Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2015

Physics

Assessment Unit AS 1

assessing

Module 1: Forces, Energy and Electricity

[AY111]

THURSDAY 11 JUNE, 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.

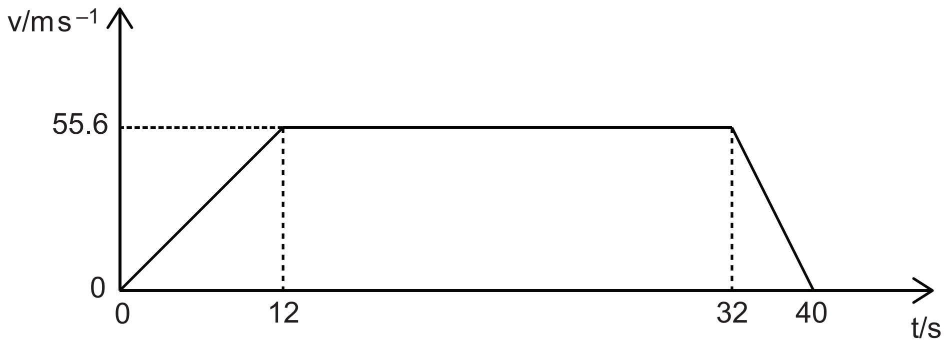
			AVAILABLE MARKS
1	**(a)**	Energy can neither be created or destroyed; it can only be converted from one form to another. [1]	
	(b)	Power is the rate at which work is done [1] **or** Power = (work done)/time	
	(c)	((In 1 second), energy converted from PE to electrical = 30×10^6 J) $\Delta PE = mgh = (6.0 \times 9.81 \times m_{water})$ [1] m_{water} moving per second = $(30 \times 10^6)/(6 \times 9.81)$ subs = 509 684 or value [1] = 510 000 kg (2 s.f.) [1] [3] sf mark is independent	5

AVAILABLE MARKS

2 **(a)** **(i)** $200\,\text{km}\,\text{h}^{-1} = \frac{200 \times 1000}{3600}$

$= 55.55\,\text{m}\,\text{s}^{-1}$ [1]

(ii)



Correct shape of graph	[1]	
Correct data on axes	[1]	[2]

(iii) Distance = area between graph and time axes [1]

$= \left(\frac{1}{2} \times 12 \times 55.6\right) + \left(20 \times 55.6\right) + \left(\frac{1}{2} \times 8 \times 55.6\right)$

$= 1668\,\text{m}$ [1] [2]

SE = 6000 m [1]/[2]

(b) **(i)** Acceleration is proportional to (resultant) force and inversely proportional to mass. [1]
Acceleration is in the same direction as force [1] [2]

or

Newton's 2nd Law states that the rate of change of momentum of an object is directly proportional to the applied force and [1]
takes place in the same direction in which this force acts. [1]

or

F = ma with terms defined [1]
F and a in same direction [1]

(ii) $F_{nett} = ma$

$8000 - [200 + (1480\,g\sin 12)] = 1480\,a$ subs [1]

$a = 3.23\,\text{m}\,\text{s}^{-2}$ [1] [2]

(iii) $\Delta s = [ut + \frac{1}{2}at^2]_{\text{sports car}} - [ut + \frac{1}{2}at^2]_{\text{heavy car}}$ eqn [1]

$180 = 0.2 \times 3.23 \times t^2$ or $180 = \frac{1}{2}(3.23 - 1.94)t^2$ subs [1]

$t = 16.7\,\text{s}$ [1] [3]

ecf for a from (b)(ii)

12

3 (a) Diagram of set-up and labels to show:
Clear indication of distance through which object falls (using a metre ruler).
Clear indication of how time for which object falls is measured.
2 x [$\frac{1}{2}$] round down [1]

Or if data logging method used:
Card length and light gate(s)

(b) Measure the distance through which the object falls, **s**, using a metre ruler [1]
(The correct distance must be marked on diagram or explained specifically)

Measure time, **t**, taken for ball to fall through distance **s** using an electronic timing system/light gates [1] [2]

Or if data logging method used:
Length of card using a metre rule/calipers [1]
Times determined using the electronics with detail in method [1]

Methods of measuring should be consistent with method used.

(c) Plot a graph of **s** (*y*-axis) against $\mathbf{t^2}$ (*x*-axis) [1]
g = 2 × gradient [1]
or
Plot a graph of **2s** (*y*-axis) against $\mathbf{t^2}$ (*x*-axis)
g = gradient
or
Plot a graph of **s** (*y*-axis) against $t^2/2$ (*x*-axis)
g = gradient
or
Calculate g for each set of data using $g = 2s/t^2$
Average g values

Or if data logging method used:
g obtained from $\frac{v - u}{t}$ [1]
Where u and v are average speeds and t the time between them [1] [2]

(d) Repeat experiment for each height. Find average time. [1]

Or if data logging method used:
Repeat (for consistency) and average.

