ASSESSMENT and QUALIFICATIONS ALLIANCE

# Mark scheme June 2002

# GCE

## Physics B

## Unit PHB6



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# Unit 6: Practical Exercises

**Notes for guidance**

Letters are used to distinguish between different types of marks in the scheme.

**M** indicates OBLIGATORY METHOD MARK
This is usually awarded for the physical principles involved, or for a particular point in the argument or definition. It is followed by one or more accuracy marks which cannot be scored unless the M mark has already been scored.

**C** indicates COMPENSATION METHOD MARK
This is awarded for the correct method or physical principle. In this case the method can be seen or implied by a correct answer or other correct subsequent steps. In this way an answer might score full marks even if *some* working has been omitted.

**A** indicates ACCURACY MARK
These marks are awarded for correct calculation or further detail. They follow an M mark or a C mark.

**B** indicates INDEPENDENT MARK
This is a mark which is independent of M and C marks.

Note: Where a correct answer only (c.a.o.) is required, this means that the answer must be as in the Marking Scheme, including significant figures and units.

Where an error carried forward (e.c.f.) is allowed by the Marking Scheme for an incorrect answer, e.c.f. must be written on the script if an error has been carried forward.

**Instructions to Examiners**

**1** Give due credit to alternative treatments which are correct. Give marks for what is correct; do not deduct marks because the attempt falls short of some ideal answer. Where marks are to be deducted for particular errors specific instructions are given in the marking scheme.

**2** Do not deduct marks for poor written communication. Refer the script to the Awardsmeeting if poor presentation forbids a proper assessment. In each paper candidates may be awarded up to two marks for the Quality of Written Communication in cases of required explanation or description. However, no candidate may be awarded more than the total mark for the paper. Use the following criteria to award marks:

2 marks: Candidates write with almost faultless accuracy (including grammar, spelling and appropriate punctuation); specialist terms are used confidently, accurately and with precision.

1 mark: Candidates write with reasonable and generally accurate expression (including grammar, spelling and appropriate punctuation); specialist terms are used with reasonable accuracy.

0 marks: Candidates who fail to reach the threshold for the award of one mark.

**3** An arithmetical error in an answer should be marked A.E. thus causing the candidate to lose one mark. The candidate's incorrect value should be carried through all subsequent calculations for the question and, if there are no subsequent errors, the candidate can score all remaining marks (indicated by ticks). These subsequent ticks should be marked C.E. (consequential error).

**4** With regard to incorrect use of significant figures, normally a penalty is imposed if the number of significant figures used by the candidate is one less, or two more, than the number of significant figures used in the data given in the question. Themaximum penalty for an error in significant figures is **one mark per paper**. When the penalty is imposed, indicate the error in the script by S.F. and, in addition, write S.F. opposite the mark for that question on the front cover of the paper to obviate imposing the penalty more than once per paper.

**5** No penalties should be imposed for incorrect or omitted units at intermediate stages in a calculation or which are contained in brackets in the marking scheme. Penalties for unit errors (incorrect or omitted units) are imposed only at the stage when the final answer to a calculation is considered. The maximum penalty is **one mark per question**.

**6** All other procedures, including the entering of marks, transferring marks to the front cover and referrals of scripts (other than those mentioned above) will be clarified at the standardising meeting of examiners.

## Exercise 1

| | | | |
|---|---|---|---|
| (a)(i) | record of $L$ in mm(500 ± 50) **and** scale reading for centre of the strip to nearest mm (condone 0) | B1 | **1** |
| (ii) | new scale reading for centre of the strip (any unit) | M1 | |
| | $d$ correct in mm with unit (ie subtracts scale readings) | A1 | |
| | repeat and average of loaded readings | B1 | **3** |
| (b)(i) | graph of log $d$ against log $L$ is a straight line if the relationship is correct | B1 | |
| | equation log $d$ = $n$ log $L$ + log $k$ stated clearly (condone ln) | B1 | |
| | $n$ is gradient of the graph<br>or $n$ can be determined from the gradient of the graph | B1 | |
| | log $k$ and/or $k$ obtainable from intercept or<br>using coordinates substitute in given or log equation<br>**NOT** $k$ is the intercept | B1 | **4** |
| (ii) | at least **four further** measurements for $L$ and $d$ | B2 | |
| | at least 5 with depressions ≥ 10 mm | B1 | |
| | repeat and averages for $d$ | B2 | |
| | record of loaded positions for each $L$ | B1 | |
| | repeat readings for $L$ | B1 | |
| | all readings for $L$ in mm | B1 | |
| | all readings of $d$ in mm (condone 1 dp in averages but must be consistent | B1 | |
| | all units in table correct ; allow even if $L$ in cm;<br>for log allow log($L$/mm) or log $L$ (where $L$ is in mm) or log($L$ in mm)<br>**not** log $L$/mm or log $L$ (mm) | B1 | |
| | logs in table determined correctly to 2/3 dp (i.e. 2/3 sf in the mantissa)<br>(allow ecf if $L$ is given in cm) (check one line –indicate c) | B1 | |
| | good tabulation of data for $d$, $L$ log$d$ and log $L$<br>no split tables; separate columns for observations if in the table; clear presentation with no ambiguous figures(condone one slip) | B1 | **12** |

