



**ADVANCED SUBSIDIARY (AS)
General Certificate of Education**

Physics

Assessment Unit AS 1

assessing

Forces, Energy and Electricity

[SPH11]

Assessment

**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 of 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 answer line for speed could reasonably be cm s^{-1} without prompt.

			AVAILABLE MARKS	
1	(a)	Current through a conductor is (directly) proportional to voltage across provided temperature remains constant (or correct alternative)	[1] [1]	[2]
		(b) (i)	Three 40 Ω resistors in SERIES	[1]
	One 40 Ω resistors in SERIES with 2 in PARALLEL		[1]	
	One 40 Ω resistors in PARALLEL with 2 in SERIES		[1]	
	Three 40 Ω resistors in PARALLEL		[1]	[4]
	(ii)	1. Equation for resistors in series Max = 120 Ω	[1] [1]	[2]
		2. Equation for resistors in parallel Min = 13.3 Ω	[1] [1]	[2]
		(evidence of use of equation is acceptable for the first mark without a formal statement of the equation)		
				10
	2	(a)	Product of force and distance moved in the direction of the force	[1] [1]
(b) (i)			KE = $\frac{1}{2} m v^2$	[1]
		$= \frac{1}{2} \times 1.25 \times 10^7 \times (1.90 \times 10^4)^2$	} subs or value	[1]
		$= 2.256 \times 10^{15} \text{ J}$		
		$= 2260 \text{ TJ}$	[1]	[3]
(ii)		0.85 of KE	[1]	
		$F \times 60 \times 10^3 = (0.85) \times 2260 \times 10^{12}$	[1]	
		$F = 3.2 \times 10^{10} \text{ N}$	[1]	[3]
Allow ecf for KE value from (i) (use of 15% or 100% of original KE carried forward with correct method scores 2 out of 3)				
(iii)	$v = d/t$	[1]		
	$t = 88 \text{ s}$	[1]	[2]	
			10	

3 (a) Vector has direction (Scalar has no direction) [1]

(b) $\left[\frac{1}{2}\right]$ each round down

Physical Quantity	Scalar (✓)
Force	
Mass	✓
Acceleration	
Time	✓
Temperature	✓
Distance	✓

[2]

(c) KE is a scalar [1]
Velocity is squared [1] [2]

(d) F Vertical: $W + F_A \sin(25)$ [1]
F Horizontal: $F_A \cos(25)$ [1]
correct equation combining F Vertical and F Horizontal [1]
F resultant = 38 000N [1]
Angle 82° [1] [5]

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4 (a) (i) Parabola/Parabolic (curve) [1]

(ii) Uniform velocity/no acceleration in one direction [1]
Constant acceleration in the perpendicular direction [1] [2]
(or equivalent wording)

(b) Horizontal line labelled H [1]
Line V starting from same place [1]
Line V decreasing [1]
Line V straight [1] [4]

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5 (a) Rate of change of momentum is (directly) proportional or equal to (resultant) force [1]
Resultant included [1]
And in the same direction [1] [3]

(b) (i) $\frac{8\,568\,000}{60 \times 60}$ [1]
[1] [2]

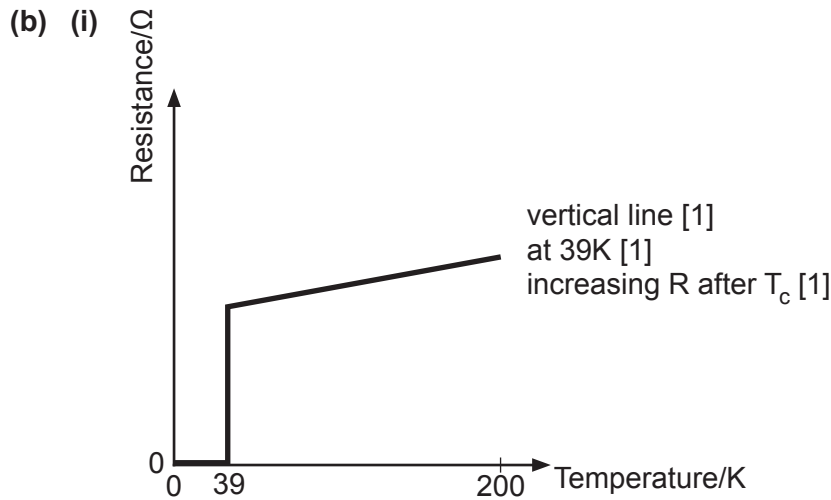
(ii) $a = (v - u)/t = 2400/150$ or $2380/150 = 16 \text{ m s}^{-2}$
equation/subs/value [1]
 $RF = ma = 2.77 \times 10^6 \times 16 = 4.43 \times 10^7 \text{ N}$
equation/subs/value [1]
 $W = m \times g = 2.77 \times 10^6 \times 9.81 = 2.72 \times 10^7 \text{ N}$
equation/subs/value [1]
Thrust = $RF + W = 7.15 \times 10^7 \text{ N}$ (or 7.11×10^7 using 2380) [1] [4]
(allow ecf within part)

