PEARSON EDEXCEL INTERNATIONAL AS / A LEVEL

BIOLOGY, CHEMISTRY & PHYSICS

TEACHER RESOURCE PACK 1

Core Practical 1: Use a semi-quantitative method with Benedict's reagent to estimate the concentrations of reducing sugars and with iodine solution to estimate the concentrations of starch, using colour standards

Objectives

- To understand what is meant by a semi-quantitative test
- To be able to estimate concentrations of reducing sugars using Benedict's reagent
- To be able to estimate concentrations of starch using iodine solution
- To develop the skills needed to plan an investigation using dilutions

Safety

- Wear eye protection.
- Avoid skin contact with Benedict's reagent, iodine and hot solutions.
- Handle the test tubes with tongs to avoid burns.
- Do not taste the fruit juice.

Maths skills

- Solve algebraic equations.

Equipment

- eye protection
- test tubes, tongs and test tube rack
- small beakers
- Benedict's reagent
- iodine solution
- 2% glucose solution
- 2% starch solution
- 'unknown' starch solution
- 1/10 dilution of fruit juice
- 1 cm^3 and 5 cm^3 syringes
- 3 cm^3 pipettes
- distilled water
- waterproof marker pen
- water bath at 60–80 °C or a large beaker of recently boiled water
- timer or stop clock

Procedure

Procedure – Part 1: Benedict's reagent method

1. Plan how you will use the stock 2% glucose solution to make the following five concentrations of glucose solution: 2%, 1%, 0.5%, 1.5% and 0.25%. Write your plan in the space provided in the Lab Book.
2. Use the waterproof pen to label six test tubes and five small beakers with the different glucose concentrations they will contain. Label the sixth test tube 'fruit juice'.
3. Use the syringes, the distilled water and the 2% glucose solution to create 5 cm^3 of each solution in the corresponding labelled beaker.
4. Use a clean syringe to add 2 cm^3 of Benedict's reagent to each of the six labelled test tubes.
5. Using a clean syringe each time, add 1 cm^3 of each glucose solution to the corresponding labelled test tubes.
6. Add 1 cm^3 of fruit juice to the last labelled test tube.
7. Give each tube a gentle shake to ensure the contents are mixed.
8. Place all six test tubes in the water bath and start the timer.

9. After 2 minutes, use tongs to remove the test tubes from the water bath and place them in the test tube rack. Take care: the tubes will be hot.
10. Observe the tubes and record the results in a suitable table.

Procedure – Part 2: Iodine solution method

1. Plan how you will use the stock 2% starch solution to make the following five concentrations of starch solution: 2%, 1%, 0.5%, 0.2% and 0.1%. Write your plan in the space provided in the Lab Book.
2. Use the waterproof pen to label five test tubes and five small beakers with the different starch concentrations they will contain. Label the sixth test tube 'unknown'.
3. Use the syringes, the distilled water and the 2% starch solution to create 5 cm^3 of each solution in the corresponding labelled beaker.
4. Use a clean syringe to add 0.5 cm^3 of iodine to each of the six labelled test tubes. Add a further 10 cm^3 of distilled water to each tube.
5. Using a clean syringe each time, add 5 cm^3 of each starch solution to the corresponding labelled test tube.
6. Add 5 cm^3 of the 'unknown' starch solution to the sixth test tube. Compare the colour produced in this tube with the colour of the diluted test tubes.
7. Record your results in a suitable table.

Analysis of results

1. Record your results for glucose in a suitable table.
2. If possible take a photograph of your standard solutions and keep it with your data.
3. Plot a suitable graph to display your data.
4. Record your results for starch in a suitable table.
5. If possible take a photograph of your standard solutions and keep it with your data.
6. Plot a suitable graph to display your data.

Learning tips

- When recording the results of the Benedict's test, use the correct descriptive language. Simply stating 'green' or 'blue' does not provide enough detail to allow comparison.
- One of the reasons for making the test semi-quantitative is to allow easier comparison, which may be less subjective and therefore more accurate. You will be expected to know the steps needed in the procedure and the expected results.

