# GCE A LEVEL MARKING SCHEME

**SUMMER 2024**

**A LEVEL**
**PHYSICS – COMPONENT 1**
**A420U10-1**

## About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

# GCE A LEVEL PHYSICS

## COMPONENT 1 – NEWTONIAN PHYSICS

## SUMMER 2024 MARK SCHEME

## GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

One tick must equate to one mark (except for the extended response question).

Question totals should be written in the box at the end of the question.

Question totals should be entered onto the grid on the front cover and these should be added to give the script total for each candidate.

Marking rules

All work should be seen to have been marked.

Marking schemes will indicate when explicit working is deemed to be a necessary part of a correct answer.

Crossed out responses not replaced should be marked.

Credit will be given for correct and relevant alternative responses which are not recorded in the mark scheme.

Extended response question

A level of response mark scheme is used. Before applying the mark scheme please read through the whole answer from start to finish. Firstly, decide which level descriptor matches best with the candidate's response: remember that you should be considering the overall quality of the response. Then decide which mark to award within the level. Award the higher mark in the level if there is a good match with both the content statements and the communication statement.

Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

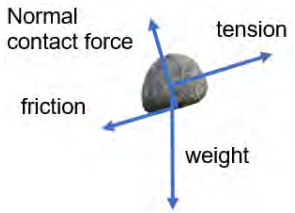
cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

## SECTION A

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **1** | (a) | (i) | 0.01 | 1 | | | 1 | | 1 |
| | | (ii) | Addition of 0.04 mm [to diameter value] of 11.68 mm / diameter becomes 11.72 mm | | 1 | | 1 | | 1 |
| | | (iii) | Use of $\rho = \frac{m}{V}$ (1)<br>$\rho = \frac{2.3}{\frac{4}{3}\pi\left(\frac{1.172}{2}\right)^3} = 2.7$[3 g cm$^{-3}$] (1) allow **ecf** from (ii) | 1<br><br>1 | | | 2 | 1 | 2 |

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (b) | | **Diameter ×(1)**<br>– Multi-marbles reduce % uncertainty in *d* **AND** caliper has lower resolution than ruler<br>– Should have used multi-marbles with calipers<br>– Multiple method better as marbles may not be identical<br>– Multiple diameter readings<br>**Mass ×(1)**<br>– Multi-marble mass has smaller % uncertainty<br>– Single marble % unc = 4% AND multi-marble mass is 0.9%<br>– Top pan balance with lower resolution would improve the experiment<br>**Density ×(1)**<br>– Single marble has % uncertainty in diameter = 0.1% AND % uncertainty in volume = 3 × 0.1%<br>– % uncertainty in density = 4%<br>– Single marble method has % uncertainty in density less than the multi-marble method<br>**Density ×(1)**<br>– Multi-marble result closer to the true value [so accurate]<br>– Manufacture's value within range of multi-marble results [so more accurate]<br>– Manufacturer's value does not fall within single marble range [(2.4 ± 0.1) g cm-3] | | | 4 | 4 | 2 | 4 |
| | | | **Question 1 total** | **2** | **2** | **4** | **8** | **3** | **8** |

