

ورقة عمل شرح وتدريبات درس السرعة والتمثيل البياني للحركة



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المزيد من مادة
فيزياء:

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التواصل الاجتماعي بحسب الصف التاسع المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف التاسع المتقدم والمادة فيزياء في الفصل الأول

شرح وتدريبات درس تصوير الحركة

1

اختبار الوحدة الثانية تمثيل الحركة

2

شرح منحنيات الموقع والزمن وتمثيل الحركة

3

ماكس بلانك في الفيزياء

4

شرح درس الرسوم البيانية للموقع-الزمن

5

تحميل تطبيق المناهج للهواتف الذكية

تطبيق المناهج على Play Google (أندرويد)

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ACADEMIC SUPPORT · PHYSICS

How Fast?

Unit 2 — Representing Motion | Section 4

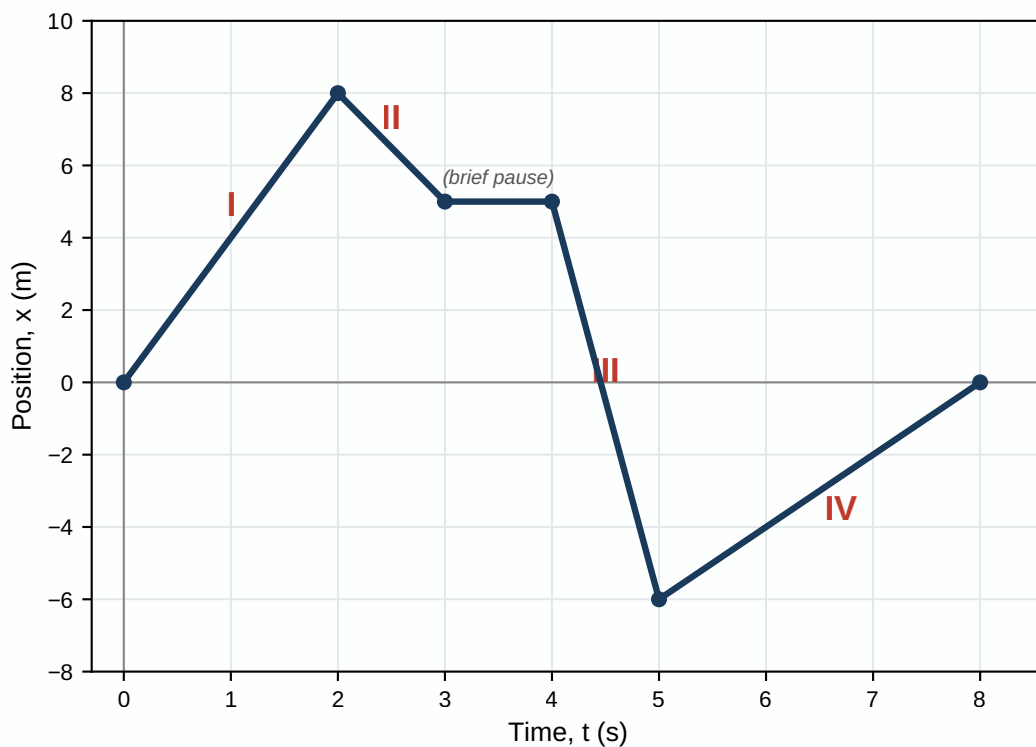
Grade Level	9 Advanced
Semester	First Semester
Topics Covered	Average speed · Average vector velocity · Instantaneous speed · Slope of a position–time graph · Equation of motion at constant velocity
Document Type	Explanatory & Assessment Worksheet
Prepared by	Dr. Hamza Shehadeh

1 Speed as the Slope of a Position–Time Graph

On a position–time graph, the **slope** of the line between two points gives the **average velocity** for that interval. The steeper the slope, the greater the speed.

Worked Example

The graph below shows an object's motion in four stages.



Position–time graph of an object moving through four stages, I–IV.

