مراجعة الدرس الأول من الوحدة الثامنة gravity of center and mass of Center منهج انسبایر

تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ⇦ المناهج الإماراتية ⇦ الصف الحادي عشر المتقدم ⇦ فيزياء ⇦ الفصل الثالث ⇦ ملفات متنوعة ⇦ الملف

تاريخ إضافة الملف على موقع المناهج: 2025-06-08 17:42:10

المزيد من مادة فيزياء:	ملفات ا كتب للمعلم ا كتب للطالب ا اختبارات الكترونية ا اختبارات ا حلول ا عروض بوربوينت ا أوراق عمل منهج انجليزي ا ملخصات وتقارير ا مذكرات وبنوك ا الامتحان النهائي ا للمدرس

التواصل الاجتماعي بحسب الصف الحادي عشر المتقدم

صفحة المناهج الإماراتية على فيسبوك					
المواد على تلغرام	التربية الاسلامية	اللغة العربية	اللغة الانجليزية	الرياضيات	

المزيد من الملفات بحسب الصف الحادي عشر المتقدم والمادة فيزياء في الفصل الثالث

1	كل ما يخص اختبار نهاية الفصل الثالث ليوم الثلاثاء بتاريخ 2025-06-10
2	نموذج اختبار تجريبي باللغتين العربية والانجليزية بدون الحل
3	ملخص تجميعة قوانين الفيزياء منهج انسبابر
4	ملخص تجميعة قوانين الفيزياء منهج بريدج
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Unit 8

8.1
Center of mass and center of gravity

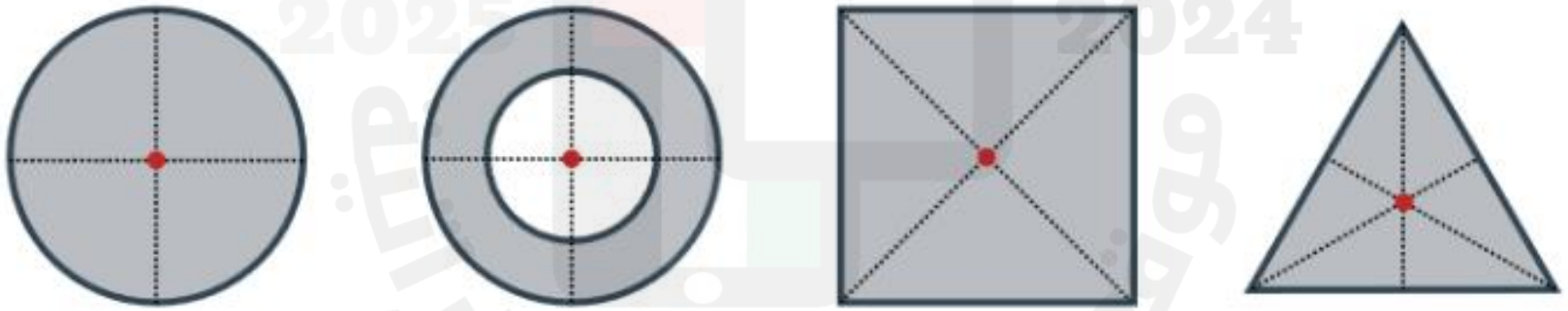


Figure 1: Center of mass for some simple geometric shapes (red dots).

Learning Objectives

8.1
Center of mass and center of gravity

By the end of this lesson, you will be able to:

1) Define the center of mass (Center of gravity).

2) Find the center of mass for two objects.

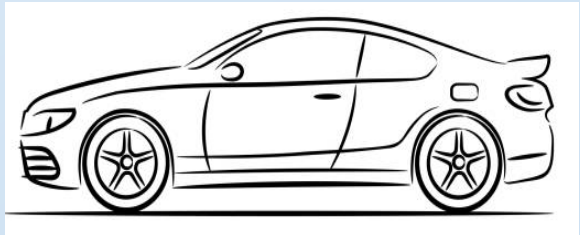
3) Identify the location of the center of mass for a system of many masses.

Center of mass.

Center of gravity.

L.O: Define the center of mass (Center of gravity).

What does this phrase mean
"There is a car at a distance of
x=3.2 m from you"



So far, we have represented the location of an object by coordinates of a single point.

However, a statement such as a car located at x=3.2 m surely does not mean that the entire car is located at that point.

So, what does it mean to give the coordinate of one particular point to represent an extended object?

In almost all situations, there is a natural choice of a point to represent the location of an extended object. This point is called the center of mass.

L.O: Define the center of mass (Center of gravity).

Write the definition of the center of mass.

WS # 1

Definition

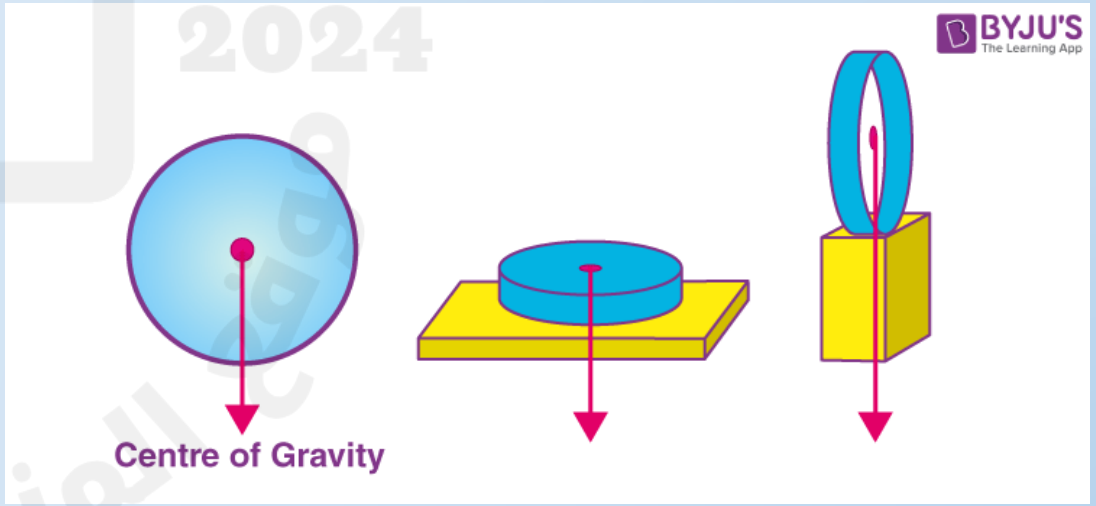
The **center of mass** is the point at which we can imagine all the mass of an object to be concentrated.

