Motion worksheet 6

Question: A racing car is travelling north. It accelerates uniformly covering a distance of 725 m in 10 s. If it has an initial velocity of 10 m·s^{-1}, find its acceleration.

Answer

Step 1 : Identify what information is given and what is asked for

We are given:

$$\begin{aligned} v_i &= 10\ \text{m}\cdot\text{s}^{-1} \\ \Delta x &= 725\ \text{m} \\ t &= 10\ \text{s} \\ a &= ? \end{aligned}$$

Step 2 : Find an equation of motion relating the given information to the acceleration

If you struggle to find the correct equation, find the quantity that is not given and then look for an equation that has this quantity in it.

$$\Delta x = v_i t + \frac{1}{2} a t^2$$

Step 3 : Substitute your values in and find the answer

$$\begin{aligned} \Delta x &= v_i t + \frac{1}{2} a t^2 \\ 725\ \text{m} &= (10\,\text{m}\cdot\text{s}^{-1} \times 10\ \text{s}) + \frac{1}{2}\text{a} \times (10\ \text{s})^2 \\ 725\ \text{m} - 100\ \text{m} &= (50\ \text{s}^2)\ \text{a} \\ a &= 12{,}5\ \text{m}\cdot\text{s}^{-2} \end{aligned}$$

Exerc **Step 4 : Quote the final answer**

The racing car is accelerating at 12,5 m·s^{-2} north.

Question: A motorcycle, travelling east, starts from rest, moves in a straight line with a constant acceleration and covers a distance of 64 m in 4 s. Calculate

- its acceleration
- its final velocity
- at what time the motorcycle had covered half the total distance
- what distance the motorcycle had covered in half the total time.

Answer

Step 1 : Identify what information is given and what is asked for

We are given:

$$\begin{aligned} v_i &= 0\ \mathrm{m \cdot s^{-1}} \text{(because the object starts from rest.)} \\ \Delta x &= 64\ \mathrm{m} \\ t &= 4\ \mathrm{s} \\ a &= ? \\ v_f &= ? \\ t &= ? \text{ at half the distance } \Delta x = 32\ \mathrm{m}. \\ \Delta x &= ? \text{ at half the time } t = 2\ \mathrm{s}. \end{aligned}$$

All quantities are in SI units.

Step 2 : <u>Acceleration</u>: Find a suitable equation to calculate the acceleration

We can use equations 11.3

$$\Delta x = v_i t + \frac{1}{2} a t^2$$

Step 3 : Substitute the values and calculate the acceleration

$$
\begin{aligned}
\Delta x &= v_i t + \frac{1}{2} a t^2 \\
64 \text{ m} &= (0 \text{ m} \cdot \text{s}^{-1} \times 4 \text{ s}) + \frac{1}{2} a \times (4 \text{ s})^2 \\
64 \text{ m} &= (8 \text{ s}^2)\text{a} \\
a &= 8 \text{ m} \cdot \text{s}^{-2} \text{ east}
\end{aligned}
$$

Step 4 : Final velocity: Find a suitable equation to calculate the final velocity

We can use equation 11.1 - remember we now also know the acceleration of the object.

$$v_f = v_i + at$$

Step 5 : Substitute the values and calculate the final velocity

$$
\begin{aligned}
v_f &= v_i + at \\
v_f &= 0 \text{ m} \cdot \text{s}^{-1} + (8 \text{ m} \cdot \text{s}^{-2})(4 \text{ s}) \\
&= 32 \text{ m} \cdot \text{s}^{-1} \text{ east}
\end{aligned}
$$

Step 6 : Time at half the distance: Find an equation to calculate the time

$$
\begin{aligned}
\Delta x &= v_i + \frac{1}{2} a t^2 \\
32 \text{ m} &= (0 \text{ m} \cdot \text{s}^{-1}) t + \frac{1}{2} (8 \text{ m} \cdot \text{s}^{-2})(t)^2 \\
32 \text{ m} &= 0 + (4 \text{ m} \cdot \text{s}^{-2}) t^2 \\
8 \text{ s}^2 &= t^2 \\
t &= 2{,}83 \text{ s}
\end{aligned}
$$

Step 7 : Distance at half the time: Find an equation to relate the distance and time

Half the time is 2 s, thus we have v_i, a and t - all in the correct units. We can use equation 11.3 to get the distance:

$$
\begin{aligned}
\Delta x &= v_i t + \frac{1}{2} a t^2 \\
&= (0)(2) + \frac{1}{2} (8)(2)^2 \\
&= 16 \text{ m east}
\end{aligned}
$$

***Note – you do not need to substitute the units along with the values into the equations- it actually makes the equation looked cluttered and confusing.**

Exercise 7:

This exercise needs to be done in your physics book and sent to your teacher via MS teams on the due date