Stage	Slope calculation	Average vector velocity	Average speed
I	$(8 - 0) / (2 - 0)$	+4 m/s	4 m/s
II	$(5 - 8) / (3 - 2)$	–3 m/s	3 m/s
III	$(-6 - 5) / (5 - 4)$	–11 m/s	11 m/s
IV	$(0 - (-6)) / (8 - 5)$	+2 m/s	2 m/s

Ranking the four stages by speed (fastest to slowest):

Stage III > Stage I > Stage II > Stage IV ($11 > 4 > 3 > 2$ m/s)

Total distance travelled (sum of the magnitude of each stage's change in position):

Distance = $8 + 3 + 0 + 11 + 6 = \mathbf{28\ m}$

Average speed over the full 8 s:

Average speed = Distance $\div$ Time = $28 \div 8 = 3.5 \text{ m/s}$

Total displacement:

$\Delta x = x_f - x_i = 0 - 0 = 0 \text{ m}$ (check: $+8 - 14 + 6 = 0$)

Average vector velocity over the full 8 s:

Average velocity = Displacement $\div$ Time = $0 \div 8 = 0 \text{ m/s}$

Average Vector Velocity vs. Average Scalar Speed**Average vector velocity, v**

- Has magnitude **and** direction — a vector quantity
- + sign: to the right / North
- – sign: to the left / South
- If the object returns to its starting point, average velocity = 0

$$v = \Delta x / \Delta t$$

displacement $\div$ time interval

Average scalar speed, v

- Magnitude only — a scalar quantity
- Always positive

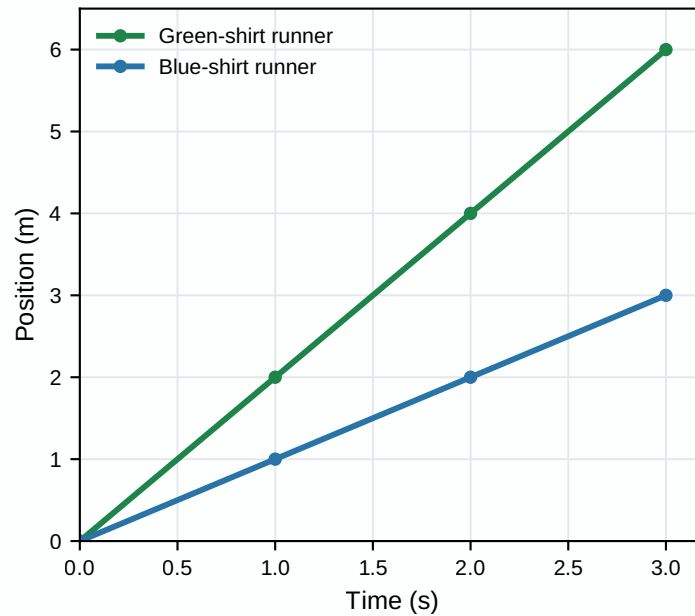
$$v = \text{distance} / \text{time}$$

total path length $\div$ time interval

When are they equal? Average speed equals the magnitude of average velocity only when **distance = displacement** — that is, when the object moves along a straight line in a single direction, with no reversal.

Worked Example

Calculate the speed of each runner shown in the graph below.



Blue-shirt runner: $v = (3.0 - 0) / (3.0 - 0) = 1.0 \text{ m/s}$

Green-shirt runner: $v = (6.0 - 0) / (3.0 - 0) = 2.0 \text{ m/s}$

2 Interpreting Position–Time Graphs & the Equation of Motion

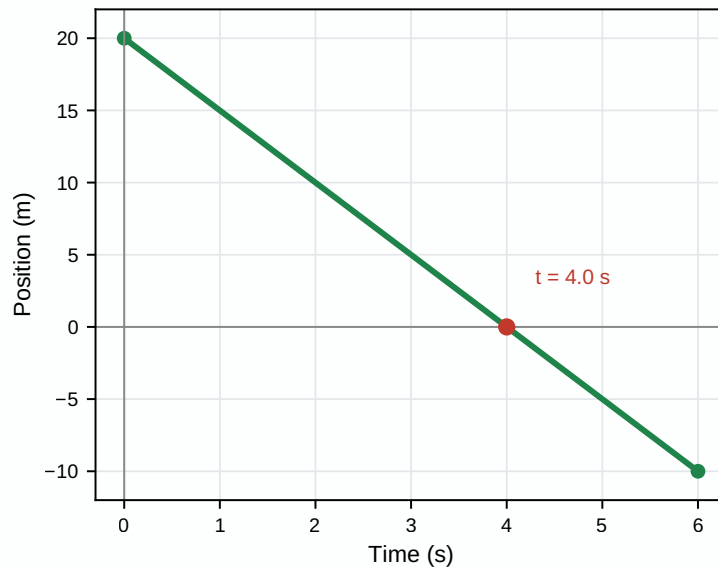
$$x_f = vt + x_i$$

Position–time equation for motion at constant velocity (matches the slope–intercept form $y = mx + b$)

Graph term	y	m	x	b
Physical meaning	Position, x	Slope, v	Time, t	Initial position, x_i

Worked Example

Describe the object's motion in the graph below. The object started at position 20 m and moved with constant velocity, reaching the origin at $t = 4 \text{ s}$, then continued moving in the same direction.



