National
Qualifications
2023

2023 Physics

Higher Paper 1 — Multiple choice

Finalised Marking Instructions

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Marking Instructions for each question

Question	Answer	Mark
1.	A	**1**
2.	B	**1**
3.	B	**1**
4.	A	**1**
5.	D	**1**
6.	A	**1**
7.	D	**1**
8.	D	**1**
9.	E	**1**
10.	B	**1**
11.	C	**1**
12.	D	**1**
13.	E	**1**
14.	C	**1**
15.	D	**1**
16.	E	**1**
17.	A	**1**
18.	E	**1**
19.	E	**1**
20.	C	**1**
21.	E	**1**
22.	B	**1**
23.	C	**1**
24.	E	**1**
25.	A	**1**

[END OF MARKING INSTRUCTIONS]

National
Qualifications
2023

2023 Physics

Higher Paper 2

Finalised Marking Instructions

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Marking instructions for each question

Question			Expected response	Max mark	Additional guidance
1.	(a)		$v^2 = u^2 + 2as$ **(1)** $0^2 = (13.4)^2 + 2 \times -2.85 \times s$ **(1)** $s = 31.5$ m **(1)**	**3**	Accept: 32, 31.50, 31.502 u and a must have opposite signs. Alternative methods: Both relationships **(1)** Both substitutions **(1)** Final answer **(1)**
	(b)		$v = u + at$ (1) $0 = 13.4 + (-2.85t)$ (1) $t = 4.70$ s (1)	**3**	Or consistent with (a) Accept: 4.7, 4.702, 4.7018 u and a must have opposite signs. Alternative methods eg $s = \frac{1}{2}(u + v)t$ **(1)** $31.5 = \frac{1}{2}(13.4 + 0)t$ **(1)** $t = 4.70$ s **(1)** For this method accept: 4.7, 4.701, 4.7015
	(c)		Straight line with negative gradient **(1)** Axes values **(1)**	**2**	Must be consistent with (b) Second mark conditional on first mark

Question			Expected response	Max mark	Additional guidance
2.	(a)		$F = ma$ **(1)** $125 - (15 + 45) = (28 + 85) \times a$ **(1)** $a = 0.58 \text{ m s}^{-2}$	**2**	**SHOW** Must show how both total mass and unbalanced force are arrived at.
	(b)		$F = ma$ **(1)** $F = 28 \times 0.58$ **(1)** $(F = Tension + Friction)$ $28 \times 0.58 = Tension + (-15)$ **(1)** $Tension = 31 \text{ N}$ **(1)**	**4**	Accept: 30, 31.2, 31.24 $T = ma$ **on its own** – 0 marks.
	(c)		(Tension) increases **(1)** (Friction increases but) unbalanced/ resultant force remains the same. **(1)**	**2**	**JUSTIFY** Must be clear it is the unbalanced force that remains constant. Accept: 'F' for unbalanced force Can be justified by calculation.

Question			Expected response	Max mark	Additional guidance
3.	(a)		$m_x u_x + m_y u_y = m_x v_x + m_y v_y$ **(1)** $(760 \times 12.0) + (840 \times 4.0)$ $= (760 \times v_x) + (840 \times 8.5)$ **(1)** $v_x = 7.0 \text{ m s}^{-1}$ **(1)**	**3**	Accept: 7, 7.03, 7.026 Equating the <u>total</u> momenta before and after **(1)** All substitutions **(1)** Final answer **(1)** If a direction is stated it must be to the right otherwise MAX 2 marks.
	(b)		$E_k = \frac{1}{2}mv^2$ *Before* $E_k = \frac{1}{2}m_x u_x^2 + \frac{1}{2}m_y u_y^2$ $E_k = (\frac{1}{2} \times 760 \times 12.0^2) + (\frac{1}{2} \times 840 \times 4.0^2)$ $E_k = 61440$ (J) *After* $E_k = \frac{1}{2}m_x v_x^2 + \frac{1}{2}m_y v_y^2$ $E_k = (\frac{1}{2} \times 760 \times 7.0^2) + (\frac{1}{2} \times 840 \times 8.5^2)$ $E_k = 48\,965$ (J) (Total) E_k before is greater than (total) E_k after, (the collision is inelastic).	**4**	Or consistent with (a) 1 mark for relationship 1 mark for **<u>all</u>** substitutions 1 mark for **<u>both</u>** total kinetic energies 1 mark for correct final statement Suspend significant figure rule for calculated values of total kinetic energies in this question. <u>Kinetic</u> energy is lost.(Therefore inelastic.) E_k before ≠ E_k after is insufficient.
	(c)		$Ft = mv - mu$ **(1)** $F \times 0.82 = (840 \times 8.5) - (840 \times 4.0)$ **(1)** $F = 4.6 \times 10^3$ N **(1)**	**3**	Accept: 5, 4.61, 4.610 Accept: Impulse = $mv - mu$ u and v must be substituted correctly If the force that car Y exerts on car X is calculated, then there must be a statement that the forces have equal magnitude for final mark, otherwise MAX 2 marks. For this method – Accept: 5, 4.63, 4.634 (when v = 7.0) Or consistent with (a)
	(d)		(During a collision the tyre wall will) increase the time of contact (between the car and the wall). **(1)** (this will) reduce the (magnitude of the) force (experienced by the driver). **(1)**	**2**	**INDEPENDENT MARKS** Accept: time/duration of collision Accept: 'rate of change in momentum' for force.