L.O: Define the center of mass (Center of gravity).

The center of mass is also the point at which we can imagine the force of gravity acting on the entire object to be concentrated.

If we can imagine all of the mass to be concentrated at this point when calculating the force due to gravity, we call this point the center of gravity.

To be precise, we should note that these two terms are only equivalent in situations where the gravitational force is constant everywhere throughout the object.



L.O: Define the center of mass (Center of gravity).

WS # 1 / Q.1

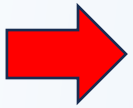
Q.9: Center of Mass and Center of Gravity

G11Advanced	Physics\(Bridge)	PHY-C-101	الفيزياء(بريدج)	الصف الحادي عشر المتقدم	T3-(2023-2024)

متى يمكننا اعتبار أن مركز الكتلة هو مركز الجاذبية(الثقل) للجسم؟

When can we consider that the center of mass is the center of gravity of the body?

When gravitational force is not constant everywhere throughout the object.	عندما تكون قوة الجاذبية غير ثابتة على جميع أجزاء الجسم.
When the density is not constant.	عندما تكون الكثافة غير ثابتة لجميع أجزاء الجسم.
When the object is irregularly shaped.	عندما يكون شكل الجسم غير منتظم.
When gravitational force is constant everywhere throughout the object.	عندما تكون قوة الجاذبية ثابتة على جميع أجزاء الجسم.



L.O: Define the center of mass (Center of gravity).

الكثافة الكتلية للجسم ثابتة

- If an object mass density is constant (**uniform mass density)**, the center of mass (center of gravity) is located in the geometrical center of the object.

المركز الهندسي للجسم.

- Thus, for most objects in everyday experience, it is a reasonable first guess that the center of gravity is in the middle of the object.

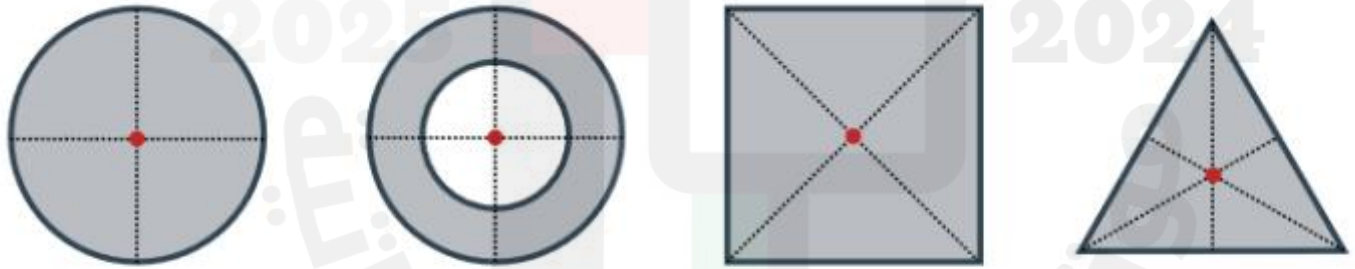


Figure 1: Center of mass for some simple geometric shapes (red dots).

L.O: Define the center of mass (Center of gravity).

WS # 1 / Q.2

What is the definition of center of mass?

- ❑ A point on the body into which part of the body's mass is embedded.
- ❑ A point on the body at which part of the body's mass is dissipated.
- ❑ A point on a body where all the body's mass is concentrated.
- ❑ A point on the body where part of the body's mass is concentrated.

ما تعريف مركز الكتلة؟

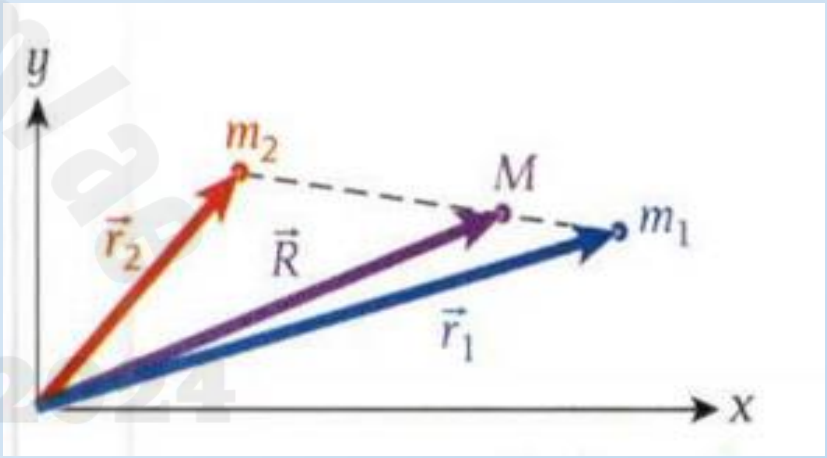
- ❑ نقطة على الجسم تندمج فيها جزء من كتلة الجسم.
- ❑ نقطة على الجسم تتبدد فيها جزء من كتلة الجسم.
- ❑ نقطة على الجسم تتركز فيها كتلة هذا الجسم كلها.
- ❑ نقطة على الجسم تتركز فيها جزء من كتلة الجسم.

L.O: Find the center of mass for two objects.