When did the object reach the origin? **t = 4.0 s**

Average vector velocity:

$$v = (0 - 20) / (4 - 0) = \mathbf{-5 \text{ m/s}}$$

Average scalar speed: **5 m/s**

Equation of motion:

$$x_f = vt + x_i \rightarrow \mathbf{x_f = -5t + 20}$$

When does the object reach position **-100 m**, assuming it keeps the same velocity?

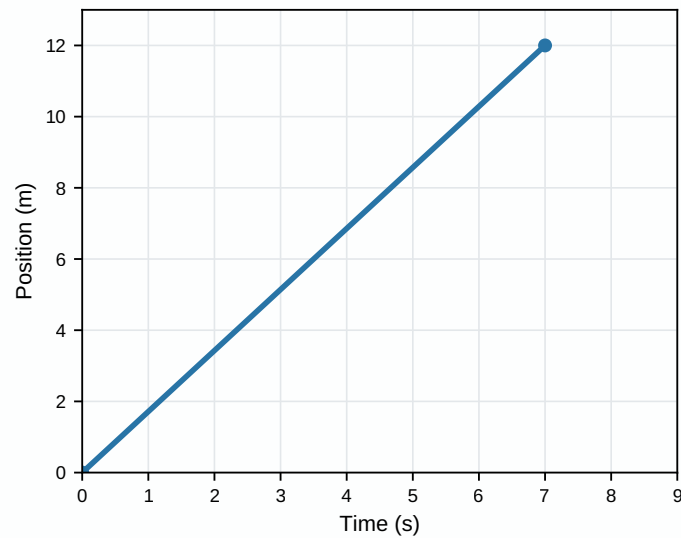
$$-100 = -5t + 20 \rightarrow \mathbf{t = 24 \text{ s}}$$

What is the object's position at **t = 9 s**?

$$x_f = -5(9) + 20 = \mathbf{-25 \text{ m}}$$

Worked Example

Describe the object's motion in the graph below. The object started at the origin and moved with constant velocity in the positive direction.



Average vector velocity:

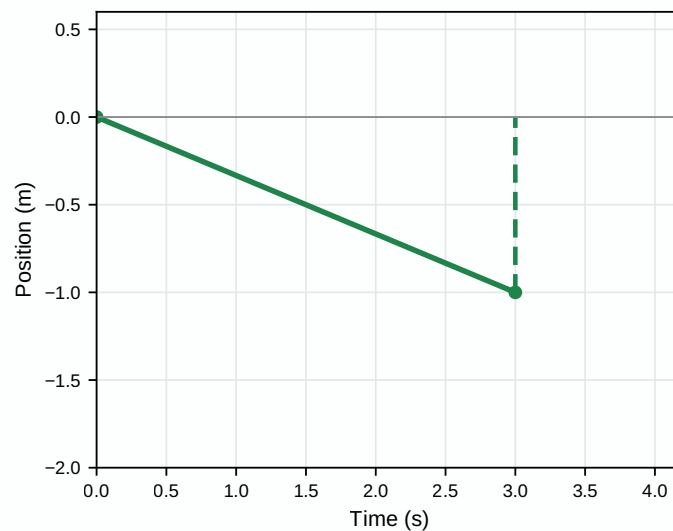
$$v = \text{slope} = (12.0 - 0) / (7.0 - 0) = \mathbf{1.7 \text{ m/s}}$$

Average scalar speed: $\mathbf{1.7 \text{ m/s}}$

Equation of motion: $\mathbf{x_f = 1.7t}$

Worked Example

Describe the object's motion in the graph below. The object started at the origin and moved with constant velocity in the negative direction.



Average vector velocity:

$$v = \text{slope} = (-1 - 0) / (3 - 0) = \mathbf{-1/3 \text{ m/s}}$$

Average scalar speed: **1/3 m/s**

Equation of motion: **$x_f = -(1/3)t$**

Worked Example

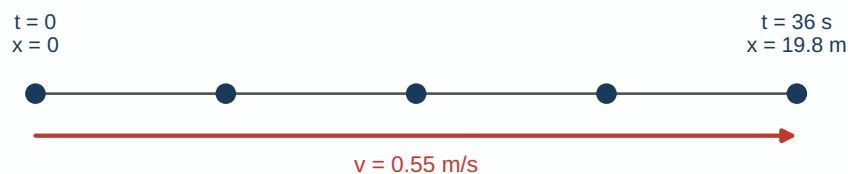
What is the average velocity of an object that moves from position 6.5 cm to position 3.7 cm, relative to the origin, over 2.3 s?

