

If $\vec{A} \times \vec{B} = 0$, the angle between the vectors $\vec{A}$ and $\vec{B}$ is:
(Hint: $\vec{A}$ and $\vec{B}$ are non-zero vectors)

Solution: $A \times B = 0 \quad \theta = 0^\circ, 180^\circ$

(D)

(A) 270°
(B) 90°
(C) 45°
(D) Zero

$A \cdot B = 0$	$A \times B = 0$
$\theta = 90^\circ$ $\perp$	$\theta = 0^\circ, 180^\circ$

Products of Vectors

Example 13:

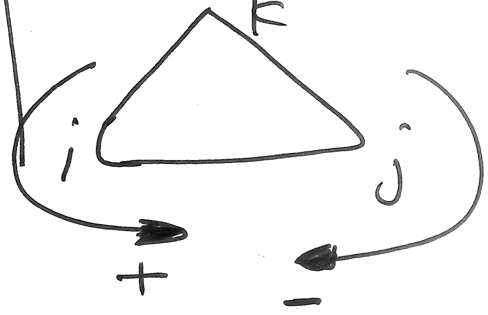
The result of $(\hat{i} \times \hat{j}) \cdot \hat{j}$ is:

Solution:

(D)

(A) $\hat{i}$
(B) $\hat{j}$
(C) $\hat{k}$
(D) Zero

القياسي $(\cdot)$	الاتجاهي $(\times)$
$i \cdot i = 1$	$i \times i = 0$
$i \cdot j = 0$	



$(i \times j) \cdot j =$

$k \cdot j = 0$

الأقواس أولاً

Products of Vectors

Example 14:

The result of $(\hat{i} \times \hat{j}) \times \hat{i}$ is:

Solution:

(B)

$(i \times j) \times i =$

$k \times i = j$ B

(A) Zero
(B) $\hat{j}$
(C) $\hat{k}$
(D) 1

* Example 1.1 (7)

$$mil/h \xrightarrow{\times \frac{1609}{3600}} m/s$$

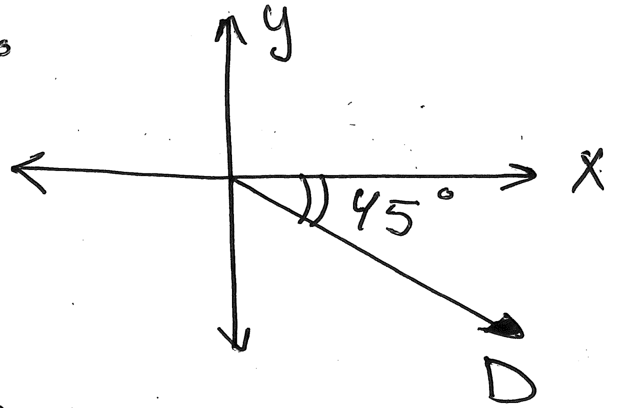
$$speed = 763 \times \frac{1609}{3600} = 341 \quad m/s$$