AVAILABLE MARKS

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. Arguments may sometimes stray from the point. There are some errors in grammar, punctuation and spelling, but not such as to suggest a 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]

AVAILABLE MARKS: 8

AVAILABLE MARKS

4 **(a)** Parabolic [1]

(b) Horizontal component = $v\cos 37°$ (= $0.8v$)
Vertical component = $v\sin 37°$ (= $0.6v$) [1]

(c) **(i)** e.c.f. [6]
Range = horizontal velocity (ecf **(b)**) × time of flight
$8.31 = 9.21\cos 37° \times t$ [1]

$$t = \frac{8.31}{9.21\cos 37°}$$

$= 1.13\,s$ [1] [2]

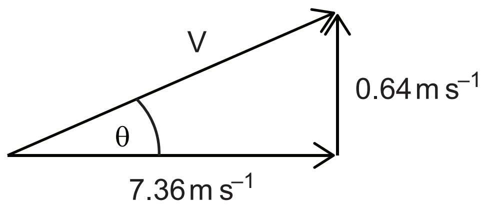
ecf from (b)
or use of time to reach max height × 2

(ii) Find vertical component of velocity v_v at $t = 0.50\,s$:
$v_v = u_v + a_v t = 9.21\sin 37 + (-9.81 \times 0.50) = 0.64\,m\,s^{-1}$ [1]

Find horizontal component of velocity v_h at $t = 0.50\,s$:
$v_h = u_h + a_h t = 9.21\cos 37 + 0 = 7.36\,m\,s^{-1}$
ecf (components) [1]

Find resultant velocity V and angle to horizontal:
$V = \sqrt{(0.64^2 + 7.36^2)} = 7.39\,m\,s^{-1}$ ecf* (components) [1]
$\theta = \tan^{-1}\left(\frac{0.64}{7.36}\right) = 4.97°$ above horizontal ecf* (components) [1] [4]
No credit for $\theta \geqslant 37°$

ecf from (b) 8



AVAILABLE MARKS

5 **(a)** 2 errors/omissions:
- when an object is in (rotational) **equilibrium** [1]
- about the same point [1] [2]

(b) **(i)** $(F_B \times 0.068) = (25 \times 0.19) + (1.5g \times 0.37)$
[1] [1] correct subs each side [2]
$F_B = 150$ N [1] [3]
Any moment calculation [1]/[3]

(ii) 1. $F_E = (F_B - 25 - 1.5g)$ **or** $F_E = (F_B - 25 - W)$ [1]
Accept correct principle of moments alternatives.

2. Use expression to calculate F_E
$F_E = [150 - 25 - (1.5 \times 9.81)]$
$F_E = 110.3$ N [1]

ecf from (b)(i) 7

6 (a) (i) The ratio of the stress (in the material) to the strain (of the material). [1]
or
$E = \sigma/\varepsilon$ if terms are correctly defined

(ii) (1Pa =) kg m^{-1} s^{-2} [1]

(b) (i) Tension in each wire = (41 g)/2 = 201 N [1]

(ii) $\varepsilon_{ni} = \sigma/E$
$= (7.05 \times 10^{7})/(1.70 \times 10^{11})$ eqn or subs [1]
$= 4.15 \times 10^{-4}$ ([–1] if a unit is given) [1] [2]

(iii) $x_{ni} = \varepsilon \times l$
$= (4.15 \times 10^{-4}) \times 5$ ecf **(ii)**
$= 2.08 \times 10^{-3}$ m = 2.08 mm [1]

(iv) Since the seat is horizontal, $\varepsilon_{cu} = \varepsilon_{ni}$
or $x_{cu} = x_{ni}$ = 2.08 mm [1]

$A_{cu} = \frac{Fl}{xE}$ (equation in this form) [1]

$= \frac{201 \times 5 \quad \text{ecf * (tension)}}{2.08 \times 10^{-3} \times 1.17 \times 10^{11}} = (4.13 \times 10^{-6})$

value or subs [1]

$d_{cu} = \left(\frac{4A}{\pi}\right)^{\frac{1}{2}}$ ecf* (area)

$= \left(\frac{4 \times 4.13 \times 10^{-6}}{\pi}\right)^{\frac{1}{2}}$

$= 2.29 \times 10^{-3}$ m = 2.29 mm [1] [4]

ecf from(b)(i) and (iii)