$$v = (x_f - x_i) / (t_f - t_i) = (3.7 - 6.5) / 2.3 = \mathbf{-1.22 \text{ cm/s}}$$

Average speed = **1.22 cm/s**

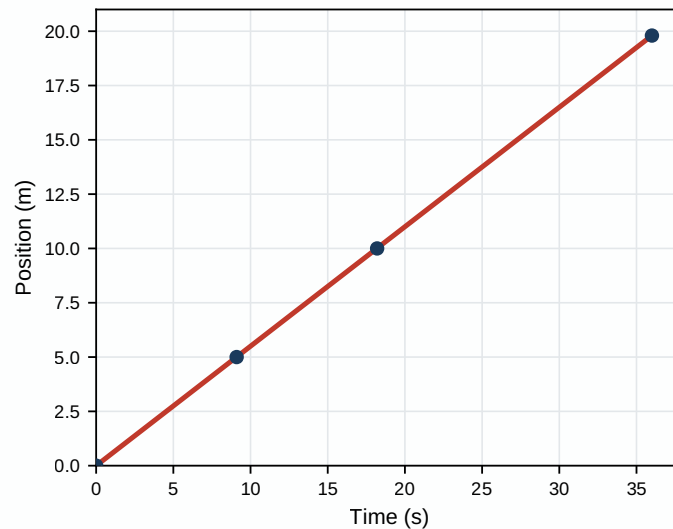
Worked Example

A bicycle set off at a constant speed of **0.55 m/s**. Draw a motion diagram and a position–time graph showing the bicycle covering a distance of 19.8 m.



Time (s)	0	9.1	18.2	36
Position (m)	0	5	10	19.8

$$\Delta t = \Delta x / v = 19.8 / 0.55 = \mathbf{36 \text{ s}}$$



3 Equation of Motion at Constant Velocity

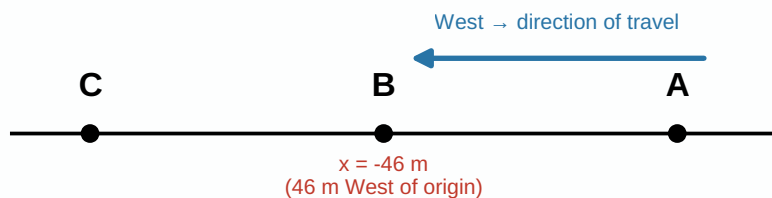
$$v = \Delta x / \Delta t$$

$$v = (x_f - x_i) / (t_f - t_i)$$

$$x_f = vt + x_i$$

Worked Example

The figure shows a motorcycle rider travelling **West** along a straight road. After passing point B, the rider continues at an average speed of **12 m/s West** and reaches point C after **3.0 s**. What is the position of point C?



$$x_i = -46 \text{ m}$$

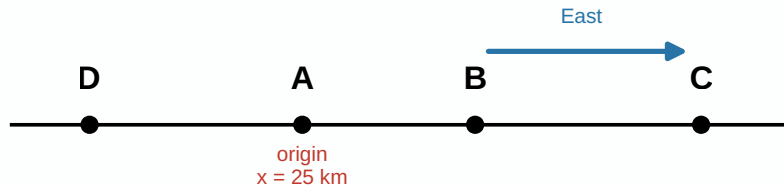
$$v = -12 \text{ m/s}$$

$$t = 3.0 \text{ s}$$

$$x_f = x_i + vt = -46 + (-12)(3.0) = \mathbf{-82 \text{ m (i.e. 82 m West of the origin)}}$$

Worked Example

The diagram shows the path of a ship sailing at **42 km/h East**. What is the ship's position when it reaches point C, relative to starting point A, if it sailed from point B to point C in **1.5 h**?



$$x_i = 25 \text{ km}$$

$$v = +42 \text{ km/h}$$

$$t = 1.5 \text{ h}$$

$$x_f = x_i + vt = 25 + 42(1.5) = \mathbf{88 \text{ km}}$$

What would the ship's position be if it had instead started from point B and sailed at an average speed of **35 km/h West** to point D over a period of **1.2 h**?