Questions

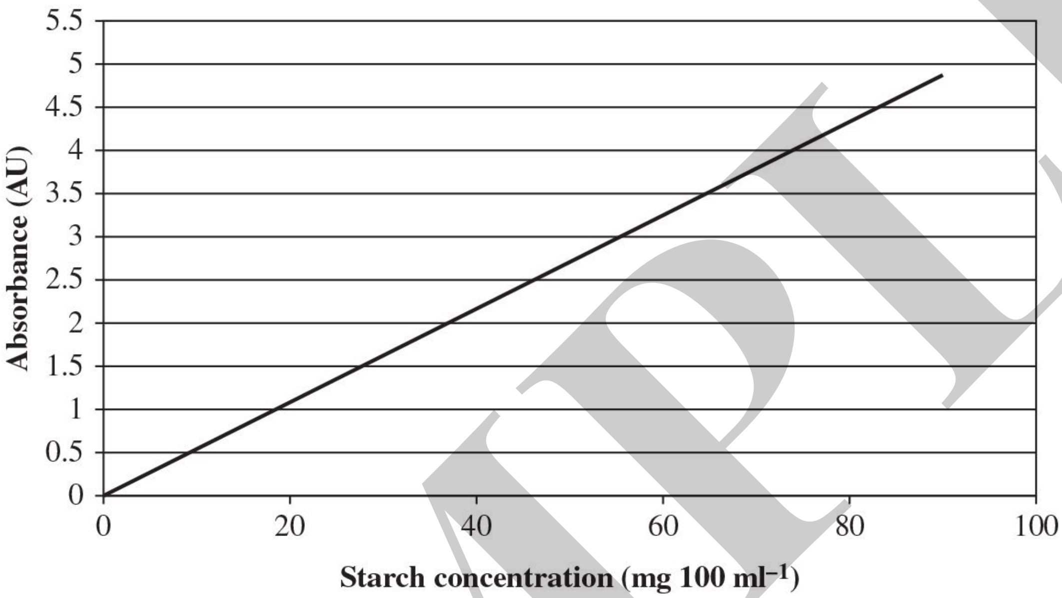
1. How could these investigations have been adapted to produce quantitative results?
2. Explain why the Benedict's test is not a suitable test for measuring the total sugar content of fruit juice.
3. Suggest one way in which the results of the Benedict's reagent investigation could have been made more reliable.
4. How could you evaluate the accuracy of your experimental value for the concentration of glucose in the fruit juice?
5. Name a variable that you controlled in the iodine investigation, explain how you controlled it and describe the possible effect on the result if it had not been controlled.

Exam-style questions

1. Explain the difference between qualitative, semi-quantitative and quantitative tests. **(3)**

2. Explain how you could use serial dilution to make a range of concentrations from a stock solution of 10% fructose. **(2)**

3. The graph shows a calibration curve obtained by measuring the absorbance of light of wavelength 650 nm in a colorimeter, through a solution of starch reacted with dilute iodine/KI solution.



(a) Suggest why light of wavelength 650 nm was used in the colorimeter. **(2)**

(b) Explain why a blank – a cuvette containing distilled water and dilute iodine/KI solution – is used to set the absorbance of the colorimeter to zero. **(1)**

(c) Explain why a scratched cuvette should not be used. **(1)**

(d) Dilute iodine/KI solution was added to a starch solution of unknown concentration and mixed. The resulting solution was placed in a cuvette in a colorimeter and the absorbance was read as 0.75. What was the concentration of starch in this solution? **(1)**

(e) Express the concentration of starch read from the graph in (d) as:

(i) a percentage

(ii) g per L

(2)

4. Explain what is meant by a 'reducing sugar'. **(3)**

5. Starch is a polymer of glucose. Name the type of reaction involved when two glucose molecules join together by a 1,4 glycosidic bond. **(1)**

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- To be able to estimate concentrations of starch using iodine solution
- To develop the skills needed to plan an investigation using dilutions

Safety

- Wear eye protection.
- Avoid skin contact with Benedict's reagent, iodine and hot solutions.
- Handle the test tubes with tongs to avoid burns.
- Do not taste the fruit juice.