1. A car starts off at 10 $m \cdot s^{-1}$ and accelerates at 1 $m \cdot s^{-2}$ for 10 s. What is its final velocity?
2. A train starts from rest, and accelerates at 1 $m \cdot s^{-2}$ for 10 s. How far does it move?
3. A bus is going 30 $m \cdot s^{-1}$ and stops in 5 s. What is its stopping distance for this speed?
4. A racing car going at 20 $m \cdot s^{-1}$ stops in a distance of 20 m. What is its acceleration?
5. A ball has a uniform acceleration of 4 $m \cdot s^{-1}$. Assume the ball starts from rest. Determine the velocity and displacement at the end of 10 s.
6. A motorcycle has a uniform acceleration of 4 $m \cdot s^{-1}$. Assume the motorcycle has an initial velocity of 20 $m \cdot s^{-1}$. Determine the velocity and displacement at the end of 12 s.
7. An aeroplane accelerates uniformly such that it goes from rest to 144 $km \cdot hr^{-1}$ in 8 s. Calculate the acceleration required and the total distance that it has traveled in this time.
8. An athlete is accelerating uniformly from an initial velocity of 0 $m \cdot s^{-1}$ to a final velocity of 4 $m \cdot s^{-1}$ in 2 seconds. Calculate his acceleration. Let the direction that the athlete is running in be the positive direction.
9. A bus accelerates uniformly from an initial velocity of 15 $m \cdot s^{-1}$ to a final velocity of 7 $m \cdot s^{-1}$ in 4 seconds. Calculate the acceleration of the bus. Let the direction of motion of the bus be the positive direction.
10. An aeroplane accelerates uniformly from an initial velocity of 200 $m \cdot s^{-1}$ to a velocity of 100 $m \cdot s^{-1}$ in 10 seconds. It then accelerates uniformly to a final velocity of 240 $m \cdot s^{-1}$ in 20 seconds. Let the direction of motion of the aeroplane be the positive direction.
    a. Calculate the acceleration of the aeroplane during the first 10 seconds of the motion.
    b. Calculate the acceleration of the aeroplane during the next 14 seconds of its motion.
11. A car decelerates from a velocity of 40$m.s^{-1}$ to the left until it reaches a velocity of 20$m.s^{-1}$ in 2 seconds. Calculate the acceleration of the object.

12. An object starts from rest and reaches a velocity of $50m.s^{-1}$ to the right in 4 seconds. Calculate the acceleration of the object.

13. An object travelling with a constant velocity of $4m.s^{-1}$ covers a distance of 100m. Calculate the time taken to travel this distance.

14. A cyclist accelerates from rest at a rate of $4m.s^{-1}$ until he reaches a speed of $20m.s^{-1}$. Calculate the time taken to reach that speed.

15. It takes Lilly 20 seconds to accelerate from a speed of $2m.s^{-1}$ to $8m.s^{-1}$ in a northerly direction. Calculate her acceleration.

16. If a car covers a distance of 2km in 2 minutes. Calculate the average speed of the car.

17. An object accelerates from $4m.s^{-1}$ to $9m.s^{-1}$ to the left in 2 seconds. Calculate the acceleration.

18. If a car accelerates at a rate of $5m.s^{-1}$ from a velocity of $2m.s^{-1}$ (to the left) in 10 seconds, determine the final velocity of the object.

19. Calculate the distance covered by an object, which accelerates from rest at a rate of $3m.s^{-1}$ for 20 seconds.

20. If a car accelerates from a velocity of $15m.s^{-1}$ until it reaches a velocity of $25ms.^{-1}$ in 5 seconds, calculate the distance covered by the object.

21. A car that is travelling on a straight road stops next to a stop sign. It then accelerates at $4m.s^{-2}$ for 15 seconds. Calculate its:

21.1 the velocity after 15 seconds

21.2 the displacement of the car after 5 seconds

21.3 the displacement of the car after 15 seconds

22. A car travels to the right at $8m.s^{-1}$. It then accelerates at $4m.s^{-2}$ over a distance of 300 m. Calculate

22.1 the car's velocity after it has travelled 300 m

22.2 what is the average velocity of the car over 300 m?

22.3 how long did it take the car to travel 300 m.

23. An aeroplane accelerates from rest along a runway. It covers 800 m in 15 seconds before it takes off. Calculate:

23.1 the acceleration of the aeroplane

23.2 the velocity of the aeroplane before it takes off

24. A taxi breaks down on the highway and places a warning triangle 50 m behind the car. A car travelling along the highway sees the triangle when the triangle is 20m in front of him. The car is travelling at a speed of $15m.s^{-1}$ when he sees the triangle and applies the brakes. The car decelerates at $2m.s^{-2}$. Will the car be able to stop in time and not collide with the taxi?

25. A car is travelling at 60km.h-1 and sees a stop sign 100 m in front of him and steps on the breaks. Calculate the rate at which he needs to decelerate in order to stop at the stop sign in time.

26. A truck is travelling at 80km.h^{-1} when it sees a stop sign 80 m in from of it. He steps on the breaks and decelerates at 4m.s^{-2}. Will he be able to stop in time?

27. A train travelling through a station at 5m.s^{-1} starts accelerating when it goes through the station at 1,5m.s^{-2}. Calculate the:

27.1 velocity of the train after accelerating for 10 seconds

27.2 the final velocity of the train after 20 seconds

27.3 the displacement of the train from the station after 20 seconds

28. If a car accelerates from a speed of 5m.s^{-1} at a rate of 4m.s^{-2} for 10 seconds. Calculate:

28.1 The final velocity of the car (in km.h^{-1})

28.2 The displacement of the car

QUESTION 29

Write only the correct term for each of the following descriptions next to the question number.

29.1 Displacement per unit time

29.2 path length taken

29.3 The speed and direction of a moving object at a particular moment in time

29.4 A physical quantity that has magnitude only

29.5 A set of reference points that enables the position of an object to be described at any time

I have finished the worksheet and submitted it on MS teams ☺