$$x_i = 25 \text{ km}$$

$$v = -35 \text{ km/h}$$

$$t = 1.2 \text{ h}$$

$$x_f = x_i + vt = 25 + (-35)(1.2) = \mathbf{-17 \text{ km (i.e. 17 km West)}}$$

**Practice Questions**

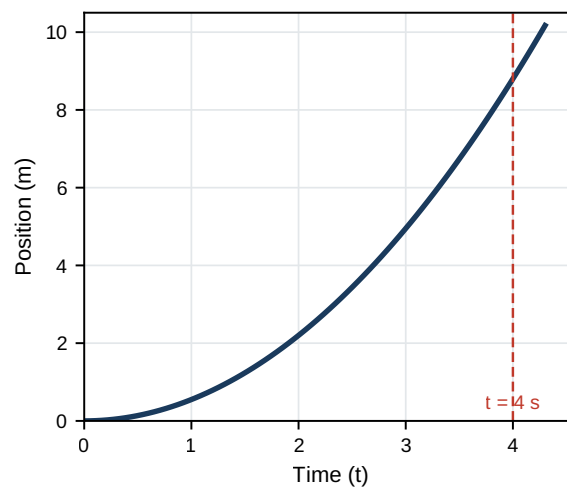
Section 4: Speed — Unit 2: Representing Motion

Question 1

The change in position divided by the time interval in which this change occurred is called the ...

Question 2

Based on the adjacent graph, the speed of the object at $t = 4$ s is ...



Question 3

Based on the data in the table below, what is the magnitude of the average vector velocity of the toy car's motion during the first 12 s?

t (s)	0.0	3.0	5.0	9.0	12
x (cm)	+50	+20	0.0	-15	-30

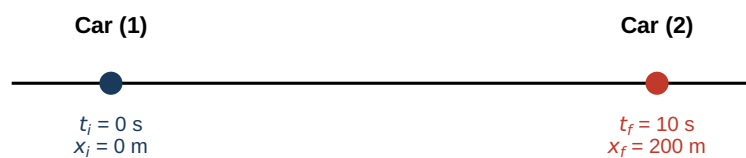
Question 4

A mouse moves along a straight line. Find the mouse's position relative to the origin if it moves at 12.8 m/s North for a period of 3.10 s.

Question 5

The figure below shows a car moving along a straight line. Calculate:

- 1– the car's displacement,
- 2– the time interval,
- 3– the average vector velocity.



Question 6

A car is driven at 97 km/h for three hours, then at 72 km/h for another three hours. What is the magnitude of its average vector velocity?

Question 7

What is the magnitude of the average vector velocity of an object that moved from position 6.5 m to position 3.5 m relative to the origin, in a time of 3.0 s?

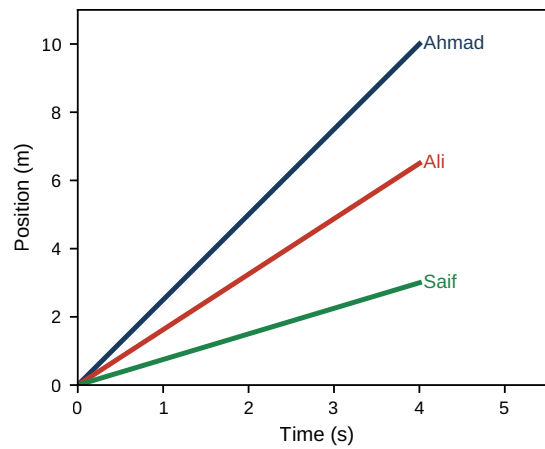
Question 8

An object moves along a straight line according to the relation $x = 12 + 5t$, where distance is measured in metres and time in seconds. Find the magnitude of:

- the object's velocity _____
- the object's initial position _____
- the object's position at $t = 6$ s _____
- the time for the object to reach position 60 m _____

Question 9

Based on the adjacent position–time graph, which of the following statements is correct?



$$v_{\text{Ali}} > v_{\text{Ahmad}} > v_{\text{Saif}}$$

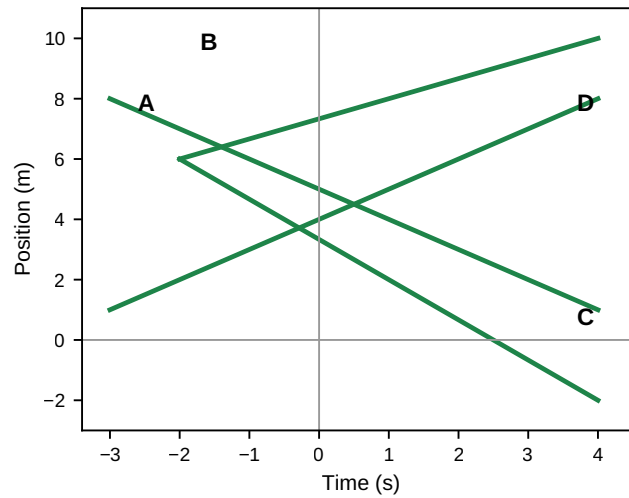
$$v_{\text{Ahmad}} > v_{\text{Ali}} > v_{\text{Saif}}$$

