

MODULE 8

DIGGING DEEPER EXERCISE 1

With the core ideas of motion in a straight line now explored, you should feel more comfortable describing and interpreting how objects move in everyday situations. However, true confidence in Physics develops not simply from reading explanations, but from testing ideas, thinking carefully, and applying them in new contexts. The Digging Deeper section is designed for exactly that purpose; to strengthen your understanding, sharpen your reasoning, and help you move from familiarity to mastery of motion concepts. Take your time with these exercises, enjoy the challenge, and remember that **complete answers to all questions are provided at the end of the exercises** so that you can check your progress, learn from mistakes, and build confidence as you advance.

EXERCISE 1A: BINDER QUESTIONS

Question 1

A boda-boda is “at rest” at the bus stand. State the values of:

- (a) its velocity
- (b) its acceleration

Give a brief explanation.

Question 2

A student says: “If acceleration is zero, the object must be at rest.” Is the statement correct? Explain.

Question 3

In straight-line motion, clearly distinguish **distance** from **displacement** using one example where distance is not equal to the magnitude of displacement.

Question 4

A car moves along a straight road and its displacement is negative. Explain what “negative displacement” means physically.

Question 5

A vehicle moves in a straight line with **constant velocity** of 12m/s. State:

- (a) its acceleration
- (b) the net force on it.

Question 6

A body has a constant acceleration of -3m/s^2 . Explain what the negative sign indicates. Give two motion situations that fit.

Question 7

State when **speed** equals the magnitude of **velocity**. State when speed can differ from the magnitude of **velocity**.

Question 8

An object moves in a straight line and its velocity changes uniformly from 4m/s to 10m/s in 3s .

- (a) State the sign of the acceleration.
- (b) Find the acceleration.

Question 9

A body moves in a straight line, comes momentarily to rest, then continues moving in the same direction.

- (a) State its velocity at that instant.
- (b) Is the acceleration necessarily zero at that instant? Explain.

Question 10

A car moves along a straight line. Its velocity is 20m/s at the start of a time interval and 20m/s at the end of the interval.

- (a) State the change in velocity.
- (b) What can you conclude about the *average acceleration* during that interval?

Question 11

An object moves 40m east, then 15m west along the same straight road.

- (a) Find the distance travelled.
- (b) Find the displacement.

Question 12

A runner starts from rest and reaches 8m/s in 4s with uniform acceleration.

- (a) Find the acceleration.
- (b) Interpret your answer in one sentence.

EXERCISE 1B: REAL QUESTIONS

Question 13

Passengers in a bus notice that roadside trees appear to move backward as the bus moves forward.

Explain why stationary objects outside appear to move.

Question 14

A student walks 200m east along a straight road to a shop, then walks 200m west back home. Her phone pedometer shows 400m, but her map app shows she ended where she started. Explain this difference.

Question 15

A boda-boda rider makes a straight out-and-back trip from a stand to a customer and returns to the same stand. He says, “*My average speed was not zero, but my average velocity for the whole trip was zero.*” Explain why both statements can be true.

Question 16

Two daladala drivers travel the same straight route. One drives steadily; the other repeatedly speeds up and slows down due to frequent stops. Passengers describe the second trip as “*more jerky,*” even if both arrive in similar time. Explain what this suggests about their motions.

Question 17

From a bridge, Kipute drops one stone and throws another stone straight downward at the same time. She observes the thrown stone reaches the ground first. Explain why (ignore air resistance).

Question 18

In real life, a dry leaf falls more slowly than a coin. Many people conclude that heavier objects fall faster. Explain what physics says about falling under gravity and why everyday observations can mislead.

Question 19

Students notice that a falling object gets faster and faster, yet physics says the acceleration due to gravity remains constant. Explain how constant acceleration can still produce increasing speed.

Question 20

A student measures motion along a straight road and reports a negative velocity. The car was not reversing; it was moving forward on the road. Explain how velocity can be negative even though the car is moving “forward” in ordinary language.

Question 21

A ball is thrown straight upward and later comes back down. Observers notice that it slows down on the way up and speeds up on the way down. Explain how the direction of velocity and the direction of acceleration compare during the upward and downward motion.

Question 22

A student says: “*At the highest point of its motion, the ball has no velocity, so it has no acceleration.*”. Was the student correct? Explain.

