Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2023

Physics

Assessment Unit AS 1

assessing

Forces, Energy and Electricity

[SPH11]

WEDNESDAY 17 MAY, MORNING

MARK SCHEME

Physics Subject Specific Instructions

It is essential that, before using the mark scheme, markers familiarise themselves with the following guidance.

General

To ensure that all candidates receive the same treatment, the mark scheme must be applied consistently.

The mark scheme for each question shows typical intermediate steps, the answer expected and the marks available for each part of the question.

In cases where a candidate has responded with a seemingly correct response which has not been anticipated in the mark scheme, the marker must make a professional judgement of the correct physics/validity of the response when awarding marks.

Brackets (...) are used to indicate information which is not essential for the mark to be awarded. Alternative answers are indicated by 'or', or the symbol for or, '/'.

Multiple/Cancelled Responses

If a candidate provides multiple responses, the general principle to be followed is that 'right + wrong = wrong'.

Responses considered to be neutral are not penalised. For example, if additional irrelevant information is given in an explanation that does not contradict the correct information given, the mark(s) can be awarded.

In a numerical problem if two different solutions are presented without a definitive answer on the answer line, credit should not be given. If an answer is given on the answer line, then the solution that has led to the answer given should be marked according to the mark scheme.

If a candidate clearly cancels their working by scoring it out, then this should not be marked. It is not the role of the marker to select from the candidate's response what should or should not be marked.

Marking Numerical Problems

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, if obtained from a valid starting point, gets full credit, even if all the intermediate steps are not shown.

This “correct answer” rule does not apply in situations where candidates have been asked to ‘show your working’ or ‘show that’. These answers must be valid in all stages to obtain full credit.

The answer to a ‘show that’ question should be quoted to one more significant figure than that given in the question.

Do not reward wrong physics. No credit is given for consistent substitution of numerical data, or subsequent arithmetic, in a physically incorrect equation.

The normal penalty for an arithmetical error is to lose the mark(s) for the answer/unit line. An arithmetic error should be penalised for one mark only. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value of a quantity given in a question.

10^n errors count as arithmetical slips and incur a penalty of one mark.

If a candidate rounds a value incorrectly this should be penalised one mark. However, care must be taken not to penalise a candidate for rounding correctly in parts leading up to their final answer in an unstructured numerical problem.

Answers should be given in decimal form. Fractional answers will not be credited with the answer mark.

Error Carried Forward

An ECF can occur between parts of a question or, in more unstructured numerical problems, within a part.

When an incorrect answer is carried forward from one question to the next, full credit should be awarded in the part where the incorrect answer is used, provided all the working is correct.

Within a part, ECF is applied where a candidate does an incorrect calculation, for example calculates a value for R incorrectly using V/I and then goes on to use their calculated value for R to calculate a resistivity value. The penalty is applied in the V/I calculation but then the value of R can be carried forward so that the remainder of the marks are available to the candidate provided all the remainder of their working is correct.

The ECF within a part will only apply in numerical problems where more than one calculation is required in a part.

Significant Figures

Candidates should show an awareness of using a sensible number of significant figures in their answers, based on the values given in the question. In SPH11, SPH21, APH11 and APH21, unless specifically asked for in the question, candidates will not be penalised for incorrect significant figures.

In SPH31, SPH32, APH31 and APH32, all answers should be given to a suitable number of significant figures and penalties will be applied in these papers unless otherwise stated in the mark schemes.

Units
In the majority of questions, the unit will be stated on the answer line.

When the unit is omitted, candidates will be clearly asked to state an appropriate unit and this will be credited in the mark scheme.

Where there is a final calculation required to get from the unit of the answer calculated to the unit on the answer line the required unit will be stated in the question. For example, if wavelength was calculated and the answer line was in nm a statement 'Give your answer in nanometres' would be included.

The unit on the answer line will generally be the SI unit but may in some cases be a more appropriate unit. For example, if values of mass in g and momentum in g cm s^{-1} were given, the unit on the answer line for speed could reasonably be cm s^{-1} without prompt.

