

## SAMPLE COHORT REPORT – ILLUSTRATIVE

# Motion Foundations Diagnostic

What teachers receive after a class completes the diagnostic

**Sample cohort:** 25 students

**Course:** IB DP Physics

**School:** XYZ International School, Oceania

**Diagnostic run:** May 2026

## Your full delivery package includes:

- **Misconception Heatmap (PDF)** – visual at-a-glance summary by question and band
- **Cohort Summary (PDF)** – prescription on page 1, detailed analysis on page 2
- **Mistake Museum (PDF)** – eight named kinematics traps with corrections
- **Words That Hurt (PDF)** – phrases to retire and what to say instead
- **Remediation Worksheet** – 35 items across 8 sections; assign only the sections your heatmap flags
- **Teacher Answer Key** – solutions plus the diagnostic logic behind each item

*This is a sample illustrative report. The data shown reflects a representative IB DP Physics cohort pattern. No real school or student is depicted. The structure, depth, and recommendations are identical to what your school would receive.*

# Misconception Heatmap

The heatmap below shows performance on each of the 24 diagnostic items, broken down by performance band (A through D) and grouped by the eight misconception bands (E1 through E8). Colour runs from red (low correct rate) through yellow (mid) to green (high). Misconception bands where the cohort mean falls below 60% are flagged red; bands with individual items below 60% trigger an amber flag for targeted attention.

## Motion Foundations – Misconception Heatmap

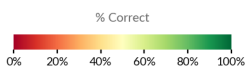
24-question diagnostic • 25 students • XYZ International School • IB DP Physics • May 2026

Mean: 17.5/24 (73%)

Median: 17/24

Range: 11–23

	Overall (n=25)	A (20–24) (n=8)	B (15–19) (n=13)	C (10–14) (n=4)	D (0–9) (n=0)	
Q01 Out-and-back displacement	76%	100%	69%	50%	—	
Q02 Origin shift invariance	84%	100%	77%	75%	—	Position & Displacement
Q03 Position vs distance (ahead)	88%	100%	85%	75%	—	
Q04 Time at exact position	72%	100%	69%	25%	—	
Q05 Event identification	84%	88%	85%	75%	—	Clock & Events
Q06 $\Delta t$ vs $t$ substitution	84%	100%	77%	75%	—	
Q07 30 m/s 'per' meaning	84%	75%	100%	50%	—	
Q08 Sub-interval averages	92%	100%	92%	75%	—	Average Velocity & Unit Rate
Q09 Average velocity calc	88%	100%	92%	50%	—	
Q10 Diagonal $x-t$ segment	32%	62%	23%	0%	—	
Q11 Graph as picture (arch)	56%	75%	38%	75%	—	
Q12 Crossing $x-t$ lines	84%	88%	77%	100%	—	$x-t$ Graph Meaning
Q13 Impossible (vertical) graph	40%	62%	31%	25%	—	
Q14 Curved $x-t$ shape	56%	75%	46%	50%	—	
Q15 Shrinking- $\Delta t$ limit	88%	100%	85%	75%	—	
Q16 Tangent slope = inst. $v$	80%	88%	92%	25%	—	Instantaneous Velocity
Q17 0/0 paradox / limit	88%	100%	85%	75%	—	
Q18 Negative velocity meaning	52%	88%	38%	25%	—	
Q19 Same speed, diff. velocity	72%	100%	62%	50%	—	Speed, Velocity & Signs
Q20 Sign reversal, same speed	52%	50%	69%	0%	—	
Q21 Two-balls passing	60%	100%	54%	0%	—	Position-Speed (Trowbridge–McDermott)
Q22 Two-balls inverse	56%	88%	31%	75%	—	
Q23 Estimation from anchors	88%	88%	100%	50%	—	
Q24 350 m/s implausibility	92%	100%	92%	75%	—	Estimation & Sense-Making



Grounded in PER: Knight, Arons, Trowbridge–McDermott, Moore, Chabay–Sherwood

Mean: 17.5/24 (73%) • Median: 17/24 • Range: 11–23 • n = 25

# Motion Foundations – Prescription Summary

24-question diagnostic · 25 students · XYZ International School · IB DP Physics · May 2026

Mixed readiness (mean 17.5/24, 73%) – one primary gap in  $x$ - $t$  graph interpretation and two linked speed-and-velocity gaps.

