Rewarding Learning

ADVANCED
General Certificate of Education
2017

Physics

Assessment Unit A2 3
Practical Techniques

Session 1

[AY231]

TUESDAY 9 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 550×10^{-6} m) count only as arithmetical slips and lose the answer mark.

In marking graphs you will have to exercise some professional judgement, but other features must be marked strictly according to the scheme. In labelling the axes, candidates should give the label/unit. The mark for “Scales” is normally awarded only if the plotted points occupy at least half of the printed graph along each axis. In addition, the scale must be to an easily manageable factor, such as 1:2, 1:4, 1:5, 1:10, 1:20. A factor of, for example 10 mm to represent 30 cm does not score because of the difficulty of accurately plotting or reading off values.

The credit for plotting the points is, following the normal tariff, 2 marks for plotting 5 points correctly and 1 mark for plotting 4. “Correctly” means to within ± one small square (± 2 mm) on the printed grid in either x- or y- direction. The marker’s professional judgement comes in here. One tick is to be awarded for drawing the best straight line through the points. Do not agonise over scoring (or not) this mark, your professional judgement will allow you to come to a decision very quickly.

In measuring the gradient, one mark is reserved for a “large triangle”. This means that either rise or run (or both) must be at least 5 cm on the printed graph/grid. Some candidates do not draw their triangle, but use points read off from the line. Provided the rise and/or run in this virtual triangle meet the 5 cm criterion, the mark is scored. Beware of candidates who read off their gradient points directly from a table. The marker must check that the points used actually **lie on the line** and meet the 5 cm test.

			AVAILABLE MARKS
1 **(a)** Five emergent ray positions indicated using X or ⊙ or ray drawn	[1]		
positions all refracting in the correct direction	[1]	[2]	
(b) Emergent rays path produced back to meet direction of incident ray		[1]	

(c)

i/°	30	40	50	60	75
D/°	42	37	35	40	46

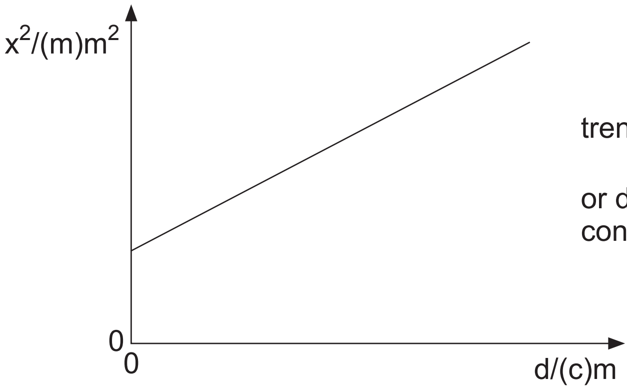
i angles measured to be as table ± 2°			
[–1] each mistake to zero	[2]		
As i increases, D decreases then increases	[1]		
5 D values	[1]		
All angles to whole number of degrees	[1]	[5]	
(d) **(i)** Axis labels and scales	[1]		
Plotting points [–1] each mistake to zero	[2]		
Best fit curve	[1]	[4]	
axis reversed [−1]. Allow 0 on horizontal, not vertical			
(ii) Minimum deviations consistent with graph			
no ecf from wrong curve		[1]	
(iii) Incident angle at minimum deviation consistent with their **(ii)**		[1]	
(e) **(i)** A = 60° (59–64°)		[1]	
(ii) Substitution of consistent values into $n = \dfrac{\sin\left(\dfrac{A + D_{min}}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$	[1]		
n = 1.5 ± 0.1	[1]	[2]	
(iii) Use of Dmin + 2	[1]		
consistent n value > their **(ii)**	[1]		
Subtraction to get absolute uncertainty	[1]	[3]	20
Use of max/min A values allowed			
If % unc used max [1]/[3] for calculating Δn from their %			

					AVAILABLE MARKS
2	**(a)**	I values approximately constant (ignore 1st)	[1]		
		V values decreasing with f increasing	[1]		
		F values 10, 20 and last value 85–90 Hz	[1]	[3]	
	(b)	5 consistent values to 2 or 3 s.f.			
		Penalty [–1] each mistake to zero		[2]	
	(c)	**(i)** Values:	[1]		
		to 2 d.p.	[1]	[2]	
		(ii) Heading: $\lg_{10}(X/\Omega)$	[1]		
		Values: consistent with table and to 2 d.p.	[1]	[2]	
		(iii) Scale	[1]		
		Points	[2]		
		Best fit line	[1]	[4]	
		x-axis should have non-zero start. Reversed axis [−1]			
	(d)	**(i)** Large triangle and points	[1]		
		Determines a gradient consistent with their values must be negative, must be to 2 sig. fig.	[1]	[2]	
		(ii) Subs (correctly) into y = mx + c	[1]		
		Determines a consistent intercept for their graph (x = 0)	[1]	[2]	
		(iii) lg x = n lg f + lg k – correct log equation	[1]		
		Equates anti-log value with $1/(2\pi C)$ (ecf from **(ii)**)	[1]		
		Quality 100–800 μF	[1]	[3]	20

AVAILABLE MARKS

3 (a) E = GPE or E = mgh } mgd sin θ [2] [1]
h = d sin θ [1]
m = mass of ball bearing and g = acceleration of free fall [1] [3]

(b) (i)



x^2 v d [1]
trend line [1] [2]

or d v x^2 [1]
consistent line [1]

Fig. 3.3

(ii) Sample results table

consistent with **(i)** [1] — at least 3 repeats [1] — [1]

x /mm	x^2 / mm^2	d_1 / cm	d_2 / cm	d_3 / cm	d_{mean} /cm

at least 5 values for x [1]

all units correct [1] [5]

(iii) mass of ball bearing/same ball bearing/same size [1]
angle of ramp [1]
friction/the ramp/surface [1] [3]
accept same spring/piston

(iv) A is the gradient (no ecf from wrong graph) [1]

(c) (i) d rule, x rule/calliper, m top pan balance, θ protractor [1]
Detail on identifying extension, e.g. piston movement [1]
Detail on identifying/measuring distance, e.g. mark stop point [1] [3]

(ii) Extreme fit graph [1]

$\%U_A = \frac{M_2 - M_1}{M_1} \times 100$ [1]

$\%U_k = \% U_m + \%U_A + \%U(\sin\theta)$ [1] [3] 20

accept θ

Total **60**