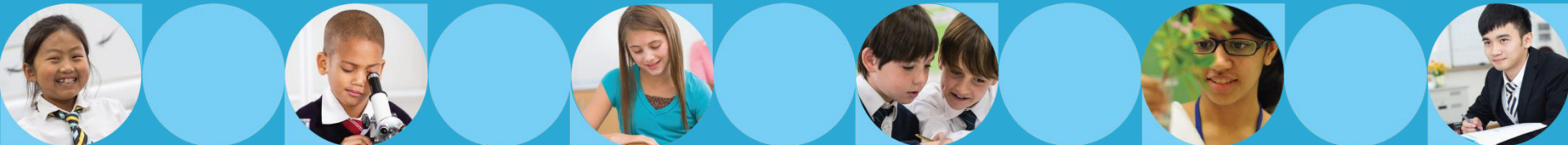


Using multiple choice questions to identify student misconceptions

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Development Manager

29 – 30 March 2019



Using multiple choice questions

Purpose:

- ▶ *To gain an insight into the writing of multiple choice questions*
- ▶ *Learn how to use statistical evidence to reveal areas of misconception and error*
- ▶ *Explore how to use multiple choice questions in the classroom to identify and address specific areas for development*
- ▶ *Share ideas for activities involving multiple choice questions to suit different learning styles*

Writing multiple choice questions



Why multiple choice questions?

- ▶ In summative assessment:
 - ▶ For wide syllabus coverage
 - ▶ Contribute to reliability
 - ▶ Quick and easy to mark electronically
 - ▶ Easy to create similar but different questions (sibling items)
- ▶ In formative assessment
 - ▶ To reinforce learning
 - ▶ To identify misconceptions
 - ▶ Easy to create sibling items to re-test misconceptions
 - ▶ Quick and easy to mark

Jargon

Term	Meaning
Item	everything: stem, question and options
Stem	the material preceding the question
Question	the question itself (the sentence ending with ‘?’)
Options	the choices A, B, C, D
Key	the correct option
Distractor	an incorrect option

The circuit of a motor racing track is 3.0 km in length. In a race, a car goes 25 times round the circuit in 30 minutes.

What is the average speed of the car?

A 75 km / hour **B** 90 km / hour **C** 150 km / hour **D** 750 km / hour

Jargon

- ▶ Sibling – a closely related item

The circuit of a motor racing track is 3.0 km in length. In a race, a car goes 25 times round the circuit in 30 minutes.

What is the average speed of the car?

A 75 km / hour **B** 90 km / hour **C** 150 km / hour **D** 750 km / hour

The circuit of a motor racing track is 7.0 km in length. In a race, a car goes 12 times round the circuit in 36 minutes.

What is the average speed of the car?

A 84 km / hour **B** 252 km / hour **C** 140 km / hour **D** 432 km / hour

What makes a good multiple choice item?

- ▶ There is a unique correct answer that is on syllabus
- ▶ The key is correct no matter how much science is known beyond the syllabus
- ▶ All options are plausible
- ▶ All distractors are on syllabus
- ▶ It is neither too easy nor too difficult
- ▶ The language is clear and technical terms are on the syllabus
- ▶ There is no trickery, or gender, racial or cultural bias of any kind

Distractors – non-calculation questions

- ▶ Distractors for non-calculation items are all reasonable choices given incomplete knowledge

When dilute sulfuric acid is electrolysed using inert electrodes, two gases are produced.

What are these two gases?

- A** hydrogen and oxygen
- B** hydrogen and sulfate
- C** hydrogen and sulfur dioxide
- D** oxygen and sulfur dioxide

Distractors – calculation questions

- ▶ Distractors for calculations can all be reached using the data given, ideally with just one mistake in the process

A 2.0 g sample of sodium chloride is dissolved in water to give a solution of volume 80 cm³.

What is the concentration of this solution in g/dm³?

A B 25 C D

- ▶ Key: $80 \div 1000 = 0.08 \text{ dm}^3$ $2.0 \div 0.08 = 25 \text{ g/dm}^3$
- ▶ What could be good distractors?
 - ▶ not converting to dm³ = 0.025 (g/cm³)
 - ▶ fraction wrong way up = 0.04 (dm³/g)
 - ▶ multiplying instead of dividing = 0.16 (g dm³)

Distractors – calculation questions

A 2.0 g sample of sodium chloride is dissolved in water to give a solution of volume 80 cm³.

What is the concentration of this solution in g/dm³?

