Physics 2019 v1.3

IA1 sample marking scheme

June 2023

Data test (10%)

This sample has been compiled by the QCAA to model one possible approach to allocating marks in a data test. It matches the examination mark allocations as specified in the syllabus (~ 30% apply understanding, ~ 30% analyse evidence and ~ 40% interpret evidence) and ensures that a balance of the objectives are assessed.

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

2. apply understanding of gravity and motion, or electromagnetism to given algebraic, visual or graphical representations of scientific relationships and data to determine unknown scientific quantities or features
3. analyse evidence about gravity and motion, or electromagnetism to identify trends, patterns, relationships, limitations or uncertainty in datasets
4. interpret evidence about gravity and motion, or electromagnetism to draw conclusions based on analysis of datasets.

Note: Objectives 1, 5, 6 and 7 are not assessed in this instrument.

Instrument-specific marking guide (ISMG)

Criterion: Data test

Assessment objectives

The student work has the following characteristics:	Cut-off	Mark
• consistent demonstration, across a range of scenarios about gravity and motion, or electromagnetism, of – selection and correct application of scientific concepts, theories, models and systems to predict outcome/s, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct and appropriate use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions.	> 90%	10
	> 80%	9
• consistent demonstration, in scenarios about gravity and motion, or electromagnetism, of – selection and correct application of scientific concepts, theories, models and systems to predict outcome/s, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions.	> 70%	8
	> 60%	7
• adequate demonstration, in scenarios about gravity and motion, or electromagnetism, of – selection and correct application of scientific concepts, theories, models and systems to predict outcome/s, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions.	> 50%	6
	> 40%	5
• demonstration, in scenarios about gravity and motion, or electromagnetism, of elements of – selection and correct application of scientific concepts, theories, models and systems to predict outcome/s, behaviours and implications – correct calculation of quantities through the use of algebraic, visual or graphical representations of scientific relationships or data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations or uncertainty – correct interpretation of evidence to draw valid conclusions.	> 30%	4
	> 20%	3
• demonstration, in scenarios about gravity and motion, or electromagnetism, of elements of – application of scientific concepts, theories, models or systems to predict outcome/s, behaviours or implications	> 10%	2

The student work has the following characteristics:	Cut-off	Mark
– calculation of quantities through the use of algebraic or graphical representations of scientific relationships and data – use of analytical techniques to identify trends, patterns, relationships, limitations or uncertainty – interpretation of evidence to draw conclusions.	> 1%	1
• does not satisfy any of the descriptors above.	≤ 1%	0

Task

See the sample assessment instrument for IA1: Data test (10%) (available on the QCAA Portal).

Sample marking scheme

Criterion	Marks allocated	Result
Data test Assessment objectives 2, 3, 4	10	—
Total	**10**	**—**

Marking scheme symbols and abbreviations

Symbol or abbreviation	Meaning
✓	The preceding section of the expected response is worth one mark.
/	Separates acceptable alternative wordings in the expected response.
()	Terms in brackets are not necessary in the response for the mark to be awarded.
shaded and underlined text	Shaded and underlined text must be included in the response for the mark to be awarded.
Accept converse.	Award the mark even if the answer is stated in its converse form, e.g. 'A comes before B' can be stated as 'B comes after A'.
Accept *min–max*.	Award the mark for any numerical answer that falls within the specified range, e.g. 'Accept 1.5–1.9' means that any answer between 1.5 and 1.9 should be considered correct. This is used in items that involve a multi-step calculation where differences in rounding in the intermediate steps could result in slight differences in the final answer.
Allow for FT error …	Means 'allow for follow-through error'. Initial errors should only be penalised once. Marks should be awarded for subsequent steps that are correct.
Allow FT error for transcription only.	Follow-through error is only allowed if the student has written down information incorrectly but processed it correctly.
AND	Separates two parts of the response that are both required for the mark to be awarded.
Correct d.p. required.	The answer must be stated to the number of decimal places indicated in the item for the mark to be awarded.
Correct s.f. required.	The answer must be stated to the correct number of significant figures indicated in the item for the mark to be awarded.
Max. # marks.	The maximum number of marks that can be awarded for the response is indicated by #.
OR	Separates acceptable alternative wordings.
OWTTE	Means 'or words to that effect'. This is used in questions where students are unlikely to use the exact wording given in the expected response. If the student's response has the same meaning as the expected response, then the mark should be awarded.
Working not required.	Evidence of working, reasoning or calculations is not required for the mark to be awarded.

The annotations are written descriptions of the expected response for each question and are related to the assessment objectives.