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **2** | (a) | (i) | Use of $v = u + at$ i.e. [0] + 0.6 × 20 | 1 | | | 1 | 1 | |
| | | (ii) | Distance = area under graph **OR** use of equations of motion (1)<br>456 [m] (1)<br>$\frac{456\ \textbf{ecf}}{51}$ = 8.9 [m s$^{-1}$] (1) | 1 | 1<br>1 | | 3 | 2 | |
| | (b) | | Mean speed = 7.6 m s$^{-1}$ **OR** return journey took longer so mean speed is less than 9 m s$^{-1}$ so Charlie is incorrect (1)<br>Total displacement = zero (1)<br>$\text{mean velocity} = \frac{\text{total displacement}}{\text{total time}}$ so Lola is correct (1) | | | 3 | 3 | 1 | |
| | (c) | | **Any×(1) valid point as a benefit e.g.**<br>• More efficient [per mile] than cars<br>• Reduces congestion on roads<br>• Ease of storage<br>• Quieter [than fuel-based transport]<br>• Reduces {$CO_2$ / greenhouse gases}<br>• May increase the mobility of some people<br>Don't accept better for the environment or no harmful emissions or doesn't use fossil fuels<br><br>**Any ×(1) valid point as a risk e.g.**<br>• May increase accidents on the road / pavements<br>• Offers little protection in the event of a collision<br>• May decrease mobility of people<br>• Lack of {insurance / regulation}<br>• Against the law [on public roads / footpaths in many places]<br>• Risk of {theft / fire} | | | 2 | 2 | | |
| | | | **Question 2 total** | **2** | **2** | **5** | **9** | **4** | **0** |