$$v_{\text{Saif}} = v_{\text{Ali}} = v_{\text{Ahmad}}$$

$$v_{\text{Saif}} > v_{\text{Ali}} > v_{\text{Ahmad}}$$

Question 10

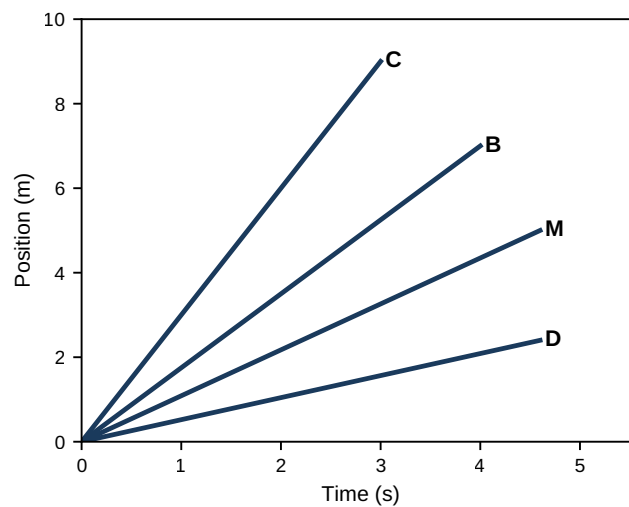
Based on the adjacent position–time graph:



- Rank the objects by initial position, from the largest positive to the largest negative.
- Rank the objects by their initial distance from the origin.
- Rank the objects by their average speed.

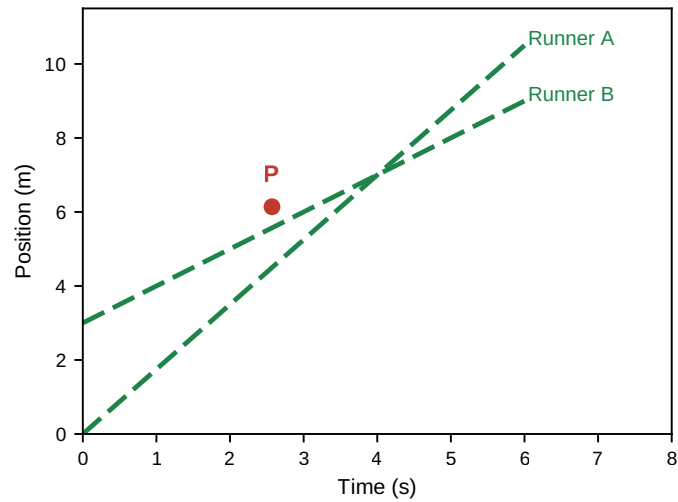
Question 11

Based on the adjacent position–time graph, rank the objects by their average vector velocity.



Question 12

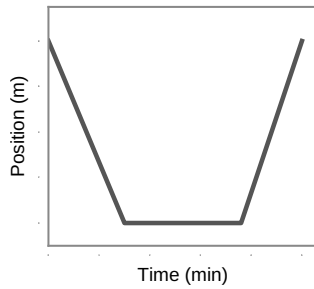
The adjacent figure shows a graph for two people practicing running.



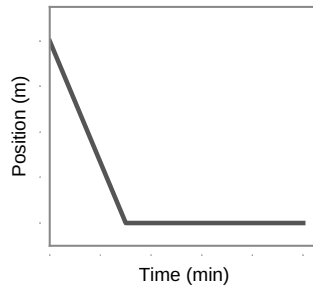
- **(a)** Describe the position of Runner A compared with Runner B at the point where they intersect the y-axis.
- **(b)** Who is the faster runner?
- **(c)** What happens at point P, and after it?

Question 13

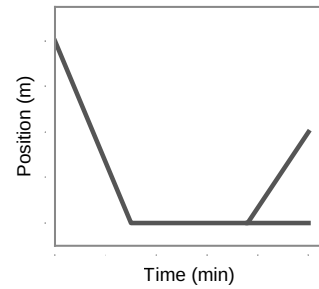
A squirrel descends from a tree 8 m tall at a constant speed within 1.5 min. It then remains at the base of the tree for 2.3 min. A loud noise causes it to climb back to the exact branch it started from within 0.1 min. Ignoring the brief speeding-up and slowing-down phases, which position–time graph best represents the squirrel's motion?