Assessment objective — annotation	Expected response Note: ✓ = 1 mark	Mark allocation
Item 1		**2 marks**
Apply understanding The item uses the cognitive verb 'calculate'. The expected response is an unknown scientific quantity.	$F_{aver} = \frac{\sum_i^n F_i}{n}$ $F_{aver} = \frac{0.060+0.060+0.062}{3}$ ✓ $F_{aver} = 0.061$ N ✓	1 mark for appropriate working. 1 mark for the correct solution.
Item 2		**1 mark**
Apply understanding The item uses the cognitive verb 'determine'. The expected response is an unknown scientific quantity.	$= \pm\frac{0.062 - 0.060}{2} = \pm\frac{0.002}{2} = \pm 0.001$ N✓	1 mark for correct solution. Working not required.
Item 3		**2 marks**
Analyse evidence The item uses the cognitive verb 'identify'. The expected response is a relationship.	As the distance between the magnets doubles, the force exerted between the magnets decreases by a factor of 4. OR There is an inverse-square relationship between force and distance. OR $r \propto \frac{1}{F^2}$ ✓ When the distance is doubled from 0.010 m to 0.020 m, the force is roughly quartered from 1.007 N to 0.250 N. OR When the distance is doubled from 0.020 m to 0.040 m, the force is roughly quartered from 0.250 N to 0.061 N. OR When the distance is doubled from 0.025 m to 0.050 m, the force is roughly quartered from 0.0156 N to 0.040 N.✓	1 mark for identification of the relationship. Accept converse. 1 mark for an appropriate justification. Accept other similar reasoning.

Assessment objective — annotation	Expected response Note: ✓ = 1 mark	Mark allocation
Item 4		**2 marks**
Interpret evidence The item uses the cognitive verb 'predict'. The expected response is a conclusion based on analysis.	When the distance is increased by a factor of 8 from 0.010 m to 0.080 m, the force will be reduced by a factor of 64, i.e. 1.007 ÷ 64 = 0.016 N. OR When the distance is increased by a factor of 4 from 0.020 m to 0.080 m, the force will be reduced by a factor of 16, i.e. 0.250 ÷ 16 = 0.016 N. OR When the distance is increased by a factor of 2 from 0.040 m to 0.080 m, the force will be reduced by a factor of 4, i.e. 0.061 ÷ 4 = 0.015 N. ✓ When the two magnets are 0.080 m apart, the magnitude of the force between will be approximately 0.016 N.✓	1 mark for reasoning. Accept other similar reasoning. 1 mark for conclusion. Accept 0.015–0.017 N.
Item 5		**1 mark**
Apply understanding The item uses the cognitive verb 'identify'. The expected response is an unknown scientific quantity.	30° and 60°✓	1 mark for identifying both angles. No half marks.
Item 6		**2 marks**
Apply understanding The item uses the cognitive verb 'determine'. The expected response is an unknown scientific quantity.	$(u_x = u \times \cos\theta)$ $u_x = 15.0 \times \cos 20$✓ $u_x = 14.1\ \text{ms}^{-1}$✓	1 mark for working. No mark for formula without substitution. 1 mark for horizontal component of velocity.

Assessment objective — annotation	Expected response Note: ✓ = 1 mark	Mark allocation
Item 7		**1 mark**
Analyse evidence The item uses the cognitive verb 'identify'. The expected response is a trend.	The graph is symmetrical. The horizontal displacement, s_h, increases as the projected angle increases from 10° to 40° and then decreases as the projected angle increases from 50° to 80°. OR s_h is proportional to $\sin 2\theta$.✓	1 mark for identifying the trend evident in the data.
Item 8		**2 marks**
Interpret evidence The item uses the cognitive verb 'infer'. The expected response is a conclusion based on analysis.	The graph is symmetrical so the largest horizontal displacement will occur when the projected angle is midway between 40° and 50°.✓ Answer: ≈ 45°✓	1 mark for reason. If the symmetry of the graph is identified in the response to Item 7, then it can be taken as given in this item. 1 mark for conclusion.
Item 9		**3 marks**
Analyse evidence The item uses the cognitive verb 'identify'. The expected response is a relationship.	The uncertainty of the gradient $= \pm \frac{3.00 - 2.51}{2}$ The uncertainty of the gradient $= \pm 0.25$ The uncertainty of the *y*-intercept $= \pm \frac{-0.005 - -0.001}{2}$ The uncertainty of the *y*-intercept $= \pm 0.002$✓ $F = (2.70 \pm 0.25)I - (0.002 \pm 0.002)$ ✓	1 mark for identifying the uncertainty associated with the gradient. 1 mark for identifying the uncertainty associated with the *y*-intercept. 1 mark for identifying the mathematical relationship between force and current with uncertainties. Units not required.

Assessment objective — annotation	Expected response Note: ✓ = 1 mark	Mark allocation
Item 10		**4 marks**
Interpret evidence The item uses the cognitive verb 'draw a conclusion'. The expected response is a conclusion based on analysis.	The gradient of the linear trend line is 2.70 ± 0.25 % uncertainty of the gradient = $\frac{0.25}{2.70} \times 100\% = 9.3\%$✓ The gradient represents: $m = \frac{\Delta F}{\Delta I}$ Rearranging the equation $F = BIL\sin\theta$ $m = \frac{F}{I} = BL\sin\theta$✓ Substituting in the known values for L, θ and the gradient $2.70 = B \times 0.02\sin 90$ Therefore, $B = \frac{2.70}{0.02} = 135$ T✓ Therefore, the magnitude of the magnetic field is: $B = 135 \text{ T} \pm 9.3\%$ OR $B = 135 \pm 13$ T✓	1 mark for calculating the percentage uncertainty of the gradient. 1 mark for interpreting the physical meaning from the gradient. 1 mark for calculating the magnitude of the magnetic field. Allow for FT error. Unit not required. 1 mark for drawing a conclusion about the magnitude of the magnetic field and its uncertainty. Allow for FT error. Unit required.