Combined Center of Mass for Two Objects

We have a general formula for calculating the location of the center of mass $\vec{R}$ for two masses $\mathbf{m_1}$ and $\mathbf{m_2}$ located at positions $\vec{r}_1$ and $\vec{r}_2$ in a coordinate system:

$$\vec{R} = \frac{\vec{r}_1 m_1 + \vec{r}_2 m_2}{m_1 + m_2}$$

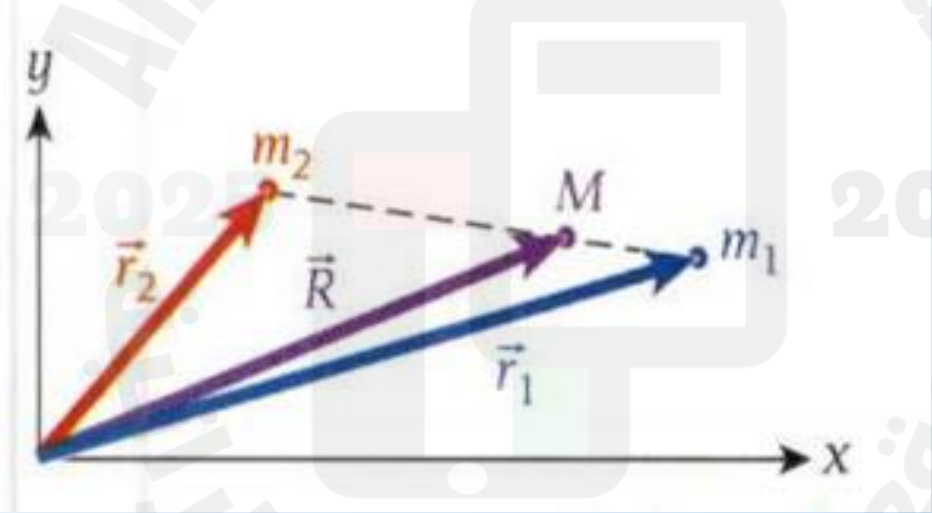


Note that we can immediately write vector equation 8.1 in Cartesian coordinates as follows:

$$X = \frac{x_1 m_1 + x_2 m_2}{m_1 + m_2} \qquad Y = \frac{y_1 m_1 + y_2 m_2}{m_1 + m_2} \qquad Z = \frac{z_1 m_1 + z_2 m_2}{m_1 + m_2}$$

Note:

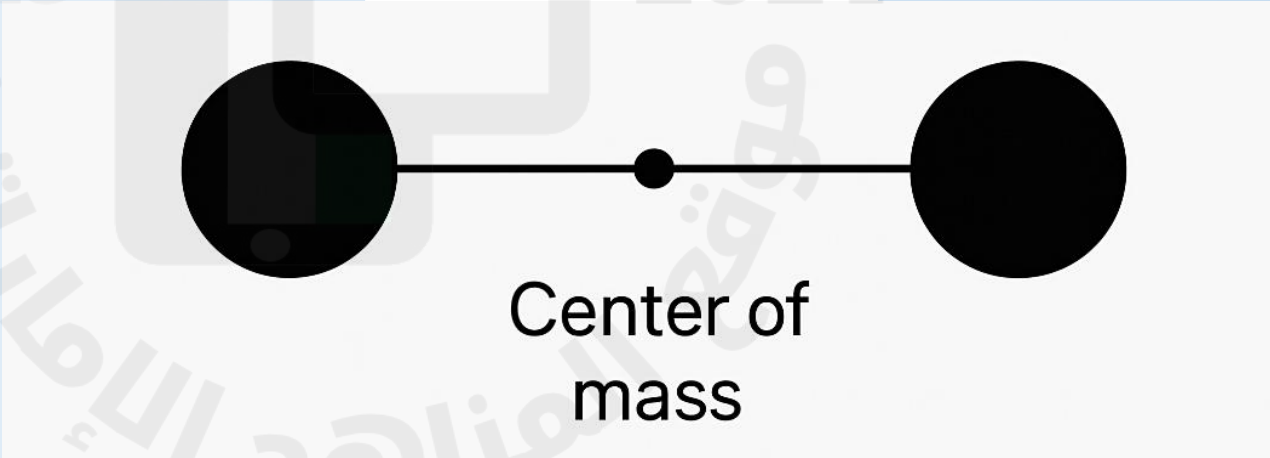
- The center of mass of this system always lies on the line connecting the two bodies.



WS # 1 / Q.3

If we have two identical objects of equal mass and want to find the center of mass for the combination of the two, Where do you expect the center of mass to be located for these two objects?

The center of mass will be exactly midway between the individual centers of mass of the two objects.



L.O: Find the center of mass of two objects.

WS # 1 / Q.4

If one of the two objects is more massive, Where do you expect the center of mass to be located for these two objects?

The center of mass for the combination is closer to the more massive one.

$$\vec{R} = \frac{\vec{r}_1 m_1 + \vec{r}_2 m_2}{m_1 + m_2}$$

L.O: Find the center of mass of two objects.

WS # 1 / Q.5

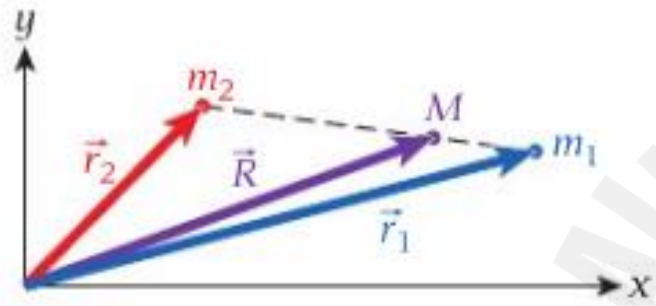


FIGURE 8.2 Location of the center of mass for a system of two masses m_1 and m_2, where $M = m_1 + m_2$.

Concept Check 8.1

In the case shown in Figure 8.2, what are the relative magnitudes of the two masses m_1 and m_2?

a) $m_1 < m_2$

b) $m_1 > m_2$

c) $m_1 = m_2$

d) Based solely on the information given in the figure, it is not possible to decide which of the two masses is larger.

Center of mass will be closer to the heavier object.

L.O: Find the center of mass of two objects.