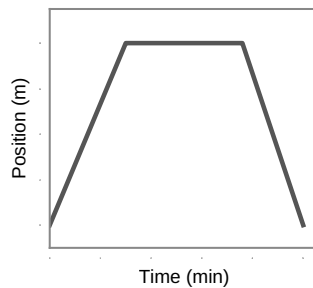
A



B



C



D

Question 14

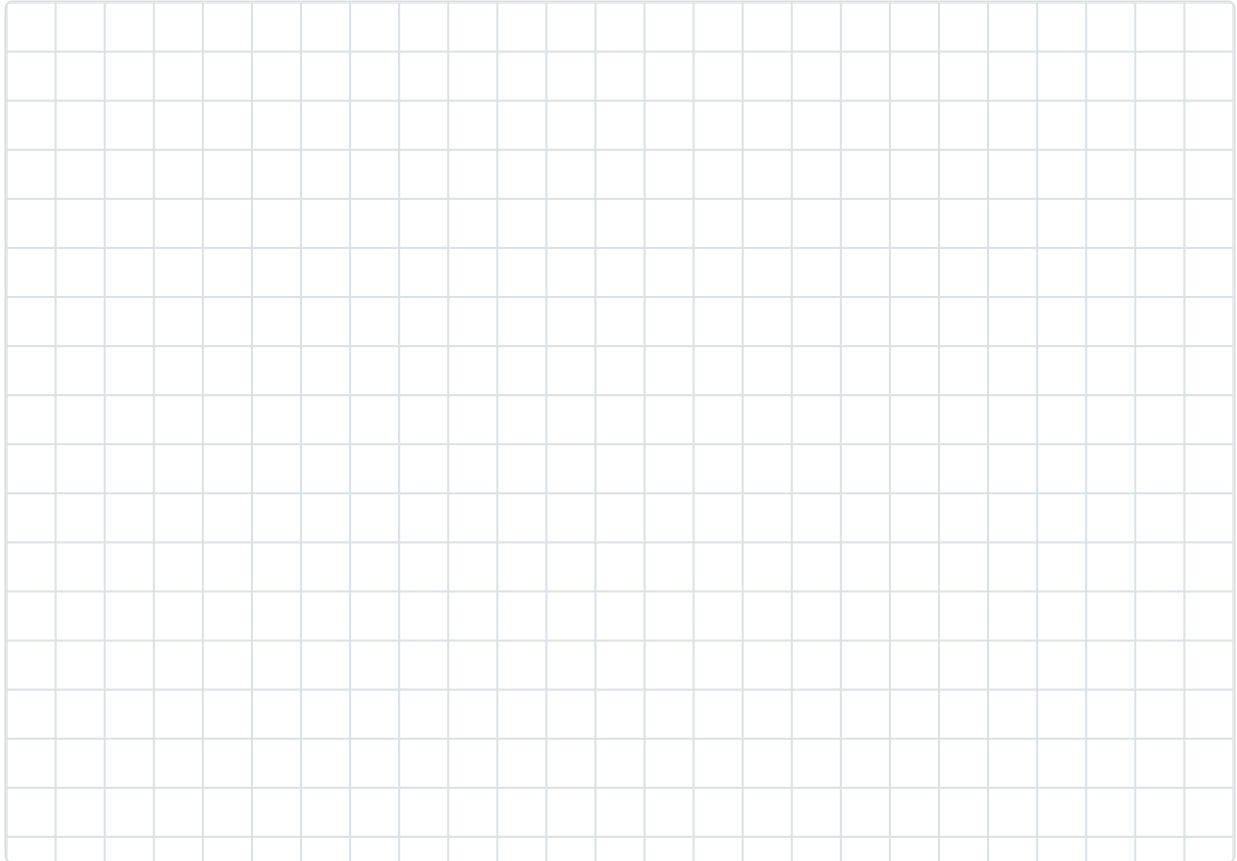
An object began its motion from position $x = 20.0$ m, East of the origin.

- 1– What is its final position if it moves at a constant speed of 12 m/s East for 0.5 min?
- 2– What is its final position if it moves at a constant speed of 10 m/s West for 0.5 min?

Question 15

A cyclist riding along one of the straight lanes maintains a constant speed of 10.0 m/s East. At $t = 0.0$ s, the cyclist is 20 m West of the origin.