Question			Expected response	Max mark	Additional guidance
4.	(a)		$0.5\ \text{m s}^{-1}$	**1**	Ignore minus sign if given in final answer.
	(b)		$1.8\ \text{m s}^{-1}$	**1**	Ignore minus sign if given in final answer.
	(c)	(i)	$3.00 \times 10^8\ \text{m s}^{-1}$ or c **(1)** Speed of light is the same for all observers **(1)**	**2**	**JUSTIFY** Accept: $3 \times 10^8\ \text{m s}^{-1}$ If the numerical value for speed is given, then unit is required, otherwise 0 marks. Accept: Speed of light is the same in all (inertial) frames of reference or equivalent.
		(ii)	$l' = l\sqrt{1-\left(\frac{v}{c}\right)^2}$ **(1)** $l' = 142\sqrt{1-\left(\frac{0.9c}{c}\right)^2}$ **(1)** $l' = 61.9\ \text{m}$ **(1)**	**3**	Accept: 62, 61.90, 61.896 Accept: $l' = 142\sqrt{1-(0.9)^2}$

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	$f_o = f_s\left(\frac{v}{v \pm v_s}\right)$ **(1)** $f_o = 440\left(\frac{340}{340-31}\right)$ **(1)** $f_o = 480$ Hz **(1)**	**3**	Accept: 500, 484, 484.1 Accept: $f_o = f_s\left(\frac{v}{v - v_s}\right)$
		(ii)	Less than **(1)** Statement that there are fewer wavefronts per second. **OR** The wavefronts are further apart **OR** The wavelength increases **OR** diagram showing wavefronts closer together ahead of the car and further apart behind it. **(1)** or any similar response	**2**	**MUST JUSTIFY** Accept: "It is less than" Do not accept: "Sound is less than" on its own. Accept: Waves or wave crests in place of wavefronts. Can be justified by calculation. Significant figure rule suspended for this calculation. Can be justified by explaining the use of the '+' version of the relationship. In a diagram, there must be an implication of direction of travel. Do not accept: Any answer that implies that the frequency/wavelength of the sound produced by the siren itself is changing.
	(b)	(i)	T = 0.5 s	**1**	

Question			Expected response	Max mark	Additional guidance
5.	(b)	(ii)	When the red LEDs are forward biased the blue LEDs are reverse biased (or vice versa). **(1)** LEDs (only) light when forward biased **(1)**	**2**	**INDEPENDENT MARKS** Accept: The red and blue LEDs are connected the opposite way round. LEDs will (only) conduct in one direction **OR** Red LEDs conduct during one half of the cycle the blue LEDs conduct during the other half of the cycle. Do not accept: 'different direction' alone.
	(b)	(iii) (A)	$v = f\lambda$ $3.00\times10^{8} = f\times625\times10^{-9}$ **(1)** $E = hf$ both relationships anywhere **(1)** $E = 6.63\times10^{-34}\times\left(\frac{3.00\times10^{8}}{625\times10^{-9}}\right)$ **(1)** $E = 3.18\times10^{-19}$ J **(1)**	**4**	Accept 3.2, 3.182, 3.1824 1 mark for **both** relationships 1 mark for **each** substitution 1 mark for final answer Alternative method: $E = \frac{hc}{\lambda}$ **(1)** $E = 6.63\times10^{-34}\times\left(\frac{3.00\times10^{8}}{625\times10^{-9}}\right)$ **(1),(1)** $E = 3.18\times10^{-19}$ J **(1)** Do not accept: $E_2 - E_1 = hf$
		(iii) (B)	The (energy) band gap in a blue LED is greater. **(1)** The <u>photons</u> of blue light have more energy (than the photons of red light). **(1)**	**2**	Accept: Converse arguments. If no mention of band gap, 0 marks. Accept: The <u>photons</u> of blue light have a higher frequency (than the photons of red light). **OR** The <u>photons</u> of blue light have a smaller wavelength (than the photons of red light).

