Rewarding Learning

**ADVANCED**
**General Certificate of Education**
**2015**

# Physics

## Assessment Unit A2 3
Practical Techniques
Session 1

**[AY231]**

**WEDNESDAY 6 MAY, MORNING**

# MARK SCHEME

## Subject-specific Instructions

In numerical problems, the marks for the intermediate steps shown in the mark scheme are for the benefit of candidates who do not obtain the final correct answer. A correct answer and unit, if obtained from a valid starting-point, gets full credit, even if all the intermediate steps are not shown. It is not necessary to quote correct units for intermediate numerical quantities.

Note that this “correct answer” rule does not apply for formal proofs and derivations, which must be valid in all stages to obtain full credit.

**Do not reward wrong physics**. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, **in a physically incorrect equation**. However, answers to subsequent stages of questions that are consistent with an earlier incorrect numerical answer, and are based on physically correct equation, must gain full credit. Designate this by writing **ECF** (Error Carried Forward) by your text marks.

The normal penalty for an arithmetical and/or unit error is to lose the mark(s) for the answer/unit line. Substitution errors lose both the substitution and answer marks, but $10^n$ errors (e.g. writing 550 nm as $550 \times 10^{-6}$ m) count only as arithmetical slips and lose the answer mark.

## Section A

AVAILABLE MARKS

**1 (a)** 1 diameter measured to 0.01 mm average of 2+ diameters calculated [1]
diameter = 0.27 mm ± 0.01 mm [1] [2]

**(b) (i)** 5 increasing values recorded in column 2
between 15 Hz–50 Hz (25 Hz–65 Hz Session 2) [1]

**(ii)** 4 increasing values recorded in column 3 [1]

**(iii)** All averages calculated correctly in column 4 [1]
Reliable as values are similar (or converse) [1] [2]

**(iv)** Consistent logf values to 2 dp [1]

**(v)** –1.00, –0.70, –0.52, –0.40, –0.30
$10^n$ error – penalise once only [1]

**(c)** regular scaling, not from origin, using > half length [1]
correctly plotted points (± 1 small square rule) [1]
an appropriate best-fit line for the plotted points [1] [3]

**(d) (i)** Use of 'large' (virtual) triangle [1]
Correct subs into gradient equation [1]
Consistent evaluation from their subs [1] [3]

**(ii)** n = 2 [1]

(d)(i) and (ii): ignore units

**(iii)** $k = 3.0 \times 10^n$ ($1.3 \times 10^n$ Session 2) (diameter) [1]
$k = 3.0 \times 10^{-4}$ kg $s^2$ ($1.3 \times 10^{-4}$ Session 2) ecf [1] [2]

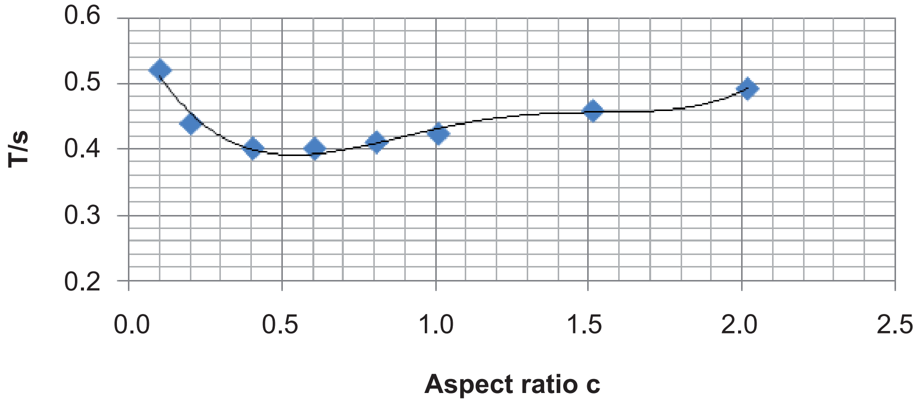
**(iv)** Using a point on the BFL [1]
subs values and their n into Equation 1.1 ecf* (point) [1]
($2.3 \times 10^{-4} < k < 3.3 \times 10^{-4}$
($2.0 \times 10^{-4} < k < 4.0 \times 10^{-4}$ Session 2)) [1] [3] 20
Consistent evaluation from their subs
S/E. C = log k → [1]/[3]