| | | | | |
|---|---|---|---|---|
| (iii) | knife edges/sharper/thinner<br>to define ends or $L$ clearly | | use vernier callipers/trav microscope<br>to measure $d$ more accurately | M1<br>A1 |
| | use longer strip<br>produce greater range of $L$ or to increase $d$ | | use string to support the mass<br>to distribute load evenly or prevent twisting | M1<br>A1 |

**not:** use a pointer; mark position of centre; use of spirit level

| | | | |
|---|---|---|---|
| (c)(i) | labels shown log $d$ and log $L$ (ignore units here) or other correct alternative | B1 | |
| | suitable scale points occupying at least ½ the paper in each direction<br>scale not multiples of three | M1 | |
| | plotting accurate; At least 5 points plotted; check 2 randomly | A1 | |
| | best line through the points | B1 | |
| | care in presentation | B1 | **5** |
| (ii) | conclusion correct for data obtained<br>e.g. points lie close to straight line so relationship is supported<br>line of best fit is a straight line<br>a straight line fits closely<br>points suggest a curve so relationship is not supported | B1 | **1** |
| (iii) | large triangle **and** coordinates or sides read correctly | M1 | |
| | answer 3.0±0.5 (allow 2/3 sf) | A1 | **2** |
| (iv) | appropriate method to find $k$<br>read log $k$ from intercept; find antilog(condone error due to false origin)<br>substitute coordinates of a point in log $d$ = n log $L$ + log $k$<br>use coordinates of $d$ and $L$ substitute in $d = kL^n$<br>(may be from table for this mark) | M1 | |
| | correct manipulation of data (allow 2/3 sf but ignore unit)<br>(log $d$ and log $L$ or $d$ and $L$ must be determined from coordinates on the graph line or correct intercept must be used) | A1 | **2** |
| (d)(i) | higher Young modulus leads to lower depression | B1 | **1** |
| (ii) | Young modulus is measure of stiffness<br>or related to stretching of materials<br>or $E$ = *stress/strain* | C1 | |
| | higher Young modulus means it is harder to stretch<br>or will be stiffer<br>or high $E$ means strain smaller for a given stress (or vice versa) | A1 | |
| | lower part of strip is in tension<br>or top part is in compression | B1 | **3** |
| (iii) | substitutions in equation correct in mm(e.c.f.) | M1 | |
| | value fo $E$ to 2 or 3 sig figs with unit (Pa or N m$^{-2}$)<br>if $10^6$ used answer is $\frac{1520}{\text{their } k}$; if $10^{-6}$ used answer is $\frac{1.52\times10^{-9}}{\text{their } k}$ | A1 | **2** |
| (iv) | uncertainty = 3 × % uncertainty in $t$ + uncertainty in $b$ + uncertainty in 1.23<br>or uses highest values/lowest values (gives 28%) or vice versa (gives 21%)<br>Accept 23 – 25% provided method correct (condone sfs) | B1 | **1** |
| | | **Total** | **39** |

## Exercise 2

***Question 1*** ***(20 marks)***

| | | | |
|---|---|---|---|
| (a)(i) | record of displacement to nearest mm; 5–20 mm | B1 | **1** |
| (ii) | there is a current (or charge moving) in a magnetic field | C1 | |
| | field (or component of) is at right angles to the current | A1 | |
| | there will be a force on the wire | C1 | |
| | there is a force at right angles to both field and current (or mention force given by Fleming's LH rule) | A1 | |
| | there is a horizontal force | A1 | |
| | there is a moment (about the pivot) | B1 | |
| | **max 4 for explanation of the magnetic force** | | |
| | any reference to the weight of the trapeze being involved | B1 | |
| | any reference to there being a moment due to the weight | B1 | |
| | bar comes to rest when the moments cancel | B1 | |
| | ***NOT*** *forces cancel; friction in pivot; eddy currents; wire moving in magnetic field* | | |
| | **max 2 for explanation of moment** | **Max** | **6** |
| | **at least 3 marks for physics +** the use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar | **2** | |
| | **at least 2 marks for physics +** the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor | **1** | |
| | the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar | **0** | |
| | | **Max** | **2** |
| (iii) | A the strength of the magnetic field or magnetic flux density strength of magnet or distance between magnet and **W** | M1 | |
| | B the length of wire in the magnetic field/of **W**/ of horizontal wire | M1 | **2** |
| (iv) | A higher field strength increases the displacement | A1 | |
| | B length of wire in the magnetic field increases the displacement separation of magnet and **W** decrease displacement increases | A1 | **2** |
| (v) | battery unable to provide the required current for a long time or battery emf/voltage would fall or current causes battery to die or go flat or heat produced in battery/due to internal resistance/wire **NOT** wasting energy/electricity; stopping battery wear; copper magnetising; saving/draining the battery; current fluctuating | B1 | **1** |