A

B 25

C

D

▶ Other possible distractors

- ▶ not converting to dm³ and wrong way up = 40 (cm³/g)
- ▶ multiplying 80 x 2 = 160
- ▶ adding 80 + 2 = 82
- ▶ random answer e.g. 33

Distractors – calculation questions

- ▶ Distractors for calculations can all be reached using the data given, ideally with just one mistake in the process

The potential difference across a resistor is 6.0 V, and the current in it is 3.0 A.

What is the resistance of the resistor?

A 0.50 Ω

B 2.0 Ω

C 9.0 Ω

D 18 Ω

- ▶ Ohm's Law: $V = I \times R$
- ▶ where V is voltage, I is current in amperes (A) and R is the resistance in ohms (Ω)
- ▶ Rearrange: $R = V \div I = 6.0 \div 3.0 = 2.0 \Omega$

Statistics



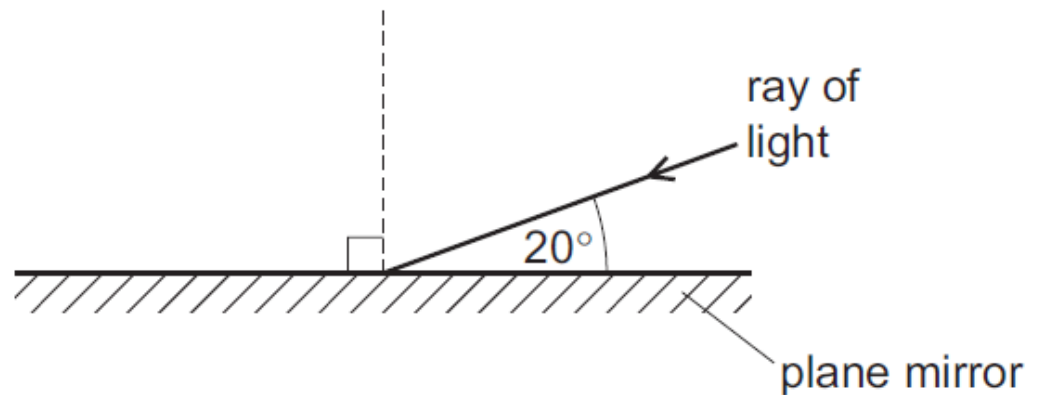
Statistics – item facility

- ▶ Facility = the proportion of students that answered correctly
- ▶ Target range is 0.25 – 0.80
- ▶ An extremely high value indicates the question is too easy
- ▶ An extremely low value indicates the question is too hard
- ▶ 0.25 is the “guessing rate” in a four-option question

Statistics

- ▶ Proportion endorsing = the proportion choosing each option

The diagram shows a ray of light striking a plane mirror.



What is the angle of reflection?

A 20°

B 40°

C 70°

D 140°

Statistics

- ▶ Look at the proportion of candidates in the upper 27% of the test score distribution who gave the correct answer to the item, and the same proportion in the lowest 27% group.
- ▶ Should find that the proportion endorsing the key is greater for the stronger group than for the weaker group
- ▶ AND the proportion endorsing for the distractors is greater for the weaker group than for the stronger group

Statistics

- ▶ Statistics for the question:

Proportion correct	Option	Proportion endorsing			Key
		All	Low	High	
0.36	A	0.56	0.63	0.40	
	B	0.03	0.06	0.01	
	C	0.36	0.25	0.57	*
	D	0.04	0.06	0.02	

- ▶ PE report: This question on reflection of light proved challenging. The majority of candidates chose option **A**; it should be noted that the angle of reflection is always measured between the ray and the normal.

Using the statistics

- ▶ Use the facility to identify which topics are generally well understood and which are less well understood
- ▶ Use the proportion endorsing to identify specific misconceptions and identify which topics weaker candidates struggle with

Using multiple choice questions in the classroom



Use in the classroom

- ▶ At the beginning of the topic to assess prior knowledge
- ▶ During a topic to assess progress
- ▶ During a lesson to check understanding
- ▶ As homework
- ▶ At the end of a topic to plan targeted revision



Sources of questions

- ▶ Past papers
- ▶ [Test-maker](#)
- ▶ Text books
- ▶ Online
- ▶ Write your own

Writing multiple choice questions - tips

- ▶ Keep notes of ideas as teaching
- ▶ Identify topic/learning outcome to test
- ▶ Start by writing a question with correct answer
- ▶ Consider distractors to test common misconceptions/mistakes
- ▶ Ask someone else to review