*E1–E8 = the eight Motion Foundations misconception bands grounded in Physics Education Research (Knight, Arons, Trowbridge–McDermott, Moore, Chabay–Sherwood). The diagnostic's 24 questions cluster by which kinematics misconception each one probes.*

## What to do next class – 20 minutes

### ■ Fix #1: Reading $x$ - $t$ graphs as motion, not as pictures – 10 minutes

Put an arch-shaped position–time graph on the board and ask the cohort: did the object go up and over a hill? Wait for the hands that say yes. Then ask what is on the vertical axis. The graph plots position against time – the "arch" means the object moved out, slowed to a stop, and came back, all along a single line in space, not up and over a hill. An  $x$ - $t$  graph represents position over time; it is never a picture of the path. Q10 (a diagonal segment read as a ramp in space) at 32% and Q13 (a vertical segment treated as possible) at 40% are the two weakest items in the whole diagnostic.

*Heatmap evidence: Q10–Q14, 54% overall (Q10 at 32% and Q13 at 40% are the drivers).*

### ■ Fix #2: Velocity carries direction; position does not tell you speed – 10 minutes

Two linked moves. First, two objects at the same speed in opposite directions: ask what is the same and what differs – speed identical, velocity opposite in sign. Then two balls reaching the same point at the same instant, one speeding up and one slowing down: which is faster there? Being at the same position says nothing about speed. The two moves target different confusions – that velocity carries a sign (first) and that position does not tell you speed (second) – but share a root: blurring kinematic quantities that are actually independent (speed for velocity, then position for speed).

*Heatmap evidence: Q18–Q20 (signs) at 59%, Q21–Q22 (two-balls) at 58%.*

## Safe to skip

### ■ Average velocity and the unit-rate meaning of $m/s$ (Q7–Q9): 88% correct – no remediation needed

The cohort computes  $\Delta x/\Delta t$  cleanly and holds the "per" meaning of  $m/s$ . Instantaneous velocity (Q15–Q17) is also secure at 85%, so the limit-and-tangent foundation is in place. The gaps are not in the rate concepts themselves but in graph interpretation and in keeping speed and velocity distinct.

## Students to watch

- **S13 (15/24)** – lands in Band B and is strong across the rate concepts (average velocity, instantaneous velocity, estimation all 100%), but scored 20% on the graph band and 0% on the two-balls items. Procedurally strong, with two sharp blind spots the two Fixes target directly.
- **S06 (11/24)** – holds position/displacement (100%) and instantaneous velocity (100%) but bottomed out on graphs (20%) and velocity sign (0%). Worth a short one-to-one first; the graph and sign foundations are the priority.
- **S21 (14/24)** – strong on clock/event discipline (100%) and estimation (100%), but the speed-and-velocity cluster lands hard: 0% on the two-balls items, 33% on the sign items. Pairs naturally with Fix #2.

*Grounded in Physics Education Research: Knight, Arons, Trowbridge–McDermott, Moore, Chabay–Sherwood*

No student accounts or emails collected · 25-minute diagnostic · Turnaround: 48 hours

# Cohort Summary – Detailed Diagnostic

## XYZ International School

IB DP Physics · 25 students · May 2026

### Band Distribution

<b>Band A (20–24):</b>	8 students	<i>Structurally sound</i>
<b>Band B (15–19):</b>	13 students	<i>Procedurally fluent, conceptually fragile</i>
<b>Band C (10–14):</b>	4 students	<i>Fragmented understanding</i>
<b>Band D (0–9):</b>	0 students	<i>Foundations not yet secure</i>