Question			Expected response	Max mark	Additional guidance
6.			**Award 3 marks** where the candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 2 marks** where the candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. **Award 1 mark** where the candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem. **Award 0 marks** where the candidate has not demonstrated an understanding of the physics involved. There is no evidence that they have recognised the area of physics involved, or they have not given any statement of a relevant physics principle. Award this mark also if the candidate merely restates the physics given in the question.	**3**	Candidates may use a variety of physics arguments to answer this question. Award marks based on candidates demonstrating overall good, reasonable, limited, or no understanding.

Question			Expected response	Max mark	Additional guidance
7.	(a)	(i) (A)	(P =) 53	**1**	
		(i) (B)	Iodine	**1**	Or consistent with (a)(i)(A) Accept: I
		(ii) (A)	Lepton(s)	**1**	
		(ii) (B)	Weak (nuclear force)	**1**	
	(b)	(i)	$W = QV$ **(1)** $W = 1.60\times10^{-19}\times32.0\times10^{3}$ **(1)** $E_k = \frac{1}{2}mv^2$ **(1)** $1.60\times10^{-19}\times32.0\times10^{3} = 0.5\times1.673\times10^{-27}\times v^2$ **(1)** $v = 2.47\times10^{6}$ m s^{-1} **(1)**	**5**	Accept: 2.5, 2.474, 2.4740 $W = QV$ anywhere $E_k = \frac{1}{2}mv^2$ anywhere
		(ii)	To ensure the electric field is always in the correct direction. OR To ensure the force acting on a proton is always in the correct direction (as it crosses the gap).	**1**	To ensure the protons accelerate in the correct direction. Do not accept: same direction
	(c)		Up the page	**1**	Accept: up/upwards/towards top of the page Arrow drawn pointing up the page is acceptable. If upwards arrow is drawn on the original diagram, it must be on the right-hand edge. The path of the particle on its own is not acceptable.

Question			Expected response	Max mark	Additional guidance
8.	(a)		Apparatus **(1)** Method used to collect data **(1)**	**2**	Any mention of laser - 0 marks. **INDEPENDENT MARKS** Must have either name or a labelled diagram of <u>all</u> <u>measuring</u> instruments. Do not accept: light sensor on its own for instrument to measure irradiance. Ignore any mention of analysis of data.
	(b)	(i)	The power per unit area (incident on a surface)	**1**	Accept: power per square metre/power per metre squared/(m^2) Do not accept: watts per square metre

Question			Expected response	Max mark	Additional guidance
8.	(b)	(ii)	$142 \times 0.200^2 = 5.68$ $63.1 \times 0.300^2 = 5.68$ $35.5 \times 0.400^2 = 5.68$ $22.7 \times 0.500^2 = 5.68$ $15.8 \times 0.600^2 = 5.69$ **(2)** statement of $I \times d^2 = \text{constant}$ **OR** $I \propto \frac{1}{d^2}$ **(1)**	**3**	If only 4 sets of data used correctly then maximum 2 marks. If only 3 sets of data used correctly then maximum 1 mark (for relationship). If only 1 or 2 sets of data used correctly, award 0 marks. Must be clear how the candidate has used the data to obtain the relationship. Accept: $I \times d^2 = 5.68$ Ignore inappropriate averaging in this case. The 'statement' mark is only available if consistent with the calculations shown. $I_1 d_1^2 = I_2 d_2^2$ is insufficient on its own for statement of relationship. $I \times d^2 = k$ is insufficient on its own for statement of relationship. Graphical method: Graph drawn correctly (1) Line of best fit through origin (1) Statement of relationship. (1) A sketch graph is not acceptable.
	(c)		Area increases **(1)** Power remains the same **(1)**	**2**	'light spreads out' is insufficient for 'area increases' Accept alternative explanation, provided the candidate refers to irradiance on light detector: Area remains the same (1) (Incident) power decreases (1)

