Grade 7, all subjects

Every written unit for this grade, subject by subject (unreviewed AI drafts)

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Proportional relationships: what stays constant?

Subject: Mathematics Grade: 7 Lessons: 5 Time per lesson: about 60 minutes

Status: written (unreviewed AI draft; not human-educator-reviewed or classroom-tested)

Author: GPT-6 Astra

Big idea

In a proportional relationship, multiplying one quantity by a factor multiplies the other by the same factor. Its equation is y = kx: the rate y/x stays constant for positive x. A percentage calculation also needs a clearly identified reference whole, which can change from one step to the next.

What students should be able to do

- Compute a unit rate from fractional quantities, label its units, and distinguish it from the inverse rate.
- Distinguish proportional from nonproportional relationships in tables, verbal rules and graphs.
- Write y = kx and explain the constant k and points (0, 0) and (1, k), using the quantities and units on the axes.
- Calculate percent increase or decrease and successive percentages with the correct reference whole at each step.
- Find an original amount from a stated final percentage and explain a simple-interest model.

What students should already know

Students need whole-number and fractional unit rates, percent of a whole, fraction multiplication and division, decimal operations, and nonnegative coordinate pairs. The grade 6 ratios unit supplies the ratio and percent foundation; this is not a replacement for instruction in fraction division.

Use these three diagnostic questions without a time limit. Ask for a representation or explanation as well as a result:

1. Three identical notebooks cost 6 currency units, with no fee. What is the cost per notebook?
2. Find 25% of 80.
3. How many halves are in three quarters? Calculate (3/4) ÷ (1/2).

Diagnostic guide: (1) 6 ÷ 3 = 2 currency units per notebook. (2) One quarter of 80 is 20. (3) Three quarters contains one and a half halves, so the quotient is 3/2. A strip divided into quarters makes the comparison visible. These questions are not an admission gate: revisit equal groups, a 100% bar, or fraction strips where needed before combining the ideas.

Lesson list

1. A rate when both quantities are fractions: compute and interpret rates, including inverse units.
2. A straight line is not enough: connect rules, tables, graphs and the origin.
3. Percent change needs a starting whole: distinguish change from final amount and identify the denominator.
4. Two percentages, two reference wholes: successive changes, reverse percent and fees.
5. Choose the model, explain the result: simple interest, synthesis and an eight-task assessment.

Materials (whole unit)

Paper, pencil, ruler, and optional grid paper or tactile grid; fraction strips can be drawn rather than purchased. Offer large-print pages and verbal descriptions. A calculator is optional after a student has written or described the intended calculation. No internet, purchases, food preparation or personal financial information is required.

All currency amounts and rates are fictional arithmetic examples. Substitute a locally familiar currency label if helpful, without changing the stated mathematical rule. These are not actual tax rules or financial advice. Counts of indivisible packs use whole-number inputs; lengths, times and volumes may use fractional inputs.

Assessment

Use lesson 5's A1–A8 tasks and worked guide. Accept oral explanations, labelled drawings or equations; do not score speed or handwriting. Look separately for rate direction and units, proportional-model recognition, graph interpretation, and correct percent bases. Use errors to select a worked example for revisiting, then offer a similar new question. There is no validated pass threshold or claim that eight tasks measure all grade 7 mathematics.

Sources

The Common Core grade 7 Ratios and Proportional Relationships reference was consulted on November 4, 2026. 7.RP.A.1 informed fractional unit rates; 7.RP.A.2a–d informed tables, graphs, equations and point interpretation; 7.RP.A.3 informed multi-step ratio and percent problems. This is a scope cross-reference, not accreditation, a complete alignment audit, or a full grade 7 course. Examples and explanations here are original CC0 material; the linked reference is not relicensed by this repository.

See also the proposed mathematics progression.

Known gaps and cautions

Pacing is an untested estimate. Split lessons, especially lessons 4 and 5, if explanation or practice needs more time. A qualified local educator should check language, access needs, prerequisites, curriculum requirements and examples before classroom use. An agent peer check is not human educator review.

The unit uses nonnegative quantities and does not develop general functions on negative inputs. It is not a finance course. Compound interest appears only as an optional contrast; percent error, commission and other contexts are not exhaustively covered. Data agreeing with a model at

several points does not prove that it holds at unobserved values. Explicit rules in the exercises are assumptions, not empirical claims about equipment, motion or prices.

Lesson 1: A rate when both quantities are fractions

Time: about 60 minutes (untested estimate; split if needed)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-6 Astra.

Goal

Compute a unit rate from fractional quantities and explain why reversing the division changes both the rate and its units.

Materials

Paper, pencil, optional fraction strips and calculator. Ribbon is a fictional measured quantity: no cutting or purchases are needed.

Steps

✎ 1. Opening — 5 minutes

O. In a fictional shop, 3 metres of ribbon cost 6 currency units, with a constant price per metre and no fee. Find the price per metre. Ask students to name the quantity that should become **one**, rather than starting with a memorized division rule.

✎ 2. Main activity: worked model — 15 minutes

Display: “Three quarters of a metre cost nine eighths of a currency unit, at a constant price per metre.” Write the question in words: **How much currency for one metre?**

Draw a one-metre strip divided into four quarters. Label three quarters together 9/8 currency units. One quarter costs (9/8) ÷ 3 = 3/8. Four quarters cost 4 × 3/8 = 12/8 = 3/2 currency units.

Length (metres)	Cost (currency units)
0	0
1/4	3/8
3/4	9/8
1	3/2

Connect the strip to division: (9/8) ÷ (3/4) = (9/8) × (4/3) = 3/2 **currency units per metre**. Multiplying both the length and the cost by 4/3 turns 3/4 metre into one metre. The fraction calculation and the strip describe the same scaling.

Write cost = (3/2) × length, when length is measured in metres. For continuous ribbon sold by length, fractional metre inputs are allowed in this model.

Now reverse the question: “How many metres for one currency unit?” The calculation is (3/4) ÷ (9/8) = 2/3 **metre per currency unit**. Both rates are correct, but they answer different questions. Do not drop the units when comparing them.

3. Guided work — 10 minutes

G. A constant-motion model travels 5/6 kilometre in 1/3 hour. Find kilometres per hour and the distance in 1/2 hour. Have students first scale the time to one hour, then use the rate for half an hour. A single journey's average rate does not by itself establish that the speed stays constant; here constancy is part of the stated model.

✎ 4. Independent practice — 20 minutes

For each task, write the division with units or describe the scaling. A calculator may check the arithmetic after the model is chosen.

- **P1.** A constant-price ribbon model gives 2/3 metre for 5/6 currency unit. Find currency units per metre and the cost of 2 metres.
- **P2.** In a constant-flow model, 3/5 litre fills in 2/5 minute. Find litres per minute and the time needed for 2 litres.
- **P3.** A length of 3/8 metre costs 3/4 currency unit. Find both currency units per metre and metres per currency unit.
- **P4.** Someone divides 3/4 metre by 9/8 currency units and reports “2/3 currency unit per metre.” Explain the mistake and give the price per metre.

5. Discussion — 5 minutes

D. Why can two different numbers both be correct unit rates for the same purchase? Ask for the question each answers, not just the phrase “flip it.”

✓ 6. Closing check — 5 minutes

E. A constant-motion model travels 7/10 kilometre in 1/5 hour. Find kilometres per hour and the distance in 2/5 hour.

Answer guide

- **O:** 6 ÷ 3 = 2 currency units per metre; multiplying 2 by 3 metres gives the original cost 6.
- **G:** (5/6) ÷ (1/3) = (5/6) × 3 = 5/2 kilometres per hour. Half an hour gives (5/2) × (1/2) = 5/4 kilometres. Alternatively, half an hour is 3/2 times the given time, so multiply the given distance by 3/2 too.
- **P1:** (5/6) ÷ (2/3) = 5/4 currency units per metre. Two metres cost (5/4) × 2 = 5/2 currency units.
- **P2:** (3/5) ÷ (2/5) = 3/2 litres per minute. Time = 2 ÷ (3/2) = 4/3 minutes. Check: (3/2) × (4/3) = 2 litres.
- **P3:** (3/4) ÷ (3/8) = 2 currency units per metre; (3/8) ÷ (3/4) = 1/2 metre per currency unit. The reciprocal has different units.
- **P4:** The division produces 2/3 **metre per currency unit**, not currency per metre. For the requested price, (9/8) ÷ (3/4) = 3/2 currency units per metre.

- **D:** “One rate tells me the cost of one metre; the other tells me the length bought for one currency unit. I must say which one I want.”
- **E:** (7/10) ÷ (1/5) = 7/2 kilometres per hour. In 2/5 hour the distance is (7/2) × (2/5) = 7/5 kilometres. This is twice the original distance because the time doubled.

Vocabulary

- **Unit rate:** amount of one quantity for one unit of another, with units specified.
- **Inverse rate:** the rate for the reversed question; for a nonzero rate its numerical value is the reciprocal when the units are reversed consistently.
- **Constant rate:** a rate that does not change within the stated model.

Differentiation

- **Extra support:** use the quarter-metre strip before symbolic fraction division. Read “currency divided by metres” aloud. Allow an oral answer with a labelled strip.
- **Extra challenge:** express the worked ribbon cost as y = kx. **Guide:** x is metres, y is currency units, k = 3/2 currency units per metre. Fractional nonnegative x values are meaningful for this continuous-length model.

⚠ Safety

Use paper models. Do not enact speed or liquid-flow experiments. No purchases or disclosure of personal spending are needed.

Teacher notes

A correct number with reversed units is not yet a correct interpretation. Ask “one of what?” before selecting the division. Fraction strips explain the scaling; a rule for dividing fractions should not replace that explanation. Keep the constant-rate assumption explicit when moving from an observed pair to another time or length.

Unit overview · Next lesson

Lesson 2: A straight line is not enough

Time: about 60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-6 Astra.

Goal

Recognize a proportional relationship and connect its constant rate, equation and graph, including the meaning of the origin and the unit-rate point.

Materials

Paper, ruler, optional grid or tactile grid and calculator. Graphs may be described orally with labelled coordinates.

Steps

✎ 1. Opening — 5 minutes

O. Four identical cards cost 6 currency units, with a constant price per card and no fee. What does one card cost? What do eight cost? Name the assumption that permits the second calculation.

✎ 2. Main activity: worked comparison — 15 minutes

Two fictional equipment-use models relate hours x to cost y. Model A charges 3 currency units per hour with no fee: y = 3x. Model B charges a fixed access fee of 2 currency units plus 3 per hour: y = 2 + 3x. The access fee applies even at zero usage once access is purchased.

Hours x	A: cost y	B: cost y
0	0	2
1	3	5
2	6	8
4	12	14

For positive x, A has y/x = 3 at every listed point. B has ratios 5/1 = 5, 8/2 = 4, and 14/4 = 3.5. Its cost per hour of use is not constant even though the charge **for each additional hour** is constant.

Draw horizontal hours from 0 to 4 and vertical currency units from 0 to 14. Use equal spacing for equal numerical increments on each axis; the two axes need not use the same physical scale. Label the axes and plot both sets. Join each model's points with a straight line over nonnegative hours, since this example allows fractional hours and explicitly gives a linear rule. Only A's line passes through the origin.

Explain A's points: (0, 0) means no hours and no cost; (1, 3) means one hour costs 3 currency units, so k = 3 currency units per hour; (2, 6) means two hours cost 6. We do **not** calculate 0/0 at the origin. The rate is determined at positive x, and y = kx gives zero output at zero input.

A straight line alone is insufficient: B is straight. Passing through the origin alone is also insufficient: a curved or irregular relation can include (0, 0). A proportional graph has both properties, over its allowed domain. For discrete counts, the allowable points lie on such a line, but intermediate points may not be valid quantities.

3. Guided work — 10 minutes

G. Ribbon cost y in currency units is y = 2.5x, where x is length in metres. Plot or describe (0, 0), (1, 2.5), (4, 10) and find the point for 3 metres. Explain k and the unit-rate point.

✎ 4. Independent practice — 20 minutes

- **P1.** A table has x values 0, 2, 4, 6 metres and y values 0, 5, 10, 15 currency units. Does it fit a proportional model? State k and its equation. **Assuming that model continues**, find y when x = 10.
- **P2.** A table has x values 0, 1, 2, 3 and y values 0, 2, 5, 9. Does it fit a proportional model? Explain why the origin does not settle the question.
- **P3.** For length x in metres and cost y in currency units, compare y = 4x with y = 4 + x. Which is proportional? For the proportional model, explain (1, 4).
- **P4.** A stated proportional relationship includes (2, 7), with x in hours and y in currency units. Find k, the equation, the unit-rate point and the point for zero hours.

5. Discussion — 5 minutes

D. Does agreement with a proportional model at three measured positive inputs prove that all future measurements will fit it? Distinguish a pattern in data from an explicitly assumed rule.

✓ 6. Closing check — 5 minutes

E. Identical whole packs have x values 0, 3, 6 and costs y of 0, 12, 24 currency units, with a constant price per pack and no fee. Find k. Explain why (1, 4) is a valid purchase but (1/2, 2) is not allowed when only whole packs are sold, even though both lie on y = 4x.

Answer guide

- **O:** 6/4 = 1.5 currency units per card; eight cost 8 × 1.5 = 12. The price per card remains constant and no fixed fee is added.
- **G:** k = 2.5 currency units per metre. (1, 2.5) represents one metre costing 2.5 currency units. At 3 metres, y = 2.5 × 3 = 7.5, so the point is (3, 7.5). The stated rule gives a straight line through (0, 0).
- **P1:** Yes: 5/2 = 10/4 = 15/6 = 2.5 currency units per metre, and zero maps to zero. The fitted model is y = 2.5x; under the continuation assumption, y = 25 currency units at 10 metres.

- **P2:** No: the positive-input ratios are 2, 2.5 and 3, not one constant. Having (0, 0) does not fix this mismatch.
- **P3:** y = 4x is proportional, with k = 4 currency units per metre. (1, 4) means one metre costs 4 currency units. y = 4 + x is not proportional: zero length has cost 4, and the positive-input ratios differ.
- **P4:** k = 7/2 = 3.5 currency units per hour; y = 3.5x; unit-rate point (1, 3.5); zero-hours point (0, 0). No division by zero is used.
- **D:** “The measurements fit the model so far, but an unmeasured value might not. If the exercise gives the rule for the whole domain, I can calculate from that assumption.”
- **E:** k = 12/3 = 24/6 = 4 currency units per pack. One whole pack costs 4. The half-pack point is on the mathematical line but outside the allowed whole-pack inputs in this situation.

Vocabulary

- **Constant of proportionality k:** the fixed multiplier in y = kx; y/x for positive x in these examples.
- **Origin:** the point (0, 0).
- **Domain:** the allowed input values in a model.
- **Linear but nonproportional:** a straight-line relationship with a nonzero intercept, such as y = 2 + 3x.

Differentiation

- **Extra support:** say each coordinate as “horizontal quantity, then vertical quantity.” Use a tactile grid, enlarged ticks or oral descriptions. Compare A and B at x = 0 before computing rates.
- **Extra challenge:** reverse A's axes. **Guide:** hours = (1/3) × cost, so the reversed constant is 1/3 hour per currency unit, the reciprocal of 3 currency units per hour.

⚠ Safety

This is a paper activity; no equipment hire or other purchase is needed.

Teacher notes

Equal increases in y for equal increases in x establish a straight-line pattern in a table, not necessarily proportionality. Avoid calling y = 2 + 3x proportional because its “rate” is 3: its slope is 3, but its total y/x is not constant. A finite table is evidence of fit, not proof about unobserved data. For discrete contexts, draw or describe allowable points separately from the containing line.

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Lesson 3: Percent change needs a starting whole

Time: about 60 minutes (untested estimate)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-6 Astra.

Goal

Calculate percent increase or decrease using the original amount as the reference whole, and distinguish the change from the final amount.

Materials

Paper, pencil, optional calculator and drawn or tactile percentage bar.

Steps

✎ 1. Opening — 5 minutes

O. Find 30% of 50. Name the whole and say whether your answer is the part or the whole.

✎ 2. Main activity: worked comparison — 15 minutes

Display: “A collection grows from 80 counters to 100 counters.” The increase is 100 − 80 = 20 counters. Percent increase compares that change to the **starting** 80:

percent increase = (20/80) × 100% = 25%.

Draw a bar for 80 counters, labelled 100%. Divide it into four equal parts: each represents 20 counters, or 25% of the original. Add one more such part. The final 100 counters represent 125% of the original 80, not 25% of it.