Mean: 17.5/24 (73%) · Median: 17/24 · Range: 11–23

### Key Patterns in This Cohort

- x–t graph interpretation (Q10–Q14) – 54% overall [E4]**  
 The cohort is reading position–time graphs as literal pictures of the path rather than as representations of position against time. Q10 (a diagonal x–t segment, 32%) and Q13 (an impossible vertical graph, 40%) are the two weakest items in the entire diagnostic; both reward treating the graph's shape as a spatial trajectory. Q11 (graph-as-picture arch, 56%) and Q14 (curved x–t shape, 56%) show the same reflex in milder form, while Q12 (crossing x–t lines, 84%) clears – the cohort reads an intersection as "same position at the same time" correctly, even as it misreads shape.  
*Heatmap Qs: Q10, Q11, Q12, Q13, Q14.*
- Velocity sign and direction (Q18–Q20) – 59% overall [E6]**  
 Speed and velocity are being treated as interchangeable. Q18 (meaning of a negative velocity, 52%) and Q20 (sign reversal at constant speed, 52%) are the weak items: students do not consistently read the sign of velocity as direction. Q19 (same speed, different velocity, 72%) sits higher – most of the cohort accepts that two objects can share a speed yet differ in velocity; what slips is reading the sign itself as direction.  
*Heatmap Qs: Q18, Q19, Q20.*
- Position–speed discrimination (Q21–Q22) – 58% overall [E7]**  
 The Trowbridge–McDermott confusion: students infer speed from position. Q21 (two balls passing, 60%) and Q22 (the inverse framing, 56%) both probe whether "same position" is read as "same speed," and roughly four in ten of the cohort make that inference. Narrow (two items) but pointed. It sits alongside the velocity-sign gap above: E6 conflates speed with velocity, E7 reads speed off position – both are failures to keep speed and velocity as distinct quantities rather than reading one off something else.  
*Heatmap Qs: Q21, Q22.*

### Recommended Remediation

- Run the x–t graph work first (the primary flagged band)**  
 E4 (Q10–Q14, 54% overall) is the cohort's largest and weakest band; remediate first. Assign Worksheet Section E4 – its items target the picture-versus-representation distinction directly. See the Mistake Museum and Words That Hurt entries for the x–t graph band for the named misconception and the phrase to retire.
- Treat the speed-and-velocity cluster together**  
 E6 (Q18–Q20, 59%) and E7 (Q21–Q22, 58%) are related – E6 conflates speed with velocity, E7 reads speed off position; both fail to keep speed and velocity as distinct quantities. Assign the sign-band and position–speed Worksheet sections together; the same "velocity carries direction; position does not tell you speed" framing addresses both.
- Confirm with a delayed check**  
 Ten to fourteen days after the worksheet work, re-test a few items from each flagged band with different numbers or framings – not an identical retest – to verify the graph-reading and direction reflexes have shifted.

*No logins required · Names are optional · Grounded in PER: Knight, Arons, Trowbridge–McDermott, Moore, Chabay–Sherwood*

# Remediation Toolkit – Preview

Two example entries from the four-document remediation package, showing the format every entry follows

The full toolkit includes the **Mistake Museum** (eight named traps), **Words That Hurt** (eight phrases to retire), the **Remediation Worksheet** (35 items across 8 sections), and the **Teacher Answer Key** (solutions plus diagnostic logic) – all built around the same diagnostic-first pattern. The toolkit covers all eight bands; each cohort summary flags which entries a class should prioritise (here: the x-t graph, velocity-sign, and position-speed bands). The two entries below illustrate the format every entry follows – drawn from the Clock & Events band as a representative example.

## From the Mistake Museum

#2

### The Mark at Two-Point-Oh

Example entry – Band E2: Clock Reading, Interval, Event & Instant (Q4–Q6)

#### The Trap

"The marked point on the cart is at  $x = 2.0$  m for about 0.1 seconds – long enough that you could see it there if you were watching."

#### Why It's Wrong

The student is treating "at a position" as having a small but nonzero duration. An instant has zero duration – it is one clock reading, not a time interval. A marked point on the cart passes through the exact position  $x = 2.0$  m at one instant, not at it for an interval. This is Arons's instantaneous-position trap (§2.4): students hold the conviction that "the marked point is at  $x = 2.0$  m" must be a fact about a stretch of time, not a fact about a single moment. The same confusion produces the  $\Delta t$ -vs- $t$  substitution error downstream.

#### The Fix

An instant is one clock reading, with zero duration. An interval is the gap between two clock readings. An event is one position labelled at one instant. Don't blur them.

## From Words That Hurt

#2

### "It's at $x = 2.0$ m for a tiny moment."

Example entry – Band E2 (Q4–Q6): Clock Reading, Interval, Event & Instant

#### Why It Hurts

Treats "at a position" as having a small but nonzero duration. An instant is one clock reading, with zero duration – not a tiny sliver of time. The phrase makes "at a position" sound interval-like, which is the upstream cause of the  $\Delta t$ -vs- $t$  substitution error students make in equations downstream (Knight's central  $\Delta t$  difficulty).

#### Say Instead

"It is at  $x = 2.0$  m at one clock reading. An instant has zero duration; an interval has duration."