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **3** | (a) | | Product of [magnitude of the] force and the distance (1)<br>moved in the direction of the force (1) | 2 | | | 2 | | |
| | (b) | (i) |  <br>Weight shown with vertical arrow (1) accept $mg$ / $W$ / 160$g$ / 1570<br>Friction and tension drawn (1) accept friction force from centre of mass accept $F$ / $Fr$ / $T$<br>[Normal] contact / reaction force drawn at right angles to base of boulder (1) accept $R$ /$C$ / $N$ | | 3 | | 3 | | |
| | | (ii) | 1 500 × 8 = 12 000 J or N m or kg m$^2$ s$^{-2}$ **UNIT MARK** | | 1 | | 1 | 1 | |
| | | (iii) | Use of $\Delta E = mg\Delta h$ [i.e.160 × 9.81 × 8sin25 = 5 307 [J] (1)<br>12 000 **ecf** – 5 307= 6 693 [J] (1)<br>$\frac{6693}{8}$ = 837 [N] (1)<br>**Alternative:**<br>Component of $mg$ down slope = $mg$sin25 (1)<br>1 500 – $mg$sin25 (1)<br>= 837 [N] (1) | 1 | 1<br>1 | | 3 | 2 | |
| | (c) | | Use of Efficiency $= \frac{\text{[useful] energy transferred}}{\text{total energy input}}$ [× 100] (1)<br>$\frac{5307\ \textbf{ecf}}{12\,000\ \textbf{ecf}}$ [×100] = 0.44 or [44 %] (1)<br>[6693 J] transferred to energies of particles in system / ramp / rock (1) accept transferred to internal energy of the system / ramp / rock | 1 | 1<br>1 | | 3 | 1 | |
| | | | **Question 3 total** | **4** | **8** | **0** | **12** | **4** | **0** |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **4** | (a) | | | $s = r\theta$ seen / $l = r\theta$ seen **OR** terms labelled on diagram (1)<br>when $s = r$ it follows that $\theta$ = 1 rad / the angle subtended at the centre of a circle by an arc equal in length to the radius (1) | 2 | | | 2 | | |
| | (b) | (i) | | Correct conversion i.e. $\times \frac{1000}{3\,600}$ = 25 [m s$^{-1}$] (1)<br>Use of $\omega = \frac{\theta}{t}$ [i.e. $\frac{2.1}{2.5} = 0.84$ [rads$^{-1}$]] (1)<br>$r = \frac{v}{\omega} = \frac{25}{0.84} = 29.8$ [m] (1) allow **ecf** on $v$ | 1 | 1<br><br>1 | | 3 | 2 | |
| | | (ii) | | Stating $1\ \text{eV}$ is $1.6 \times 10^{-19}$ J **OR** KE of electron = $4 \times 10^{-16}$ [J] **or** by implication (1)<br>speed of electron = $3.0 \times 10^{7}$ m s$^{-1}$ **or** by implication (1)<br>$F = \frac{mv^2}{r} = Bev$ seen or equivalent (1)<br>$r = \frac{mv}{Bq} = 2.8 \times 10^{-3}$ [m] (1) allow **ecf** on KE and $v$ | 1 | 1<br><br>1<br>1 | | 4 | 3 | |
| | | (iii) | I | $\Sigma F_{\text{car}}$ provided by friction accept grip **AND** $\Sigma F_{\text{electron}}$ provided by magnetic / [left hand] motor force | | 1 | | 1 | | |
| | | | II | $\Sigma F_{\text{car}}$= 17 kN (1) **ecf** from (b)(i)<br>$\Sigma F_{\text{electron}}$= 0.29 pN (1) **ecf** from (b)(ii)<br>comparison made e.g. $\Sigma F_{\text{car}} > \Sigma F_{\text{electron}}$ **or** $\Sigma F_{\text{car}}$ is [6 ×] $10^{16}$ times bigger than $\Sigma F_{\text{electron}}$ (1) **ecf** | | | 3 | 3 | 2 | |
| | | | | **Question 4 total** | **4** | **6** | **3** | **13** | **7** | **0** |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **5** | (a) | | | [When an object moves such that its] acceleration is always directed toward a fixed point / equilibrium position (1)<br>and is proportional to its distance / displacement from the fixed point / equilibrium position (1) | 2 | | | 2 | | |
| | (b) | | | $ma_{\max} = kx_{\max} = kA$ (1)<br>$A = \frac{ma_{\max}}{k} = \frac{0.35 \times 1.8}{4.5}$ seen (1)<br>**Alternative:**<br>$\omega^2 = \frac{k}{m}$ used or equivalent [e.g. $\omega^2$ = 12.9 rad$^2$ s$^{-2}$] (1)<br>$a_{\max} = \omega^2 A$ rearranged to give $A = \frac{a_{\max}}{\omega^2} = \frac{1.8}{12.9}$ or equivalent seen (1) | | 2 | | 2 | 1 | |
| | (c) | (i) | | $A$ = amplitude [of oscillation] and is 14.0 ± 0.2 cm so correct (1)<br>$T$ from graph = 1.75 s and $\omega = \frac{2\pi}{1.75}$ = 3.6 so correct (1)<br>$x_{t=0} = 14\cos([-]1.28)$ = 4 so correct **OR** phase shift calculated directly from graph e.g. $\frac{0.35}{1.75} \times 2\pi = 1.26$ so close **OR** use of $t$ value in equation and showing that the calculated point does not fit the graph curve so incorrect (1)<br>$'+1.28'$ incorrect as negative sign required / should be $'-1.28'$ (1)<br>**Alternative for last two marks:**<br>' + ' is correct but phase angle should be $(2\pi - 1.28) = 5.0$ | | | 4 | 4 | 4 | 4 |