Example 1.6 → 15

$|D| = 3m \qquad \theta = 45^\circ$

المتجه يقع فى الربع الرابع

$\theta = 360 - 45 = 315^\circ$



* $D_x = |D| \cos\theta$

$= 3 \cos(315) = 2.1 \quad m$

* $D_y = |D| \sin\theta$

$= 3 \sin(315^\circ)$

$= -2.1 \quad m$

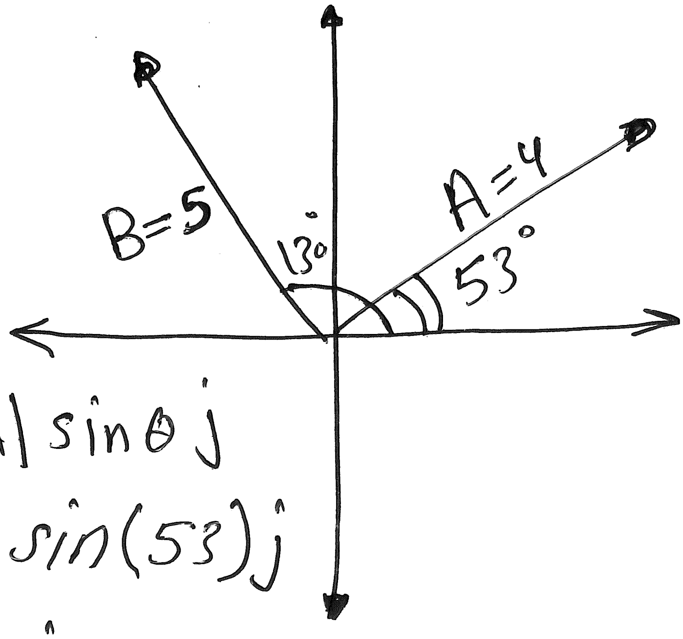
Example 1.8 → 19

$$\vec{D} = 6\hat{i} + 3\hat{j} - k$$
$$\vec{E} = 4\hat{i} - 5\hat{j} + 8k$$

$$2D - E = ?$$
$$2(6\hat{i} + 3\hat{j} - k) - (4\hat{i} - 5\hat{j} + 8k) =$$
$$12\hat{i} + 6\hat{j} - 2k - 4\hat{i} + 5\hat{j} - 8k =$$
$$= 8\hat{i} + 11\hat{j} - 10k$$

$$|2D - E| = \sqrt{8^2 + 11^2 + 10^2} = 16.9$$

* Example 1.9 → 21



$$\vec{A} = |A|\cos(\theta)\hat{i} + |A|\sin\theta\,\hat{j}$$
$$= 4\cos(53)\hat{i} + 4\sin(53)\hat{j}$$
$$= 2.407\,\hat{i} + 3.195\,\hat{j}$$

$$\vec{B} = |B|\cos(\theta)\hat{i} + |B|\sin(\theta)\hat{j}$$
$$= 5\cos(130)\hat{i} + 5\sin(130)\hat{j}$$
$$\vec{B} = -3.214\hat{i} + 3.830\hat{j}$$

$$\vec{A} = 2.407\hat{i} + 3.195\hat{j}$$
$$B = -3.214\hat{i} + 3.830\hat{j}$$

$$A \cdot B = (2.407)(-3.214) + (3.195)(3.830)$$
$$A \cdot B = 4.50 \checkmark$$

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* <u>Example 1.10</u> → 21

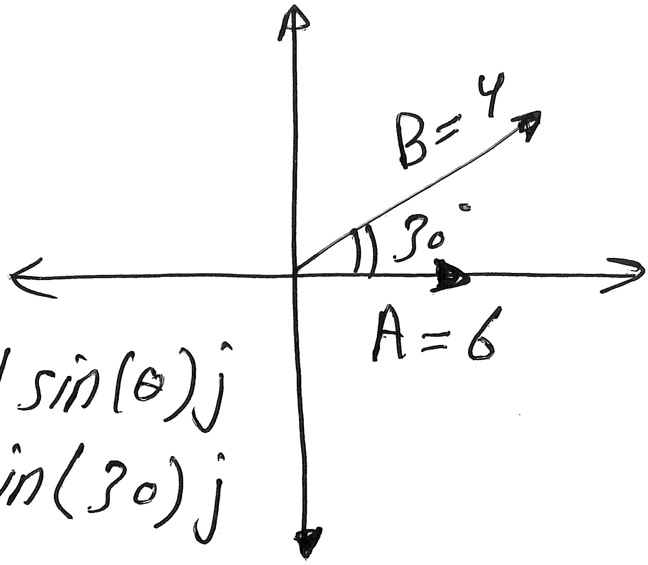
$$\vec{A} = 2\hat{i} + 3\hat{j} + k$$
$$B = -4\hat{i} + 2\hat{j} - k \qquad \theta = ?$$
$$\theta = \cos^{-1}\left(\frac{A \cdot B}{|A||B|}\right)$$

$$|A| = \sqrt{2^2 + 3^2 + 1^2} = \sqrt{14}$$
$$|B| = \sqrt{4^2 + 2^2 + 1^2} = \sqrt{21}$$
$$A \cdot B = -8 + 6 - 1 = -3$$

$$\theta = \cos^{-1}\left(\frac{-3}{\sqrt{14} \times \sqrt{21}}\right)$$

$$\theta = 100^\circ$$

* Example 1.11 $\longrightarrow$ 24



$$\vec{A} = 6\hat{i}$$

$$\vec{B} = |B|\cos(\theta)i + |B|\sin(\theta)\hat{j}$$

$$\vec{B} = 4\cos(30)i + 4\sin(30)\hat{j}$$

$$\vec{B} = 3.464\,\hat{i} + 2\hat{j}$$

$$A \times B = \begin{vmatrix} i & j & k \\ 6 & 0 & 0 \\ 3.464 & 2 & 0 \end{vmatrix}$$

$$A \times B = (\quad)i - (\quad)\hat{j} + (\quad)k$$

$$A \times B = (\quad)i - (\quad)j + (12 - 0)k$$

$$A \times B = 12k$$

Jeddah University

PHYSICS (101)