					AVAILABLE MARKS
1	**(a)**	Base units – units from which all other units can be derived	[1]		
		Derived units – a combination of (two or more) base units	[1]	[2]	
	(b)	$F = 6\pi r\eta v$			
		$\eta = \dfrac{F}{6\pi rv}$ Rearranges	[1]		
		Base units of F: kg m s^{-2}	[1]		
		Base units of r and v: m & m s^{-1}	[1]		
		kg m^{-1} s^{-1} (First mark awarded if rearranges units instead of quantities)	[1]	[4]	
	(c) (i)	$\rho = \dfrac{m}{V}$ or $m = \rho \times V$	[1]		
		conversion to 3×10^{-3} m	[1]		
		$V = \dfrac{4}{3}\pi r^3 = \dfrac{4}{3} \times \pi(3 \times 10^{-3})^3 = 1.13 \times 10^{-7}$ m^3	[1]		
		$m = 7.85 \times 10^3 \times 1.13 \times 10^{-7} = 8.88 \times 10^{-4}$ kg	[1]	[4]	
	(ii)	Mass of iron in sphere = $0.52 \times 8.88 \times 10^{-4} = 4.62 \times 10^{-4}$kg	[1]		
		Number of atoms = $\dfrac{(6.02 \times 10^{23} \times 4.62 \times 10^{-4})}{0.056}$ subs	[1]		
		$= 4.96 \times 10^{21}$	[1]		
		S.E. If 52% not accounted for, number of atoms = 9.55×10^{21}	[2/3]	[3]	13

				AVAILABLE MARKS
2 **(a)** "provided no external forces act" or "closed system"		[1]		
(b) **(i)** $KE = \frac{1}{2}mv^2$	[1]			
$v^2 = \frac{(2 \times 281)}{2.5}$	[1]			
$v = 15.0 \text{ m s}^{-1}$	[1]	[3]		
(ii) $p = mv$ **or** $0 = (m_1 \times v_1) + (m_2 \times v_2)$	[1]			
$0 = (2.5 \times 15) + (1.7 \times v_2)$ Subs	[1]			
$v_2 = (–)\ 22.1 \text{ m s}^{-1}$	[1]	[3]		

(c)

	Momentum	Total energy	Kinetic energy
Elastic	✓	✓	✓
Inelastic	✓	✓	✗

[2] 9

[1] for each row correct

3 **(a)** The product of the force and (perpendicular) distance from the force to the point [1]

perpendicular [1] [2]

(b) N m [1]

(c) (∑) acwm = (∑) cwm (about point A) [1]

Fsin50 × AD = (0.9g × 15) + (8g × 45) ([1] each moment) [3]

$AD = \frac{25}{\tan 50}$ [1]

= 21 cm [1]

F = 228 N [1]

S.E. If omit sin(50), F = 174N [5/7] [7]

or

(∑) acwm = (∑) cwm (about point A)

F × perpendicular distance from A = (0.9g × 15) + (8g × 45)

Perpendicular distance from A = 25 × sin 40

= 16 cm

F = 228 N

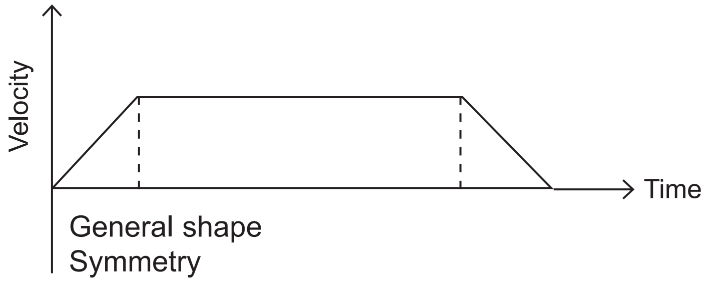
(d) Impulse or Ft = Δmomentum and is constant [1]

Bending knees increases time (for which force acts) [1]

This reduces force (through legs) [1] [3] 13

			AVAILABLE MARKS

4 (a)



General shape [1]
Symmetry [1] [2]

(b) $a = \frac{(v - u)}{t}$ [1]

$= \frac{(47.8 - 0)}{6.25}$ [1]

$= 7.65 \text{ m s}^{-2}$ [1] [3]

(c) Calculate distance travelled during acceleration

$s = \frac{1}{2}(u + v)\,t$ or $v^2 = u^2 + 2as$ or $s = ut + \frac{1}{2}at^2$ [1]

$= \frac{1}{2}(0 + 47.8) \times 6.25$ [1]

= 149 m [1]

149 × 2 [1]

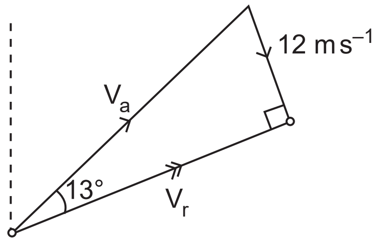
Distance travelled at maximum speed = (500 – 80 – 298) = 122 m [1]
S.E. If forget to multiply 149m by 2, distance = 271 m [4/5] [5]

(d) Time to travel 122 m = $\frac{s}{v} = \frac{122}{47.8}$ = 2.6 s [1]