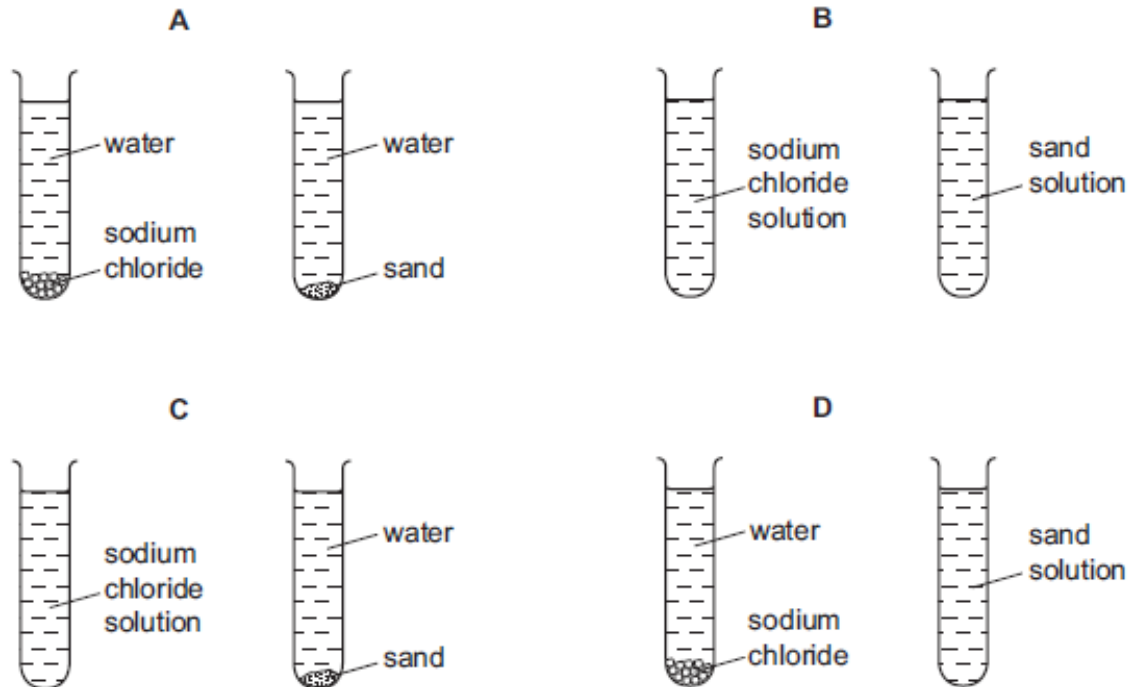
Learning styles



Learning styles

Small amounts of sodium chloride and sand are shaken with separate samples of water in two test-tubes. The test-tubes are left to stand for 24 hours.

Which diagram shows how the test-tubes appear after leaving them to stand for 24 hours?

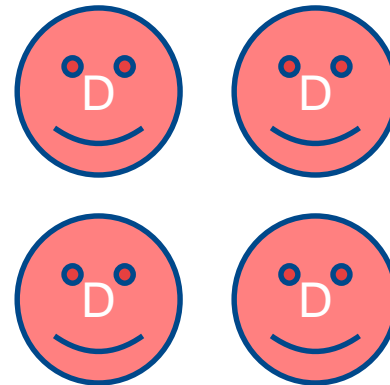
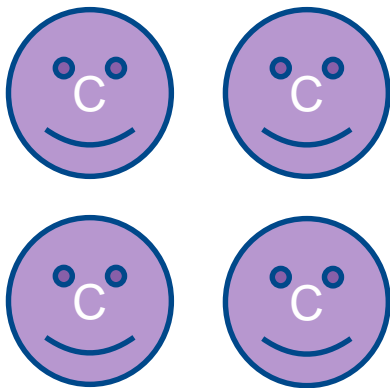
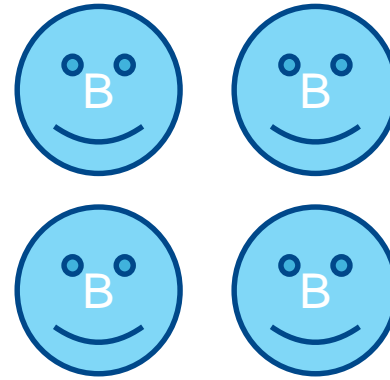
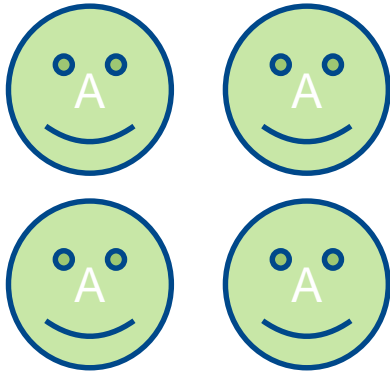