The center of mass of the Sun and Jupiter is located

a) exactly at the center of the Sun.

b) near the center of the Sun.

c) exactly at the center of Jupiter.

d) near the center of Jupiter.

e) halfway between the Sun and Jupiter.

WS # 1 / Q.6

Mass of the sun greater than mass of the Jupiter

WS # 1 / Q.7

How is the body mass density such that the body mass is not located at the geometric center of the body?

a) Heterogeneous
b) Constant mass density
c) Large mass density
d) Small mass density

كيف تكون الكثافة الكتلية لجسم بحيث لا يقع مركز كتلة الجسم في الجسم في المركز الهندسي للجسم؟

- ❑ ستكون غير متجانسة.
- ❑ ستكون ثابتة.
- ❑ ستكون كبيرة.
- ❑ ستكون صغيرة.

WS # 1 / Q.8

The center of mass of an irregular rigid object is *always* located

a) at the geometrical center of the object.
b) somewhere within the object.
c) both of the above.
d) none of the above

يقع مركز كتلة الجسم الصلب غير المنتظم دائما:

1) عند المركز الهندسي للجسم.
2) مكان ما داخل الجسم.
3) كلاهما.
4) لا شيء مما سبق

L.O: Find the center of mass of two objects.

WS # 2 :

Write the formula for calculating the location of the center of mass for two masses.

$$\vec{R} = \frac{\vec{r}_1 m_1 + \vec{r}_2 m_2}{m_1 + m_2}$$

$$X = \frac{x_1 m_1 + x_2 m_2}{m_1 + m_2} \qquad Y = \frac{y_1 m_1 + y_2 m_2}{m_1 + m_2} \qquad Z = \frac{z_1 m_1 + z_2 m_2}{m_1 + m_2}$$

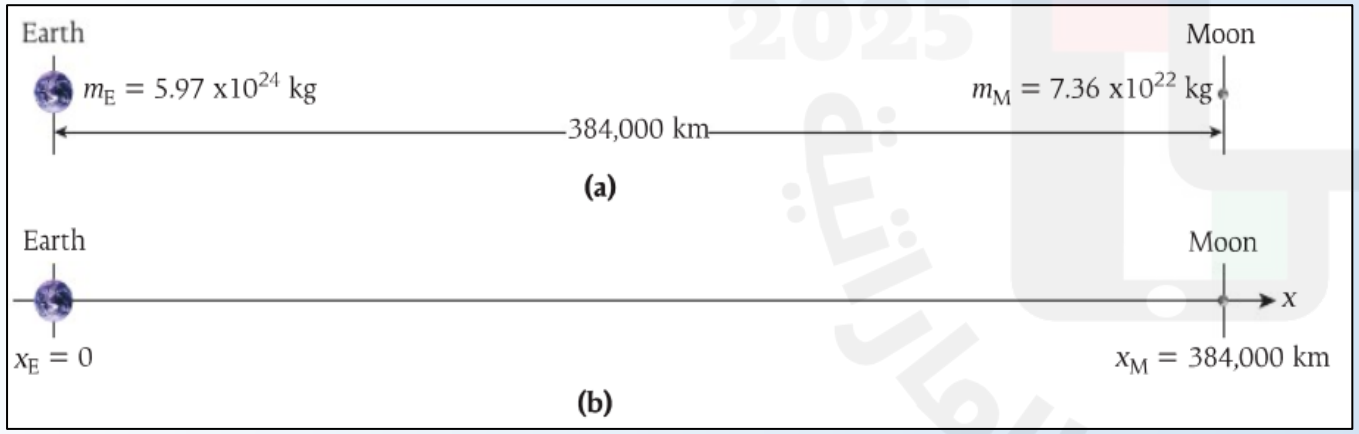
Example page 227:

The Earth has a mass of $5.97\,x\,10^{24}$ kg, and the Moon has a mass of $7.36\,x\,10^{22}$ kg. The Moon orbits the Earth at a distance of 384,000 km; that is, the center of the Moon is a distance of 384,000 km from the center of Earth, as shown in Figure 8.3a.

PROBLEM

How far from the center of the Earth is the center of mass of the Earth-Moon system?

THINK The center of mass of the Earth-Moon system can be calculated by taking the center of the Earth to be located at $x = 0$ and the center of the Moon to be located at $x = 384{,}000$ km. The center of mass of the Earth-Moon system will lie along a line connecting the center of the Earth and the center of the Moon (as in Figure 8.3a).



$$X = \frac{x_1 m_1 + x_2 m_2}{m_1 + m_2}$$

$$X = \frac{(0 \times 5.97 \times 10^{24}) + (384{,}000 \times 7.36 \times 10^{22})}{5.97 \times 10^{24} + 7.36 \times 10^{22}}$$

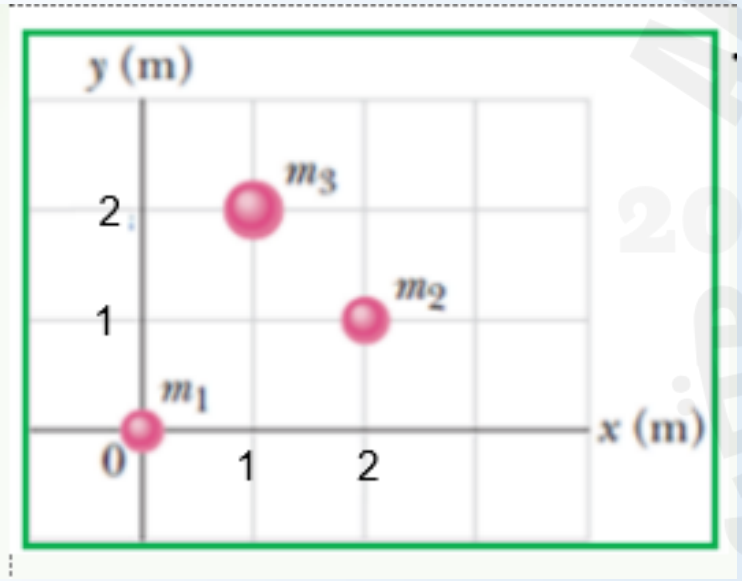
$$X = 4676.4\ Km$$

Answer:
4680 Km

L.O: Identify the location of the center of mass for a system of many masses.