Procedure	Notes on procedure
Procedure – Part 1: Benedict's reagent method **1.** Plan how you will use the stock 2% glucose solution to make the following five concentrations of glucose solution: 2%, 1%, 0.5%, 1.5% and 0.25%. Write your plan in the space provided in the Lab Book. **2.** Use the waterproof pen to label six test tubes and five small beakers with the different glucose concentrations they will contain. Label the sixth test tube 'fruit juice'. **3.** Use the syringes, the distilled water and the 2% glucose solution to create 5 cm^3 of each solution in the corresponding labelled beaker. **4.** Use a clean syringe to add 2 cm^3 of Benedict's reagent to each of the six labelled test tubes. **5.** Using a clean syringe each time, add 1 cm^3 of each glucose solution to the corresponding labelled test tubes. **6.** Add 1 cm^3 of fruit juice to the last labelled test tube. **7.** Give each tube a gentle shake to ensure the contents are mixed. **8.** Place all six test tubes in the water bath and start the timer. **9.** After 2 minutes, use tongs to remove the	**Procedure – Part 1: Benedict's reagent method** • Students can easily become confused and reuse pipettes during serial dilutions. Ensure that they have been briefed to use clean pipettes or to clean them between uses. • As many clear solutions will be used, accurate labelling of glassware is essential. • This investigation could be extended with the use of a colorimeter to allow a quantitative comparison. **Procedure – Part 2: Iodine solution method** • Starch solutions are prone to settling. Remind students to shake the bottle containing the starch solution before use. • As iodine is so dark it can be difficult to read the scale on some syringes – a pipette can be used instead, though this is a less precise method, which should be discussed with the students.

test tubes from the water bath and place them in the test tube rack. Take care: the tubes will be hot. **10.** Observe the tubes and record the results in a suitable table. **Procedure – Part 2: Iodine solution method** **1.** Plan how you will use the stock 2% starch solution to make the following five concentrations of starch solution: 2%, 1%, 0.5%, 0.2% and 0.1%. Write your plan in the space provided in the Lab Book. **2.** Use the waterproof pen to label five test tubes and five small beakers with the different starch concentrations they will contain. Label the sixth test tube 'unknown'. **3.** Use the syringes, the distilled water and the 2% starch solution to create 5 cm^3 of each solution in the corresponding labelled beaker. **4.** Use a clean syringe to add 0.5 cm^3 of iodine to each of the six labelled test tubes. Add a further 10 cm^3 of distilled water to each tube. **5.** Using a clean syringe each time, add 5 cm^3 of each starch solution to the corresponding labelled test tube. **6.** Add 5 cm^3 of the 'unknown' starch solution to the sixth test tube. Compare the colour produced in this tube with the colour of the diluted test tubes. **7.** Record your results in a suitable table.	

Answers to questions

1. The absorbance of the samples could have been measured using a colorimeter.
2. Fruit juices contain sucrose, which is a non-reducing sugar and does not react with Benedict's reagent.
3. One of:
   - Larger quantities of each sample concentration could have been made, so repeat readings could be taken.
   - Results from the whole class could be collated to give an average estimate.
4. One of:
   - Compare with the reference values on the nutrition label, which will show the glucose content.
   - Calculate the concentration of glucose in the juice and then compare with the estimate generated experimentally.
5. Controlled variables include: concentration of iodine / volumes of solutions / time in water bath / Benedict's reagent (or other reasonable suggestion).

   Control method: this must be linked with the named variable. For example, the concentration of iodine was controlled by using the same solution and diluting by the same amount each time.

Effect on the result if the variable was not controlled: any reasonable suggestion. For example, failure to control the concentration of iodine would result in over- or underestimation of the concentration of starch.