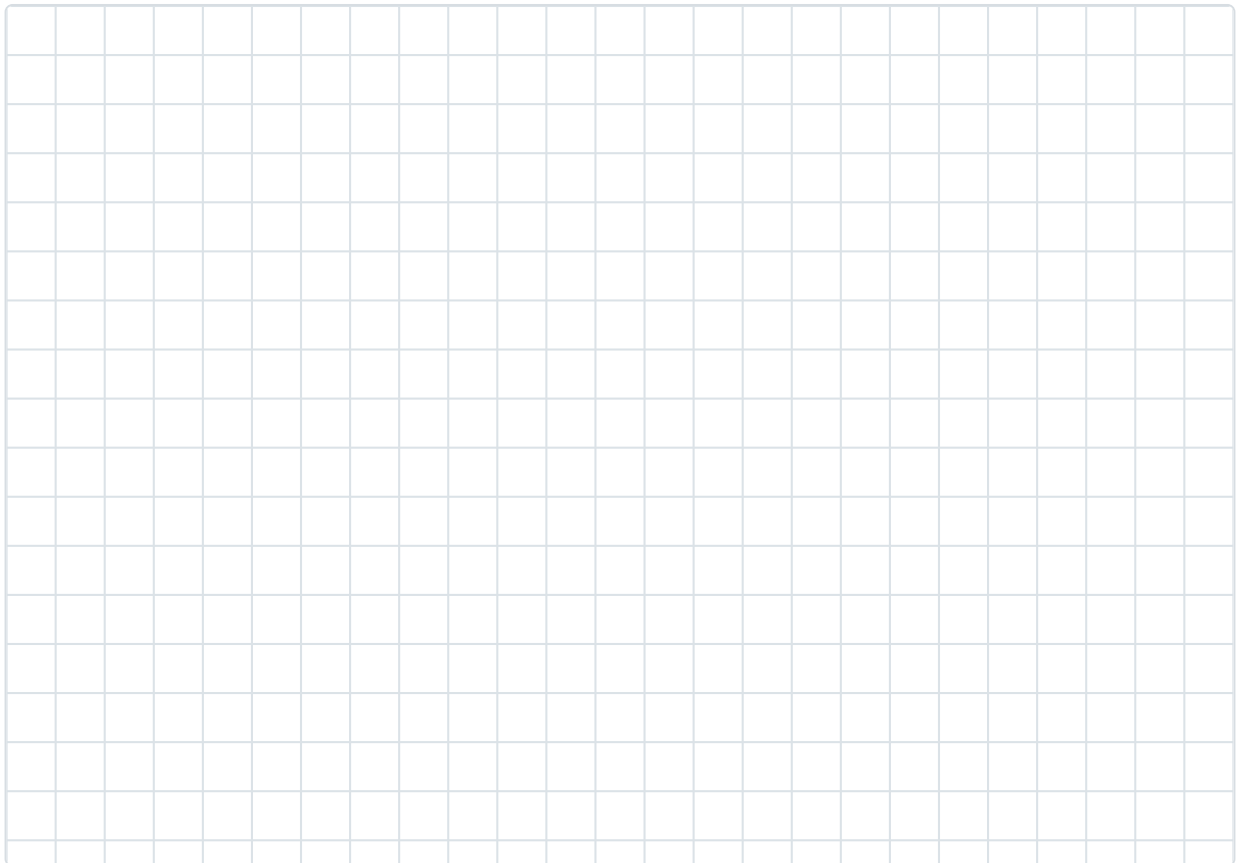
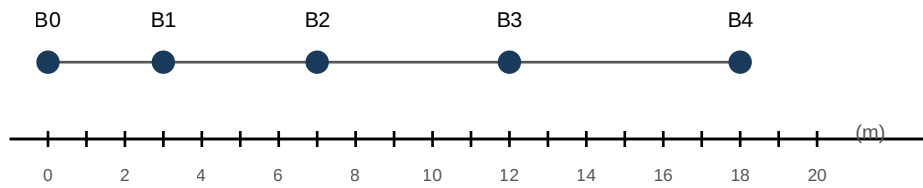
- 1– Sketch a position–time graph for the rider’s motion over 60 s.
- 2– What is the rider’s position at $t = 60$ s?
- 3– What is the rider’s displacement from the starting point up to $t = 60$ s?



Question 16

The figure below shows a toy car moving in a straight line on a frictionless surface. The time interval between each two consecutive positions of the ball is 1.5 s.

- 1– Sketch the position–time graph for the car's motion.
- 2– What is the position of the cart at $t = 6.0$ s?
- 3– What is the rider's displacement from the starting point up to $t = 6.0$ s?
- 4– If the cart's speed doubled, sketch the new position–time relationship on the same grid.



Question 17

A truck moves from position $x = 125.0$ m towards the origin ($x = 0.0$), as shown in the figure. Calculate the truck's average vector velocity over the time interval shown.