WS # 2 / Q.1

Use the following figure to find the center of mass vector.
(m_1=2.0 Kg , m_2=6.0 Kg , m_3=8.0 Kg)



$(1.2\hat{x} - 1.47\hat{y})m$ ❐ $(1.43\hat{x} + 1.57\hat{y})m$ ❐

$(1.43\hat{x} - 1.36\hat{y})m$ ❐ $(1.25\hat{x} + 1.375\hat{y})m$ ❐

$$X = \frac{x_1m_1 + x_2m_2 + x_3m_3}{m_1 + m_2 + m_3} = \frac{(0\times2)+(2\times6)+(1\times8)}{2+6+8} = 1.25 \text{ m}$$

$$Y = \frac{y_1m_1 + y_2m_2 + y_3m_3}{m_1 + m_2 + m_3} = \frac{(0\times2)+(1\times6)+(2\times8)}{2+6+8} = 1.375 \text{ m}$$

L.O: Identify the location of the center of mass for a system of many masses.

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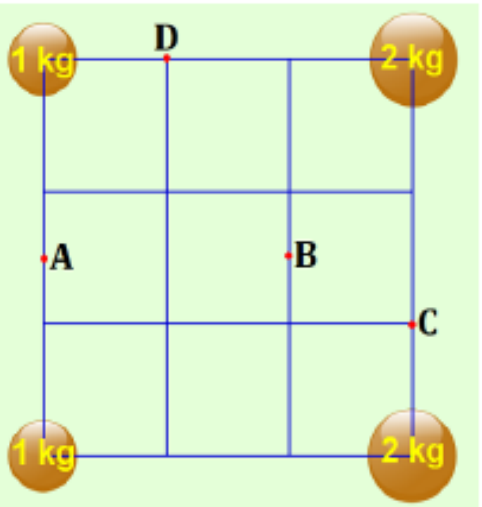


اعتماداً على تعريف مركز الكتلة، أي من النقاط على الشكل تعتبر مركز الكتلة للمجموعة المكونة من أربع كرات متجانسة من نفس المادة؟

Based on the definition of the center of mass, which point on the figure is the center of mass of the set of four homogeneous balls of the same material?

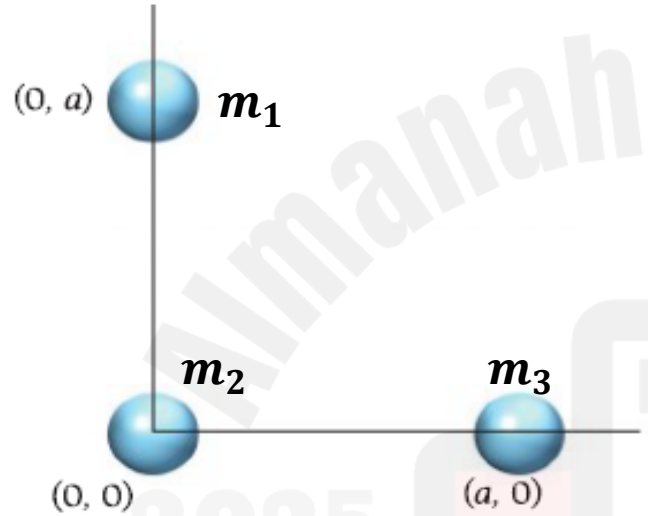
WS # 2 / Q.2

- ❑A
- ❑B
- ❑C
- ❑D

L.O: Identify the location of the center of mass for a system of many masses.

(Q 58 page 252)

Three identical balls of mass m are placed in the configuration shown in the figure. Find the location of the center of mass.



WS # 2 / Q.3

$$X = \frac{x_1m_1+x_2m_2+x_3m_3}{m_1+m_2+m_3}$$

$$= \frac{(0\times m)+(0\times m)+(a\times m)}{m+m+m} =$$

$$= \frac{am}{3m} = \frac{a}{3}$$

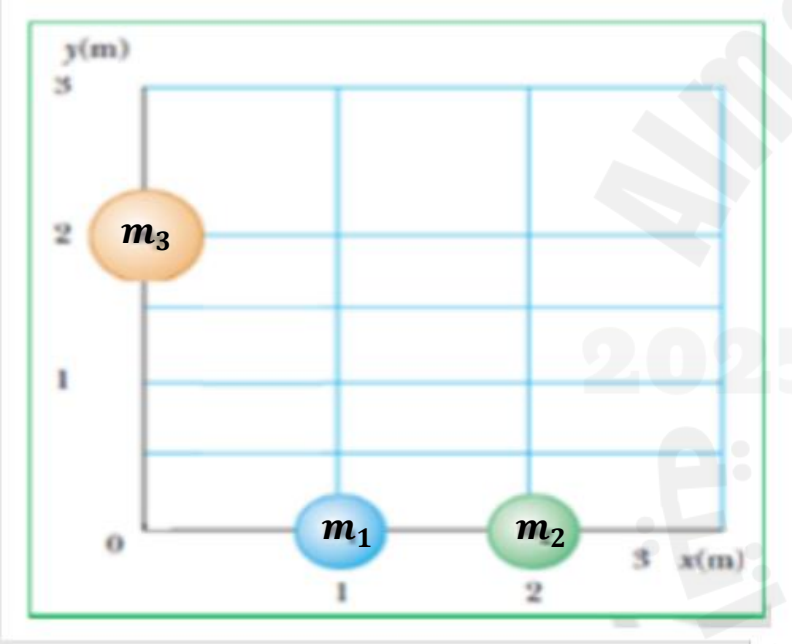
$$Y = \frac{y_1m_1+y_2m_2+y_3m_3}{m_1+m_2+m_3} = \frac{(a\times m)+(0\times m)+(0\times m)}{m+m+m} = \frac{am}{3m} = \frac{a}{3}$$

$$\vec{R} = (X, Y) = (\frac{a}{3}, \frac{a}{3})$$

L.O: Identify the location of the center of mass for a system of many masses.