Answers to exam-style questions

1. A qualitative test tells you whether something is present or absent. **(1)** A quantitative test enables you to determine exactly how much of the substance is present. **(1)** A semi-quantitative test enables you to estimate roughly how much of the substance is present. **(1)**
2. Credit any methods that would work. For example, 1 ml from the stock solution into 9 ml distilled water makes a 1 in 10 / ×10 dilution of 1%. 1 ml of that in 9 ml of water gives a 0.1% solution, etc.

   5 ml stock solution and 5 ml distilled water = 5% solution. 5 ml of that and 5 ml water = 2.5% solution.

   9 ml stock solution + 1 ml water = 9% solution; 8 ml stock solution and 2 ml water = 8% solution **(2)**
3.
   (a) Light of wavelength 650 nm is red **(1)** and will be absorbed by the blue / black solution. **(1)**

   (b) The blank – water and dilute iodine/KI solution – will be pale brown. If we set the absorbance to 0 this eliminates any absorbance due to just the iodine solution so we are measuring absorbance due to iodine/starch complex. **(1)**

   (c) A scratched surface would absorb some light / interfere with absorption. **(1)**

   (d) 14 mg 100 ml^{-1} **(1)**

   Accept in range 12–16 mg 100 ml^{-1}

   (e)

   (i) In range 0.012–0.016% **(1)**

   (ii) In range 0.12–0.16 g in 1 L water **(1)**
4. A sugar that has a free aldehyde or ketone group **(1)** in its molecule that can reduce (donate electrons to) **(1)** Benedict's reagent, changing copper(II) ions to copper(I) ions. **(1)**
5. Condensation **(1)**

Sample data

Solution	Colour observed
0.25%	blue / no change
0.5%	green
1%	light red
1.5%	orange
2%	brick-red

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Objectives	Safety
• To understand what is meant by a semi-quantitative test • To be able to estimate concentrations of reducing sugars using Benedict's reagent • To be able to estimate concentrations of starch using iodine solution • To develop the skills needed to plan an investigation using dilutions	• Wear eye protection. • Avoid skin contact with Benedict's reagent, iodine and hot solutions. • Handle the test tubes with tongs to avoid burns. • Do not taste the fruit juice.

Equipment per student/group	Notes on equipment
eye protection	One per student.
test tubes	Six test tubes for each procedure per group.
tongs	One per group; shaped for holding test tubes.
test tube rack	One per group.
small beakers	Six per group, per procedure. 50 cm^3 beakers are the best size to use.
Benedict's reagent	
iodine solution	Iodine (in potassium iodide) solution.
2% glucose solution	One bottle per group.
2% starch solution	One bottle per group.
'unknown' starch solution	This should be in the range of 0.2–2%.
1/10 dilution of fruit juice	Clear fruit juices with minimal colour are ideal. Apple juice works best. Avoid using fresh juices with pulp.
1 cm^3 and 5 cm^3 syringes	Six of each per group. Alternatively, students can clean them between uses. Supply distilled water and a large beaker or sink for rinsing.
3 cm^3 pipettes	Two per group.
distilled water	One bottle per group.
waterproof marker pen	One per group.
water bath at 60–80°C or a large beaker of recently boiled water	Submerged test tube racks are needed in the water baths to hold the test tubes during the experiment.
timer or stop clock	One per group.

Notes

TOPIC 1: FORMULAE, EQUATIONS AND AMOUNT OF SUBSTANCE

1 Which of the following contains the most atoms?

A 27.0 g of H_2O

B 35.0 g of Ne

C 32.0 g of O_2

D 34.0 g of H_2O_2

Your answer ☐

(1)

(Total for Question 1 = 1 mark)

2 Hydrogen gas can be prepared in the laboratory by adding an excess of hydrochloric acid to zinc metal granules:

In one such preparation, 1.90 g of zinc.

(a) Write the balanced reaction equation.

(1)

....

(b) Calculate the amount (in moles) of zinc used.