Chapter (2)
Motion in Straight Line

Mahmoud Al-Zamil

0508601922

Displc., Time, and Average Velocity

Example 1:

A bicycle travels 12 km in 90 min. Its average speed is:

Solution:

$$\text{min} \xrightarrow{\div 60} h$$

(A)

(A) 8 km/h
(B) 18 km/h
(C) 28 km/h
(D) 48 km/h

$$X = 12 \text{ km}$$

$$t = \frac{90}{60} = 1.5 \text{ h}$$

$$S = \frac{X}{t} = \frac{12}{1.5} = 8 \text{ km/h}$$

Instantaneous Velocity

Example 2:

The position of a particle moving on an x axis is given by $x = 4 + 7t - t^2$, with x in (m) and t in (s). The velocity at 3 s is:

Solution:

(A) 4 m/s
(B) 2 m/s
(C) 1 m/s
(D) 0.4 m/s

(C)

$\boxed{X = 4 + 7t - t^2}$

اشتقاق

$v = 7 - 2t$

$v = 7 - 2 \times 3$ $t = 3$

$v = 1$ m/s

Average and Instant. Acceleration

Example 3:

A car uniformly changes its speed from 20 m/s to 5 m/s in 5 s. The average acceleration is:

Solution:

(A) 9 m/s^2
(B) -3 m/s^2
(C) 4 m/s^2
(D) -6 m/s^2

(B)

$$a_{ave} = \frac{v_2 - v_1}{t_2 - t_1}$$

$$a_{ave} = \frac{5 - 20}{5}$$

$$a_{ave} = -3 \ m/s^2$$

Average and Instant. Acceleration

Example 4:

The velocity of a train is given by $v(t)=98 - 3t$, (where t in seconds and v is in m/s), has an acceleration of:

Solution:

(B)

(A) 2 m/s^2
(B) -3 m/s^2
(C) 98 m/s^2
(D) 0.3 m/s^2

$\boxed{v = 98 - 3t}$

اشتقاق

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

B

Motion with Constant Acceleration

Example 5:

A particle starts motion at 15 m/s. If it moves 20 m in 2 s, its final velocity is:

Solution:

(B)

(A) 10 m/s
(B) 5 m/s
(C) 3 m/s
(D) zero

$v_0 = 15$ m/s

$x = 20$ m

$t = 2$ s

$v = ?$

$$\boxed{x = \frac{v_0 + v}{2} \times t} \rightarrow 4$$

$$20 = \frac{15 + v}{2} \times 2 \qquad v = 5 \text{ m/s}$$

Motion with Constant Acceleration

Example 6:

A car takes 10 s to accelerate from 0 to 50 m/s with constant acceleration. This acceleration is:

Solution:

(C)

$v_0 = 0 \quad m/s$

$v = 50 \quad m/s$

$t = 10 \quad s$

$a = ?$

(A) 15 m/s^2
(B) 9 m/s^2
(C) 5 m/s^2
(D) 2 m/s^2

$$\boxed{v = v_0 + at}$$

$50 = 0 + 10a$

$a = 5 \; m/s^2$ (C)

Motion with Constant Acceleration

Example 7:

A train changes its velocity from 70 km/h to 20 km/h in 6 s. The distance it covered is:

Solution:

$$v_0 = 70 \times \frac{1000}{3600} = 19.44 \ m/s$$

$$v = 20 \times \frac{1000}{3600} = 5.56 \ m/s$$

$$t = 6 \ s$$

$$\boxed{x = \frac{v_0 + v}{2} \times t} \rightarrow (4)$$

$$x = \frac{19.44 + 5.56}{2} \times 6 \qquad x = 75 \ m$$

(A) 75.0 m
(B) 9.87 m
(C) 15.4 m
(D) 20.6 m

Motion with Constant Acceleration

Example 8:

A car moves along the x-axis with constant speed, the acceleration of the car is:

Solution:

(A) Decreasing
(B) Increasing
(C) $9.8\ m/s^2$
(D) Zero

* constant speed سرعة ثابتة

$a = 0$ التسارع = صفر

Free Falling Bodies

Example 9:

A ball is thrown vertically upward at a speed of 12 m/s. It will reach its maximum height in:

$\boxed{\text{max height } v = 0}$

Solution:

$+$

$g = -9.8$

$v_0 = 12$ m/s

$v = 0$

$t = ?$

$$\boxed{v = v_0 + gt}$$

$$0 = 12 - 9.8 \times t$$

$$t = 1.22 \text{ s}$$

(A) 1.22 s
(B) 1.84 s
(C) 2.33 s
(D) 3.21 s

Free Falling Bodies

Example 10:

ترك

A stone is dropped vertically downwards from a height h. If the stone reaches a height of 10 m above the ground in 2 s, the height h is:

$g = -9.8$

$v_0 = 0$

$t = 2\ s$

$y = ?$

Solution:

(A) 4.9 m
(B) 9.6 m
(C) 19.6 m
(D) 29.6 m

$$\boxed{y = v_0 t + \frac{1}{2} g t^2}$$

$$y = 0 + \frac{1}{2} \times (-9.8) \times 2^2$$

$$y = -19.6\ m$$

$$* \quad h = 10 + 19.6 = 29.6\ m$$

Free Falling Bodies

Example 11:

A boy shot a foot ball vertically up with an initial speed v_0. When the ball was 2 m above the ground, the speed was 0.4 of the initial speed. The initial speed is:

Solution:

(A) 11.7 m/s
(B) 8.41 m/s
(C) 6.83 m/s
(D) 4.82 m/s

+

$g = -9.8$

$v_0 = v_0$

$v = 0.4 v_0$

$y = 2$ m

$v^2 = v_0^2 + 2gy$

$(0.4 v_0)^2 = v_0^2 + 2 \times -9.8 \times 2$

$0.16 v_0^2 = v_0^2 - 39.2$

$v_0 = 6.83$ m/s

C

CH-2

Example 2.3 → 42

(a)

$$V = 60 + 0.5t^2$$

$t_1 = 1 \quad V_1 = 60 + 0.5(1)^2 = 60.5 \text{ m/s}$

$t_2 = 3 \quad V_2 = 60 + 0.5(3)^2 = 64.5 \text{ m/s}$

$$\Delta V = V_2 - V_1 = 64.5 - 60.5 = 4 \text{ m/s}$$

(b)

$$a_{ave} = \frac{V_2 - V_1}{t_2 - t_1} = \frac{64.5 - 60.5}{3 - 1}$$

$$a_{ave} = \frac{4}{2} = 2 \text{ m/s}^2$$

(c)

$t_1 = 1 \quad V_1 = 60 + 0.5(1)^2 = 60.5$

$t_2 = 1.1 \quad V_2 = 60 + 0.5(1.1)^2 = 60.605$

$$a = \frac{\Delta V}{\Delta t} = \frac{60.605 - 60.500}{1.1 - 1}$$

$$a = 1.05 \text{ m/s}^2$$

* Example 2.4 → 48

$v_0 = 15 \quad m/s$

$a = 4 \quad m/s^2$

$t = 2 \quad s$

$$\boxed{X = v_0 t + \frac{1}{2} a t^2}$$

$$X = 15 \times 2 + \frac{1}{2} \times 4 \times 2^2 = 38 \; m$$

$$X_f = X_0 + X$$
$$= 5 + 38 = 43 \; m$$

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

$$V = 15 + 4 \times 2$$
$$= 23 \quad m/s$$

Example 2.6 $\longrightarrow$ 51

$g = -9.8$

$v_0 = 0$

$t = 1$

$y = ?$

$v = ?$

(1) $\longrightarrow$ $\boxed{y = v_0 t + \frac{1}{2} g t^2}$

$y = 0 + \frac{1}{2} \times (-9.8) \times 1^2$

$y = -4.9$ m

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(2) $\longrightarrow$ $\boxed{v = v_0 + g t}$

$v = 0 - 9.8 \times 1$

$v = -9.8$ m/s

$t_2 = 2$ s كرر المعادلتين (1) ، (2) عند

$t_3 = 3$ s

وهكذا

* <u>Example 2.7</u> → 51

$+ \uparrow$

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

$v_0 = 15 \quad m/s$

$t = 1$

$y = ?$ $\quad \boxed{y = v_0 t + \frac{1}{2} g t^2}$

$$y = 15 \times 1 + \frac{1}{2} \times (-9.8) \times 1^2$$

$$y = 10.1 \quad m$$

$t = ?$ max hieght

$\boxed{v = v_0 + gt}$

$0 = 15 - 9.8 \times t$

$t = 1.53 \quad s$ زمن الصعود

زمن الهبوط لقمة البرج؟ $= 1.53 + 1.53 = 3.1 \; s$

$t = 4 - 3.1 = 0.9 \; s$

$\downarrow$ $\boxed{y = v_0 t + \frac{1}{2} g t^2}$

$$y = -15 \times 0.9 + \frac{1}{2} \times (-9.8)(0.9)^2$$

$$y = -17.469 \quad m$$

أسفل قمة البرج

$$\boxed{v = v_0 + gt}$$

$$v = -15 - 9.8 \times 0.9$$

$$= -23.82 \quad m/s$$