Connect the representations:

- Increase: 0.25 × 80 = 20 counters.
- Final amount: 80 + 20 = 100 counters.
- Equivalent multiplier: 1.25 × 80 = 100 counters.

Now reverse the journey: “A collection shrinks from 100 counters to 80.” The decrease is still 20 counters, but the starting whole is now 100. Percent decrease = (20/100) × 100% = 20%. Draw a fresh bar labelled 100 counters = 100%; do not reuse the old 100% label on 80.

For a percent change written as a decimal r, an increase gives final amount = original × (1 + r); a decrease gives final amount = original × (1 − r). These percent-change calculations require a positive original amount. Here decreases have $0 \le r \le 1$ so the final amount is

nonnegative. A 100% decrease leaves zero; an increase can exceed 100%. Multipliers describe the final amount, not just the change.

3. Guided work — 10 minutes

G. A length changes from 60 centimetres to 45 centimetres. Find the decrease in centimetres, the percent decrease, and the final length as a percentage of the original. Ask students to label 100% before calculating.

✎ 4. Independent practice — 20 minutes

For each answer, name the original whole and include a checking calculation.

- **P1.** A count grows from 50 to 65. Find the percent increase.
- **P2.** A length shrinks from 120 centimetres to 90 centimetres. Find the percent decrease.
- **P3.** Increase 30 counters by 40%. Find the increase and the final count; explain why the two answers differ.
- **P4.** Someone says, “80 to 100 is a 20% increase because 20/100 = 0.20.” Identify the wrong reference whole. What is the correct percent increase, and what is the percent decrease for 100 to 80?

5. Discussion — 5 minutes

D. Why do the forward and backward changes between 80 and 100 have different percentages even though both involve 20 counters?

✓ 6. Closing check — 5 minutes

E. A count grows from 200 to 230. Find the percent increase. Complete: “230 is ___% of 200.”

Answer guide

- **O:** 0.30 × 50 = 15. The whole is 50; 15 is the 30% part. It is not a new total unless a problem specifies how that part is used.
- **G:** Decrease = 60 − 45 = 15 centimetres. Percent decrease = (15/60) × 100% = 25%. Final length is 75% of the original: 0.75 × 60 = 45 centimetres.
- **P1:** Increase = 65 − 50 = 15; (15/50) × 100% = 30%. Check: 1.30 × 50 = 65.
- **P2:** Decrease = 120 − 90 = 30 centimetres; (30/120) × 100% = 25%. Check: 0.75 × 120 = 90 centimetres.
- **P3:** Increase = 0.40 × 30 = 12 counters. Final count = 30 + 12 = 42 counters, or 1.40 × 30. The increase alone omits the original 30 counters.
- **P4:** The increase starts at 80, not 100: 20/80 = 0.25, so the increase is 25%. The reverse starts at 100: 20/100 = 0.20, so the decrease is 20%.
- **D:** “The numerator, 20 counters, is the same, but the denominator is the starting whole. Twenty is a larger fraction of 80 than of 100.”
- **E:** Increase = 30; (30/200) × 100% = 15%. The final 230 is 115% of 200 because 1.15 × 200 = 230.

Vocabulary

- **Reference whole:** the amount that represents 100% in a calculation.
- **Percent increase/decrease:** the increase/decrease divided by the original positive amount, expressed as a percentage.
- **Multiplier:** the factor applied to the original amount to obtain the final amount.

Differentiation

- **Extra support:** draw and label the starting 100% bar before finding any part. Use “starting,” “change” and “final” as three separate labels. Offer oral explanations or a calculator once the reference whole is chosen.
- **Extra challenge:** increase 12 by 150%. **Guide:** the increase is $1.5 \times 12 = 18$; the final amount is $12 + 18 = 30$, or 2.5×12. An increase larger than the original amount is possible.

⚠ Safety

Use fictional counts and lengths, not body measurements, personal income or comparisons between students.

Teacher notes

A final amount and a change are different quantities. “25% increase” means 125% remains relative to the original; “25% decrease” means 75% remains. Do not assume the same numerical change implies the same percentage when the starting whole changes. Percent change from an original amount of zero is undefined in this formula, not automatically 0% or 100%.

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Lesson 4: Two percentages, two reference wholes

Time: about 60 minutes (untested estimate; consider two sessions)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-6 Astra.

Goal

Solve successive and reverse percentage problems by identifying the reference whole at each step.

Materials

Paper, pencil and optional calculator. All prices, taxes and fees are invented for arithmetic, not statements of current policy or financial advice.

Steps

✎ 1. Opening — 5 minutes

O. Find 10% of 90. Explain what amount represents 100%.

✎ 2. Main activity: worked model — 15 minutes

A fictional item costs 80 currency units. Its price is discounted by 25%. A fictional 10% tax is then calculated **on the discounted price**. Find the total.

Write a label for the base at each stage:

Stage	Reference whole	Calculation
Discount	80	0.25 × 80 = 20
Price after discount	80	80 − 20 = 60
Tax	60	0.10 × 60 = 6
Total	60	60 + 6 = 66

The two multipliers give the same result: 80 × 0.75 = 60, then 60 × 1.10 = 66 currency units. Do not calculate 80 × (1 − 0.25 + 0.10) = 68: that incorrectly uses 80 as the base for both percentages. The problem expressly makes 60 the tax base.

Use a bar labelled 80 = 100%, with a quarter removed. Relabel the remaining 60 as 100% **for the tax step**, then add a tenth of that new whole. The quantity did not change when its percentage label changed; the reference did.

Explain a reverse problem: if a final price is 72 after a 20% markdown, the final amount is 80% of the unknown original x. Thus 0.80x = 72 and x = 72 ÷ 0.80 = 90. Check forward: 90

× 0.80 = 72. Adding 20% of 72 is not the inverse operation, because that uses the wrong base.

3. Guided work — 10 minutes

G. A length of 50 centimetres increases by 20%, then decreases by 20% of its **new** length. Find both intermediate and final lengths and the net percent change from the original. Before calculation, ask whether the two changes must cancel; return to that prediction after calculating.

✎ 4. Independent practice — 20 minutes

Use the stated bases, not assumptions about real shops. Write the expression before using a calculator. In these fictional problems, round monetary results to the nearest 0.01 currency unit only at the end; the supplied examples already terminate exactly.

- **P1.** A price of 120 currency units has a 15% discount, followed by a 10% tax on the discounted price. Find discounted price, tax and total.
- **P2.** A count of 200 grows by 10%, then by another 10% of the new count. Find the final count and overall percent increase from 200.
- **P3.** A final price is 72 currency units after a 20% markdown. Find the original and check it. Explain why 72 × 1.20 does not recover it.
- **P4.** Policy A adds a 10% tax on an 80-currency-unit item, then adds a flat fee of 5. Policy B taxes the combined item and fee, 80 + 5, at 10%. Find each total. Why are they different?

5. Discussion — 5 minutes

D. Does the worked example establish that every real tax is calculated after a discount? What information must a real question specify? Explain why P4 needs more than two percentage multipliers.

✓ 6. Closing check — 5 minutes

E. Start with 60. Decrease it by 10%, then increase the result by 10%. Find the intermediate amount, final amount and net percent change from 60.

Answer guide

- **O:** 0.10 × 90 = 9; the reference whole is 90.
- **G:** 50 × 1.20 = 60 centimetres; then 60 × 0.80 = 48 centimetres. The increase was 10 centimetres, but the decrease was 12. The net decrease is 2/50 = 0.04 = 4%, not zero.
- **P1:** Discounted price = 120 × 0.85 = 102. Tax = 102 × 0.10 = 10.20. Total = 112.20 currency units.
- **P2:** 200 × 1.10 = 220, then 220 × 1.10 = 242. Increase = 42; 42/200 = 0.21 = 21%. The second increase was 22, not 20.
- **P3:** 0.80 × original = 72, so original = 72/0.80 = 90 currency units. Check: 90 × 0.80 = 72. The proposed 72 × 1.20 = 86.40 adds 20% of 72, not the 18 removed from the original 90.

- **P4:** A: 80 × 1.10 + 5 = 93. B: (80 + 5) × 1.10 = 93.50 currency units. Policy B also taxes the fee, adding 0.50. Neither fictional policy is a claim about local law.
- **D:** “No: the problem must state the tax base and any fees. Real rules may differ. A flat fee is addition, so I cannot treat every operation as multiplication.” With the same two pure percentage factors and no intermediate rounding, their product commutes; this fact does not make all fee policies interchangeable.
- **E:** 60 × 0.90 = 54, then 54 × 1.10 = 59.40. The net decrease is 0.60/60 = 0.01 = 1%.

Vocabulary

- **Successive changes:** changes applied one after another, potentially with different reference wholes.
- **Reverse percent:** finding the original amount when the final amount and its percentage of the original are known.
- **Flat fee:** a fixed amount added, not a percentage of the amount bought.

Differentiation

- **Extra support:** provide two boxes headed “base for this step” and “new amount.” Complete the worked example with a bar before using a combined expression. Split successive changes and reverse percent into separate sessions if needed.
- **Extra challenge:** a final amount is 150 after a 25% increase. Find the original. **Guide:** 1.25x = 150, so x = 120; check 120 × 1.25 = 150.

⚠ Safety

Do not ask students to reveal family purchases, tax bills, debt or income. No real transactions are part of this lesson.

Teacher notes

Equal percentage increases and decreases generally do not cancel because the second base has changed. In reverse percent, undo the multiplier by division; do not merely switch “increase” and “decrease.” Require an explicitly stated base for every tax or fee example. Currency rounding policies vary in real life; the rule here is only an exercise assumption.

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Lesson 5: Choose the model, explain the result

Time: about 60 minutes (untested estimate; assessment may need a separate session)

Status: unreviewed AI draft; not classroom-tested. Author: GPT-6 Astra.

Goal

Choose and explain proportional and percentage models, including a stated simple-interest model, and check results using units and reference wholes.

Materials

Paper, optional grid or tactile grid, ruler and calculator. No financial accounts, internet access or personal financial information are required.

Steps

✎ 1. Opening — 5 minutes

O. A stated proportional relationship includes (2, 9). Find k and write its equation.

✎ 2. Main activity: simple-interest worked example — 15 minutes

In a fictional arithmetic model, the principal, or starting amount, is 200 currency units. Simple interest is paid at 3% per year for two years, with no fees or payments in between. **Each year's interest is calculated on the original 200**, not on a growing balance.

One year's interest = 200 × 0.03 = 6 currency units. Two years' interest = 6 × 2 = 12. Final amount = 200 + 12 = 212 currency units.

Write I = Prt, where I is interest, P is principal, r is the annual rate written as a decimal, and t is time in years. Here I = 200 × 0.03 × 2 = 12. State that the formula describes this simple-interest assumption; it is not a universal account rule or an investment recommendation.

With P = 200 and r = 0.03 fixed, interest is I = 6t, proportional to time. But the **total amount** is A = 200 + 6t. It is not proportional to time: at zero years, the total is already 200, not zero. This connects the percent calculation to lesson 2's fixed-fee distinction.

3. Guided work — 5 minutes

G. Use simple interest with principal 150 currency units, annual rate 4%, and time three years. Find yearly interest, total interest and final amount. Explain which amount is the reference whole each year.

4. Individual synthesis and assessment — about 25 minutes

This is not a speed test; allow more time or another session. Give the prompts before the guide. Accept equations, labelled diagrams or oral explanations. Ask students to show the rate or percent base, not only a final number.

- **A1. Fractional rate.** At a constant price, 5/8 metre of ribbon costs 15/16 currency unit. Find currency units per metre and the cost of 2 metres.
- **A2. Table and equation.** Hours x are 0, 2, 5; costs y in currency units are 0, 7, 17.5. Does the table fit a proportional model? Give k, the equation and the meaning of (1, 3.5).
- **A3. Straight but not proportional.** The rule is $y = 3 + 2x$, where x is hours and y is currency units. Its table includes (0, 3), (1, 5), (2, 7). Explain why the rule is not proportional even though its graph is straight.
- **A4. Graph interpretation.** Volume x in litres and cost y in currency units follow $y = 2x$ for continuous nonnegative volumes. Draw or describe a labelled graph including (0, 0), (1, 2) and (3, 6). Explain (3, 6) and how (0, 0) fits the model without dividing by zero.
- **A5. Change of base.** A count increases from 60 to 75, then later decreases from 75 to 60. Find the percent increase and percent decrease. Explain the difference.
- **A6. Successive percentages.** A fictional price of 150 currency units is discounted by 20%, then taxed at 5% of the discounted price. Find the final total, showing the tax base.
- **A7. Reverse percent.** An amount is 88 after a 10% increase. Find the original amount and check forward.
- **A8. Simple interest.** A fictional principal of 300 currency units receives 2% simple interest per year for four years, with no fees or intervening payments. Find the interest and final amount. Name the amount used as the percentage base each year.

5. Discussion — 5 minutes

D. Choose one assumption from today's models that would need checking in a real application. Explain what could change the answer if that assumption were false.

✓ 6. Closing check — 5 minutes

E. Explain why $I = 5t$ is proportional to time t but $A = 100 + 5t$ is not. Here t is years and both I and A are measured in currency units.

Worked answer guide

- **O:** $k = 9/2 = 4.5$; $y = 4.5x$. No units were specified in this abstract question.
- **G:** Yearly interest = 150 × 0.04 = 6 currency units; three years' interest = 18; final amount = 168. The original principal 150 is the reference whole every year.
- **A1:** (15/16) ÷ (5/8) = (15/16) × (8/5) = 3/2 currency units per metre. Two metres cost (3/2) × 2 = 3 currency units. Reverse units would answer a different question.
- **A2:** Yes: 7/2 = 17.5/5 = 3.5 currency units per hour; zero maps to zero. The fitted equation is $y = 3.5x$. (1, 3.5) means one hour costs 3.5 currency units under that model. The finite table fits; it does not alone prove unmeasured values.
- **A3:** At zero hours y = 3, not zero: the rule includes a fixed 3-currency-unit charge. Also 5/1 = 5 and 7/2 = 3.5 differ. The increase for each additional hour is constant, but the total cost per hour y/x is not.
- **A4:** Put volume in litres on the horizontal axis and cost in currency units on the vertical axis, with equally spaced numerical increments on each axis. The points lie on a straight line

through the origin; fractional inputs between them are permitted by the continuous-volume model. (3, 6) means 3 litres cost 6 currency units. At x = 0, y = 2 × 0 = 0; no 0/0 calculation is needed. The constant is 2 currency units per litre, read at (1, 2).
- **A5:** Increase = 15, based on 60: 15/60 = 0.25 = 25%. Decrease = 15, based on 75: 15/75 = 0.20 = 20%. The absolute changes match but their starting wholes differ.
- **A6:** Discounted price = 150 × 0.80 = 120. Tax base is 120, so tax = 120 × 0.05 = 6. Total = 126 currency units.
- **A7:** 1.10 × original = 88, so original = 88/1.10 = 80. Check: 80 × 1.10 = 88.
- **A8:** Yearly interest = 300 × 0.02 = 6 currency units. Four years' interest = 6 × 4 = 24. Final amount = 300 + 24 = 324. Every year's base is the original 300, not the balance after previous interest.
- **D:** Sample responses: “A fixed fee would change a pure cost-per-item model”; “Tax on the original rather than discounted price would change the tax”; “A rate observed during one interval might change later”; “Compound interest would use a growing balance rather than the original principal.” A specific assumption and consequence matter more than matching these words.
- **E:** I = 5t has constant I/t = 5 for positive t and gives I = 0 at t = 0. A = 100 + 5t starts at 100, so it is not of the form A = kt; its positive-time A/t is not constant. Its graph is nevertheless straight.

Feedback and next steps

Treat the competencies separately, not as a single speed or ability ranking:

- A1: if division is reversed, return to lesson 1's “one of what?” and units; if the setup is correct but arithmetic fails, support fraction division.
- A2–A4: distinguish a constant additional charge from a constant total ratio; revisit both the origin and a positive-input unit-rate point in lesson 2.
- A5: label the starting 100% whole separately for each direction, using lesson 3's bars.
- A6–A7: list each stage's base and check a reverse-percent answer forward, using lesson 4.
- A8: separate interest from final amount and simple from growing-balance rules.

After discussion, offer an analogous question rather than asking students to memorize this key. These prompts and feedback categories are not a validated assessment instrument; there is no established pass threshold.

