

1 mark for each correct answer. Total 15 marks. Each question also explains why every wrong option is wrong, so you can see which mistake each one tests.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	B	D	B	D	D	A	C	C	C	B	B	D	B	A

1. An object moves along a straight line and returns to its starting point.

- I. Its displacement is zero.
- II. Its average velocity is zero.
- III. Its average speed is zero.

Which statements are correct?

- A. I only
- B. I and II only**
- C. II and III only
- D. I, II and III

Answer: B · Distance and displacement

The displacement is zero, so the average velocity is zero. The distance is not zero, so the average speed is not zero.

A: II is also correct: average velocity = displacement ÷ time, and the displacement is zero.

C: I is correct, and III is wrong: the object travelled a distance, so its average speed is greater than zero.

D: III is wrong: average speed = distance ÷ time, and the distance is not zero.

2. A car moves at constant velocity along a straight road. Its position changes from 120 m to 30 m in 15 s. What is its velocity?

- A. -8.0 m s^{-1}
- B. -6.0 m s^{-1}**
- C. $+6.0 \text{ m s}^{-1}$
- D. $+10 \text{ m s}^{-1}$

Answer: B · Speed and velocity

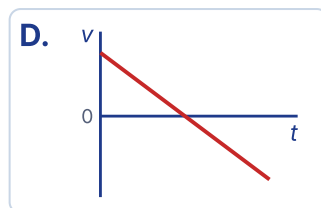
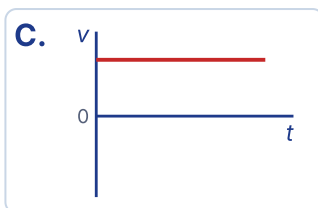
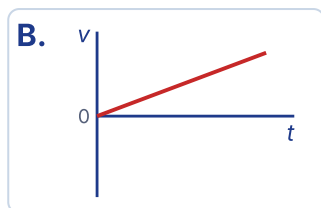
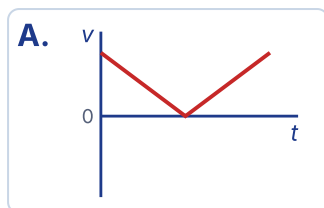
$v = \Delta s / \Delta t = (30 - 120) / 15 = -6.0 \text{ m s}^{-1}$: the car moves towards decreasing position.

A: This uses $120 \text{ m} \div 15 \text{ s}$ and adds a minus sign.

C: The size is right but the car moves towards decreasing s, so v is negative.

D: This divides the final position by 3.

3. A ball is thrown vertically upwards and caught at the same height. Air resistance is negligible. Upwards is positive. Which graph shows how the velocity v of the ball varies with time t ?



- A. Graph A
- B. Graph B
- C. Graph C
- D. Graph D**

Answer: D · Motion graphs

One straight line from $+u$ to $-u$ with gradient $-g$.

A: This is the speed, which is never negative.

B: This shows a velocity increasing from zero.

C: This is constant velocity, with no acceleration.

4. An object starts from rest and moves with constant acceleration. It travels a distance d in the first time interval t . What distance does it travel in the next time interval t ?

- A. d
- B. $3d$**
- C. $4d$
- D. $8d$

Answer: B · Equations of motion

$s \propto t^2$, so after $2t$ the total distance is $4d$. In the second interval it travels $4d - d = 3d$.

A: This would be true for constant velocity.

C: This is the total distance after $2t$, not the distance in the second interval.

D: This uses $s \propto t^3$.

5. A car travelling at speed v stops in a braking distance s . The car now travels at speed $3v$ and brakes with the same deceleration. What is the new braking distance?

- A. $\sqrt{3} s$
- B. $3s$
- C. $6s$
- D. $9s$

Answer: D · Equations of motion

From $v^2 = u^2 + 2as$ with $v = 0$, $s \propto u^2$, so the distance is $3^2 = 9$ times larger.

A: The braking distance grows faster than the speed, not more slowly.

B: This assumes the braking distance is proportional to the speed.

C: This adds the extra speed instead of squaring it.

6. A ball is thrown vertically upwards at 15 m s^{-1} and caught at the same height. Air resistance is negligible. How long is the ball in the air?

- A. 0.65 s
- B. 1.5 s
- C. 2.3 s
- D. 3.1 s

Answer: D · Free fall

Time up = $15/9.8 = 1.53 \text{ s}$; the flight is symmetric, so the total is $2 \times 1.53 = 3.1 \text{ s}$.

A: This is g divided by the speed, which has no meaning here.

B: This is the time to reach the top only.

C: This is 1.5 times the time to the top.

7. A ball is thrown vertically upwards. Air resistance is negligible. What are the velocity and the acceleration of the ball at its highest point?

	Velocity	Acceleration
A	zero	g downwards
B	zero	zero
C	g downwards	zero
D	upwards	g downwards

Answer: A · Free fall

The ball is momentarily at rest, but its velocity is still changing, so the acceleration is g downwards.

B: The velocity is changing at the top, so the acceleration cannot be zero.

C: Velocity and acceleration have been swapped.

D: At the top the ball has stopped moving upwards.

8. A stone is dropped from rest from a height h and hits the ground with speed v . Air resistance is negligible. What is the speed of the stone after it has fallen a distance $\frac{1}{2}h$?

- A. $v/4$
- B. $v/2$
- C. $v/\sqrt{2}$
- D. $(\sqrt{3}/2)v$

Answer: C · Free fall

$v^2 = 2gh$, so $v^2 \propto h$. At $\frac{1}{2}h$ the speed is $v/\sqrt{2} \approx 0.71v$.