WS # 2 / Q.4

The center of mass vector $\vec{R} = 0.5\hat{x} + 1.37\hat{y}$, if $m_1 = 2kg$, $m_2 = 3kg$. **Use the following figure to calculate m_3.**



$$X = \frac{x_1m_1 + x_2m_2 + x_3m_3}{m_1 + m_2 + m_3}$$

$$0.5 = \frac{(1 \times 2) + (2 \times 3) + (0 \times m_3)}{2 + 3 + m_3}$$

$$0.5 = \frac{8}{2 + 3 + m_3}$$

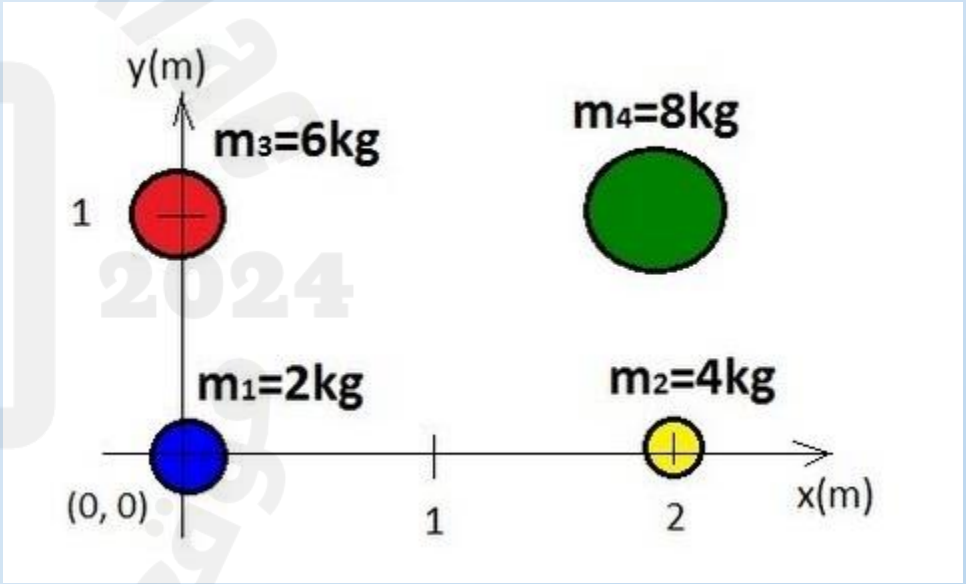
$$m_3 = 11 \text{ Kg}$$

WS # 3 / Q.1

Based on the adjacent figure, determine the coordinates of the center of mass for the group of objects in the figure.

$$X = \frac{x_1m_1+x_2m_2+x_3m_3+x_4m_4}{m_1+m_2+m_3+m_4}$$

$$X = \frac{(0\times2)+(2\times4)+(0\times6)+(2\times8)}{2+4+6+8} = 1.2 \text{ m}$$



$$Y = \frac{y_1m_1+y_2m_2+y_3m_3+y_4m_4}{m_1+m_2+m_3+m_4}$$

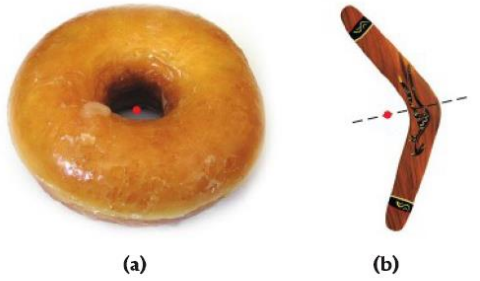
$$Y = \frac{(0\times2)+(0\times4)+(1\times6)+(1\times8)}{2+4+6+8} = 0.7 \text{ m}$$

$$\vec{R} = (X, Y) = (1.2, 0.7) \text{ m}$$

Question 2:

WS # 3 / Q.2

8.20 Can the center of mass of an object be located at a point outside the object, that is, at a point in space where no part of the object is located? Explain.



Yes, the center of mass can be located outside the object. Take a donut for example. If the donut has a uniform mass density, then the center of mass is located at its geometric center, which would be the center of a circle. However, at the donut's center, there is no mass, there is a hole. This means the center of mass can lie outside the object.

Important note:

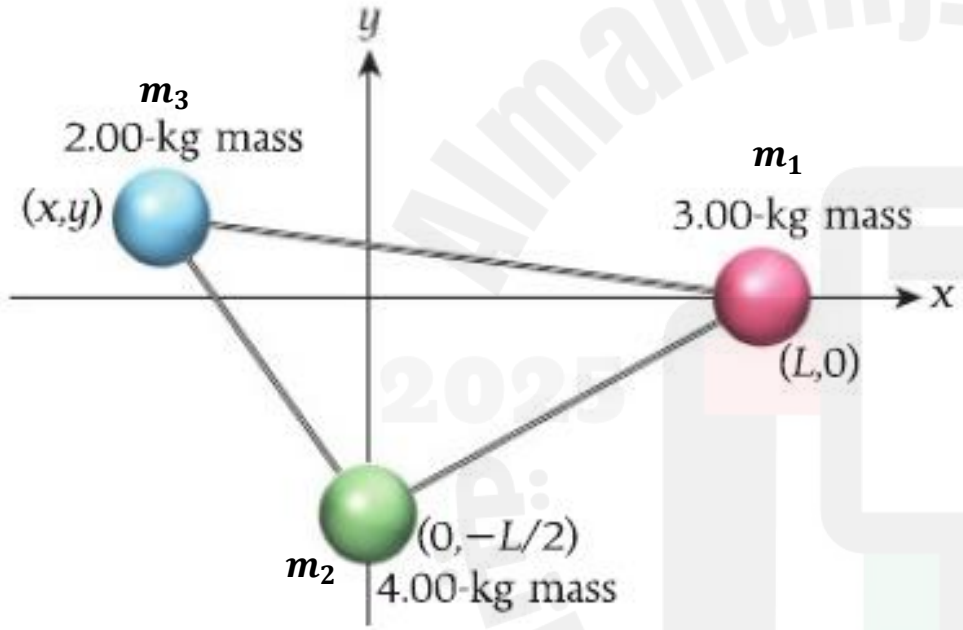
Note that the center of mass of an object does not always have to be located inside the object. Two obvious examples are shown in Figure 8.21. From symmetry considerations, it follows that the center of mass of the donut (Figure 8.21a) is exactly in the center of its hole, at a point outside the donut. The center of mass of the boomerang (Figure 8.21b) lies on the dashed symmetry axis but, again, outside the object.