(1)

....

(c) State the amount (in moles) of hydrogen produced.

(1)

....

(d) Calculate the maximum mass of zinc chloride, $ZnCl_2$, that would be produced.

(1)

....

....

(Total for Question 2 = 4 marks)

3 Copper(II) chloride solution, $CuCl_2(aq)$, can be prepared by reacting excess powdered copper(II) oxide, CuO(s), with hot hydrochloric acid:

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

Unreacted copper(II) is then removed by filtration, and water is evaporated from the filtrate to leave crystals of copper(II) chloride-2-water, $CuCl_2 \cdot 2H_2O$.

In one such preparation, 50 cm^3 of 0.50 mol dm^{-3} hydrochloric acid is used.

(a) Calculate the amount (in moles) of hydrochloric acid used.

(1)

....

(b) Calculate the minimum amount (in moles) of copper(II) oxide needed.

(1)

....

(c) Calculate the mass of copper(II) oxide needed, if an excess of 20% is necessary.

(2)

....

(d) Calculate the molar mass of copper(II) chloride-2-water, $CuCl_2 \cdot 2H_2O$.

(1)

....

(e) 1.81 g of copper(II) chloride-2-water is obtained. Calculate the percentage yield.

(2)

....

....

(Total for Question 3 = 7 marks)

4 An oxide of nitrogen contains 30.4% nitrogen by mass.

(a) State the meaning of the term *empirical formula*.

(1)

....

(b) Determine the empirical formula of this oxide of nitrogen.

(3)

....

....

....

(c) The relative formula mass of this oxide of nitrogen is 92.0. Determine its molecular formula.

(1)

....

(Total for Question 4 = 5 marks)

5 A precipitate forms when 0.04 moles aqueous potassium iodide solution is mixed with 0.06 moles aqueous silver nitrate solution.

(a) Which of the following is the ionic equation for the reaction?

A $Ag^{2+}(aq) + I^{2-}(aq) \rightarrow AgI(s)$

B $Ag^{+}(aq) + I^{-}(aq) \rightarrow AgI(s)$

C $K^{2+}(aq) + 2NO_3^{-}(aq) \rightarrow K_2(NO_3)_2(s)$

D $K^{+}(aq) + NO_3^{-}(aq) \rightarrow KNO_3(s)$

Your answer ☐

(1)

(b) Give the colour of the precipitate formed.

(1)

....

(c) State the number of moles of precipitate that were formed.

(1)

....

(Total for Question 5 = 3 marks)

TOTAL FOR ASSESSMENT = 20 MARKS

TOPIC 1: FORMULAE, EQUATIONS AND AMOUNT OF SUBSTANCE

Question number	Answer	Additional guidance	Mark
1	A (1)		(1)

(Total for Question 1 = 1 mark)

Question number	Answer	Additional guidance	Mark
2(a)	$Zn + 2HCl = ZnCl_2 + H_2$	Ignore state symbols, if given	(1)
2(b)	1.90/ 65 = 0.029 moles	2.9×10^{-2} mole	(1)
2(c)	0.029 moles	2.9 x 10^-2 moles	(1)
2(d)	(65 + 35.5 + 35.5) x 0.029 = 3.944 g	Allow 3.95 g	(1)

(Total for Question 2 = 4 marks)

Question number	Answer	Additional guidance	Mark
3(a)	0.50 × 50 ÷ 1000 = 0.025 mol (1)	2.5×10^{-2} mol	(1)
3(b)	0.025 ÷ 2 = 0.0125 mol (1)	1.25×10^{-2} mol	(1)
3(c)	excess = 0.0125 × 1.2 = 0.015 (1) molar mass of CuO = 63.5 + 16.0 = 79.5 mass = 0.015 × 79.5 = 1.19(25) g (1)		(2)
3(d)	63.5 + (2 × 35.5) + (2 × 18.0) = 170.5 (1)		(1)