Question			Expected response	Max mark	Additional guidance
9.			**Award 3 marks** where the candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks. **Award 2 marks** where the candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem. **Award 1 mark** where the candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem. **Award 0 marks** where the candidate has not demonstrated an understanding of the physics involved. There is no evidence that they have recognised the area of physics involved, or they have not given any statement of a relevant physics principle. Award this mark also if the candidate merely restates the physics given in the question.	**3**	Candidates may use a variety of physics arguments to answer this question. Award marks based on candidates demonstrating overall good, reasonable, limited, or no understanding.

Question			Expected response	Max mark	Additional guidance
10.	(a)		A (central) positively charged nucleus. **OR** When an electron moves from one state to another, the energy lost or gained is done so ONLY in very specific amounts of energy. **OR** Each line in a spectrum is produced when an electron moves from one energy level/orbit/shell to another.	**1**	Do not accept: Atom is mainly empty space. Nucleus is small compared to size of atom. Any statement referring to photons and photon frequency is a consequence, not a feature.
	(b)	(i)	If an electron is in an excited state it can return to a lower energy level. When it does this, it emits a photon. **(1)** Different transitions produce different lines/ frequencies (of photons). **(1)**	**2**	Accept: When an electron drops down a level it releases energy. If absorption described - 0 marks.
		(ii)	(For the brighter lines) more electrons are making those transitions (per second). **(1)** (Therefore), there are more <u>photons</u> (per second) emitted (of that specific energy and so produce brighter lines). **(1)**	**2**	**INDEPENDENT MARKS** Do not accept: greater brightness due to greater frequency/energy of the photons. 'More electrons release more photons' on its own – MAX 1 mark
	(c)	(i)	10	**1**	
		(ii)	$E_2 - E_1 = hf$ **(1)** $-0.871\times10^{-19} - (-5.45\times10^{-19}) = 6.63\times10^{-34} \times f$ **(1)** $f = 6.91\times10^{14}$ Hz **(1)**	**3**	Accept: 6.9, 6.906, 6.9065 Accept: $(\Delta)E=hf$ **OR** $E_4 - E_1 = hf$ Note: $\Delta E = 4.579\times10^{-19}$ (J) Accept: $5.45\times10^{-19} - 0.871\times10^{-19} = 6.63\times10^{-34} \times f$ for energy substitution mark If $0.871\times10^{-19} - 5.45\times10^{-19}$ is shown for ΔE, maximum (**1 mark)** for **relationship**.
		(ii) (B)	486 nm **(1)**	**1**	Accept: 4.86×10^{-7} m

Question			Expected response	Max mark	Additional guidance
10.	(c)	(ii) (C)		**5**	Or consistent with (c)(ii)(B) Accept: 4.9, 4.933, 4.9332
			$z = \frac{v}{c}$ **(1)**		$z = \frac{v}{c}$ anywhere, 1 mark
			$z = \frac{4.52 \times 10^6}{3.00 \times 10^8}$ **(1)**		
			$z = \frac{\lambda_o - \lambda_r}{\lambda_r}$ **(1)**		$z = \frac{\lambda_o - \lambda_r}{\lambda_r}$ anywhere, 1 mark
			$\frac{4.52 \times 10^6}{3.00 \times 10^8} = \frac{\lambda_o - 486 \times 10^{-9}}{486 \times 10^{-9}}$ **(1)**		substitution of 486×10^{-9} **(1)** Accept: 486
			$\lambda_o = 4.93 \times 10^{-7}$ m **(1)**		Alternative method: $\frac{v}{c} = \frac{\lambda_o - \lambda_r}{\lambda_r}$ $\frac{4.52 \times 10^6}{3.00 \times 10^8} = \frac{\lambda_o - 486}{486}$ $\lambda_o = 4.93 \times 10^{-7}$ m Equating formula, **(2)** Substitution of v and c **(1)** Substitution of λ_r **(1)** Final answer **(1)**