EXERCISE 1C: HOT QUESTIONS**Question 23**

A car moves along a straight road. It starts from rest, accelerates uniformly at 2.0m/s^2 for 8.0s, then continues at constant velocity for 10s, then decelerates uniformly at 4.0m/s^2 until it stops. Find:

- (a) the maximum speed reached
- (b) the total distance travelled
- (c) the total time taken.

Question 24

Two bodabodas start from the same point at the same time. Bodaboda A moves with constant speed 12m/s . Bodaboda B starts from rest and accelerates uniformly at 1.5m/s^2 . Find:

- (a) the time when B first catches A
- (b) the distance from the starting point where they meet.

Question 25

A ball is thrown vertically upward with speed 24m/s . Take $g = 9.8\text{m/s}^2$. Find:

- (a) the time to reach the highest point
- (b) the maximum height reached
- (c) the total time of flight
- (d) Why the upward and downward times are equal.

Question 26

From a bridge, a stone is dropped. Exactly 1.5s later, a second stone is thrown vertically downward with speed 20m/s from the same point. Take $g = 9.8\text{m/s}^2$. Find the time (measured from the first release) when the second stone catches the first.

Question 27

A car's velocity changes from $+18\text{m/s}$ to -12m/s in 5.0s with uniform acceleration. Find:

- (a) the acceleration
- (b) the displacement during the interval
- (c) the distance travelled
- (d) Why distance is not equal to the magnitude of displacement in this motion.

Question 28

A ball is thrown vertically upward from a balcony 30m above the ground and hits the ground after 4.0s . Take $g = 9.8\text{m/s}^2$. Find:

- (a) the initial velocity of the ball
- (b) the speed just before impact.

Question 29

A stone is thrown vertically upward from the ground with speed 25m/s. Take $g = 9.8\text{m/s}^2$.

Find:

- (a) the two times when the stone is at a height of 20m
- (b) which time corresponds to upward motion
- (c) How velocity is used to select the correct time.

Question 30

A stone is dropped from a height of 80m at the same instant another stone is thrown vertically upward from the ground with speed 30m/s. Take $g = 9.8\text{m/s}^2$. Find:

- (a) the time when they meet
- (b) the height above the ground where they meet
- (c) the velocity of each stone at the meeting instant.

Question 31

A ball is thrown vertically upward from a balcony 45m above the ground with speed 10m/s. Take $g = 9.8\text{m/s}^2$. Find:

- (a) the time taken to reach the ground
- (b) the speed just before impact.

Question 32

Ball A is thrown vertically upward from the ground with speed 20m/s at the same instant Ball B is dropped from rest from a height of 30m. Take $g = 9.8\text{m/s}^2$. Find:

- (a) the time when they are at the same height
- (b) the height at which they meet.

Question 33

Ball A is thrown vertically upward with speed 18m/s. Exactly 1.0s later, Ball B is thrown vertically upward from the same point with speed 24m/s. Take $g = 9.8\text{m/s}^2$. Find:

- (a) the time (from A's launch) when B catches A
- (b) the height at which they meet
- (c) the velocity of each ball at the meeting instant.

Question 34

A ball is thrown vertically upward from a roof 25m above the ground with speed 15m/s. Take $g = 9.8\text{m/s}^2$. Find:

- (a) the maximum height above the ground
- (b) the time taken to hit the ground
- (c) the speed just before impact
- (d) If a student obtained a negative value for time, explain why this result is not physically acceptable.

Question 35

Stone A is dropped from a bridge at $t = 0$. Stone B is dropped from the same point at $t = 2.0\text{s}$. Take $g = 9.8\text{m/s}^2$. At $t = 6.0\text{s}$ (from the first release), find:

- (a) the separation between the stones
- (b) the relative speed of A with respect to B
- (c) Explain why the separation is increasing at this instant at constant rate.

ANSWERS TO DIGGING DEEPER EXERCISE 1

EXERCISE 1A

1. (a) $v = 0\text{m/s}$ (b) $a = 0\text{m/s}^2$

Explanation

At rest means the velocity is zero. If the velocity does not change with time, then acceleration (rate of change of velocity) is zero too.

2. Not correct.

Explanation

$a = 0\text{m/s}^2$ means velocity is constant; it can be 0m/s or non-zero.

3. Distance is the total path length while displacement is the change in position with direction.

Example: moving 6m east then 6m west means distance = 12m, while displacement = 0m.