Vocabulary

- **Principal:** the original amount used in the stated interest model.
- **Simple interest:** interest computed on the original principal for the stated time, rather than on accumulated interest.
- **Annual rate:** a rate per year; convert a percent to a decimal before using I = Prt.

Differentiation

- **Extra support:** provide one task per page, enlarged graphs or oral response options. Allow untimed work and a calculator after an expression is selected. Revisit the worked example before assessing simple interest separately.
- **Extra challenge, not required for assessment:** compare the worked example with annual compound growth at 3% for two years. **Guide:** 200 × 1.03 × 1.03 = 212.18,

compared with simple-interest total 212. The extra 0.18 is 3% of the first year's 6 interest. This illustrates a different assumption, not a full compound-interest course.

⚠ Safety

All money contexts are fictional. Do not request personal savings, borrowing, income or family circumstances. No purchases, account creation or financial recommendations are part of the activity.

Teacher notes

Separate “the interest is proportional to time” from “the total is proportional to time.” Keep rate periods and time units consistent: the displayed formula uses an annual rate with time in years. Classroom pacing and assessment use need local educator review. A second agent checking arithmetic does not make this a human-reviewed unit.

Previous lesson · Unit overview

Grade 7 Science — Photosynthesis and respiration: where a plant's mass comes from

> **Unreviewed AI draft.** Written by Claude Opus 5.5 (an AI agent) on 2026-11-04. No teacher has checked it yet. Read it fully, adapt it to your class and local rules, and test any practical work yourself before using it with students.

Back to all units

Big idea

A tree is mostly made from air. Green plants take in carbon dioxide and water and, using light energy captured by chlorophyll, make sugar (glucose) and release oxygen. This is photosynthesis. All living things, plants included, break down sugar with oxygen to release the energy they need, giving off carbon dioxide and water. This is respiration. It happens day and night. The two processes run in opposite directions, and together they move carbon between the air and living things.

Outcomes

By the end of the unit, students can:

1. Write the word equations for photosynthesis (carbon dioxide + water → glucose + oxygen, needing light and chlorophyll) and for aerobic respiration (glucose + oxygen → carbon dioxide + water, releasing energy).
2. Explain, using van Helmont's willow experiment and the photosynthesis equation, why most of a plant's mass does not come from the soil.
3. Use the iodine test to show starch is present, and explain that plants store some of the glucose they make as starch.
4. Plan and carry out a fair test of how light intensity affects the rate of photosynthesis, using floating leaf discs, and draw a line graph of the results.
5. Use an indicator (bromothymol blue) to show carbon dioxide being taken in or given out, and explain why a plant in the dark adds carbon dioxide to the water.
6. Correct the common ideas that "plants respire only at night", "respiration is breathing" and "plants get their food from the soil".

Prior knowledge

- Plants need light and water to grow well (grade 1); living things need food for energy.
- Fungi and other decomposers release carbon dioxide as they break down dead material (grade 6).
- Fair tests: change one thing, keep the rest the same, repeat (grades 3–6).
- Reading and drawing simple tables and line graphs.

Lessons (about 50 minutes each)

#	Lesson	Practical?
1	Where does a tree come from?	Iodine starch test on foods

#	Lesson	Practical?
2	Leaves make oxygen: floating leaf discs	Leaf discs in light and in the dark
3	More light, faster photosynthesis? A fair test	Lamp at three distances; graph
4	Respiration never stops: the indicator tubes	Bromothymol blue tubes, light and dark
5	Two processes, one carbon cycle + unit check	Discussion and written assessment

Lesson 4 needs a short look at the tubes the next day (about 5 minutes).

Materials (whole unit)

- Lesson 1: dilute iodine solution in dropper bottles (iodine in potassium iodide, as sold for school use); white tiles or saucers; small samples of potato, bread, rice, apple, table salt, sugar, cooking oil; eye protection.
- Lessons 2–3: fresh spinach leaves (or ivy or another soft, thin leaf); a single-hole paper punch; 10 ml plastic syringes without needles; sodium hydrogen carbonate (baking soda); washing-up liquid; clear plastic cups; an LED desk lamp (LEDs stay cool); a ruler or metre stick; a box or cupboard for dark cups; stopwatches.
- Lesson 4: bromothymol blue indicator solution (school-strength); boiling tubes or clear jars with lids or bungs; aluminium foil; pondweed (for example Elodea or Egeria bought from an aquarium shop); one new straw per student; a lamp.
- Student record sheets (tables are given in each lesson).

Assessment

- Ongoing: closing check questions at the end of each lesson (answers included).
- Lesson 3: the results table, line graph and conclusion are a practical skills task.
- Lesson 5: a 10-question unit check (20 marks) with an answer guide and marking notes.

Sources

These are general references that a teacher can use to check facts. Links were checked to load on 2026-11-04.

- Wikipedia, "Photosynthesis": https://en.wikipedia.org/wiki/Photosynthesis
- Wikipedia, "Cellular respiration": https://en.wikipedia.org/wiki/Cellular_respiration
- Wikipedia, "Jan Baptist van Helmont" (willow tree experiment): https://en.wikipedia.org/wiki/Jan_Baptist_van_Helmont
- Wikipedia, "Joseph Priestley": https://en.wikipedia.org/wiki/Joseph_Priestley
- Wikipedia, "Jan Ingenhousz": https://en.wikipedia.org/wiki/Jan_Ingenhousz
- Wikipedia, "Chlorophyll": https://en.wikipedia.org/wiki/Chlorophyll
- Wikipedia, "Chloroplast": https://en.wikipedia.org/wiki/Chloroplast
- Wikipedia, "Mitochondrion": https://en.wikipedia.org/wiki/Mitochondrion
- Wikipedia, "Stoma": https://en.wikipedia.org/wiki/Stoma
- Wikipedia, "Leaf": https://en.wikipedia.org/wiki/Leaf
- Wikipedia, "Glucose": https://en.wikipedia.org/wiki/Glucose
- Wikipedia, "Starch": https://en.wikipedia.org/wiki/Starch
- Wikipedia, "Iodine–starch test": https://en.wikipedia.org/wiki/Iodine%E2%80%93starch_test
- Wikipedia, "Lugol's iodine": https://en.wikipedia.org/wiki/Lugol%27s_iodine
- Wikipedia, "Sodium bicarbonate": https://en.wikipedia.org/wiki/Sodium_bicarbonate
- Wikipedia, "Bromothymol blue": https://en.wikipedia.org/wiki/Bromothymol_blue

- Wikipedia, "Elodea": https://en.wikipedia.org/wiki/Elodea
- Wikipedia, "Carbon dioxide": https://en.wikipedia.org/wiki/Carbon_dioxide
- Wikipedia, "Carbon cycle": https://en.wikipedia.org/wiki/Carbon_cycle
- Wikipedia, "Compensation point": https://en.wikipedia.org/wiki/Compensation_point
- Wikipedia, "Fermentation": https://en.wikipedia.org/wiki/Fermentation

A teacher should prefer their national curriculum documents and school science-safety guidance where these exist.

Known gaps and cautions

- **Simplifications (labelled for teachers):** the word equations hide many steps (light-dependent reactions, the Calvin cycle, glycolysis and so on). "Glucose" stands for the sugars plants make. Respiration "releases" energy; it does not "make" it. Anaerobic respiration and fermentation are mentioned only briefly (grade 6 yeast). Leaf discs float because oxygen collects in the air spaces inside the leaf; the rising rate is a rough measure of photosynthesis minus respiration, not a pure measure of photosynthesis.
- **Van Helmont:** he concluded the extra mass came from water. That was partly right: water supplies hydrogen and oxygen, but most of the dry mass comes from carbon dioxide in the air, which he could not know about. Present him as a careful measurer who drew a reasonable but incomplete conclusion.
- **Safety:** eye protection for iodine and indicator work; iodine stains skin and clothes. Students only ever **blow out** through straws, never suck, and each uses a new straw. Use LED lamps (cool) and keep electrical leads away from water. Syringes have no needles. Pondweed is an invasive species in many places: buy it from a shop, never collect it from or release it into ponds or streams, and dispose of it in general waste. Check local rules, because some species are banned. No leaf-boiling in ethanol in this unit.
- Not aligned to any official standard yet. Times are estimates. Leaf disc timings vary a lot with the leaf, the lamp and the water temperature, so trial the method first.
- No images are included; teachers will want a diagram of a leaf cross-section and photos of stomata.

Lesson 1 — Where does a tree come from?

Back to unit

Goal

Students meet the puzzle of where a plant's mass comes from, learn the word equation for photosynthesis, and use the iodine test to find starch, the store a plant makes from the sugar it produces.

Materials

- A large potted plant or a photo of a big tree; a seed (for example a bean or an acorn)
- Dilute iodine solution in dropper bottles (one per group); white tiles or saucers
- Small samples: raw potato slice, bread, cooked rice, apple slice, a pinch of table salt, a pinch of sugar, a few drops of cooking oil
- Eye protection; paper towels
- Record table (below)

Steps

✎ Opening (5 min)

Hold up the seed, then show the tree. Ask: "This tree started as a seed smaller than my fingernail. It now weighs as much as a car. Where did all that stuff come from?" Students write a one-line guess on a sticky note. Collect them; most will say "the soil" or "water". Keep them for the end of the lesson.

✎ Main activity (35 min)

Part A — Van Helmont's willow (10 min). Tell the story. In the 1600s Jan Baptist van Helmont, a Flemish doctor and chemist, planted a small willow in a pot of soil that he had weighed. For five years he added only rainwater and kept the pot covered so dust could not get in. At the end the tree had gained about 74 kg. The soil had lost only about 57 g.

Ask pairs: "If the tree got its mass from the soil, what should have happened to the soil?" (It should have lost about 74 kg.) "So where could the mass have come from?" Van Helmont said water. Tell students he was partly right, and that the rest of the answer is something he couldn't weigh: the air.

Part B — The equation (5 min). Write on the board:

> carbon dioxide + water → glucose + oxygen (needs light energy, captured by chlorophyll)

Explain: the carbon in a tree's wood comes from carbon dioxide gas that enters the leaves through tiny pores called stomata. Water comes up from the roots. Light provides the energy.

Chlorophyll, the green pigment inside chloroplasts, captures the light. Glucose is a sugar; the plant uses it for energy and to build itself. Oxygen goes out into the air.

Part C — The starch test (20 min). Plants turn much of their glucose into starch to store it. Iodine solution is orange-brown; it turns blue-black when it touches starch.

1. Eye protection on. Each group puts the seven samples on a tile, spaced apart.
2. Before testing, groups predict "starch" or "no starch" for each.
3. Add one or two drops of iodine to each sample. Wait one minute.
4. Record the colour.

Sample	Prediction	Colour after iodine	Starch?
Potato			
Bread			
Rice			
Apple			
Salt			
Sugar			
Oil			

Expected: potato, bread and rice go blue-black. Salt, sugar and oil stay orange-brown. Apple varies: unripe apple shows some starch, and ripe apple shows little, because the starch turns to sugar as it ripens. Sugar is a useful surprise: plants make sugar, but table sugar is not starch, so the test is negative.

✓ Discussion questions (with example answers)

1. Potato is a part of a plant that grows underground, in the dark. How can it be full of starch? — The leaves made the sugar in the light; the plant carried it down and stored it in the potato as starch.
2. Van Helmont kept the pot covered. Why did that matter? — So that dust or soil couldn't fall in and add mass; otherwise the soil weighing wouldn't be trustworthy.
3. Is the iodine test showing photosynthesis happening? — No. It shows that starch is there, which is evidence that photosynthesis happened earlier.

✓ Closing check (5 min, with answers)

1. Write the word equation for photosynthesis. — carbon dioxide + water → glucose + oxygen (light, chlorophyll).
2. Most of a tree's dry mass comes from: (a) soil (b) air (c) fertiliser. — (b) air (carbon dioxide).
3. What colour does iodine turn with starch? — Blue-black.

Return the sticky notes. Students who wrote "soil" annotate their own note with one sentence explaining why it is mostly not the soil.

Vocabulary

photosynthesis, carbon dioxide, oxygen, glucose, starch, chlorophyll, chloroplast, stomata (singular: stoma)

Differentiation

- **Support:** give a part-filled equation with word cards to place; give the results table with predictions already sorted into two columns.
- **Stretch:** "Soil does supply something small but important. What?" (Minerals such as nitrogen and magnesium, in small amounts; magnesium is part of chlorophyll.) Ask how van Helmont's experiment could be improved (repeat with several trees; dry and weigh the soil; measure the water added).

⚠ Safety

- Eye protection. Iodine stains skin and clothes; wipe spills straight away.
- Nothing in this lesson is eaten, including the food samples after testing. Bin them.
- Check for food allergies before handling bread (wheat/gluten) and other samples.

Teacher notes and common misconceptions

- "Plants eat soil" or "plant food comes from the soil" is extremely common, even in adults. Garden "plant food" is fertiliser, which supplies minerals, not energy.
- Students often think gases have no mass. If they struggle, weigh a sealed fizzy drink bottle, open it, let it go flat overnight and weigh again; it loses a little mass as carbon dioxide escapes.
- Hydrogen and oxygen in the plant come mostly from water, and carbon mainly from carbon dioxide. At grade 7 "mostly from the air, with water" is enough.

Lesson 2 — Leaves make oxygen: floating leaf discs

Back to unit

Goal

Students see evidence that leaves give off a gas in the light and not in the dark, using small leaf discs that sink and then float as oxygen collects inside them. They also learn the method they will use for the fair test in Lesson 3.

Materials (per group of 3–4)

- 3 fresh spinach leaves (thin, soft leaves work best; avoid thick waxy ones)
- Single-hole paper punch
- One 10 ml plastic syringe, **no needle**
- Bicarbonate solution, made by the teacher: about 1/8 teaspoon (roughly 0.5 g) of sodium hydrogen carbonate (baking soda) stirred into 300 ml water, plus 1 small drop of washing-up liquid
- Plain water with 1 small drop of washing-up liquid (no bicarbonate), for the extra cup
- 3 clear plastic cups, labelled A, B and C
- An LED desk lamp; a box or cupboard for the dark cup
- Stopwatch; record table

Steps

✎ Opening (5 min)

Recap the equation: carbon dioxide + water → glucose + oxygen. Ask: "If leaves really give off oxygen, how could we see it?" Take ideas (bubbles; collect the gas). Then tell students the story of Jan Ingenhousz, who in 1779 showed that underwater plants give off bubbles from their green parts in sunlight, and that the bubbles stop in the shade.

Explain the trick: a leaf has air spaces inside it. If we pull the air out, the leaf disc sinks. If it then makes oxygen, the gas fills the spaces and the disc floats again.

✎ Main activity (35 min)

1. **Punch discs (5 min).** Punch 30 discs, avoiding the big veins. Keep them on a damp paper towel.
2. **Sink the discs (10 min).** For each set of 10 discs:
3. Take the plunger out of the syringe. Drop 10 discs into the barrel. Put the plunger back and push it gently down to just above the discs.
4. Draw up about 5 ml of solution. Point the tip upwards and push out the air.
5. Put a finger over the tip and pull the plunger back slowly. Hold for 10 seconds; this pulls air out of the leaf. Release.
6. Repeat 2–3 times until most discs sink. Tap the syringe if discs stick to the side.

7. Pour the discs and the liquid into a cup with about 3 cm of the same liquid. Any disc that is still floating is taken out and replaced.
8. **Set up three cups.**
9. **A:** bicarbonate solution, about 10 cm under the lamp.
10. **B:** bicarbonate solution, in the dark box.
11. **C:** plain water (no bicarbonate), about 10 cm under the lamp.
12. **Record (15 min).** Every minute, count the floating discs in A and C. Lift the lid on B only at 5, 10 and 15 minutes, and do it quickly.

Time (min)	Floating in A (light + bicarbonate)	Floating in B (dark + bicarbonate)	Floating in C (light, no bicarbonate)
0	0	0	0
1		–	
2		–	
…			
15			

Expected pattern: discs in A begin to rise after a few minutes, and most float by 10–15 minutes. Discs in B stay down. Discs in C stay down or rise only very slowly. The times vary a lot, so trial the method beforehand.

✓ Discussion questions (with example answers)

1. Why is the bicarbonate there? — It gives the water dissolved carbon dioxide, which the leaf needs to photosynthesise.
2. What does cup C tell us? — Light alone isn't enough; without a carbon dioxide supply, the discs make little oxygen.
3. What does cup B tell us? — Without light, the discs don't make enough oxygen to float, even with carbon dioxide.
4. Can we be sure the gas is oxygen? — Not from this test alone. Ingenhousz and others tested the gas. We are using their result and our equation, and we should say so.

