Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2014

Physics

Assessment Unit AS 1

assessing

Module 1: Forces, Energy and Electricity

[AY111]

WEDNESDAY 15 JANUARY, 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.

1 (a)

Quantity	SI base unit
mass	kilogram
length	metre
time	**second**
current	**amp(ere)**
temperature	kelvin
amount of substance	mole

[–1] for each mistake [2]

(b) Correct energy/work equation [1]
$kg\,m^2\,s^{-2}$ [1] [2]

(c) Magnitude **= 7.6 N** [1]
Direction **= 23.2°** to the horizontal if resultant correct [1] [2] 6

2 (a) (i) Ruler [1]

(ii) Distance AND corresponding time [1]
Vary distance [1] [2]

(iii) Plot length v time^2 [1] (Calculate g from $s = 0.5gt^2$ [1]; Repeat and average [1]) [2]

(b) Acceleration decreases to zero or velocity increases to a max [1]
Resultant force on freefaller decreases to zero [1] [2] 7

3 (a) Vertical component = 34 sin 49° **= 25.7 m s^{-1}** [1]
correct vector subs into $v = u + at$ [1]
time = 2.62 s [1] [3]

(b) Total flight time **= 5.24 s** e.c.f. **(a)** [1]
horizontal component **= 22.3 m s^{-1}** [1]
distance **= 117 m** [1] [3] 6

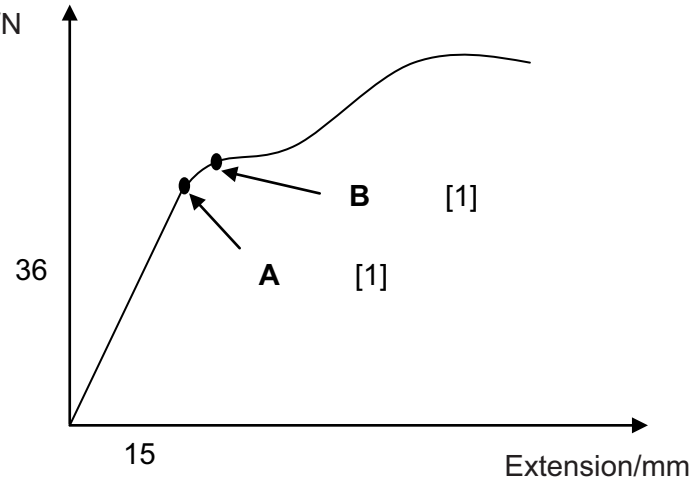
4 (a) Acceleration is proportional to (resultant) force [1]
and inversely proportional to mass [1] [2]
Penalty [–1] if direction of acceleration not referenced

(b) (i) Use of $v^2 = u^2 + 2as$ (KE = 142 560 J = W; W = Fd; $F = \frac{142\,560}{24} = 5940\,N$) [1]
retardation **= 6.75 m s^{-2}** [1]
braking force **= 5940 N** [1] [3]

(ii) New braking force **= 3560 N** e.c.f. **(i)** [1]
braking distance **= 40 m** [1]
(stopping distance **= 52 m**) Braking distance +12 [1] [3] 8

AVAILABLE MARKS

					AVAILABLE MARKS
5	**(i)**	Total force **= 10 800 N**	[1]		
	(ii)	Taking moments about P or Q → all forces referenced	[1]		
		Force on P **= 5960 N**	[1]		
		Force on Q **= 4840 N**	[1]	[3]	4
		[P + Q = total force: [1]]			
6	**(a)**	Energy can neither be created nor destroyed, but can be changed from one form to another	[1]		
	(b)	**(i)** $KE = 0.5mv^2$	Eqn or subs [1]		
		loss in KE **= 297 MJ**	[1]	[2]	
		(ii) $\Delta GPE = mg\Delta h$	Eqn or subs [1]		
		loss in PE **= 3220 MJ**	[1]	[2]	
		(iii) P = W/t e.c.f. **(i)** and **(ii)**	Eqn or subs [1]		
		power **= 3911 kW**	[1]	[2]	7
		Apply 10^n penalty once only			
7	**(a)**	Hooke's Law states that the extension (of a spiral spring) is (directly) proportional to the applied force,	[1]		
		provided the proportional limit is not exceeded	[1]	[2]	
	(b)	**(i)**			