(a) (b)

Question 3:

WS # 3 / Q.3

The coordinates of the center of mass for the extended object shown in the figure are $(L/4, -L/5)$. What are the coordinates of the 2.00-kg mass?



$$X = \frac{x_1m_1+x_2m_2+x_3m_3}{m_1+m_2+m_3}$$

$$Y = \frac{y_1m_1+y_2m_2+y_3m_3}{m_1+m_2+m_3}$$

$\left(-\frac{3L}{8}, \frac{L}{10}\right)$

$X = \frac{x_1m_1 + x_2m_2 + x_3m_3}{m_1+m_2+m_3}$

$\frac{L}{4} = \frac{3L + 0 + 2x_3}{9}$

$\frac{9L}{4} = 3L + 2x_3$

$\frac{9L}{4} - 3L = 2x_3$

$\frac{-3L}{4} = 2x_3$

$x_3 = -\frac{3L}{8}$

$Y = \frac{y_1m_1 + y_2m_2 + y_3m_3}{m_1+m_2+m_3}$

$\frac{-L}{5} = \frac{0 + \left(-\frac{L}{2} \times 4\right) + 2y_3}{9}$

$\frac{-9L}{5} = -2L + 2y_3$

$\frac{-9}{5}L + 2L = 2y_3$

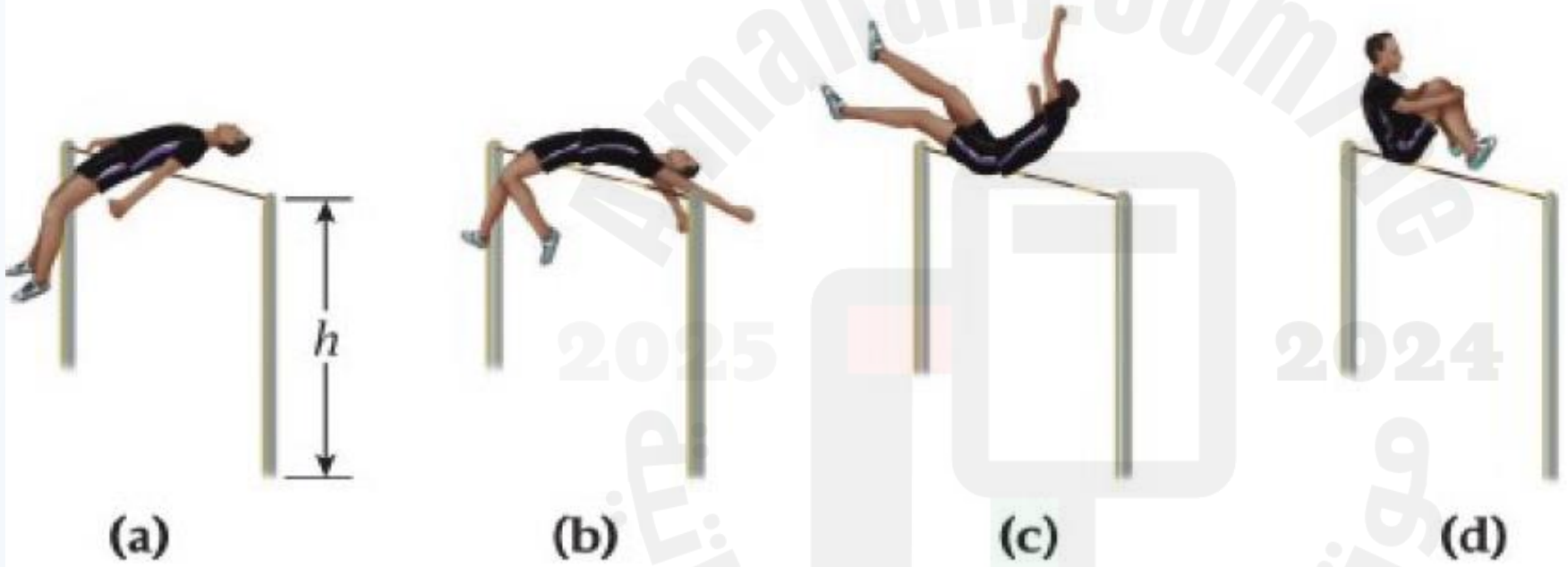
$2y_3 = \frac{1}{5}L$

$y_3 = \frac{L}{10}$

Question 4:

WS # 3 / Q.4

8.7 The figures show a high jumper using different techniques to get over the crossbar. Which technique would allow the jumper to clear the highest setting of the bar?