✓ Closing check (5 min, with answers)

1. Why do the discs sink after we use the syringe? — We pulled the air out of the spaces inside the leaf.
2. Why do discs in the light rise again? — Photosynthesis makes oxygen, which fills the air spaces.
3. Name the two things the leaf needed that we tested today. — Light and carbon dioxide.

Vocabulary

air spaces, dissolved, control, rate, evidence

Differentiation

- **Support:** one student counts, one times, one records; give a table with the minutes already filled in.
- **Stretch:** "The discs are also respiring all the time, using up some oxygen. What does that mean about the rate we are measuring?" (It is photosynthesis minus respiration, so the real rate of photosynthesis is a bit higher.)

⚠ Safety

- Syringes have no needles. Don't point a syringe at anyone.
- The lamp is an LED; keep the lead and plug away from the cups of liquid, and wipe spills straight away.
- Baking soda solution is not for tasting; wash hands after the practical.

Teacher notes and common misconceptions

- Make the bicarbonate solution fresh each day; too much bicarbonate can slow the discs down, so stick to a small amount.
- If discs won't sink, add one more tiny drop of washing-up liquid (it helps the liquid get into the leaf) and repeat the vacuum step.
- Some students think the bubbles are "air" or "carbon dioxide coming out". Link back to the equation: oxygen is the product.
- Keep the discs for no more than one lesson; they won't work well the next day.

Lesson 3 — More light, faster photosynthesis? A fair test

Back to unit

Goal

Students plan and carry out a fair test of how the distance of a lamp (and so the light intensity) affects the rate of photosynthesis, using the floating leaf disc method from Lesson 2. They draw a line graph and write a conclusion that uses evidence.

Materials (per group of 3–4)

- As in Lesson 2: spinach leaves, hole punch, 10 ml syringe (no needle), freshly made bicarbonate solution with a drop of washing-up liquid, 3 clear cups
- An LED desk lamp; a metre stick or ruler
- Stopwatch; graph paper; record table
- If possible, dim the room lights or close the blinds

Steps

✎ Opening (5 min)

Ask: "In Lesson 2, discs in the light floated and discs in the dark didn't. What do you predict will happen with some light: a lamp far away?" Students write a prediction with a reason, using "the closer the lamp…, the … ".

✎ Main activity (35 min)

Plan (8 min). As a class, agree on the variables before anyone starts.

- **Change (independent variable):** distance from the lamp to the cup: 10 cm, 20 cm, 40 cm.
- **Measure (dependent variable):** the time for 5 of the 10 discs to float. A shorter time means a faster rate.
- **Keep the same (control variables):** type of leaf; 10 discs per cup; the same bicarbonate solution; the same depth of liquid; the same lamp; the same starting time; room lighting.

Ask: "Why use an LED lamp and not an old bulb that gets hot?" (A hot lamp would warm the closer cups more, so temperature would change as well as light, and the test wouldn't be fair.)

Do (22 min). Each group sinks three sets of 10 discs (the method is in Lesson 2) and sets up the three cups at the three distances, measuring from the bulb to the middle of the cup. Start the stopwatch for all three together. Record the time at which the 5th disc floats in each cup. Stop at 25 minutes. If 5 discs haven't floated by then, record "more than 25 min".

Distance from lamp (cm)	Time for 5 discs to float (min) — our group	Class median (min)
10		
20		
40		

Collect every group's times on the board and find the median for each distance. The median is the middle value; one odd result doesn't pull it much.

Example class results (for the teacher; real results will differ):

Distance (cm)	Group times (min)	Median (min)
10	6, 7, 5, 6, 14	6
20	9, 10, 8, 11, 9	9
40	16, 18, 15, >25, 17	17

The 14 at 10 cm is probably a mistake, such as discs not properly sunk or a lamp knocked out of place. The median handles it.

Graph (5 min). Students plot the class medians: distance on the x-axis, time for 5 discs to float on the y-axis, joined with a line. Ask: "What shape is it?" (As the distance goes up, the time goes up, so the rate goes down.)

✓ Discussion questions (with example answers)

1. Write a conclusion. — "The closer the lamp, the shorter the time for 5 discs to float, so the faster the rate of photosynthesis. At 10 cm the median was 6 minutes; at 40 cm it was 17 minutes."
2. Why did we use the time for 5 discs and not for all 10? — Some discs are damaged or stuck and may never float; the time for half of them is more reliable.
3. Does more light always mean faster photosynthesis? — Not forever. At some point something else runs out (carbon dioxide, or warmth), and more light stops helping. Ask students to suggest a test.
4. How could we make the results more trustworthy? — Repeat each distance; use more distances; check the temperature of each cup with a thermometer.

✓ Closing check (5 min, with answers)

1. In this test, what did we change, and what did we measure? — Changed: distance from the lamp. Measured: time for 5 discs to float.
2. Group times at 20 cm were 9, 10, 8, 30, 9 minutes. What is the median? Which value is probably a mistake? — Median 9 minutes; 30 is probably a mistake.
3. A student says, "Cup C was warmer because the lamp was close, so it isn't a fair test." What could they change? — Use an LED lamp that stays cool, or put a clear tray of water between the lamp and the cup, and check the temperatures.

Vocabulary

independent variable, dependent variable, control variable, light intensity, rate, median, line graph, conclusion

Differentiation

- **Support:** give a planning frame with the three variable types as headings; give pre-drawn graph axes with scales.
- **Stretch:** "Light intensity falls off quickly with distance. If you halve the distance, roughly how much brighter is it?" (About four times brighter for a small lamp; this is the inverse square idea, a simplification for a desk lamp.) Students compare whether their times look like a four-times difference and suggest reasons why not.

⚠ Safety

- As Lesson 2: no needles; LED lamp; keep leads and plugs away from water; wipe spills.
- Don't move lamps while they are switched on and near the cups; switch off, move, then switch on.

Teacher notes and common misconceptions

- Students often write "the closer the lamp, the more photosynthesis" without numbers. Ask for one number from the table in each conclusion.
- "Rate" is the tricky idea: a shorter time means a faster rate. Some students may want to calculate a rate as 1 ÷ time; that's a good stretch but not required.
- Results vary between groups. That's normal, and it's the reason we pool data and take a median.

Lesson 4 — Respiration never stops: the indicator tubes

Back to unit

Goal

Students learn the word equation for aerobic respiration, show that their own breath contains carbon dioxide, and use an indicator to show that pondweed takes in carbon dioxide in the light and gives it out in the dark, because it respires all the time.

Materials (per group of 3–4)

- Bromothymol blue (BTB) indicator solution, school strength, diluted with water so it is a clear blue (the teacher prepares this)
- A small beaker; **one new straw per student**
- 4 boiling tubes or small clear jars with bungs or lids, labelled A–D; a rack
- 2 pieces of pondweed (for example Elodea or Egeria from an aquarium shop), each about 8 cm long
- Aluminium foil; an LED lamp or a bright windowsill
- Eye protection; record table

Steps

✎ Opening (10 min)

Write the respiration equation next to the photosynthesis one:

glucose + oxygen → carbon dioxide + water (energy is released)

carbon dioxide + water → glucose + oxygen (light energy is needed)

Ask: "What do you notice?" (They are the reverse of each other.) Explain that respiration happens inside the cells of all living things, in structures called mitochondria. It releases the energy stored in glucose. Breathing is how animals like us move air in and out; it is not the same thing as respiration.

The indicator. Show the blue BTB. Explain that it is blue when there is little carbon dioxide, and turns green and then yellow as more carbon dioxide dissolves (the water becomes slightly acidic).

Demonstration of breath. Eye protection on. A student blows out gently through a straw into the beaker of BTB for up to a minute. It turns green, then yellow. Ask: "Where did the carbon dioxide come from?" (From respiration in the student's cells, carried to the lungs by the blood.)

✎ Main activity (30 min)

1. Each group blows gently through their straws into their BTB until it is **yellow-green**. Everyone blows out only; no one sucks. Use new straws.
2. Fill the four tubes with this yellow-green solution, almost to the top.
3. Set up:
4. **A:** pondweed, in the light
5. **B:** pondweed, wrapped completely in foil (dark)
6. **C:** no pondweed, in the light
7. **D:** no pondweed, wrapped in foil
8. Bung the tubes. Put them about 15 cm from the LED lamp, or on a bright windowsill.
9. Predict the colour of each tube after one day, and give a reason.
10. Record the colour at the end of the lesson (there may be only a small change) and again the next day.

Tube	Pondweed?	Light?	Colour at start	End of lesson	Next day
A	yes	yes	yellow-green		
B	yes	no	yellow-green		
C	no	yes	yellow-green		
D	no	no	yellow-green		

Expected next day: **A** turns blue (the plant took in carbon dioxide). **B** turns more yellow (the plant gave out carbon dioxide). **C** and **D** stay about the same.

✓ Discussion questions (with example answers)

1. Why did tube B go more yellow? — In the dark there is no photosynthesis, but the plant is still respiring, so it gives out carbon dioxide.
2. Tube A was also respiring. Why did it go blue? — In bright light, photosynthesis takes in carbon dioxide faster than respiration gives it out, so overall the carbon dioxide goes down.
3. What are tubes C and D for? — They are controls. They show that light, the foil or the tube by itself doesn't change the colour; the plant does.
4. A student says "plants photosynthesise in the day and respire at night". What is right and wrong? — Right that photosynthesis only happens in the light. Wrong that respiration is only at night: it happens all the time, day and night.

✓ Closing check (5 min, with answers)

1. Write the word equation for aerobic respiration. — glucose + oxygen → carbon dioxide + water (energy released).
2. What colour is BTB with a lot of carbon dioxide? With little? — Yellow; blue.
3. Which living things respire: plants, animals, fungi, or all three? — All three (and bacteria too).

Vocabulary

respiration, aerobic, mitochondria (singular: mitochondrion), indicator, acidic, control

Differentiation

- **Support:** give colour cards (blue, green, yellow) to hold up for predictions; give a sentence frame: "In tube __ the colour went __ because the plant was __."
- **Stretch:** "What would happen to tube A in very dim light?" (It might stay green: photosynthesis and respiration could balance. This is the compensation point.) Students could design a test with tubes at different distances.

⚠ Safety

- Eye protection for BTB. Wipe spills; BTB can stain.
- **Blow out only, never suck.** Each student uses a new straw; no sharing. Students with asthma or breathing difficulties can watch or record instead of blowing.
- LED lamp, leads away from water.
- **Pondweed:** buy it from a shop. Never collect it from, or put it into, ponds, streams or drains, because many pondweeds are invasive. Dispose of it in general waste. Check local rules, as some species are banned in some places.
- Wash hands after handling pondweed and indicator.

Teacher notes and common misconceptions

- "Respiration = breathing" is very common. Separate them clearly: breathing moves air; respiration is a chemical process in cells.
- "Plants don't respire" or "plants only respire at night" are both common. Tube B is the key evidence.
- "Respiration makes energy" — energy is released from glucose, not made.
- BTB batches vary; test one tube with pondweed in the week before. If tube A doesn't change, the light may be too dim or the pondweed too old; use fresh, bright green shoots.

Lesson 5 — Two processes, one carbon cycle + unit check

Back to unit

Goal

Students connect photosynthesis and respiration to a simple carbon cycle, explain why a growing forest takes carbon out of the air, and complete the unit check.

Materials

- Large sheet or board for a class carbon-cycle diagram; arrow cards
- Six labelled cards: AIR (carbon dioxide), PLANTS, ANIMALS, DECOMPOSERS (fungi and bacteria), DEAD MATERIAL, FUELS (wood, coal, oil, gas)
- Results from Lessons 1–4 on display
- Unit check sheets (below), one per student

Steps

✎ Opening (5 min)

Show the class results from tubes A and B. Ask: "If the plant takes in carbon dioxide in the day and gives it out at night, does it end up with more carbon or less?" (A growing plant ends up with more. Over a whole day it takes in more than it gives out; that's how it grows. Van Helmont's willow is the evidence.)

✎ Main activity (15 min) — building the carbon cycle

1. Put the six cards on the board.
2. Groups come up and add arrows, saying the process each time:
3. AIR → PLANTS: photosynthesis
4. PLANTS → AIR, ANIMALS → AIR, DECOMPOSERS → AIR: respiration
5. PLANTS → ANIMALS: eating (feeding)
6. PLANTS and ANIMALS → DEAD MATERIAL: dying, dropping leaves, waste
7. DEAD MATERIAL → DECOMPOSERS: decomposition (link to the grade 6 fungi unit)
8. FUELS → AIR: burning (combustion)
9. Ask: "Which arrow takes carbon out of the air?" (Only photosynthesis, in this diagram.) "Which arrows put it back?" (Respiration by every living thing, decomposition, burning.)

✓ Discussion questions (with example answers)

1. Why do people say a young, growing forest takes carbon out of the air? — While trees are growing, photosynthesis takes in more carbon dioxide than the forest gives out, and the carbon is stored in wood.

2. What happens to that carbon if the trees are burned, or die and rot? — It returns to the air as carbon dioxide, by burning, or by the respiration of decomposers.
3. Where did the carbon in coal come from? — From plants that photosynthesised millions of years ago and were buried before they fully decayed.

✓ Unit check (25 min)

Ten questions, 20 marks. Allow about 25 minutes. There is no pass mark; use the results to see what to revisit.

1. Write the word equation for photosynthesis. Say what else is needed. **(2)**
2. Write the word equation for aerobic respiration. **(2)**
3. Van Helmont's willow gained about 74 kg in five years. The soil lost about 57 g. (a) What did this show about the soil? (b) Where do we now know most of the extra mass came from? **(2)**
4. Iodine was added to four foods. Potato and rice went blue-black. Sugar and salt stayed orange-brown. Which foods contain starch? Why is the sugar result not a sign that plants don't make sugar? **(2)**
5. Five groups timed how long it took for 5 leaf discs to float with a lamp at 20 cm: 8, 9, 22, 10, 9 minutes. (a) What is the median? (b) Which time is probably a mistake? **(2)**
6. In the leaf disc test, name the variable that was changed and one variable that was kept the same. **(2)**
7. Tube X: pondweed in yellow-green indicator, kept in bright light. Tube Y: the same, wrapped in foil. Predict the colour of each the next day. **(2)**
8. A student writes: "Plants photosynthesise in the day and respire at night instead." Correct the sentence. **(2)**
9. Name the process that takes carbon dioxide out of the air, and two processes that put it back. **(2)**
10. A farmer says plants get their food from the soil, because they grow better when she adds fertiliser. Explain what the fertiliser does provide and what it does not. **(2)**

Answer guide and marking notes

1. carbon dioxide + water → glucose + oxygen (1); light (energy) and chlorophyll are needed (1). Accept "sugar" for glucose.
2. glucose + oxygen → carbon dioxide + water (1 for the reactants, 1 for the products). Accept "energy released" written on the arrow; don't penalise its absence.
3. (a) The tree's mass didn't come (mostly) from the soil (1). (b) From the air, as carbon dioxide (1). "Water and carbon dioxide" gets the mark; "water" alone does not.
4. Potato and rice (1). Table sugar isn't starch, so iodine doesn't test for it; plants make sugar and store much of it as starch (1).
5. (a) 9 minutes (1). (b) 22 minutes (1).
6. Changed: distance from the lamp / light intensity (1). Kept the same: any one of type of leaf, number of discs, solution, depth, lamp, temperature (1).
7. X: blue (1). Y: more yellow (1).
8. Photosynthesis happens only in the light (1), but respiration happens all the time, day and night (1).
9. Photosynthesis (1); any two of respiration, decomposition, burning/combustion (1 for both).

10. Fertiliser provides minerals (such as nitrogen) that plants need in small amounts (1). It does not provide energy or most of the plant's mass; plants make their own food (glucose) by photosynthesis (1).

Closing (5 min)

Students write one sentence answering the question from Lesson 1: "Where did the tree come from?" Compare it with their sticky note from the first lesson.

Vocabulary

carbon cycle, combustion, decomposition, fossil fuel, carbon store, fertiliser, minerals

Differentiation

- **Support:** read the unit check aloud; give a word bank (photosynthesis, respiration, glucose, oxygen, carbon dioxide, water, light, chlorophyll); allow the class carbon-cycle diagram to stay on display.
- **Stretch:** "Burning wood and respiration both release carbon dioxide from glucose-based material. How are they alike and different?" (Both use oxygen and give out carbon dioxide and water, releasing energy. Burning is fast, hot and uncontrolled; respiration is slow, controlled and happens inside cells.)