Learning styles

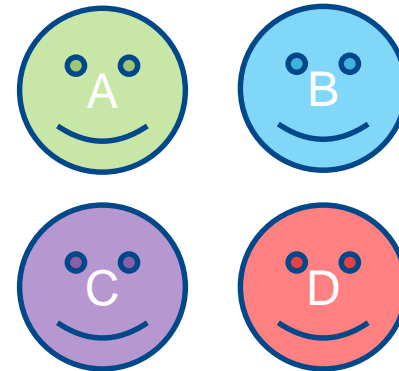
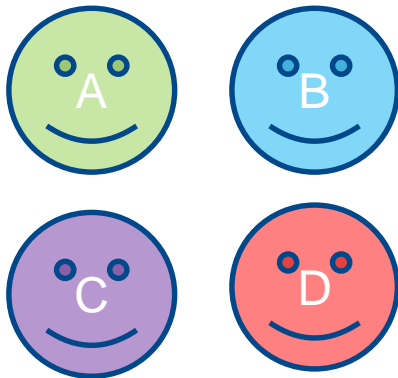
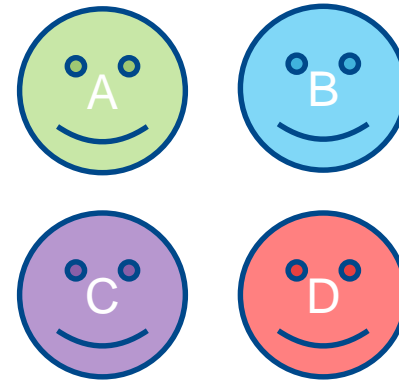
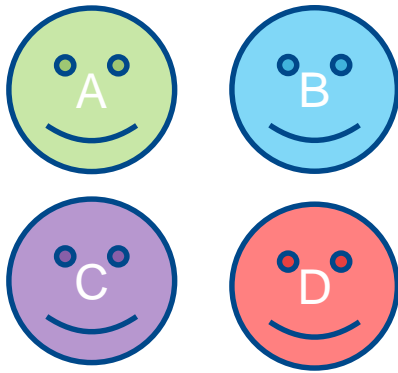
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Learning styles

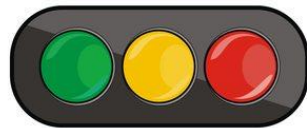


Learning styles



Learning styles

- ▶ Further ideas...
- ▶ Students to write their own
- ▶ Using paper/mini white boards to hold up what they think it is – gives quick idea whether they are getting it
- ▶ Yes/no/maybe – traffic lights or smiley faces, to vote on each choice



- ▶ A, B, C, D stations around the classroom

Summary



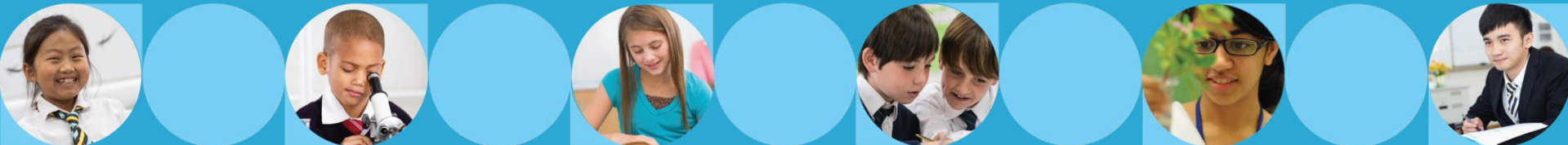
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Outcomes:

- ▶ *Gained an insight into the writing of multiple choice questions*
- ▶ *Learned how to use statistical evidence to reveal areas of misconception and error*
- ▶ *Explored how to use multiple choice questions in the classroom to identify and address specific areas for development*
- ▶ *Shared ideas for activities involving multiple choice questions to suit different learning styles*

Assessment

We recognise that assessment has two important roles: to prove and improve – to prove what students are learning, and to suggest how they can improve their understanding and skills.



Thank you
Any questions?



Learn more!

Getting in touch with Cambridge is easy

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