**2 (a) (i)** 6 values for L/mm (200, 100, 60, 40, 30, 20) ± 2 mm [1]
⩾ 8 oscillations timed for cards A, B (and C)
⩾2 N oscillations timed D, E and F [1]
Periods consistent with results + to 2 dp [1]
Periods decreasing then increasing [1]
Repeat N oscillations [1] [5]

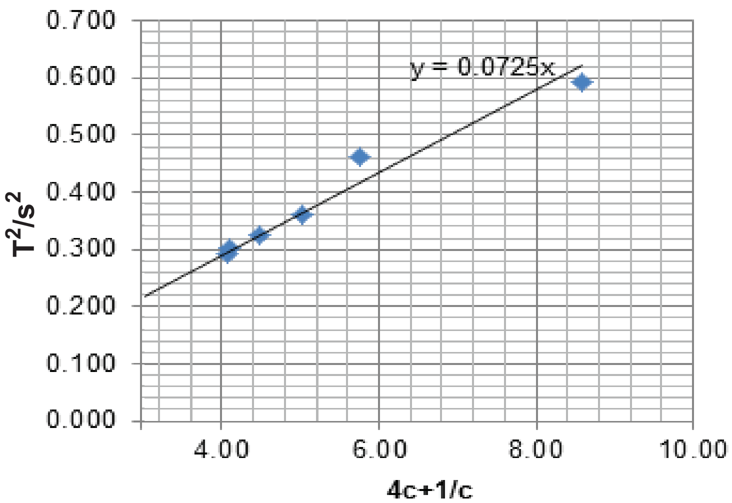
**(ii)** Sensible comment on reliability
Sensible comment on damping
Sensible comment on difficulty in counting oscillations for short lengths
Any other sensible comment
Any **two** [1] each [2]

**(iii)** Aspect Ratios correctly calculated [1]
expressed to 3 sf cards A + B
2 sf cards C, D, E, F [1] [2]

| | | | | |
|---|---|---|---|---|
| **(b)** | **(i)** | 6 correctly plotted points (± 1 small square rule)<br>good best-fit curve | [1]<br>[1] | [2] |




| | | | | |
|---|---|---|---|---|
| | **(ii)** | c = 0.5 between 0.4 and 0.6 consistent with graph | | [1] |
| **(c)** | **(i)** | A column headed $T^2/s^2$ | [1] | |
| | | A column headed $\left(4c+\frac{1}{c}\right)$ with no units | [1] | |
| | | Values calculated correctly | [1] | [3] |
| | **(ii)** | 5 or 6 points plotted correctly<br>Good best-fit line | [1]<br>[1] | [2] |




| | | | | |
|---|---|---|---|---|
| | **(iii)** | Determines gradient (5 cm rule)<br>Equates their gradient with $4\pi^2(0.017)/g$<br>Quality $8 < g < 12$ | [1]<br>[1]<br>[1] | [3] |

AVAILABLE MARKS: 20

## Section B

AVAILABLE MARKS

**3** **(a)** **(i)** Joule's Law of Heating is verified + linear graph [1]
Intercept is zero [1] [2]

**(ii)** The current flowing would be too large for the apparatus
**or**
The water temperature cannot exceed 100°C/may have started to boil [1]

**(b)** Water bath + heating coil [1]
Thermometer [1]
PSU [1]
Means of varying the supply [1]
Ammeter [1]
Stopwatch [1] [6]
Penalty for wrong circuit [–1]/including a Bunsen burner [–1]
No labels [–1]

**(c)** **(i)** The same mass of water is heated [1]
Each heating duration is the same [1]
The temperatures before and after heating are recorded [1]
(The same heating coil is used but) with different currents [1] [4]

**(ii)** Stir the water (to ensure an even temperature throughout) [1]
The final temperature is the maximum value reached and not that recorded when the heating time elapses [1] [2]
Accept reasonable alternatives, e.g. Insulation

**(d)** Measure the current flowing through the coil and the corresponding p.d. across it [1]
calculate R from $R = \frac{V}{I}$ [1]

**or**
Measure length and obtain value for resistivity and measure the diameter [1]
Calculate using R = ρl/A [1]

**or**
k = grad [1]
$R = \frac{k(mc + 41)}{t}$ [1] [2]

**(e)** Using k = 1.54 [1]
Subs into Eqn 3.2 [1]
t = 5 minutes (6 minutes Session 2) [1] [3] 20

**Total** **60**