3(e)	expected yield = 0.0125 × 170.5 = 2.13 (1) % yield = (1.81 ÷ 2.13) × 100 = 85.0% (1)	2.13125 84.9% if 2.13125 used	**(2)**

(Total for Question 3 = 7 marks)

Question number	Answer	Additional guidance	Mark
4(a)	Simplest *whole-number* ratio of the atoms of each element in a compound		**(1)**
4(b)	O = 100 – 30.4 = 69.6% (1) N: 30.4 ÷ 14.0 = 2.17 O: 69.6 ÷ 16.0 = 4.35 (1) N: 1 O: 2 NO_2 (1)		**(3)**
4(c)	factor = 92.0 ÷ 46.0 = 2 molecular formula is N_2O_4 (1)		**(1)**

(Total for Question 4 = 5 marks)

Question number	Answer	Additional guidance	Mark
5(a)	B (1)		**(1)**
5(b)	(Bright) Yellow	Neither accept pale yellow nor cream	**(1)**
5(c)	0.04		**(1)**

(Total for Question 5 = 3 marks)

TOTAL FOR ASSESSMENT =20 MARKS

Teaching plan 1A.1 Velocity and acceleration

Student Book links	Specification links	Links to prior learning
• 1A.1	• 1.3.1 • 1.3.4	• SI units for motion • Calculations of speed, velocity and acceleration • Use of a stopclock to measure times

Suggested teaching order

1. Review of SI units and prefixes for kinematic quantities.
2. Review of simple speed, distance, time calculations.
3. Distinguishing average and instantaneous speeds.
4. Definition and examples of scalar and vector quantities including distance/displacement and speed/velocity.
5. Definition of 'acceleration' and calculations of acceleration.
6. Acceleration as a vector.

Learning objectives

- Explain the distinction between scalar and vector quantities.
- Distinguish between speed and velocity and define acceleration.
- Calculate values using equations for velocity and acceleration.

Key terms

- Speed
- Velocity
- Displacement
- Vector
- Scalar
- Average speed
- Instantaneous speed
- Acceleration

Practical skills

- Determine average speed using a metre rule and stopclock.
- Determine average speed using light gates and datalogger.

Suggested activity

- Determine the acceleration of a freely-falling object (Core practical 1).

Maths skills

- Recognise and make use of appropriate units in calculations (C.0.1).
- Recognise and use expressions in decimal and standard form (C.0.2).
- Use ratios, fractions and percentages (C.0.3).
- Use calculators to find and use power, exponential and logarithmic functions (C.0.5).
- Understand and use the symbols: $=$, $<$, $<<$, $>>$, $>$, ∞, $\approx$, Δ (C.2.1).
- Calculate rate of change from a graph showing a linear relationship (C.3.5).
- Distinguish between instantaneous rate of change and average rate of change (C.3.7).

Digital learning ideas

- Use light gates and datalogging software to measure displacements, velocities and accelerations.
- Use video capture and analysis software (e.g. freeware such as *Tracker*).
- Use high speed cameras (if available) to capture and analyse rapid motion.

• Apply the concepts underlying calculus (but without requiring the explicit use of derivatives or integrals) by solving equations involving rates of change, e.g. $\frac{\Delta x}{\Delta t} = \lambda x$ using a graphical method or spreadsheet modelling (C.3.9).		
Pre-unit homework suggestions		
• Students should practise speed, distance, time calculations. • Set students a research task to find out about the SI units for motion. • Students should practise prefixes and powers of ten such as milli-, micro-, nano-, kilo- , mega-.		
Suggested starter activities	**Equipment**	**Teacher notes**
1. Pose a question such as 'At what speed does a fingernail grow?' or 'At what speed does a spacecraft travel to the Moon?' Ask students to discuss and then justify their answers.		This introduces the idea of speed as distance divided by time and will involve a discussion of appropriate units (including prefixes). Both examples are likely to lead to a discussion of instantaneous versus average speed. It can also be used to discuss scientific notation and uncertainties.
2. Ask students to measure, in pairs, the average speed of a squash ball dropped from a height of 2.0 m.	Squash ball, stopclock, metre rules (two per group) or tape measure	Plenty to draw out in discussion: the need to repeat a measurement, the distinction between average and instantaneous speed, the concept of acceleration, uncertainties in measurements ('Which is most significant – time or distance?').
3. Discuss distance, speed, velocity and acceleration of athletes taking part in 100 m and 400 m events.		The 400 m event involves a total displacement of 0 m and therefore an average velocity of 0 m s^{-1}. To run 100 m in 10 s requires a maximum velocity of greater than 10 m s^{-1}.
Suggested main activities	**Equipment**	**Teacher notes**
1. Analysis of a multiflash photograph.	Multiflash photograph(s)	Search for 'multiflash photography' online or create images in class.