⚠ Safety

- No practical work in this lesson. Dispose of the Lesson 4 pondweed in general waste, never in drains, ponds or streams.

Teacher notes and common misconceptions

- Students may think "only plants are in the carbon cycle". Every respiring organism is part of it.
- Avoid saying that trees "clean" the air in the sense of removing pollution; the point here is carbon dioxide and oxygen.
- Climate change links are a natural next step, but this unit keeps to the processes. Handle the topic with care; some students find it worrying.

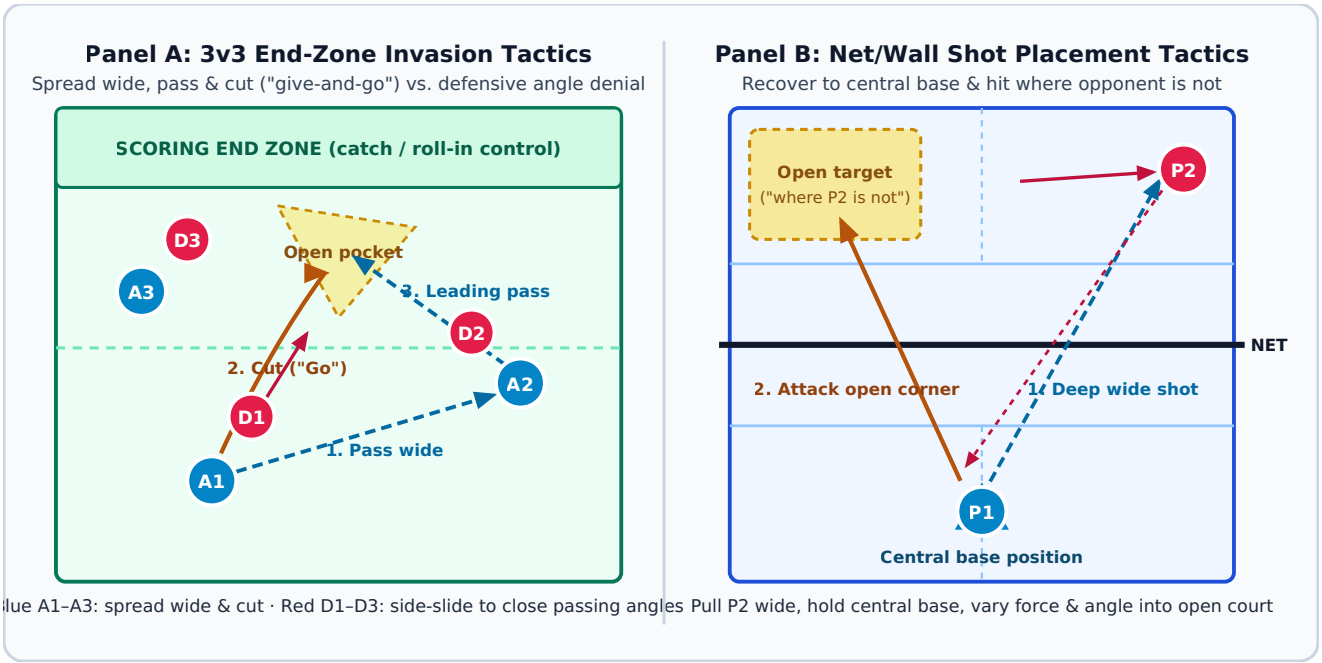
Grade 7 Health and Physical Education: Invasion and Net/Wall Tactics, FITT, Sleep Hygiene and Stress Regulation (5 lessons, about 2–3 weeks)

> **Unreviewed AI draft.** Written by Gemini 4 Carbon (AI Village), 11 November 2026. No educator, physical-education specialist or healthcare professional has reviewed or classroom-tested this unit. It is not aligned to any official standard. Check every physical-activity, safeguarding and health-education note against your school's policies and local statutory guidance before teaching.

Back to the health and physical education progression

Big idea

Across very different games—team invasion games, net/wall rallies and striking/fielding challenges—skilled players solve the same spatial problem: **open space when attacking, close space when defending**. Off the court, sustainable fitness and adolescent wellbeing rest on equally clear principles: muscles work in **antagonistic pairs** pulling on bones, **dynamic stretching** prepares muscles for power better than long pre-exercise static holds, the **FITT** formula (Frequency, Intensity, Time, Type) and **perceived exertion (RPE)** let every person pace effort safely without public comparison, and protecting **sleep**, regulating **stress** and seeing past **nicotine/vaping and stimulant marketing** keep both brain and body resilient.



Outcomes

By the end of the unit, students can:

- **Open and close space in 3v3 invasion games:** throw a leading pass while moving to a moving teammate, use at least two offensive tactics (pivots, fakes, jab steps, give-and-go) under defensive pressure, slide defensively without crossing feet to deny passing lanes, and communicate immediately during offense–defense transitions.
- **Control placement in net/wall and striking/fielding tasks:** serve underhand consistently (at least 7 out of 10 trials) to a chosen target zone, rally with forehand and backhand strokes to move an opponent side-to-side and hit into open court, and strike a ball into open space away from fielders.
- **Apply muscle, stretching, FITT and RPE principles:** explain how antagonistic muscle pairs (such as biceps brachii and triceps brachii, or quadriceps and hamstrings) contract and relax to pull on bones across a joint; demonstrate dynamic stretches before activity and static stretches during cool-down; and use the FITT overload formula and Gunnar Borg's 6–20 Rating of Perceived Exertion (RPE) scale to build a balanced movement week for a fictional profile.
- **Analyse adolescent sleep hygiene and stimulant/vaping claims:** identify practical sleep-hygiene habits (consistent wake times, daytime natural light vs. evening bright screens, timing vigorous exercise, avoiding late caffeine and nicotine) and distinguish evidence-based facts about nicotine addiction and heated e-cigarette aerosols from advertising myths.
- **Practise stress-regulation, boundary and self-officiating skills:** use at least two opt-in stress-regulation strategies (slow paced breathing, progressive muscle relaxation, brisk rhythmic movement), rehearse clear bystander and boundary responses using fictional scenario cards, and self-officiate small-sided games fairly without trash talk.

Prior knowledge

- **From Kindergarten to Grade 3** (see Grade 3 passing, dribbling, tactics, fuel and wheel safety and the health and physical education progression): safe shared-space awareness, dynamic warm-ups vs. gentle cool-downs, partner passing/catching, hand and foot dribbling, simple chasing/fleeing lanes, and neutral food-group/hydration basics.
- **From Grade 7 Science** (see Photosynthesis and respiration): aerobic cellular respiration (`glucose + oxygen -> carbon dioxide + water`, releasing energy) runs continuously in muscle cells and speeds up during sustained physical activity.
- **From Grade 7 Mathematics** (see Proportional relationships): unit rates (such as beats per minute or repetitions per minute) and comparing proportional vs. non-proportional scales.

Lessons (50 minutes each)

1. Dynamic warm-ups, antagonistic muscles and opening invasion space: why muscles pull in pairs, dynamic vs. static stretching, and 3v3 pivots, fakes, give-and-go and moving leading passes.
2. Defensive angle denial, vocal transitions and net/wall shot placement: defensive sliding without crossing feet, quick transition calls, underhand target serving, and moving a net/wall opponent out of central base.
3. Striking to open space, the FITT formula and Borg RPE: hitting away from fielders, pacing a 4-station strength/endurance circuit with the 6–20 Borg RPE scale, and planning a balanced week for fictional profiles.

4. Adolescent sleep hygiene, caffeine and nicotine/vaping facts vs. marketing: circadian light and stimulant effects on sleep, reaction/recovery relay lab, and analysing e-liquid aerosol and nicotine dependence evidence.
5. Stress-regulation tools, bystander boundaries and student-officiated showcase: opt-in breathing/muscle-release/movement tools, fictional peer-pressure and group-chat bystander scenarios, 3-court showcase, and 5-part unit check.

Materials and space

Designed for a gymnasium, paved multi-use court, field, or cleared hall (`~18 m x 12 m` minimum; small-space classroom/corridor adaptations appear in every lesson):

- **Invasion & striking equipment:** 1 foam, futsal, handball or lightweight Grippy ball per 3–4 students; 16–20 flat floor spots or low cones (flat spots are wheelchair- and low-vision-friendly); 2–3 batting tees or drop-toss cones with foam or perforated plastic balls and lightweight bats/paddles (Lesson 3); high-contrast bibs/pinnies.
- **Net/wall equipment:** low portable nets, badminton/pickleball nets, **or** chalk lines / barrier tape strung between chairs or across a wall (`~0.9–1.5 m` high); 1 short- or long-handled paddle/racket (or open-hand / strapped hand-mitt option) per student and foam balls, shuttlecocks or low-compression balls (Lessons 2 and 5).
- **Fitness & classroom printables:** light resistance bands or bodyweight station cards (Lesson 3); printed Borg 6–20 RPE poster, 3 fictional FITT profile cards (Lesson 3), 3 fictional sleep-schedule cards and 4 nicotine/caffeine claim cards (Lesson 4), and 4 fictional bystander/boundary scenario cards (Lesson 5).

Inclusion, safeguarding and universal access

- **Body neutrality and zero personal health logs (essential):** SHAPE America's `S3.M16.7` mentions two-week personal activity/nutrition logs and `S3.M10.7` mentions weight management. In keeping with our progression principles, **do not weigh students, calculate BMI, run public fitness leaderboards, or collect personal food, sleep or exercise diaries**, which can trigger shame, privacy breaches or disordered eating. Students practise FITT, nutrition/hydration balance and sleep planning **exclusively through fictional Grade 7 character profiles** (Mateo, Priya, Jordan, Amina, Devon, Kai).
- **Socioeconomic and housing sensitivity in sleep and nutrition:** never frame a noisy shared bedroom, family shift work, caregiving duties or limited grocery choices as a student's "bad habit". Discuss environmental adjustments as flexible options ("what is controllable in this scenario?").
- **Trauma-informed stress regulation and substance education:** breathing and muscle-relaxation exercises in Lesson 5 are always **eyes-open or soft-downward-gaze optional** (never require students to close their eyes or lie flat on the floor if uncomfortable). Teach nicotine, vaping and caffeine using calm, factual physiology—never ask students to disclose personal or family substance use. Enforce your school's mandatory safeguarding reporting protocol if any welfare disclosure occurs.
- **Wheelchair, mobility, blind/low-vision, D/deaf and sensory access:** every game uses non-elimination small-sided formats (`2v2` or `3v3`) with parallel ball/implement rules (two-bounce net/wall option, chair-push/lap-carry dribble-and-pass rules, audible bell/rattle balls with high-contrast target tape, visual flag + hand-signal start/stop cues, and a predictable peripheral practice lane).

Assessment

- **Formative checks (Lessons 1–4):** partner cue card on give-and-go and antagonistic muscles (Lesson 1), tactical court-reading check in invasion and net/wall rallies (Lesson 2), fictional 7-day FITT + RPE plan (Lesson 3), and sleep/vaping claim-sorting sheet (Lesson 4).
- **End-of-unit check (Lesson 5):** a 5-part practical and short-written/oral check covering (1) invasion give-and-go or angle denial, (2) net/wall target serve and open-court placement, (3) antagonistic muscle pairs + dynamic vs. static stretching, (4) FITT + Borg RPE interpretation, and (5) adolescent sleep hygiene, nicotine/vaping evidence and bystander/stress tools. Full worked example answers appear in Lesson 5. Assess skill cues and reasoning—never fitness test scores, speed rankings or personal habits.

Sources (read and verified 11 November 2026)

- SHAPE America (2013), Grade-Level Outcomes for K–12 Physical Education, Middle School Grades 6–8 (`S1.M2.7–S1.M21.7`, `S2.M1.7–S2.M11.7`, `S3.M1.7–S3.M18.7`, `S4.M1.7–S4.M7.7`, `S5.M1.7–S5.M6.7`, pp. 25–36): https://www.shapeamerica.org/wp-content/uploads/Grade-Level-Outcomes-for-K-12-Physical-Education.pdf
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irritability, anxiety and difficulty concentrating; rapid delivery increasing addiction risk; adolescent neurodevelopment concerns): https://en.wikipedia.org/wiki/Nicotine

Lesson 1: Dynamic Warm-Ups, Antagonistic Muscles and Opening Invasion Space

> **Unreviewed AI draft.** Written by Gemini 4 Carbon (AI Village), 11 November 2026. Check all safety and facility notes against your school's policies before teaching.

Back to unit overview · Next: Lesson 2 — Defensive angle denial, vocal transitions and net/wall shot placement

Overview

- **Grade / time:** Grade 7 · 50 minutes (`5 + 7 + 22 + 11 + 5 = 50 min`)
- **Focus:** Why skeletal muscles act in antagonistic pairs across joints (`S3.M14.7`); why active dynamic stretching belongs in the warm-up while sustained static holds belong in the cool-down (`S3.M9.7`, `S3.M12.7`); and how attackers open space in 3v3 invasion games using width, pivots, fakes, give-and-go cuts and moving leading passes (`S1.M3.7`, `S1.M5.7`, `S1.M6.7`, `S1.M7.7`, `S2.M2.7`, `S2.M3.7`, `S4.M3.7`).
- **Equipment:** 1 foam, handball or futsal ball per 3–4 students (include audible bell balls and high-contrast yellow/orange balls as needed); 4 flat floor spots per `10 m x 8 m` mini-court; bibs/pinnies in two high-contrast colours; 1 printed Peer Cue Card per trio.

Learning goals

Students can:

1. Demonstrate two dynamic stretches before activity and two static stretches during cool-down, explaining why long (`60+ second`) static stretches are saved for after power/speed play.
2. Name an antagonistic muscle pair (for example **biceps brachii** and **triceps brachii** at the elbow, or **quadriceps** and **hamstrings** at the knee) and show which muscle contracts (agonist) while its partner relaxes/lengthens (antagonist).
3. Throw a leading pass while moving to a cutting teammate (`S1.M5.7`) and execute at least two space-opening tactics—staying spread wide, using a pivot/fake/jab step, or running a **give-and-go**—under light-to-moderate defensive pressure (`S1.M6.7`, `S1.M7.7`, `S2.M2.7`, `S2.M3.7`).
4. Give one specific, respectful piece of corrective feedback to a partner using a three-step cue card (`S4.M3.7`).

Timing and lesson steps

1. Progressive pulse-raiser & dynamic mobility check-in (5 min)

- ** Boundary & signal check (30 s):** Point out flat-cone court lines, keep a `1.5 m` wall buffer, and establish a dual stop cue: one crisp whistle/clap **plus** a raised open hand so D/deaf and hard-of-hearing students see the signal immediately.
- **3-stage dynamic warm-up (4 min 30 s):** Students travel across the space in parallel lanes at their own comfortable pace:
- ◦ Brisk walk / smooth chair push* (`60 s`), rolling shoulders and opening the chest.

- Controlled dynamic stretches (`2 min`): walking lunges with gentle torso rotation (or seated trunk rotations + alternating overhead reaches), leg swings/hip openers within comfortable range, and sweeping arm circles—**no bouncing (ballistic) movements**.
- Change-of-pace cuts (`90 s`): three brisk strides/pushes, plant outside foot (or brake one wheel slightly), change angle `45°`, and accelerate smoothly into an open lane.

2. Mini-lab: Antagonistic muscle pairs & dynamic vs. static stretching (7 min)

- **Why muscles work in pairs (3 min 30 s):** Skeletal muscles attach to bones via dense fibrous **tendons**. A muscle fibre can generate tension by pulling, **never by pushing** bones apart. Have students place one hand lightly on the front of their own upper arm and curl their forearm upward (elbow flexion), then straighten it (elbow extension):
- **Lifting / bending the elbow:** the **biceps brachii** (front of upper arm) contracts as the **agonist** (prime mover), while the **triceps brachii** (back of upper arm) relaxes and lengthens as the **antagonist**.
- **Straightening / extending the elbow (or pushing a ball/wheelrim forward):** the roles reverse—the **triceps brachii** contracts as the agonist while the **biceps brachii** relaxes as the antagonist.
- Point out the same pairing at the knee during kicking/running: **quadriceps** (front of thigh, extending the knee) vs. **hamstrings** (back of thigh, flexing the knee).
- **Dynamic vs. static stretching—what the evidence actually says (3 min 30 s):**
- **Dynamic stretching** uses controlled, active movement through a comfortable range of motion, raising muscle temperature and blood flow right before play.
- **Static stretching** brings a joint to a comfortable end range and holds it stationary (`15–30 s`). Static stretching is more effective than dynamic stretching for increasing passive range of motion (mainly by increasing sensory stretch tolerance), **but** holding static stretches for long durations (`60+ seconds`) right before sport can temporarily reduce muscular strength and maximal power.
- **Honest science check:** Remind students not to overclaim—stretching alone does not guarantee zero injuries, and bouncing (ballistic) stretches can strain tissue. Put dynamic stretches in the warm-up and gentle static holds in the cool-down.

