A.1 Kinematics

Practice Worksheet — name: _____ date: _____

FORMULAS FOR THIS TOPIC

FINAL VELOCITY $v = u + at$ DISPLACEMENT $s = ut + \frac{1}{2}at^2$ VELOCITY–DISPLACEMENT $v^2 = u^2 + 2as$

DISPLACEMENT (AVERAGE VELOCITY) $s = \frac{(u+v)}{2}t$

SECTION A — MULTIPLE CHOICE

A1. A ball is thrown vertically upwards. At the highest point of its motion, which statement is correct?

- (A) Velocity and acceleration are both zero
- (B) Velocity is zero; acceleration is 9.81 m s^{-2} downwards
- (C) Velocity is zero; acceleration is 9.81 m s^{-2} upwards
- (D) Velocity and acceleration are both non-zero

A2. A car accelerates uniformly from rest to 24 m s^{-1} over a distance of 144 m. What is its acceleration?

- (A) 1.0 m s^{-2}
- (B) 2.0 m s^{-2}
- (C) 3.0 m s^{-2}
- (D) 4.0 m s^{-2}

A3. Two identical balls are launched horizontally from the same height, one at 5 m s^{-1} and one at 10 m s^{-1}. Ignoring air resistance, which lands first?

- (A) The slower ball
- (B) The faster ball
- (C) They land at the same time
- (D) It depends on their masses

SECTION B — SHORT ANSWER

B1. Distinguish between distance and displacement, using an athlete completing one lap of a 400 m track as your example. [2 marks]

B2. A stone is projected horizontally at 12 $\mathrm{m\ s^{-1}}$ from a cliff 45 m high. Calculate the time of flight and the horizontal range. [4 marks]

B3. Sketch the velocity–time graph for an object falling through air until it reaches terminal speed, and explain its shape. [3 marks]

ANSWER KEY

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Section A

A1: Velocity is zero; acceleration is $9.81\ \text{m s}^{-2}$ downwards — At the top of the flight the ball is momentarily at rest, but gravity never switches off — the acceleration remains g downwards throughout. This is the single most common misconception in kinematics.

A2: $2.0\ \text{m s}^{-2}$ — No time is given, so use $v^2 = u^2 + 2as$: $24^2 = 0 + 2a(144)$, giving $a = 576/288 = 2.0\ \text{m s}^{-2}$. Choosing the equation that avoids the unknown you don't need is the key skill.

A3: They land at the same time — Vertical and horizontal motion are independent. Both balls start with zero vertical velocity and fall the same height under the same g, so their flight times are identical — the faster one simply lands further away.

Section B

B1: Distance is the scalar length of the path travelled — 400 m for the lap. Displacement is the vector change in position from start to finish — zero for a complete lap, since the athlete returns to the starting point.

B2: Vertical: $45 = \frac{1}{2}(9.81)t^2$ gives $t = \sqrt{9.17} \approx 3.0\ \text{s}$. Horizontal: constant velocity, so range $= 12 \times 3.0 = 36\ \text{m}$. The two directions are treated independently, linked only by time.

B3: The graph starts at the origin with gradient g (only weight acts initially). As speed increases, fluid resistance grows, the resultant force and hence gradient (acceleration) decrease, and the curve flattens, approaching a horizontal asymptote at terminal speed where drag balances weight.