A: This assumes the speed is proportional to the height squared.

B: This assumes the speed is proportional to the distance fallen.

D: This is the speed after falling $\frac{3}{4}h$.

9. A stone is thrown horizontally at 12 m s^{-1} from the top of a cliff 45 m high. Air resistance is negligible. How far from the foot of the cliff does it land?

- A. 12 m
- B. 26 m
- C. 36 m
- D. 45 m

Answer: C · Projectiles

$45 = \frac{1}{2} \times 9.8 \times t^2$ gives $t = 3.0 \text{ s}$, so $x = 12 \times 3.0 = 36 \text{ m}$.

A: This is the distance travelled in 1 s .

B: This uses $t = \sqrt{(h/g)}$, leaving out the factor 2.

D: This is the height of the cliff.

10. A projectile is launched from level ground. Air resistance is negligible.

- I. The horizontal component of its velocity is constant.
- II. Its acceleration is zero at the highest point.
- III. The time to rise to the highest point equals the time to fall back to the ground.

Which statements are correct?

- A. I only
- B. I and II only
- C. I and III only
- D. II and III only

Answer: C · Projectiles

v_x is constant and the flight is symmetric; the acceleration is always g downwards.

A: III is also correct: the flight is symmetric on level ground.

B: II is wrong: the acceleration is g at every point.

D: II is wrong and I is correct.

11. A ball is launched at speed u and angle θ above the horizontal. It reaches a maximum height H . The ball is now launched at speed $2u$ at the same angle. Air resistance is negligible. What is the new maximum height?

- A. $2H$
- B. $4H$
- C. $8H$
- D. $16H$

Answer: B · Projectiles

$H = (u \sin \theta)^2 / 2g$, so $H \propto u^2$. Doubling u gives $4H$.

A: H depends on the square of the speed, not on the speed.

C: This assumes $H \propto u^3$.

D: This squares the factor twice.

12. A stone is thrown from the top of a cliff 20 m high at 10 m s^{-1} , at 30° **below** the horizontal. Air resistance is negligible. How long does the stone take to reach the sea below?

- A. 1.2 s
- B. 1.6 s
- C. 2.0 s
- D. 2.6 s

Answer: B · Projectiles

Vertical: $u = 10 \sin 30^\circ = 5.0 \text{ m s}^{-1}$ downward. $20 = 5.0t + 4.9t^2$ gives $t = 1.6 \text{ s}$.

A: This uses the whole 10 m s^{-1} as the downward velocity. Only the vertical component, $10 \sin 30^\circ = 5.0 \text{ m s}^{-1}$, is downward.

C: This is the time for a stone thrown horizontally ($u = 0$ vertically).

D: This treats the 5.0 m s^{-1} component as upward. The stone is thrown below the horizontal.

13. A ball is launched with the same velocity, first with negligible air resistance and then with air resistance. How do the maximum height and the range with air resistance compare with those without air resistance?

	Maximum height	Range
A	smaller	larger
B	larger	smaller
C	the same	smaller
D	smaller	smaller

Answer: D · Fluid resistance

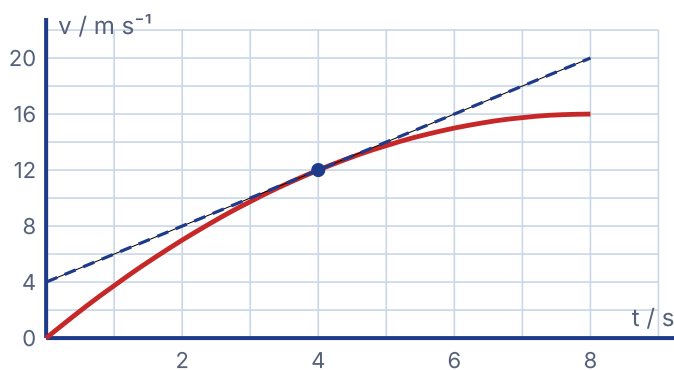
Drag opposes the motion all the time: lower maximum height and shorter range.

A: Drag removes energy, so the ball cannot travel further.

B: Drag also acts during the rise, so the ball cannot go higher.

C: Drag acts during the rise too, so the maximum height is also smaller.

14. The graph shows how the velocity v of a car varies with time t . The dashed line is the tangent to the curve at $t = 4.0$ s. What is the acceleration of the car at $t = 4.0$ s?



- A. 1.0 m s^{-2}
- B. 2.0 m s^{-2}
- C. 3.0 m s^{-2}
- D. 5.0 m s^{-2}

Answer: B · Motion graphs

Instantaneous acceleration = gradient of the tangent = $(20 - 4.0) \div (8.0 - 0) = 2.0 \text{ m s}^{-2}$.

A: This is half the gradient of the tangent.

C: This is the average acceleration from 0 to 4.0 s ($12 \div 4.0$), the gradient of the chord, not of the tangent.

D: This divides the tangent's end value (20 m s^{-1}) by 4.0 s.

15. A cart accelerates uniformly from rest to 8.0 m s^{-1} in 4.0 s. It then slows uniformly and stops 6.0 s later. What is its average speed for the whole motion?

- A. 4.0 m s^{-1}
- B. 5.0 m s^{-1}
- C. 6.7 m s^{-1}
- D. 8.0 m s^{-1}

Answer: A · Motion graphs

The v - t graph is one triangle: distance = $\frac{1}{2} \times 10 \times 8.0 = 40 \text{ m}$ in 10 s, so the average speed is 4.0 m s^{-1} .

B: This divides 40 m by 8.0 s instead of 10 s.

C: This divides 40 m by 6.0 s.

D: This is the maximum speed.