| | | (ii) | | Sinusoid with time period of 1.75 s (1)<br>Original $x$-$t$ graph mirrored in time axis (1) | | 2 | | 2 | 2 | |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (d) | | | **Indicative content:**<br>**Experimental method**<br>• Labelled diagram<br>• Length of pendulum varied<br>• Length measured with ruler<br>• Measured to centre of bob<br>• Bob displaced by small angle<br>• 5+ oscillations timed with a stopwatch<br>• Timed from equilibrium position [marked with fiducial marker]<br>• Periodic time calculated<br>• Repeat readings for each length<br><br>**Graph analysis**<br>• Plot graph of $T^2$ against $l$ OR $T$ against $\sqrt{l}$<br>• Error bars shown on graph<br>• Straight line of best fit<br>• Calculate gradient / steepest and least steep gradients<br>• gradient equal to $\frac{4\pi^2}{g}$ **OR** $\left(\frac{2\pi}{\sqrt{g}}\right)$<br>• $g = \frac{4\pi^2}{\text{gradient}}$ **OR** $\left(\frac{2\pi}{\text{gradient}}\right)^2$<br>• Max and min value of $g$ calculated / uncertainties calculated | 6 | | | 6 | 2 | 6 |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | | | | **5-6 marks**<br>Comprehensive description of both the method and the analysis.<br>*There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.*<br>**3-4 marks**<br>Comprehensive description of either the method **or** the analysis **or** a limited description of both.<br>*There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.*<br>**1-2 marks**<br>Limited description of either the method or the analysis.<br>*There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.*<br>**0 marks**<br>No attempt made or no response worthy of credit. | | | | | | |
| | | | | **Question 5 total** | **8** | **4** | **4** | **16** | **9** | **10** |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **6** | (a) | | | It is the amount containing as many particles (e.g. molecules) as there are atoms in 12 g of carbon-12 | 1 | | | 1 | | |
| | (b) | (i) | | $pV = nRT = \frac{1}{3}Nm\overline{c^2}$ (1)<br>Convincing algebra e.g.<br>$\frac{1}{2}nRT = \frac{1}{2}\frac{1}{3}Nm\overline{c^2}$ leading to $\frac{3}{2}nRT = \frac{1}{2}Nm\overline{c^2}$ (1)<br>If $n = 1$ then $N = N_A$ and $\frac{3}{2}RT = N_A \times \frac{1}{2}m\overline{c^2}$ (1) | 3 | | | 3 | 2 | |
| | | (ii) | | $N_A\frac{1}{2}m\,\overline{c^2} = \frac{3RT}{2}$ and gradient = $\frac{3R}{N_A m}$ (1)<br>Correct gradient e.g. $\frac{1.4\ [\times 10^6]}{225}$ = 6 200 (1)<br>$m$ = 6.7 × 10$^{-27}$ [kg] so helium (1)<br>**Alternative 1:**<br>$N_A\frac{1}{2}m\,\overline{c^2} = \frac{3RT}{2}$ and manipulation to give $m = \frac{3RT}{N_A\,\overline{c^2}}$ (1)<br>Sub data point from line e.g. $m = \frac{3\times R\times 160}{N_A\times 1\times 10^6}$ (1)<br>$m$ = 6.6 × 10$^{-27}$ [kg] so helium (1)<br>**Alternative 2:**<br>$\frac{1}{2}m\,\overline{c^2} = \frac{3kT}{2}$ and manipulation to give $m = \frac{3kT}{\overline{c^2}}$ (1)<br>Sub data point from line e.g. $m = \frac{3\times k\times 160}{1\times 10^6}$ (1)<br>$m$ = 6.6 × 10$^{-27}$ [kg] so helium (1) | | | 3 | 3 | 3 | |
| | | | | **Question 6 total** | **4** | **0** | **3** | **7** | **5** | **0** |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **7** | (a) | | | $pV = \text{constant}$ or equivalent (1)<br>$pV$ = 30 or 30 000 at 2 points or equivalent (1)<br>Confirmed at a third point (1) | 1 | <br>1<br>1 | | <br><br>3 | <br><br>2 | |
| | (b) | (i) | | The sum of the kinetic energies of the particles [of the gas]<br>Treat as neutral reference to potential energy | 1 | | | 1 | | |
| | | (ii) | I | $U = \frac{3}{2}nRT = \frac{3}{2}pV$ (1)<br>$\frac{3}{2}pV$ at B = 45 **or** 45 000 [J] **and** $\frac{3}{2}pV$ at C = 108 **or** 108 000 [J] (1) | | 2 | | 2 | 1 | |
| | | | II | $U$ or $P$ or $T$ increases by [e.g. $\frac{108}{45}$] = 2.4 (1) **ecf** from (ii)(I)<br>$c_{\text{rms}}$ increases by a factor of $\sqrt{2.4}$ = 1.55 (1) | | 2 | | 2 | 2 | |
| | | (iii) | | **First bullet point:**<br>Molecules colliding with walls cause change in momentum of molecule [is away from wall], so molecule exerts a[n outward] force on the wall (1)<br>Forces act over an area leading to pressure (accept reference to $P = \frac{F}{A}$ ) (1)<br><br>**Second bullet point:**<br>[As $T$ increases], $c_{\text{rms}}$ increases leading to a greater change in momentum per collision (1)<br>[As $T$ increases], $c_{\text{rms}}$ increases leading to more collisions per second **OR** greater rate of change of momentum (1) | | 4 | | 4 | | |