(iii) Thrust = 12% of Max Thrust [1]
Max Thrust = $5.96 \times 10^8 \text{ N}$ [1] [2]
(ecf from (ii))

AVAILABLE MARKS

- (iv) Both mass and weight would decrease [1]
 Fuel will be burnt [1]
 gravity would decrease therefore less weight [1] [3]

- 6 (a) Resistance is zero when [1]
 at/below critical temp/transition temp [1] [2]



[3]

- (ii) $Q = I \times t = 20\,000 \times 2 = 40\,000\text{ C}$ equation/subs/value [1]
 $n = 40\,000 / 1.6 \times 10^{-19} = 2.5 \times 10^{23}$ [1] [2]
 (allow ecf within part)

- (iii) $(2.5 \times 10^{23} / 6.02 \times 10^{23}) \times 100$ [1]
 $= 42\%$ [1] [2]
 Ecf from (ii)

- (iv) $P = I^2 R$ [1]
 $= (15 \times 10^3)^2 \times 1.5 \times 10^{-6}$ [1]
 $E = P \times t$ [1]
 $= 2.0 \times 10^4\text{ J}$ [1] [4]

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- 7 (a) Product of force and perpendicular distance [1]
 from point to (line of action of) force [1] [2]

- (b) (i) Moment due to lorry $(3500 \times 9.81 \times 2) = 68\,670\text{ Nm}$ [1]
 sub or value [1]
 Moment due to weight of arm $(400 \times 9.81 \times 3) = 11\,772\text{ Nm}$ [1]
 sub or value [1]
 Moment due to bricks = 56 898 Nm [1]
 $CM = ACM$ or $W \times 8 = 56\,898$ [1]
 Weight 7112 N [1]
 Mass = 725 kg [1] [6]
 (allow ecf within part)

- (ii) Increases distance of weight of lorry from pivot [1]
 Increasing the clockwise moment [1]
 Decreases the dist of weight of bricks from pivot (less ACM) [1]
 Decreases the distance to c.o.g. of crane (less ACM) [1]
 moment due to weight of crane [1] [3]

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AVAILABLE
 MARKS

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			AVAILABLE MARKS		
8	(a) (i)	Ammeter in series	[1]	[2]	14
		Voltmeter in parallel with wire (penalty [-1] if not a working circuit)	[1]		
	(ii)	Diameter of wire	[1]	[2]	
		micrometer screw gauge	[1]		
	(b) (i)	$A = (\pi d^2)/4$	[1]	[6]	
		$R = \rho L/A$	[1]		
		correct subs into $R = \rho L/A$	[1]		
		$A = 6.125 \times 10^{-8}$	[1]		
		$d = 2.79 \times 10^{-4} \text{ m}$	[1]		
		0.28 mm (allow ecf within part)	[1]		
(ii)	Resistivity $49.0 \times 10^{-8} \Omega \text{ m}$	[1]	[4]		
	Resistance doubles due to length	[1]			
	Resistance quarters due to CSA	[1]			
	Resistance = 6 Ω	[1]			
9	(a)	In a system of colliding objects	[1]	[2]	11
		the total momentum before = total momentum after provided no external forces act/in an isolated system (or correct alternative)	[1]		
	(b) (i)	0.03 or 3040	[1]	[2]	
		kg m s^{-1} or Ns or g cm s^{-1} , unit consistent with value	[1]		
		(ii) Before	[1]		
	(ii)	$P_T = (125 \times 16) + (95 \times -32)$	[1]	[4]	
		After	[1]		
		$P_T = (125 \times -14) + (95 \times v)$	[1]		
		$v = 7.5 \text{ cm s}^{-1}$	[1]		
		right	[1]		
(iii)	Inelastic	[1]	[3]		
	Ke not conserved	[1]			
	Total KE before = $6.46 \times 10^{-3} \text{ J}$	[1]			
	Total KE after = $1.49 \times 10^{-3} \text{ J}$	[1]			
Total				100	