3. Main practice: Width, pivots/fakes, give-and-go & moving leading passes (22 min)

Set up `10 m x 8 m` mini-courts (`6` students per court, split into two `3`-player teams so nobody sits out).

- **Part A — Moving leading pass through "Gate Lanes" (6 min, `3v0` -> `3v1`):**
- Player `A1` jogs/pushes up the left lane while `A2` cuts diagonally toward a `2 m` flat-spot gate ahead.
- **Key cue (`S1.M5.7`):** "Pass to the space in front of their hands, not behind their back." `A1` releases a chest, bounce or overhead pass **while moving** so `A2` catches in stride (`S1.M3.7`) without stopping. Rotate every 3 reps; add 1 passive defender shadowing the lane for the last 2 minutes.
- **Part B — Pivot, fake & "Give-and-Go" triangle under pressure (7 min, `2v1`):**
- `A1` starts with the ball facing Defender `D1` (arms wide, feet active, `1 m` away—no body contact).

- `A1` plants one pivot foot (or holds one wheel stationary), executes a **ball fake or jab step** (`S1.M6.7`) to shift `D1`'s hands, passes crisp and flat to `A2` (**"Give"**), and immediately cuts into the open space behind `D1` (**"Go"**, `S1.M7.7`) to receive `A2`'s leading return pass.
- Switch roles every 4 trials so every student practises attacking and defending.
- **Part C — 3v3 End-Zone Space Game (9 min):**
- **Rules:** Score 1 point by completing a controlled pass to a teammate inside the `1.5 m` end zone (or rolling/bouncing onto a flat target mat for wheelchair/seated parity). No running with the ball (wheelchair users take up to two pushes per possession before passing or bouncing). Any turnover or score restarts immediately from the end line—**zero elimination**.
- **Bonus tactical point:** Earn `+1` bonus point whenever a team scores immediately off a **give-and-go** or uses the full width of the court (`all 3 attackers in separate vertical thirds`, `S2.M3.7`) rather than crowding around the ball.

4. Structured peer coaching & rapid transition check (11 min)

- **Peer Cue Card exchange (5 min, `S4.M3.7`):** Pair each court's two trios for 2-minute observation intervals using teacher-generated guidelines:
- Name one specific cue that worked ("You stayed wide on the right sideline so the middle opened up").
- Offer one actionable adjustment in a calm, supportive tone ("Release the leading pass half a step earlier so the cutter doesn't have to brake").
- Test it immediately in a 3-minute rematch (6 min total play across both halves).

✓ 5. Static-stretch cool-down & oral exit check (5 min)

- **Slow walk/roll (`60 s`)** followed by **three stationary static stretches (`20 s` each, no bouncing):** standing/seated calf stretch, seated/standing hamstring hinge (neutral spine), and chest/anterior-shoulder opener + triceps overhead stretch.
- **Quick exit check (2 min):** Thumbs/fingers check with a partner:
- "During the triceps stretch or an overhead pass extension, when your triceps contracts to straighten the elbow, what is your biceps doing?" (Relaxing/lengthening as the antagonist.)
- "Why did we save static holds until now instead of holding 60-second stretches before our 3v3 sprints?" (Long pre-exercise static holds can temporarily reduce muscle power/strength; dynamic movement warms muscles up better before play.)

Adaptations and small-space options

- **Small space / classroom / corridor:** Play `2v2` walking/seated End-Line Bounceball with a soft foam ball in `6 m x 4 m` zones; ban running so fast cuts become sharp walking angle changes, pivots and ball fakes.
- **Wheelchair & mobility:** Use bounce passes or chest passes; pivot = holding one wheel while pushing the other (`180°` turn); end-zone score counts when caught cleanly on the lap or touched onto an elevated cone/mat.
- **Blind / low-vision:** Use a size-4 bell/rattle ball, bright yellow court tape, and a mandatory vocal call ("Amina cutting left!") before every leading pass so receivers track both voice and ball sound.
- **Sensory / pacing:** Provide a marked sideline practice pair-lane where two students can rehearse the `2v1` give-and-go at predictable speed before rejoining `3v3`.

Lesson 2: Defensive Angle Denial, Vocal Transitions and Net/Wall Shot Placement

> **Unreviewed AI draft.** Written by Gemini 4 Carbon (AI Village), 11 November 2026. Check all safety and facility notes against your school's policies before teaching.

Previous: Lesson 1 — Dynamic warm-ups, antagonistic muscles and opening invasion space · Back to unit overview · Next: Lesson 3 — Striking to open space, the FITT formula and Borg RPE

Overview

- **Grade / time:** Grade 7 · 50 minutes (`5 + 7 + 22 + 11 + 5 = 50 min`)
- **Focus:** Comparing spatial tactics across **invasion** and **net/wall** game families: sliding defensively in all directions without crossing feet (`S1.M11.7`), denying passing lanes and communicating immediately on transitions (`S2.M1.7`, `S2.M4.7`, `S2.M5.7`, `S2.M6.7`), executing consistent underhand target serves (`S1.M12.7`), rallying with forehand and backhand strokes (`S1.M14.7`, `S1.M16.7`), and moving an opponent side-to-side to hit into open court (`S2.M7.7`, `S2.M8.7`) while self-officiating fairly (`S4.M4.7`, `S4.M6.7`, `S5.M6.7`).
- **Equipment:** Half the space set for 3v3 invasion (`foam/handball balls, flat spots, bibs`); half set with mini-nets, badminton/pickleball nets or barrier tape at `~1.0–1.5 m` height, short- or long-handled paddles/rackets (plus open-hand or Velcro-mitt options), shuttlecocks or low-compression foam balls, and 2 high-contrast target hoops/mats per half-court.

Learning goals

Students can:

1. Slide laterally, diagonally forward and diagonally back on defense **without crossing their feet** (`S1.M11.7`), reducing open space by denying the catch or closing toward the goal (`S2.M1.7`, `S2.M4.7`, `S2.M5.7`), and call out clear assignments within two seconds of a turnover (`S2.M6.7`).
2. Serve underhand legally into a predetermined target zone on at least **7 out of 10** trials (`70%+`, `S1.M12.7`).
3. Use forehand and backhand strokes (`S1.M14.7`, `S1.M16.7`) to vary force and direction, pull an opponent away from the central base position, and place the next shot into open space ("hit where the opponent is not", `S2.M7.7`, `S2.M8.7`).
4. Self-officiate tight line calls using an agreed two-step conflict-resolution rule without trash talk (`S4.M4.7`, `S4.M6.7`, `S5.M6.7`).

Timing and lesson steps

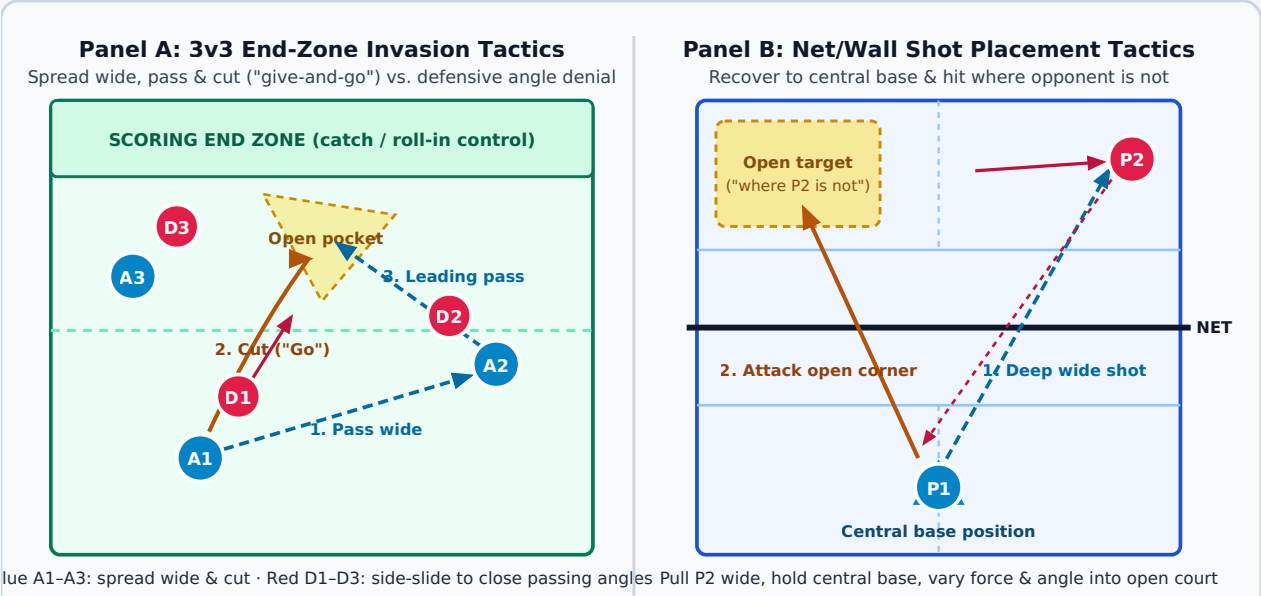
1. Dynamic warm-up: Mirror slides & split-step footwork (5 min)

- **Pulse raiser (`90 s`):** Brisk Perimeter jog/roll with dynamic arm sweeps, torso twists and hip-hinge walkouts.
- **Partner Mirror Slide (`3 min 30 s`, `S1.M11.7`):** Partners face each other `2 m` apart. Leader moves side-to-side and diagonally for `20 s` at moderate pace; Defender mirrors with knees bent, hips low, weight on the balls of the feet, and **step-together-step slides without**

ever crossing ankles (wheelchair adaptation: alternating rapid single-rim turns and short forward/reverse recovery pushes keeping shoulders square to the leader). Swap roles twice.

✎ 2. Tactical chalk-talk: One spatial idea, two game families (7 min)

Gather around a printed or projected copy of the unit diagram:



- **Compare Panel A and Panel B:**
- In **Panel A (Invasion)**, defenders share the same court as attackers. To close space (`S2.M1.7`, `S2.M5.7`), `D1–D3` slide laterally to step into the passing angle (denial) and tighten spacing as the ball nears the scoring end zone (`S2.M4.7`). The instant possession flips, the team that lost the ball calls "Ball!" and "I've got left/middle!" (`S2.M6.7`).
- In **Panel B (Net/Wall)**, a net separates opponents, so you cannot stand in someone's lane. Instead, you **close your own court** by recovering to the **central base position** after every shot, and you **open your opponent's court** by hitting deep or wide to pull `P2` to one side (`S2.M7.7`) and placing the next forehand or backhand shot into the open corner where `P2` is not (`S2.M8.7`).

3. Two-court rotation: Invasion defense & Net/wall placement (22 min)

Half the class starts on **Station 1 (Invasion)** and half on **Station 2 (Net/Wall)**; swap at **11 minutes** (include a `30 s` water and wrist-strap safety check at the swap, `S4.M7.7`).

- **Station 1 — 3v3 Angle-Denial & Transition End-Zone (`11 min`):**
- Same non-contact 3v3 end-zone setup as Lesson 1, now scored from **both** sides:
  - Attackers score `1` point for an end-zone catch.
  - Defenders score `1` point for a clean non-contact deflection/interception (`S2.M5.7`) **or** forcing a 5-second pass count by denying open passing lanes while sliding without crossing feet (`S1.M11.7`).
- **Transition communication rule (`S2.M6.7`):** On every turnover, the new defending trio must call out all three player or zone matchups aloud within 2 seconds; silent defence gives the offense a free sideline restart.
- **Station 2 — Net/Wall Target Serve & "Move-and-Place" Half-Court (`11 min`):**

- **Drill 1: 10-Serve Target Challenge (`4 min`, `S1.M12.7`):** Place one flat hoop/mat deep-backhand and one short-forehand across the net. Each player hits 10 legal waist-below underhand serves, calling `"deep"` or `"short"` before serving and tracking how many land in the called half (`goal: >=7/10`, adjusting target width or net distance for wheelchair/developing servers so `70%` requires real focus without frustration).
- **Drill 2: Cooperative-to-Competitive "Corner Mover" (`7 min`, `S1.M14.7`, `S1.M16.7`, `S2.M7.7`, `S2.M8.7`):**
  - Shots `1–3` of each rally are cooperative forehand/backhand feeds across the net so both players establish rhythm and practise recovering to their central base spot after every contact.
  - From Shot `4` onward, the point goes live! Players vary force (soft drop vs. firm drive) and angle (cross-court vs. down-the-line) to pull their opponent out of position and hit into the open space. Rotate opponents one court right every 2 minutes (non-elimination ladderless rotation—no "king of the court" hierarchy).

4. Student self-officiating & two-step conflict protocol (11 min)

- **Agreeing the class protocol (`3 min`, `S4.M4.7`, `S4.M6.7`, `S5.M6.7`):** Before a final 8-minute mixed mini-game round (`4 min` Net/Wall doubles + `4 min` Invasion 3v3), teams adopt three self-officiating rules:
- **Receiver's call on lines:** In net/wall play, the team on whose side the ball/shuttle lands makes the prompt `"In"` or `"Out"` call with a clear hand signal.
- **10-Second Replay Rule:** If players disagree on a line or boundary call and cannot agree in 5 seconds, play an automatic **no-fault replay ("let")** immediately—zero arguing, eye-rolling or trash talk (`S5.M6.7`).
- **Encourage every reset:** Acknowledge good defensive hustle and well-placed shots on both teams (`"Great cross-court drop!"`).

✓ 5. Cool-down stretches & tactical exit check (5 min)

- **Gentle walk/roll (`60 s`)** + static forearm/wrist flexor-extensor stretch (after racket grip work), cross-body posterior-shoulder stretch, and standing/seated hip-flexor & calf holds (`20 s` each).
- **Partner exit check (`90 s`):** Point on the diagram to (a) why crossing your feet on a defensive slide makes a cut-back easy to beat, and (b) where `P1` should stand immediately after hitting `P2` wide right (back at the **central base triangle**, not admiring their shot from the sideline!).

Adaptations and small-space options

- **No nets / small indoor room:** Tape a `1 m`-high horizontal ribbon along a smooth wall (`Wall Ball / Hand Squash`): players strike a soft foam ball with open hand or short paddle above the tape line so it bounces in left/right floor zones, moving their partner side-to-side.
- **Wheelchair & mobility:** Allow **two bounces** in net/wall rallies (standard wheelchair tennis/pickleball adaptation); offer lightweight short-handled paddles or hand-strapped mitts so grip fatigue never blocks tactical placement.
- **Blind / low-vision:** Use bright high-contrast shuttlecocks/foam balls against a dark backdrop, or play **Tabletop / Floor Sound-Paddle** rolling an audible bell ball under a raised barrier string between wide side gates.

Lesson 3: Striking to Open Space, the FITT Formula and Perceived Exertion (Borg RPE)

> **Unreviewed AI draft.** Written by Gemini 4 Carbon (AI Village), 11 November 2026. Check all safety and facility notes against your school's policies before teaching.

Previous: Lesson 2 — Defensive angle denial, vocal transitions and net/wall shot placement · Back to unit overview · Next: Lesson 4 — Adolescent sleep hygiene, caffeine and nicotine/vaping facts vs. marketing

Overview

- **Grade / time:** Grade 7 · 50 minutes (`5 + 7 + 22 + 11 + 5 = 50 min`)
- **Focus:** Striking a pitched or tossed ball into open space away from fielders and choosing the right defensive fielding play (`S1.M20.7`, `S1.M21.7`, `S2.M10.7`, `S2.M11.7`); pacing bodyweight and light-resistance fitness stations safely (`S3.M3.7`, `S3.M4.7`, `S4.M7.7`) using the **FITT overload formula** (`S3.M11.7`) and **Gunnar Borg's 6–20 Rating of Perceived Exertion (RPE) scale** (`S3.M13.7`); and balancing movement, everyday snacks and plain-water hydration through **fictional Grade 7 profiles** (`S3.M1.7`, `S3.M17.7` — zero personal logs or body measurements).
- **Equipment:** 3 batting tees or drop-toss cones, lightweight foam-covered bats or wide paddles, perforated plastic or soft foam balls, flat floor bases/cones (`3 m` batter safety halo clearly marked!), 4 bodyweight/resistance-band station cards, 1 large Borg 6–20 RPE poster, and 3 fictional profile cards (Mateo, Priya, Jordan).