Total time = (6.25 × 2) + (2.6) = 15.1 s [1] [2] 12
Ecf from **(c)**

					AVAILABLE MARKS
5	**(a)**	The acceleration of a body is proportional to the (resultant) force and inversely proportional to the mass	[1]		
		and occurs in the same direction as the (resultant) force	[1]		
		resultant force included	[1]	[3]	
		or			
		Rate of change of momentum is proportional to the (resultant) force and occurs in the same direction as the (resultant) force resultant force included			
	(b)	**(i)** $F_{(res)} = ma$	[1]		
		$650 - 9.81m = m \times 0.8$	[1]		
		61.3 kg (S.E. 72.1 kg gets [2]/[3])	[1]	[3]	
		(ii) $R - 9.81m = 0$	[1]		
		$R = 9.81 \times 61.3 = 601$ N ecf from **(b)(i)**	[1]	[2]	8
		S.E. If R = 650 N	[0/2]		

						AVAILABLE MARKS
6	**(a)**	**(i)**	Correctly drawn vectors with directions	[1]		
			Correctly labelled	[1]		
			Angle 13° correctly marked.	[1]	[3]	



	(ii)	$\sin 13 = \left(\frac{12}{V_a}\right)$	[1]		
		$V_a = 53.3\ m\ s^{-1}$	[1]	[2]	
	(iii)	$V_r^2 = (53.3^2 - 12^2)$	[1]		
		$V_r = 52.0\ m\ s^{-1}$	[1]	[2]	
		or			
		$\tan 13 = \left(\frac{12}{V_r}\right)$			
		$V_r = 52.0\ m\ s^{-1}$			
	(iv)	11.2 × 60 time conversion	[1]		
		d = 52.0 × 11.2 × 60	[1]		
		= 34944 m	[1]		
		conversion to km	[1]	[4]	
(b)		Direction	[1]		
		Correct curve	[1]	[2]	13

						AVAILABLE MARKS
7	**(a)**		$I = \frac{Q}{t}$	[1]		
			$= \frac{28.8}{60}$	[1]		
			= 0.48 A	[1]	[3]	
	(b)		E = I(R + r)			
			$6 = 0.48(10 + r_{tot})$	[1]		
			$r_{tot} = 2.49$	[1]		
			r = 0.83	[1]	[3]	6
8	**(a)**	**(i)**	$P = I^2R$	[1]		
			$I^2 = \left(\frac{3}{5.33}\right)$	[1]		
			I = 0.75	[1]	[3]	
		(ii)	$V_{bulb} = IR$ or V = P/I or $V^2 = P \times R$	[1]		
			= 0.75 × 5.33 = 3/0.75 = 3 × 5.33	[1]		
			= 4.0 = 4.0 = 15.99, V = 4.0	[1]		
			$V_{box} = (6 – 4) = 2$ V ecf from **(a)(i)**	[1]	[4]	
	(b)	**(i)**	Curve from origin	[1]		
			Decreasing gradient not to horizontal or below	[1]	[2]	
		(ii)	Resistance increases	[1]		
			(An increase in current causes) temperature to increase	[1]		
			(Positive lattice) ions vibrate with greater amplitude/vibrate more	[1]		
			Opposition to flow of electrons increases/number of collisions increases	[1]	[4]	
	(c)	**(i)**	Diode or LED		[1]	
		(ii)	Bulb off	[1]		
			Current in circuit zero (very small)	[1]	[2]	16

					AVAILABLE MARKS
9	**(a)**	**(i)** CSA decreases	[1]		
		length increases	[1]	[2]	
		(ii) $R = \frac{\rho L}{A}$	[1]		
		$A = 3.14 \times 10^{-10}$ m^2	[1]		
		subs $\frac{(6.5 \times 10^{-7})(6.0 \times 10^{-2})}{3.14 \times 10^{-10}}$	[1]		
		124 Ω	[1]	[4]	
	(b)	$4 = \frac{R \, x \, 12}{R + 100}$	[1]		
		R = 50 Ω	[1]		
		$\frac{1}{50} = \frac{1}{R_{SG}} + \frac{1}{78}$	[1]		
		RSG = 139 Ω	[1]	[4]	
		or			
		Current through resistor = $\frac{8}{100}$ = 0.08 A			
		Current through buzzer = $\frac{4}{78}$ = 0.05 A			
		Current through strain gauge = (0.08 – 0.05) = 0.03 A			
		RSG = $\frac{4}{0.03}$ = 139 Ω (133 Ω if use rounded values throughout)			10
				Total	**100**