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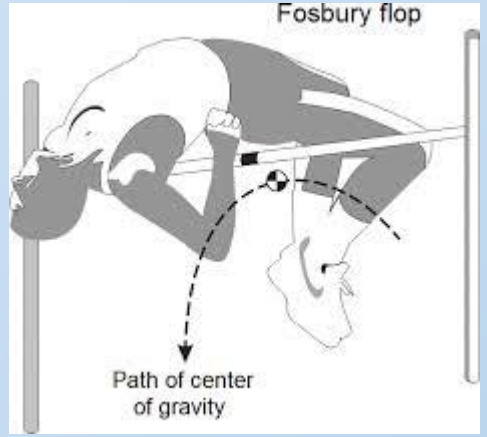
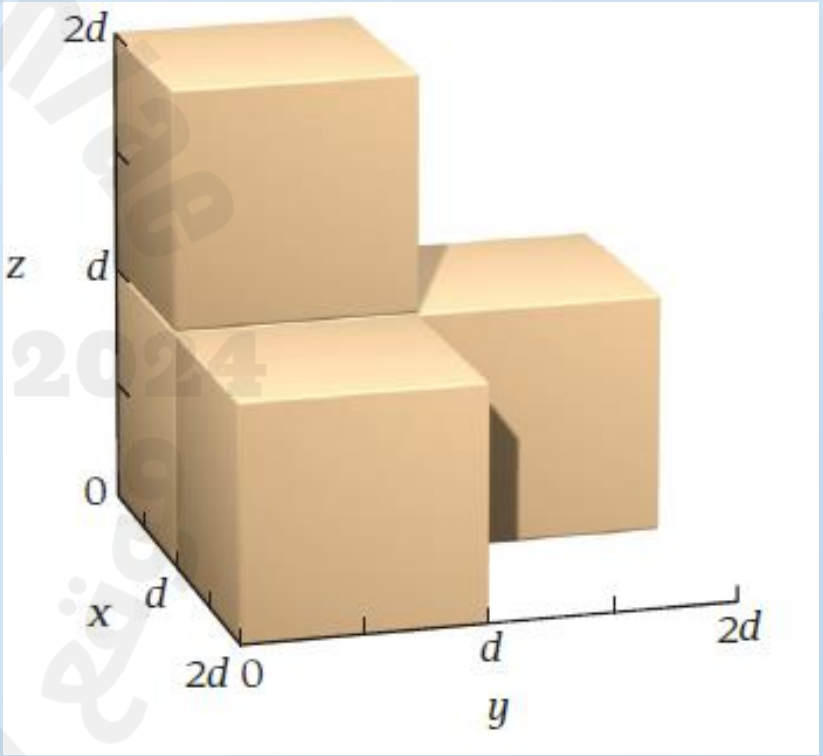
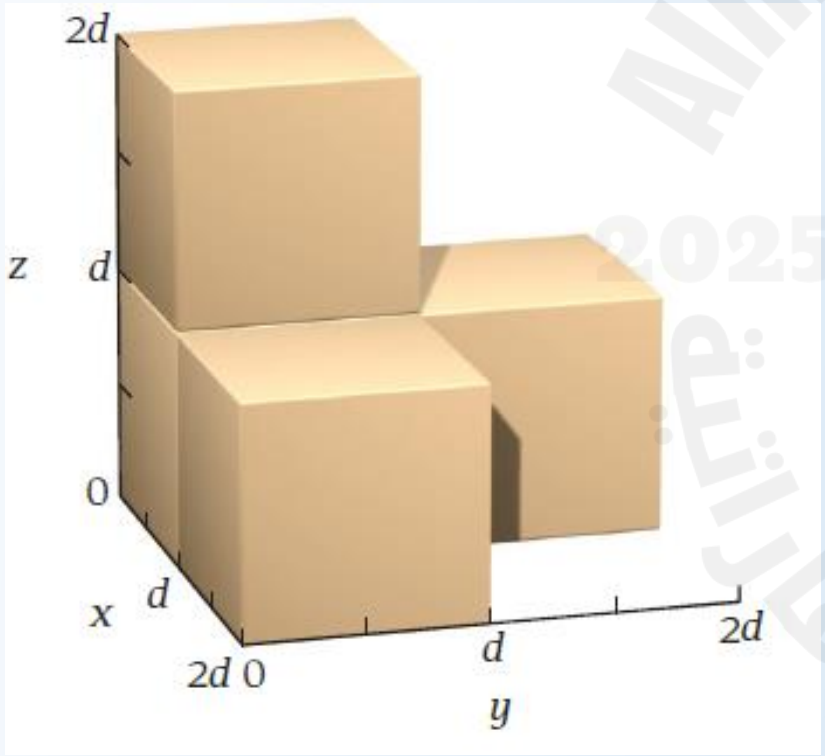


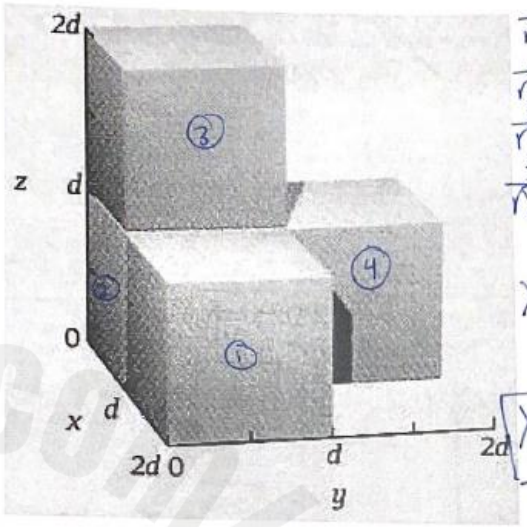
Q.18 – Textbook:

8.18 Find the center of mass of the arrangement of uniform identical cubes shown in the figure. The length of the sides of the each cube is d.



8.18 Find the center of mass of the arrangement of uniform identical cubes shown in the figure. The length of the sides of the each cube is d.





$\vec{r}_1 = (1.5d, 0.5d, 0.5d)$

$\vec{r}_2 = (0.5d, 0.5d, 0.5d)$

$\vec{r}_3 = (0.5d, 0.5d, 1.5d)$

$\vec{r}_4 = (0.5d, 1.5d, 0.5d)$

$$X = \frac{1.5dm + 0.5dm + 0.5dm + 0.5dm}{4m}$$

$$\boxed{X = \frac{3d}{4}}$$

$$Y = \frac{0.5dm + 0.5dm + 0.5dm + 1.5dm}{4m}$$

$$\boxed{Y = \frac{3d}{4}}$$

$$Z = \frac{0.5dm + 0.5dm + 1.5dm + 0.5dm}{4m}$$

$$\boxed{Z = \frac{3d}{4}}$$

$$\vec{R} = \left(\frac{3d}{4}, \frac{3d}{4}, \frac{3d}{4}\right)$$