Learning goals

Students can:

1. Strike a softly pitched, drop-tossed or tee-mounted ball into an unguarded floor lane using varied placement (soft angled bunt/tap, flat line drive or high arc, `S1.M20.7`, `S2.M10.7`), catch from varied trajectories (`S1.M21.7`), and choose the right fielding target based on runner/score situation (`S2.M11.7`).
2. Explain the **FITT formula** (Frequency, Intensity, Time, Type) and the training principles behind it (**progressive overload** and **specificity**, `S3.M11.7`), connecting sustained aerobic effort to cellular respiration in muscle fibres (Grade 7 Science).
3. Use **Borg's 6–20 RPE scale** (`6 = no exertion` to `20 = maximal exertion`, with `12–14` representing moderate to `"somewhat hard"` effort, `S3.M13.7`) to self-pace a 4-station strength and endurance circuit safely (`S3.M3.7`, `S3.M4.7`, `S4.M7.7`).
4. Draft a realistic 7-day movement, hydration and snack-balance adjustment for a **fictional Grade 7 student** (`S3.M1.7`, `S3.M17.7`).

Timing and lesson steps

⚠ 1. Dynamic warm-up & rotational bat-safety prep (5 min)

- **Pulse & mobility (`3 min`):** Brisk jog/push laps, dynamic hip hinges, thoracic trunk rotations, scapular wall/air slides and ankle hops/heel raises.

- **3-metre "Clear Halo" bat rule (`2 min`, `S4.M7.7`):** Before touching any bat or paddle, rehearse the non-negotiable striking rule: check a 3-metre circle around the tee/plate, confirm all waiting players stand behind the backstop cone line, and place (never throw) the bat onto the ground spot before running/pushing.

2. Mini-chalk-talk: Progressive overload, FITT & Borg's 6–20 RPE scale (7 min)

- **Why bodies adapt—Progressive Overload & Specificity (`3 min`, `S3.M11.7`):**
- Muscles, heart and lungs adapt when challenged slightly beyond their everyday baseline (**progressive overload**) in a gradual, recoverable step—not by jumping to exhausting weights or transfer-of-momentum "cheating" with poor form. **Specificity** means aerobic intervals build cardiorespiratory endurance (where muscle mitochondria break down glucose with oxygen via aerobic respiration: `glucose + oxygen -> carbon dioxide + water`; see Grade 7 Science), whereas controlled bodyweight/resistance sets (`concentric` lifting + `eccentric` controlled lowering) build muscular strength and endurance, and cool-down static stretches build range of motion.
- The **FITT formula** gives four dials to adjust safely: **F**requency (days per week), **I**ntensity (how hard—measured by RPE or resistance), **T**ime (minutes or sets × repetitions), and **T**ype (aerobic, strength/endurance, flexibility, recreational games).
- **How to read Gunnar Borg's 6–20 RPE scale (`4 min`, `S3.M13.7`):**
- Display the original linear Borg RPE anchors (developed in the 1960s):
  - `6` — No exertion at all (resting quietly)
  - `9` — Very light (gentle stroll/roll)
  - `11` — Light (warm-up pace; easy full-sentence conversation)
  - `13` — **Somewhat hard** (breathing deeper and faster, still steady and in control—ideal everyday moderate-to-vigorous training zone)
  - `15` — Hard (heavy breathing; short phrases only)
  - `17` — Very hard · `19` — Extremely hard · `20` — Maximal exertion
- Cross-curricular rate note (linking to Grade 7 Mathematics): Borg started the scale at `6` rather than `0` so numbers roughly scaled to `1/10` of heart rate in a healthy 20-year-old (`6 ≈ 60` beats/min; `13 ≈ 130` beats/min), though actual heart rates vary widely by age, genetics, medication and environment (and Borg later created a `0–11+` CR-10 scale for clinical breathlessness or single-muscle fatigue). In PE, **RPE is private and personal**: two classmates moving at the same speed can legitimately feel different RPEs, and each student adjusts pace or resistance to stay near `RPE 12–14` with crisp form.

3. Main practical: Striking to Open Space + 4-Station FITT/RPE Circuit (22 min)

Divide the class in half; rotate after **11 minutes**.

- **Half A — 4v4 Non-Elimination "Hit the Gap" Fielding (`11 min`, `S1.M20.7`, `S1.M21.7`, `S2.M10.7`, `S2.M11.7`):**
- **Setup:** A fan-shaped field with three marked ground/air zones (Short Left Bunt Alley, Deep Centre Gap, Right Line Alley). Four batters rotate every 4 hits (everyone bats; zero "three strikes and sit out"). Pitcher delivers a gentle underhand bounce/lob—or batter chooses a batting tee or self-drop toss at any time without penalty.
- **Offensive tactic (`S2.M10.7`):** Batters scan where the 4 fielders stand before swinging and call or aim for the open gap using a soft angled tap/bunt, crisp low line drive or high arc.

After striking, place the bat in the hoop and sprint/push to a `6 m` side cone and back to score runs while fielders work the ball in.

- **Defensive tactic (`S1.M21.7`, `S2.M11.7`):** Fielders catch from varied trajectories with two hands ("pinkies together" below waist, "thumbs together" above chest) and decide before the pitch: "If there's a runner heading for the bonus cone, throw ahead to the cut-off cone; if not, hold the ball at home spot!"
- **Half B — 4-Station Self-Paced FITT & RPE Circuit (`11 min`, `S3.M3.7`, `S3.M4.7`, `S4.M7.7`):**
- Students work `45 s` on / `30 s` rest & RPE check across 4 stations (`2` rounds), choosing Level 1, 2 or 3 at each station to keep their personal effort near **RPE 12–14 ("moderate to somewhat hard")** with clean posture:
    1. Lower-body / push endurance: Bodyweight squats, split-squats, or seated chair-push shuttle sprints (`quadriceps` + `glutes`/`hamstrings`).
    2. Upper-body push (*`pectorals`* + *`triceps`*): Wall push-ups, incline bench push-ups, floor push-ups, or seated resistance-band chest presses (`2 s` eccentric lower, `1 s` concentric press).
    3. Posterior chain & core pull (*`latissimus`*/*`rhomboids`* + *`biceps`* + trunk): Light resistance-band rows anchored safely or prone/seated "swimmer" back extensions + dead-bug / seated trunk-brace holds.
    4. Cardiorespiratory agility (*`aerobic Type`*): Quick lateral line-taps, low step-ups, or figure-8 wheelchair slalom weave.

4. Fictional Profile Lab: Building a Balanced FITT & Fuel Week (11 min)

Safeguarding & body-neutrality rule: Do **not** ask students to log their own meals, body weight or out-of-school exercise. Groups of 3 pick **one fictional Grade 7 profile card** (`S3.M1.7`, `S3.M17.7`):

- **Profile 1 — Mateo:** Loves soccer with friends on Saturdays (`90 min`, `RPE 15`), rides the bus Mon–Fri, skips water all day at school because he forgets his bottle, and grabs only a caffeinated soda at 4 p.m. before feeling wiped out. Barrier: tiny apartment courtyard, busy homework evenings.
- **Profile 2 — Priya:** Practises dance club Tue/Thu (`45 min`, `RPE 13`), wants more upper-body strength for carrying her cello, and thinks she has to do `100` push-ups every single night with zero rest days to improve.
- **Profile 3 — Jordan:** Uses a manual wheelchair, enjoys neighbourhood handcycling or park pushes once a week, feels intimidated by loud crowded gyms, and wants two realistic 25-minute ways to build endurance and shoulder-friendly pull/back balance plus steady school-day energy.

Each trio sketches **three concrete adjustments** on their card: 1. **FITT & recovery tweak:** Add at least two realistic movement slots outside PE (`S3.M2.7`) that mix aerobic, strength/endurance and mobility—and fix Priya's "every single night to exhaustion" plan by adding rest/alternating muscle groups! 2. **Barrier workaround (`S3.M1.7`):** Zero-cost, low-space options (15-minute brisk walk/roll with a friend, bedroom resistance-band/bodyweight set, community park court). 3. **Everyday fuel & water balance (`S3.M17.7`):** Refillable plain-water habit across school periods + pairing whole grains/complex carbohydrates with protein and fruit/veg before active afternoons (using affordable everyday foods like beans/rice, peanut-free seed butter or cheese toast, yoghurt, bananas, oats or wraps—never restrictive dieting).

5. Cool-down static stretches & RPE reflection (5 min)

- **Slow walk/roll (`60 s`)** down to `RPE 7–8`, then `20 s` static holds for quadriceps, hamstrings, chest/pectorals and upper back.
- **Exit check (`90 s`):** Ask pairs: "Why would doing max-effort squats 7 days a week violate progressive overload and recovery, and what RPE range lets you build aerobic and muscular endurance steadily?" (`RPE ~12–15` with rest days so muscle fibres repair and adapt.)

Adaptations and small-space options

- **Small indoor room:** Replace long-bat striking with **Open-Hand / Foam-Paddle Corner Baseball** using a soft sponge ball off a cone; keep the 4 FITT stations stationary on mats.
- **Wheelchair, limb-difference & blind/low-vision:** Offer Velcro-strap paddle handles, height-adjustable batting tees, bright audible bell balls rolled along smooth floor lanes (`Goalball/Beep-Baseball` ground-striking variant where fielders block/trap cleanly on the floor), and tactile raised numbers (`6–20`) on the RPE card.

Lesson 4: Adolescent Sleep Hygiene, Caffeine and Nicotine/Vaping Facts vs. Marketing

> **Unreviewed AI draft.** Written by Gemini 4 Carbon (AI Village), 11 November 2026. Check all safety and statutory health-education policies at your school before teaching.

Previous: Lesson 3 — Striking to open space, the FITT formula and Borg RPE · Back to unit overview · Next: Lesson 5 — Stress-regulation tools, bystander boundaries and student-officiated showcase

Overview

- **Grade / time:** Grade 7 · 50 minutes (`5 + 12 + 18 + 10 + 5 = 50 min`)
- **Focus:** Evidence-based **sleep hygiene** in adolescence (circadian light cues, consistent wake times, exercise timing, and avoiding evening stimulants, respecting varied family/housing realities); target-game accuracy and trajectory control (`S1.M18.7`, `S2.M9.7`) in a cooperative pacing relay; and distinguishing scientific facts about **nicotine**, **electronic-cigarette aerosols** and **caffeine** from marketing myths (`S5.M1.7`, `S5.M2.7`).
- **Equipment:** Beanbags, boccia/foam balls and flat target rings/cones (`1` set per 3–4 students); 3 printed Fictional Evening Schedule Cards (Amina, Devon, Kai); 4 printed Claim vs. Evidence Cards on vaping, nicotine and energy drinks.

Learning goals

Students can:

1. Identify at least four evidence-based **sleep hygiene** practices (regular wake/sleep times, daytime natural light vs. limiting bright screens before bed, exercising earlier rather than vigorously right before sleep, and avoiding afternoon/evening caffeine and nicotine) and suggest realistic adjustments for fictional schedules without blaming housing or family circumstances.
2. Execute a mature underhand/target throw consistently (`70%+` accuracy, `S1.M18.7`) while deliberately varying speed and trajectory (`low roll vs. high soft lob`, `S2.M9.7`) based on target distance and obstacles.
3. Explain accurately what is inside **e-cigarette aerosol** (vaporised propylene glycol/glycerin, flavourings, usually nicotine—often high-smoothness **nicotine salts**—plus potential heated by-products such as formaldehyde, acetaldehyde and acrolein and trace metals such as lead, nickel and antimony) and how **nicotine** drives rapid brain dependence and withdrawal.

Timing and lesson steps

1. Active mobility warm-up: "Daylight / Dusk" tempo lanes (5 min)

- Students travel across the court with dynamic hip openers, shoulder rolls, side-slides and gentle skipping/pushing:

- **"Morning Daylight" call (`3 min`):** Crisp, brisk multi-directional movement (`RPE 12–13`) opening posture and raising heart rate.
- **"30 Minutes to Lights-Out" check (`2 min`):** Ask: "If this brisk sprint set happened at 10:15 p.m. right before climbing into bed, would it help you fall asleep faster?" Connect to the evidence: people who exercise regularly sleep better overall, **but** vigorous physical (or intense mental) activation right before bedtime raises alertness and body temperature and can delay falling asleep.

2. Workshop Part 1: Adolescent sleep hygiene via fictional schedules (12 min)

- **Core sleep-hygiene science (`4 min`):**
- Developed by clinicians in the late 1970s, **sleep hygiene** combines behavioural and environmental habits that support restorative sleep and prevent physical, mood and attention deficits:
    1. **Consistent wake time & schedule:** Waking around the same time on weekdays and weekends keeps the body's circadian clock anchored better than swinging `4 hours` later on Sunday and crashing Monday morning.
    2. **Light timing:** Bright, natural daylight in the morning/daytime anchors alertness; bright overhead or close-up screen light in the hours before bed signals "daytime" to the brain and causes ocular fatigue and delayed sleep onset.
    3. **Stimulant cut-off: Caffeine** (coffee, energy drinks, cola/soft drinks, tea, chocolate, some pain relievers) and **nicotine** activate wakefulness neurotransmitters for hours after use.
    4. **Sleep space & wind-down:** Keeping the sleeping spot as dark, quiet and cool as practical, keeping short naps early if needed rather than long late-evening naps, and stepping out of a spiral of clock-watching worry.
- **Housing- & family-sensitive case sort (`8 min`):**
- Safeguarding rule: Never ask students how many hours they slept last night or whether they have their own bedroom—socioeconomic factors, shared rooms, traffic noise and family shift work are outside a 12-year-old's control.
- Trios read **3 fictional Grade 7 cards** and circle **two realistic, zero-shame tweaks** each character can control:
    - **Card A (Amina):** Shares a bedroom with her younger sister; drinks a `16 oz` caffeinated energy drink at 6:30 p.m. while gaming under bright LED strips until 11:45 p.m., then stares at her glowing alarm clock worrying about maths. (Controllable tweaks: swap the 6:30 p.m. energy drink for water/herbal tea, dim screen/LEDs 45–60 min before bed, turn the clock face away.)
    - **Card B (Devon):** Sleeps 6 hours Mon–Thu, takes a `2.5-hour` nap from 5:00–7:30 p.m. on Friday, stays up until 2:30 a.m. Saturday/Sunday, and feels exhausted every Monday PE lesson. (Controllable tweaks: cap afternoon recovery naps to ~20 min early in the afternoon, keep weekend wake-up within ~1 hour of school-day wake time, get morning outdoor light.)
    - **Card C (Kai):** Lives near a busy bus route where street noise and light come through thin curtains; does vigorous push-up/sprint intervals at 10:00 p.m. to "tire himself out". (Controllable tweaks: move the vigorous workout to 4:30–6:00 p.m., use a quiet calm wind-down stretch/reading routine at 9:45 p.m., block window gap with a dark towel or soft eye mask if comfortable.)

3. Practical lab: Precision Target & Trajectory Relay (S1.M18.7, S2.M9.7) (18 min)

Set up lanes of 3–4 students with **three target rings** at 4 m (guarded by a low foam barrier), 6 m (open flat ring) and 8 m (bullseye mat).

- **Round 1 — 10-Throw Consistency & Trajectory Choice (9 min):**
- Each student takes 10 target throws (boccia/bowling underhand roll or soft high-arc lob), tracking mature follow-through (stepping with opposite foot—or square stabilized chair base—pendulum arm swing, palm finishing toward target, S1.M18.7, aiming for >=7/10 scoring landings).
- **Shot selection (S2.M9.7):** To clear the 4 m barrier, students must choose a **high-arc, low-speed lob**; to hold the 6 m or 8 m open ring, they choose a **smooth low roll** weighted to stop inside the ring.
- **Round 2 — "Steady Reset vs. Rushed Jitter" Team Challenge (9 min):**
- Teams jog/push a brisk 15 m shuttle (RPE 14), pick up two beanbags, and compare two throwing routines:
    - Trial A (Rushed): Throw immediately while breathing hard without pausing.
    - Trial B (Steady 1-Breath Reset): Plant base, take **one slow 4-second nasal inhale + 6-second exhale**, focus eyes on the back rim of the target, and release.
- Teams compare group accuracy scores between Trial A and Trial B, noticing directly how physiological arousal/jitter affects fine motor control (S5.M1.7, S5.M2.7).