Question			Expected response	Max mark	Additional guidance
11.	(a)	(i)	$n = \frac{\sin\theta_1}{\sin\theta_2}$ **(1)** $1.53 = \frac{\sin 36.0}{\sin\theta_2}$ **(1)** $\theta_2 = 22.6°$ **(1)**	**3**	Accept: 23, 22.59, 22.592 Accept: $\frac{n_2}{n_1} = \frac{\sin\theta_1}{\sin\theta_2}$ **(1)** $\frac{1.53}{1} = \frac{\sin 36.0}{\sin\theta_2}$ **(1)** $\theta_2 = 22.6°$ **(1)**
		(ii)	$180 - 60 - [90 - 22.6]$ **(1)** $(= 52.6°)$ $(90 - 52.6 = B)$ B=37.4° **(1)**	**2**	Or consistent with (a)(i) Value must be given to 1 decimal place or consistent with the number of decimal places in answer to (a)(i)
	(b)	(i)	The angle of incidence that produces an angle of refraction of 90°.	**1**	Accept a description of the incident ray as an alternative to the word 'incidence'. Do not accept: The minimum angle of incidence that causes total internal reflection.
		(ii)	$\sin\theta_c = \frac{1}{n}$ **(1)** $\sin\theta_c = \frac{1}{1.53}$ **(1)** $\theta_c = 40.8°$ **(1)**	**3**	Accept: 41, 40.81, 40.813

Question			Expected response	Max mark	Additional guidance
11.	(c)		Emergent ray drawn at an angle greater than angle B **(1)** $\left(n = \frac{\sin\theta_1}{\sin\theta_2} \right)$ $1.53 = \frac{\sin\theta_1}{\sin 37.4}$ **(1)** $(\theta_1 = 68.3°)$ calculated angle correctly shown on diagram **(1)**	**3**	or consistent with (a)(ii) and/or (b)(ii) Accept: 68, 68.32, 68.324 Ignore any partially reflected rays. If (a)(ii) has a greater angle than (b)(ii) then the total internal reflection would be correct Internally reflected ray drawn (1) Angle of reflection approximately equal to angle B (1) Value for angle of reflection shown on diagram consistent with (a)(ii) (1) Ignore any further refraction at other glass-air boundaries.

Question			Expected response	Max mark	Additional guidance
12.	(a)	(i)	$\left(\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}\right)$ $\left(\frac{1}{R_T}=\frac{1}{16}+\frac{1}{16}\right)$ $R_T=8(\Omega)$ **(1)** $R=((8+16)=)24(\Omega)$ **(1)** $V=IR$ **(1)** $V=0.38\times 24$ **(1)** $V=9.1$ V **(1)**	**5**	Accept: 9, 9.12, 9.120 24 (Ω) anywhere 2 marks $V=IR$ anywhere - 1 mark Alternative methods 2 marks for 24 (Ω) anywhere 1 mark for **all** relationships 1 mark for **all** substitutions 1 mark for final answer
		(ii)	$E=V+Ir$ **(1)** $12=9.1+(0.38\times r)$ **(1)** $r=7.6\ \Omega$ **(1)**	**3**	Or consistent with a(i)* Accept: 8, 7.63, 7.632 *If V = 12 V then max 1 mark for relationship. Alternative method: $E=I(R+r)$ **(1)** $12=0.38(24+r)$ **(1)** $r=7.6\ \Omega$ **(1)** For this method accept: 8, 7.58, 7.579 for 'lost volts' accept: $V=Ir$ $V=IR$

Question			Expected response	Max mark	Additional guidance
12.	(a)	(iii)	$P = I^2R$ **(1)** $P = 0.38^2 \times 7.6$ **(1)** $P = 1.1\ \text{W}$ **(1)**	**3**	Or consistent with (a)(i) and/or(a)(ii) Accept: 1, 1.10, 1.097 Accept: $P = I^2r$ Alternative methods: $P = IV$ **(1)** $P = 0.38 \times (12 - 9.1)$ **(1)** $P = 1.1\ \text{W}$ **(1)** **OR** $P = \frac{V^2}{R}$ **(1)** $P = \frac{(12 - 9.1)^2}{7.6}$ **(1)** $P = 1.1\ \text{W}$ **(1)**
	(b)		(Power dissipated) less than **(1)** (Total circuit resistance increases), current decreases, internal resistance stays the same **(1)**	**2**	**MUST JUSTIFY** Accept: current decreases, and lost volts decreases. lost volts decreases, and internal resistance stays the same.