AVAILABLE MARKS

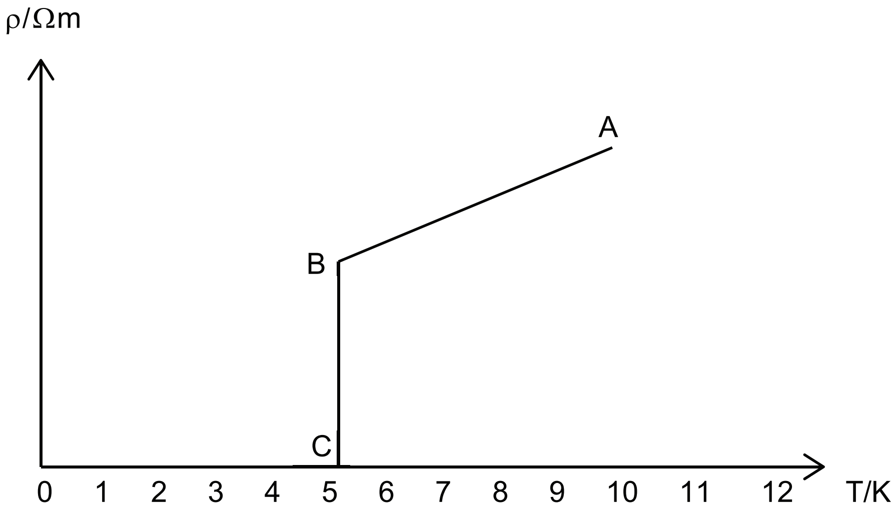
10

7 **(a)** The resistivity of a material is numerically equal to the resistance of a 1 metre sample of the material with (cross-sectional) area $1m^2$. [1]

AVAILABLE MARKS

(b) (Tungsten is a) conductor
(Tungsten has) more charge carriers
Charge carriers flow freely
} Any 2 of 3 [2]

(c) **(i)**



Section AB of graph [1]
Section BC of graph [1] [2]

(ii) Transition or Critical temperature [1]

(iii) Greater efficiency or
Reduced expense incurred in cooling [1] 7

	AVAILABLE MARKS

8 **(a)** The electromotive force of a source is the energy converted (from chemical) to electrical when unit charge passes (through it). [1]

(b) (i)

	emf > tpd	**emf = tpd**	**emf < tpd**
Switch Open		✓	
Switch Closed	✓		

both correct [1]

(ii) e.m.f. = intercept on *x*-axis = 1.80 V [1]

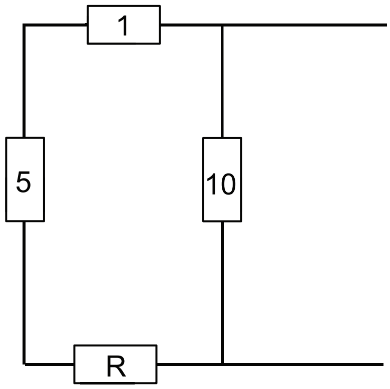
(iii) Calculate gradient using large triangle [1]
Internal resistance = –1 ÷ gradient
= $0.22\,\Omega \pm 0.02\,\Omega$ [1] [2]

Or

Use of E = Ir + V and correct substitution [1] to obtain 'r' [1] ecf **(ii)** 5

Negative resistance, penalty [–1]

				AVAILABLE MARKS
9 **(a)** Resistance of 6Ω and 2Ω in parallel = 1.5Ω	[1]			
Resistance of network of 4 resistors = $(12.5 - 6 - 1.5) = 5\Omega$	[1]			



Resistance of 1Ω, 5Ω and R in series = 10Ω	[1]		
Hence $R = (10 - 5 - 1) = 4\Omega$	[1]	[4]	
(b) Current drawn from battery = $\frac{15}{12.5}$ = 1.2 A	[1]		
Current = 0.9 A (through 2Ω resistor)	[1]		
Power dissipated in R = I^2R = 1.62 W	[1]	[3]	7
(ecf for I)			
10 **(a)** V_{out} in bright = $\frac{10 \times 15}{10 + 300}$ subs	[1]		
= 0.48 V	[1]	[2]	
(b) Voltage across 300Ω resistor = 9 V	[1]		
Thus resistance of LDR and motor combination = $200\ \Omega$	[1]		
$R_m = \left[\frac{1}{200} - \frac{1}{250}\right]^{-1}$ **or** $\left[\frac{1}{250} + \frac{1}{R_m} = \frac{1}{200}\right]$ ecf* subs	[1]		
$R_m = 1000\ \Omega$	[1]	[4]	6
Penalty [–1] for negative resistance			
		Total	**75**