2. Practice with calculations.		This should not be underestimated. The basic equations and mathematical techniques are simple but students need to become proficient with interpreting a range of different dynamic contexts.
3. Use of light gates and datalogging equipment to measure velocities and to calculate accelerations.	Light gate(s) and datalogger, inclined planes and trolley	Velocity can be measured at different positions along the ramp or for different angles. Acceleration can be measured directly but better still from the velocity at two different positions and the time taken to move between them.
4. Analysis of motion using a webcam and *Tracker* software (or, if available, a high speed camera).	Video camera, moving object (fast moving if a high speed camera is available), suitable software package If it is not possible to capture your own video, you can find public domain video clips online.	Students will need to understand frame rates and have some way of connecting a scale with the images. Freeware such as *Tracker* is excellent but you will require a lesson to teach students how to use it.
Suggested plenary activities	**Equipment**	**Teacher notes**
1. Video analysis of an athletics event, for example, a 100 m final at a major athletics event.		Clips can be found on *YouTube*. The race can be started and stopped to estimate velocities at different points and to estimate the initial acceleration of the sprinter.
2. Quick quiz on units, prefixes, equations and terminology.		Ask students to fill in a partially completed table.
3. Ask each student to write a multiple choice question and solution based on the unit (divide into themes if necessary). Collect, check and collate questions then set as a class test.		Students could be invited to review their own questions when the test is completed or returned. This could involve peer-to-peer marking.

Homework suggestions

- Provide a list of moving things and ask students to estimate their speed and give an explanation of how they did this. The list could include: a cheetah, a 100 m sprinter, a racing car, a falling raindrop, a snail, growth rate of a tree, a strand of hair, a child or a fingernail. The important point is that they consider distance travelled and time taken and can justify their responses/units/notation.
- Students should practise calculations of average speed, velocity and speed (in situations where they need to be distinguished), and acceleration, for example, Q1–3 from the Student Book.

Wider reading
● Research the definitions of ‘metre’ and ‘second’.
Support ideas
● Practise simple calculations of speed, distance and time.
Extension ideas
● Consider vector acceleration in circular motion: ‘How can something have constant speed but be accelerating?’
Potential misconceptions
● The concept of a ‘rate of change’ is challenging and will need reinforcement through a variety of examples. ● Confusion between velocity and acceleration may occur. ● The motion of a ball thrown vertically and caught can be used to consolidate and extend ideas about vectors and scalars. It can also be used to help the understanding of velocity and acceleration, for example: ‘How can the ball be accelerating downwards whilst moving upwards?’, ‘How can the ball be accelerating when it is instantaneously at rest at the top of its motion?’, ‘How does the velocity and displacement change with time?’
Links to future learning
● Consideration of how displacement, velocity, and acceleration change with time links to the graphical representation of motion. ● Vector addition and subtraction, and resolution of vectors along particular axes: ‘If I travel 50 km NW how far north do I go?’ ● The idea of cause for acceleration, such as gravity for a projectile, as a link from acceleration to resultant force.
Differentiation for IAS students
● Although the idea of acceleration when an object moves along a curved path reinforces the vector nature of acceleration, IAS students will not study circular motion so this challenging idea could be omitted.
Notes