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (c) | | | $\Delta U$ = 0 for complete cycle (1)<br>$\overrightarrow{[CA]}$ work on gas $>$ $\overrightarrow{[AB]}$ work by gas **OR** area $\overrightarrow{CA}$ $>$ area $\overrightarrow{AB}$ so work done on gas (1)<br>$Q = \Delta U + W$= 0 + (-$W$) so $Q$ must be negative / heat flows out of the system (1) | | 3 | | 3 | | |
| | | | | **Question 7 total** | **2** | **13** | **0** | **15** | **5** | **0** |

## SECTION B

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| **8** | (a) | (i) | 5 "loops" drawn  | 1 | | | 1 | | |
| | | (ii) | $\frac{\lambda_0}{5}$ or $0.2\lambda_0$ | | 1 | | 1 | 1 | |
| | (b) | | 2.9966 or 3.0 or 0.1% difference calculated (1)<br>Little difference or any reasonable comment (1) | | | 2 | 2 | | |
| | (c) | | $40 \times 0.00188$ seen (1)<br>0.0752% compared with 0.1% e.g. it's smaller than 0.1% as stated (1) | | | 2 | 2 | 1 | |
| | (d) | | $v$ or $c = f\lambda$ (or similar) stated or implied (1)<br>Air temperature increases (1)<br>(sound) speed increases (1)<br>Comment about $\lambda$ being constant or the expansion being negligible (1) | 1 | 1<br>1<br>1 | | 4 | | |
| | (e) | | Substitution into $c = a\sqrt{T}$ (1)<br>Speed at -10 °C = 325 [m s$^{-1}$] **OR**<br>speed at 30 °C = 349 [m s$^{-1}$] (1)<br>$\frac{440 \times 325}{349}$ or equivalent = 410 [Hz] (1)<br>**Alternative:**<br>$0.93 \times 440$ = 409 [Hz] or equivalent (2)<br>Incorporating a 0.3 Hz increase due to length **OR** stating that this is negligible / far smaller (1) | 1 | 1<br>1 | | 3 | 2 | |

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (f) | | Steel / string is magnetised by permanent magnet (1)<br>Vibrating string linked to varying $B$-field (1)<br>Flux in coil is varying (1)<br>Faraday stated or implied (1)<br>Amplified **and** sent to speakers (1) | 1 | 1<br>1<br>1<br><br>1 | | 5 | | |
| | (g) | | Strings won't be magnetised **OR** not [ferro]magnetic (1)<br>So no change in flux of coil **OR** no induced emf / current in coil (1) | | | 2 | 2 | | |
| | | | **Question 8 total** | **4** | **10** | **6** | **20** | **4** | **0** |

# A LEVEL COMPONENT 1: NEWTONIAN PHYSICS

## SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

| Question | AO1 | AO2 | AO3 | TOTAL MARK | MATHS | PRAC |
|---|---|---|---|---|---|---|
| **1** | 2 | 2 | 4 | 8 | 3 | 8 |
| **2** | 2 | 2 | 5 | 9 | 4 | 0 |
| **3** | 4 | 8 | 0 | 12 | 4 | 0 |
| **4** | 4 | 6 | 3 | 13 | 7 | 0 |
| **5** | 8 | 4 | 4 | 16 | 9 | 10 |
| **6** | 4 | 0 | 3 | 7 | 5 | 0 |
| **7** | 2 | 13 | 0 | 15 | 5 | 0 |
| **8** | 4 | 10 | 6 | 20 | 4 | 0 |
| **TOTALS** | **30** | **45** | **25** | **100** | **41** | **18** |