[2]

	(ii)	Determining area of cross section:			
		$A = \pi d^2/4$ Eqn or subs; **or** value = $4.15 \times 10^n\ m^2$	[1]		
		Correct equation for the Young modulus;			
		$E = Fl/Ax = \sigma/\varepsilon$ where $\sigma = F/A$ and $\varepsilon = x/l$	[1]		
		Young modulus **= 1.16 × 10^{11} Pa**	[1]	[3]	7

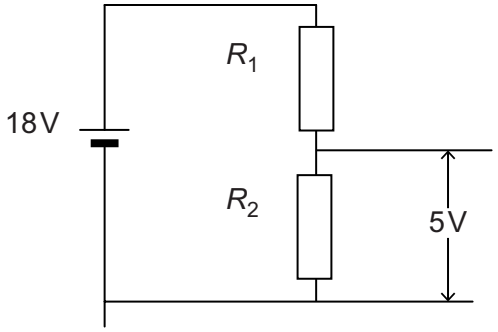
					AVAILABLE MARKS
8	**(a)**	The e.m.f. of a battery is *electrical* energy delivered	[1]		
		per unit charge (or equivalent)	[1]	[2]	
		(Allow e.m.f. = terminal p.d. when I = 0A for [1])			
	(b)	**(i)** Q = It; Eqn or subs	[1]		
		charge **= 28 200 C**	[1]	[2]	
		(ii) Potential difference = 12.6 – 11.2 × 0.027	[1]		
		= 12.3 V	[1]	[2]	
		(iii) P = VI e.c.f. **(ii)**	[1]		
		Power **= 138 W**	[1]	[2]	
		(iv) Power **= 55 W** e.c.f. **(iii)**		[1]	9
9	**(a)**	Identifies resistance (or voltage and current), length and diameter as required data	[1]		
		Diameter measured at different locations along the wire	[1]		
		One other sensible procedure, e.g. multiple values of resistance determined or length measured with the wire taut or change wire length and repeat readings	[1]	[3]	
	(b)	Identifies diameter	[1]		
		Reason: (d^2 means) $\%U_d$ is *doubled*	[1]	[2]	5
10	**(a)**	Positive intercept with negative gradient		[1]	
	(b)	As temperature rises the atoms vibrate more,	[1]		
		increased number of electron/metal ion collisions	[1]	[2]	
	(c)	As the resistance of the component rises the resistance of the thermistor falls,	[1]		
		preventing a *"current surge"* (when first switched on)	[1]	[2]	

Quality of written communication

2 marks
The candidate expresses ideas clearly and fluently, through well-linked sentences and paragraphs. Arguments are generally relevant and well structured. There are few errors of grammar, punctuation and spelling.

1 mark
The candidate expresses ideas clearly, if not always fluently. There are some errors in grammar, punctuation and spelling, but not such as to suggest weakness in these areas.

0 marks
The candidate expresses ideas satisfactorily, but without precision. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling are sufficiently intrusive to disrupt the understanding of the passage. [2] 7

						AVAILABLE MARKS
11	**(a)**	**(i)**	Current = 5.33/16.4 = 0.325 A	[1]		
			Lost volts = 6.52 – 5.33 = 1.19 V	[1]		
			Total internal resistance = 1.19/0.325 = 3.66 Ω	[1]		
			Average internal resistance per cell = 0.92 Ω	[1]	[4]	
		(ii)	V_1 higher since connecting wires have a small resistance		[1]	
	(b)	**(i)**	 **Fig. 11.2**			
			R_1 = 312 Ω		[1]	
		(ii)	1. Combined resistance = 96 Ω		[1]	
			2. V_o = 18 × 96/(96 + 312) e.c.f. **(i)**	Subs [1]		
			Voltage = 4.23 V	[1]	[2]	9
					Total	**75**