4. The final position is opposite to the chosen positive direction relative to the origin.

5. (a) $a = 0\text{m/s}^2$ (b) Net force = 0N

6. The acceleration is in the negative direction (opposite to the chosen positive direction).

Examples:

First situation: moving forward and slowing down (velocity positive but decreasing in magnitude).

Second situation: moving backward and speeding up (velocity negative and increasing in magnitude).

7.

- Equal when motion is in one direction only.
- Different when motion involves a change of direction over the interval.

8. (a) positive (b) 2m/s^2

9. (a) $v = 0\text{m/s}$ (b) No, the acceleration is not necessarily zero.

Explanation:

Acceleration depends on the **rate of change of velocity**, not on the value of velocity itself. At the instant the body is momentarily at rest, the velocity is 0m/s , but it may still be **changing direction or magnitude**. Therefore, the acceleration can be non-zero even when velocity is zero.

10. (a) 0m/s (b) $a = 0\text{m/s}^2$ during that interval.

11. (a) 55m (b) 25m east

12. (a) 2m/s^2 (b) The velocity increases by 2m/s every 1s .

EXERCISE 1B

13. Motion is relative. Relative to the moving bus, stationary trees have velocity in the opposite direction, so they appear to move backward.

14. Distance measures total path length (400m), while displacement depends only on initial and final positions. Returning home makes displacement = 0m .

15. Average speed depends on total distance and time, so it is non-zero. Average velocity depends on displacement and time; for an out-and-back trip, displacement = 0m , so average velocity = 0m/s .

16. The steady driver has nearly uniform motion, while the other has non-uniform motion with changing velocity. Repeated speeding up and slowing down causes the “jerky” feeling.

17. Both stones experience the same downward acceleration due to gravity, but the thrown stone starts with a non-zero initial downward velocity, so it reaches the ground first.

18. Ignoring air resistance, all objects fall with the same acceleration due to gravity, g , regardless of mass. In air, the effect of air resistance depends on how large the resistive force is **compared to the object’s weight**. For a leaf, air resistance is large compared with its small weight, so it greatly reduces the acceleration and velocity. For a coin, the weight is much larger compared with air resistance, so the motion is only slightly affected.

19. Acceleration is the rate of change of velocity. With constant acceleration due to gravity, velocity increases by equal amounts in equal times, so speed increases even though acceleration remains constant.

20. Velocity depends on the chosen reference direction. If the chosen positive direction is opposite to the car’s motion, the velocity is negative even though the car is moving forward.

21. On the way up, velocity is upward while acceleration is downward. On the way down, both velocity and acceleration are downward.

22. No, the student was not correct.

Explanation

At the highest point, the velocity of the ball is momentarily zero, but acceleration depends on the rate of change of velocity, not on the value of velocity itself. Gravity continues to act downward, so the ball still has a downward acceleration even when its velocity is zero.

EXERCISE 1C

23.

(a) 16m/s

(b) 256m

(c) 22s

24.

(a) 16s

(b) 192m

25.

(a) 2.45s

(b) 29.4m

(c) 4.90s

(d) Motion is symmetric under constant gravitational acceleration.

26. 3.58s

27.

(a) -6.0m/s^2

(b) 15m

(c) 39m

(d) Direction reversal increases distance without increasing displacement.

28.

(a) $+12.1\text{m/s}$

(b) 27.1m/s

29.

(a) 0.993s and 4.11s

(b) 0.993s

(c) Velocity is positive at the earlier (smaller) time and negative at the later (larger) time.

30.

(a) 2.67s

(b) 45.2m

(c) Thrown-up stone: $+3.87\text{m/s}$; dropped stone: -26.1m/s

31.

(a) 4.22s

(b) 31.3m/s

32.

(a) 1.50s

(b) 19.0m

33.

(a) 1.83s

- (b) 16.5m
- (c) +0.08m/s and +15.9m/s

34.

- (a) 36.5m
- (b) 4.26s
- (c) 26.7m/s
- (d) Negative time would correspond to an event before the chosen start instant and is therefore rejected as unphysical.

35.

- (a) 98.0m
- (b) 19.6m/s
- (c) After Stone B is released, both stones have the same acceleration, so their relative acceleration is zero. Since Stone A has been accelerating for longer, it already has a larger downward velocity; therefore, the separation increases at a constant rate.