| | | | |
|---|---|---|---|
| (b)(i) | values for current (1.1 to 1.3 A) and length of wire in the field (≈ 50 mm)<br>allow if seen in equation; condone length in mm or cm | M1 | |
| | force = (candidate's displacement) × 1.4 × $10^{-4}$ N | M1 | |
| | value for $B$ **unit essential** | A1 | **3** |
| (ii) | uncertainty in $L$ ±1 or ±2 mm | B1 | |
| | uncertainty in displacement = ±1 or 2 mm | B1 | |
| | uncertainty in $I$ ±0.1 or ±0.01 or ±0.05 A | B1 | |
| | | **Max** | **2** |
| (iii) | uncertainty in $B$ consistent with their (ii) | B1 | **1** |
| | e.g = ($F$)14% + $d$ (e.g. 10%) + ($I$)8% + (L)2 % = 34% | | |
| | Adds all their uncertainties(there must be at least 3 components) | | |
| | may use highest/lowest approach | | |

***Question 2*** ***(19 marks)***

| | | | |
|---|---|---|---|
| (a)(i) | ball compresses on impact | B1 | |
| | work is done in compressing the ball or block | B1 | |
| | the ball and/or block becomes warmer or gains internal energy | B1 | |
| | mention of one other energy transfer or cause of ke loss<br>e.g. ke of air particles (condone sound); air resistance | B1<br>**max** | **3** |
| (ii) | measurements of initial and final maximum displacements to nearest mm<br>must be explicit | B1 | |
| | calculates either (initial amplitude)$^2$ or (final amplitude)$^2$ | B1 | |
| | energy lost ∝ difference in amplitude$^2$ | M1 | |
| | percentage energy lost = $\frac{(A_I^2 - A_F^2)}{A_I^2} \times 100$ using candidate's values | A1 | **4** |
| | **OR (instead of last two marks)** | | |
| | percentage of energy left = $\frac{A_F^2}{A_I^2}$ x 100 | M1 | |
| | subtracts from 100 | A1 | |
| (b)(i) | at collision point all energy is kinetic energy | B1 | |
| | ½ $mv^2 \propto A^2$ (hence $v \propto A$) | B1 | |
| | or | | |
| | $v_{(max)} = 2\pi fA$ | B1 | **2** |
| | $f$ constant so (**max**)$v \propto A$ | B1 | |
| (ii) | measure initial displacement and final displacement<br>TO for irrelevant measurements: Period OK but not time to hit block<br>no use of sensors to measure $v$ | B1 | |
| | for at least 5 different initial displacements (allow if measuring $h$) | B1 | |
| | 30 cm ≥ initial displacements ≥10 cm | B1 | |
| | in 5 cm ≥ increments ≥ 2 cm | B1 | |
| | **2 max for range etc**<br>repeat and average for each displacement/measurement<br>or take care to avoid parallax errors (allow if measuring $h$) | B1 | |
| | plot final displacement against initial displacement which should be a straight line through the origin if hypothesis is correct<br>or determine ratios of displacements which should be the same<br>(allow if measuring $h$) (allow final $v$ against initial $v$ if method for $v$ correct.) | B1<br>**Max** | **5** |
| | **at least 3 marks for physics** + use of Physics is accurate, the answer is fluent/well argued with few errors in spelling, punctuation and grammar | 2 | |
| | **at least 1 mark for physics** + the use of Physics is accurate, but the answer lacks coherence or spelling, punctuation and grammar are poor | 1 | |
| | the use of Physics is inaccurate, the answer is disjointed, with significant errors in spelling, punctuation and grammar | 0<br>**Max** | **2** |

| | | | |
|---|---|---|---|
| (c) | ratio would be lower | B1 | |
| | more energy would be lost (on collision)or ratio higher since less energy loss | B1 | |
| | polystyrene: deforms due to collision or deforms plastically or is less elastic or contains lots of air pocket<br>**not** it is softer or due to damping | B1 | **3** |