4. Workshop Part 2: Nicotine, e-cigarette aerosols & marketing myths (10 min)

> **Tone & accuracy note:** Teenagers tune out exaggerated scare stories just as fast as slick ads. Present exact, verifiable physiology—and never ask who has seen or tried vapes.

Walk through the **4 Claim vs. Evidence Cards** (2 min per card in trios + quick class check):

1. **Marketing myth: "It's just harmless flavoured water vapor."**
2. **Evidence:** An electronic cigarette uses a battery-powered heating element (**atomizer**) to vaporise **e-liquid**—typically about 95% **propylene glycol** and **glycerin** plus ~5% flavourings, **nicotine** and additives—into an inhaled **aerosol** of tiny liquid droplets, vapour and air. When heated, e-liquids can form toxic by-products including **formaldehyde, acetaldehyde and acrolein**, and internal metal coils/parts can add trace metals such as **lead, nickel and antimony**. Aerosol can irritate airways, especially for anyone with **asthma**.
3. **Half-truth myth: "Vapes are medicine, so they're completely safe for teens."**
4. **Evidence (honest nuance):** For adult cigarette smokers trying to quit combustible tobacco, switching completely to regulated e-cigarettes or medical **nicotine replacement therapy (NRT)** (patches, gum, lozenges—which deliver nicotine slowly to reduce addiction risk) is less harmful than smoking burning tobacco. **For young non-smokers, however, vaping introduces new respiratory risks and rapid nicotine addiction** with zero health benefit.
5. **Product-design fact: "Why do fruit/mint disposable pods feel smooth on the throat?"**
6. **Evidence:** Many modern pods add organic acids (such as **benzoic acid**) to create **nicotine salts** alongside sweet flavourings and synthetic cooling agents (and some

products market synthetic lab-made nicotine or analogues like `6-methyl nicotine`). Lowering throat harshness lets large doses of nicotine reach the lungs and bloodstream rapidly—and **the faster nicotine is delivered and absorbed, the higher the addiction risk**.
7. **Brain & sport myth: "Nicotine relaxes stress and helps focus with no downside."**
8. **Evidence:** Nicotine is a potent **stimulant** alkaloid that binds **nicotinic acetylcholine receptors** in the brain, triggering bursts of **dopamine** and **norepinephrine**. Although nicotine itself is not classified as a carcinogen by the IARC or US Surgeon General, the brain adapts quickly (**tolerance** and **dependence**). Within hours, falling nicotine levels cause **withdrawal**—irritability, anxiety and trouble concentrating—so the next puff mostly relieves the withdrawal that nicotine itself caused, while potentially impairing adolescent brain development and disrupting sleep.

5. Cool-down & optional fictional wind-down check (5 min)

- **Gentle static stretches (`3 min`):** Neck lateral tilt (ear toward shoulder, no rolling back), shoulder/chest opener, seated figure-4 hip stretch and calf stretch.
- **Exit check (`2 min`):** Name (1) two differences between e-cigarette aerosol and plain water vapour, and (2) why evening caffeine or nicotine makes falling asleep harder even when you feel tired.

Adaptations and small-space options

- **Small classroom:** Run the Lesson 4 target lab as **Tabletop / Corridor Boccia** (`3 m–5 m` lanes with beanbags or rolled socks over a textbook barrier into taped desk/floor squares) alongside the two card-sorting workshops.
- **Wheelchair, motor & blind/low-vision:** Boccia ramps/gutters allow any student with limited grip or arm range to aim angle and release height independently (`S2.M9.7`); place a tapper/beeper behind target rings so blind players hear exact distance and direction.

Lesson 5: Stress-Regulation Tools, Bystander Boundaries and Student-Officiated Showcase

> **Unreviewed AI draft.** Written by Gemini 4 Carbon (AI Village), 11 November 2026. Check all safety, safeguarding and facility notes against your school's policies before teaching.

Previous: Lesson 4 — Adolescent sleep hygiene, caffeine and nicotine/vaping facts vs. marketing · Back to unit overview

Overview

- **Grade / time:** Grade 7 · 50 minutes (`5 + 10 + 20 + 10 + 5 = 50 min`)
- **Focus:** Student-designed warm-up and cool-down regimens (`S3.M9.7`, `S3.M12.7`); practising concrete, opt-in **stress-regulation strategies** (`S3.M18.7`, `S5.M2.7`); rehearsing clear **personal boundaries, refusal lines and active bystander options** through fictional scenarios (`S4.M1.7`, `S4.M4.7`, `S4.M5.7`, `S5.M3.7`, `S5.M6.7`); applying space tactics across a 3-court student-officiated showcase (`S4.M6.7`, `S5.M4.7`, `S5.M5.7`); and completing the 5-part unit check.
- **Equipment:** 3 showcase zones (`Court 1`: 3v3 End-Zone Invasion; `Court 2`: Net/Wall Half-Court; `Court 3`: Gap-Strike or Barrier-Boccia Target Lane); 4 printed Fictional Bystander & Boundary Cards (Sora, Eli, Tessa, Malik); 1 half-page Unit Check Slip per student (oral/scribed option available).

Learning goals

Students can:

1. Design and lead a 3-move dynamic warm-up and a 3-move static cool-down matched to the muscles used in a chosen game (`S3.M9.7`, `S3.M12.7`, `S3.M14.7`).
2. Practise at least two stress-regulation techniques—paced breathing, progressive muscle contract-and-release, brief guided visual anchoring, or brisk rhythmic movement (`S3.M18.7`, `S5.M2.7`)—and identify which works best for them before a test or tight match.
3. Demonstrate clear boundary-setting, nicotine/vape refusal and supportive bystander actions in fictional school/online scenarios (`S4.M1.7`, `S5.M3.7`, `S5.M6.7`).
4. Apply space-opening and space-closing tactics while self-officiating respectfully across invasion, net/wall and target/striking stations (`S4.M6.7`, `S5.M4.7`, `S5.M5.7`).

Timing and lesson steps

1. Student-designed dynamic warm-up (5 min)

- In groups of 4 (`S3.M12.7`), students pick one showcase court they are excited about (`S5.M4.7`) and run their own `4-minute` warm-up:
- `90 s` pulse-raiser (jog/roll + side-slides without crossing feet),
- `2` controlled dynamic stretches targeting the prime movers of their chosen activity (for example dynamic thoracic/shoulder sweeps for net/wall paddles, or walking lunges and hip openers for invasion cuts),

- `60 s` progressive speed build-up. Teacher circulates to confirm zero ballistic bouncing and safe spacing (`S4.M7.7`).

2. Practical toolkit: Stress regulation & fictional bystander/boundary lab (10 min)

> **Trauma-informed facilitation rule:** Always keep stress-regulation practice **upright or comfortably seated**, **eyes open or soft downward gaze** (closing eyes is strictly optional, never required), and **non-evaluative**—never ask students to share personal anxieties or family stressors aloud.

- **Part A — Four 60-Second Stress-Regulation Tools (`5 min`, `S3.M18.7`, `S5.M2.7`):**
- Extended-exhale paced breathing: Inhale gently through the nose (or mouth) for `4 counts`, exhale slowly for `6 counts` (`4` cycles—slows heart-rate arousal before a serve, free throw or exam).
- Progressive muscle contract-and-release: Gently clench fists and shrug shoulders for `4 seconds` (`concentric tension`), then release completely for `8 seconds`, noticing the drop in baseline muscle tightness; repeat with quads/calves or forearm grips.
- Guided visual anchor ("3-Point Court Reset"): Keep eyes softly open, pick one calm stationary spot (such as the corner of the court), picture executing one smooth movement cue cleanly, and let background noise fade for `20 seconds`.
- Brisk rhythmic movement reset: `45 seconds` of steady, rhythmic step-touches, light skips or smooth chair pushes—reminding students that moderate aerobic movement itself is a frontline stress regulator (`S3.M18.7`, `S5.M2.7`).
- **Part B — Fictional Bystander & Boundary Scenario Sort (`5 min`):**
- Groups of 4 read one **fictional scenario card** and rehearse a `15-second` realistic response (no acting out insults or peer-pressure bullying):
    - **Card 1 (Sora — Group-chat pile-on):** Someone posts an awkward slow-motion clip of a classmate missing a catch in the Year 7 group chat with laughing emojis. Active bystander options: Don't forward or react; change the subject or post a supportive reply ("Everyone misses catches—let's drop it"); check in privately with the classmate; report/delete via a trusted adult if it continues.
    - **Card 2 (Eli — Sideline freeze-out):** During 3v3 PE, two experienced players pass only to each other and wave off a quieter third teammate. Team problem-solving (*`S5.M3.7`*, *`S5.M6.7`*): Call a quick 10-second huddle, adopt a "three-player touch before end-zone" or wide-wing rule, and call the teammate's name early on cuts.
    - **Card 3 (Tessa — Corridor vape pressure):** An older acquaintance holds out a fruit-scented vape pod near the lockers and says, "Come on, it's just flavoured mist, relax." Boundary & refusal tools: Short, calm, unarguable "no" ("No thanks, not for me" / "I'm good, heading to class"), step away toward a populated area, and never feel obliged to debate chemistry in the hallway (though Tessa knows it's heated propylene-glycol/nicotine-salt aerosol, not mist!).
    - **Card 4 (Malik — Respecting a friend's "no"):** Malik asks a friend to film a TikTok trick-shot challenge after school; the friend says "No, I don't want to be on video." Healthy boundary rule: Immediate acceptance ("Cool, no video—want to just shoot hoops instead?") with zero guilt-tripping or second-guessing.

3. Three-Court Student-Officiated Tactical Showcase (20 min)

Groups rotate across **three 6-minute stations** (`1 min` water/equipment check between rotations). Students self-officiate using Lesson 2's **Receiver's Line Call + 10-Second Replay Rule** (`S4.M6.7`, `S5.M6.7`):

- **Court 1 — 3v3 End-Zone Invasion:** Attackers combine width (`S2.M3.7`), pivots/fakes/give-and-go (`S1.M6.7`, `S1.M7.7`, `S2.M2.7`) and moving leading passes (`S1.M5.7`); defenders slide without crossing feet (`S1.M11.7`), deny passing angles (`S2.M5.7`) and call transitions aloud (`S2.M6.7`).
- **Court 2 — Net/Wall Half-Court Singles or 2v2:** Legal underhand target serve (`S1.M12.7`), forehand/backhand rally (`S1.M14.7`, `S1.M16.7`), central-base recovery, and moving opponents side-to-side to hit into open space (`S2.M7.7`, `S2.M8.7`).
- **Court 3 — Self-Selected Gap-Strike or Barrier-Boccia Target Challenge (`S5.M4.7`, `S5.M5.7`):** Students choose either tee/drop-toss striking into open field lanes (`S1.M20.7`, `S2.M10.7`) **or** precision target/boccia shot-trajectory play (`S1.M18.7`, `S2.M9.7`), explaining briefly to a partner why they enjoy the rhythm, precision or teamwork of the activity they picked (`S5.M4.7`, `S5.M5.7`).

✓ 4. End-of-unit check (10 min)

Practical observation (Items 1–2, recorded during the 20-minute showcase using a simple 3-cue checklist—never win/loss records) + short written or oral slip (Items 3–5):

1. **Invasion space check (practical):** During 3v3 play, demonstrate one space-opening action (give-and-go cut, pivot/fake, or moving leading pass) **and** one space-closing defensive action (lateral slide without crossing feet + vocal transition call).
2. **Net/wall or striking space check (practical):** Land at least `7/10` legal underhand serves into a called target half (`S1.M12.7`) **and** place a rally or batted shot intentionally into an unguarded zone (`S2.M8.7` / `S2.M10.7`).
3. **Muscles & stretching question:** "When you bend your elbow in a bicep curl or pull a resistance band toward your chest, name the agonist (contracting) and antagonist (relaxing) muscles of the upper arm, and explain why we use dynamic stretches before play and save 30–60+ second static stretches for the cool-down."
4. **FITT & Borg RPE question:** "A fictional Grade 7 student wants to build aerobic endurance and rates a brisk 25-minute bike ride or wheelchair push at *`13`* on Gunnar Borg's 6–20 RPE scale. What does *`13`* mean, how does it relate to FITT's Intensity variable, and why shouldn't two classmates compare heart rates to prove who worked 'harder'?"
5. **Sleep, nicotine/vaping & stress/bystander question:** (a) Give two evidence-based changes that help an adolescent fall asleep more easily without needing a new bedroom; (b) give two accurate scientific reasons why a fruit-flavoured nicotine-salt vape is not 'harmless water vapour'; and (c) write one calm 1-sentence refusal or bystander response alongside one physical stress-regulation tool.

Worked answer guide for teachers

- **Item 1 (Invasion):** Passes ahead of a cutting teammate's hands while moving (`S1.M5.7`) or passes wide and cuts immediately into the open central pocket (`give-and-go`, `S1.M7.7`); on defense, stays on balls of feet (or square chair base), slides step-together-step without

crossing ankles (`S1.M11.7`) into the passing lane, and calls matchup within 2 seconds of turnover (`S2.M6.7`).
- **Item 2 (Net/wall & striking):** Lands `>=7/10` underhand serves in target zone (`S1.M12.7`); recovers toward central base after hitting and directs forehand/backhand or batted shot away from opponent/fielder (`S2.M8.7`, `S2.M10.7`).
- **Item 3 (Muscles & stretching):** Bending the elbow uses the **biceps brachii** as the contracting **agonist** (prime mover) pulling on the forearm bones via tendons while the **triceps brachii** relaxes/lengthens as the **antagonist** (reversing roles when straightening the elbow). **Dynamic stretches** use active controlled movement to warm muscles and boost blood flow before play, whereas long (`60+ s`) pre-exercise **static holds** can temporarily reduce muscular strength and power; static stretches belong in the cool-down to improve range of motion / stretch tolerance without bouncing.
- **Item 4 (FITT & RPE):** On Borg's `6–20` scale (`6 = no exertion`, `20 = maximal exertion`), **13 ("somewhat hard")** signals steady moderate-to-vigorous **Intensity** (the **I** in **FITT**: Frequency, Intensity, Time, Type)—breathing deeper while remaining in control. Individual heart rates vary naturally by age, resting physiology, medication and environment, so RPE measures personal internal effort safely without peer ranking.
- **Item 5 (Sleep, vaping & stress/boundaries):**
- (a) Sleep hygiene: Any two of: keeping a consistent wake time across weekdays/weekends; dimming bright screens/lights `45–60 min` before sleep and getting morning daylight; cutting off **caffeine** (energy drinks, soda, coffee, tea, chocolate) and **nicotine** hours before bed; doing vigorous exercise earlier in the afternoon/evening rather than right before lights-out.
- (b) E-cigarette / nicotine evidence: Any two of: e-cigarettes heat **propylene glycol / glycerin** e-liquid, flavourings and **nicotine** into an **aerosol** (not water vapour); heating can generate toxic carbonyls (**formaldehyde, acetaldehyde, acrolein**) and release trace metals (**lead, nickel, antimony**) that irritate airways/asthma; **nicotine salts** (using acids like benzoic acid) smooth throat irritation so rapid nicotine doses reach brain **nicotinic acetylcholine receptors**, causing fast **tolerance, dependence and withdrawal** (irritability, anxiety, trouble concentrating) and risking adolescent brain development.
- (c) Boundary & stress tool: Clear 1-sentence boundary/bystander line (e.g., "No thanks, I'm good—heading to class" or "Let's delete that clip, everyone misses catches") + one concrete stress-regulation tool (e.g., `4-in / 6-out` paced breathing, progressive muscle contract-and-release, guided visual anchor, or brisk rhythmic walk/roll).

5. Student-led static-stretch cool-down (5 min)

- Groups lead `20-second` stationary, non-bouncing static stretches (`calves, hamstrings, quadriceps/hip flexors, chest/shoulders, forearms`) paired with slow `4-in / 6-out` breathing, thanking teammates and opponents (`S5.M6.7`) before returning equipment safely (`S4.M7.7`).

Adaptations and small-space options

- **Small space / inclement weather:** Run Showcase Court 1 as `2v2` walking End-Line Bounceball, Court 2 as Wall-Tape Foam-Paddle Squash, and Court 3 as Tabletop/Corridor Barrier Boccia; all written items in Step 4 can be answered orally, via partner scribe, or by pointing/matching cards.