Question			Expected response	Max mark	Additional guidance
13.	(a)	(i)	$C = \frac{Q}{V}$ **(1)** $C = \frac{136.8 \times 10^{-3}}{5.7}$ **(1)** $C = 24 \times 10^{-3}$ F **(1)**	**3**	Accept: 20, 24.0, 24.00
		(ii)	$\%\Delta V = \left(\frac{0.1}{5.7} \times 100\right) = 1.8(\%)$ **(1)** $\Delta C = \frac{1.8}{100} \times 24 \times 10^{-3}$ **(1)** $\Delta C = 4 \times 10^{-4}$ F **(1)**	**3**	Or consistent with (a)(i) Suspend significant figures rule in this question. Anywhere Accept rounding at an intermediate stage in this question. Alternative method: $\Delta V = \left(\frac{0.1}{5.7}\right) = 0.018$ anywhere **(1)** $\Delta C = \frac{0.1}{5.7} \times 24 \times 10^{-3}$ **(1)** $\Delta C = 4 \times 10^{-4}$ F **(1)**
	(b)		$(t = 5RC)$ $t = 5 \times 15 \times 10^{3} \times 24 \times 10^{-3}$ **(1)** $t = 1800$ s **(1)**	**2**	Or consistent with (a)(i) Accept: 2000

Question			Expected response	Max mark	Additional guidance
14.	(a)		Axes appropriately labelled (quantity and units) and axes linearly scaled **(1)** [Allow for axes starting at zero or broken axes or an appropriate value] Data points plotted accurately **(1)** Appropriate line of best-fit **(1)**	**3**	If the origin is shown the scale must either be continuous, or the axis must be 'broken'. Otherwise, maximum 2 marks. If non-linear scale is used over the range of the data on either axis eg values from the table are used as the scale points. **(0)** marks Do not penalise if candidates plot *frequency* against *switch on voltage*. Accuracy of plotting should be easily checkable with the scale chosen. An appropriate scale to allow the accuracy of plotting to be checked must be linear over the range of the data.
	(b)		Choosing 2 points on their line **(1)** Calculate gradient: **(1)** (min 1 sig fig, max 4 sig figs) (Gradient works out as approx. 5.0×10^{-15})	**2**	**Must** be consistent with graph drawn for (a). Candidates are asked to calculate the gradient of **their graph**. Tolerance required depending upon best fit line drawn by the candidate. If candidates use values from the table, these points must lie on **their line**. If ($\times 10^{14}$) is not accounted for in the final answer, maximum 1 mark unless this being omitted is consistent with the graph drawn in (a). A unit is not required in the final answer, but if stated it must be correct. If candidate has a non-linear scale over the range of the values used in the substitution, **(0)** marks. If candidate has drawn a 'dot to dot' graph or no line, **(0)** marks.

Question			Expected response	Max mark	Additional guidance
14.	(c)		$(h = e \times gradient)$ $h = 1.60 \times 10^{-19} \times 5.0 \times 10^{-15}$ **(1)** $h = 8.0 \times 10^{-34}$ Js **(1)**	**2**	**Must be** consistent with (b) **Must** substitute the gradient of **their graph**, and not a single data point. If a single data point is substituted into in the calculation, award (0) marks Accept: correct alternative units If candidate has plotted frequency against switch on voltage, the formula becomes $\left(h = \frac{e}{gradient}\right)$ $h = \frac{1.60 \times 10^{-19}}{2.0 \times 10^{14}}$ **(1)** $h = 8.0 \times 10^{-34}$ Js **(1)**
	(d)		Repeat the measurements and take the mean. **OR** Use a greater range of colours/ frequencies of LEDs. **OR** Carry out experiment in a dark room/use a viewing tube to see when LED first emits light. **OR** Use a photodiode to detect when the LED lights/use an ammeter to detect when the circuit conducts.	**1**	Accept: 'Average' for 'mean' Do not accept: 'Repeat the **experiment** and take the mean' on its own. Accept: Use more colours/frequencies of LEDs. Do not accept: Use more LEDs take more measurements on its own.

[END OF MARKING INSTRUCTIONS]

General marking principles for Physics Higher

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must always be assigned in line with these marking principles, the Physics: general marking principles (GMPs) (Physics: general marking principles - National 3 to Advanced Higher (sqa.org.uk)) and the detailed marking instructions for this assessment.

(b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

(c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

(d) Where a candidate answers part of a question incorrectly and carries the incorrect answer forward in the following part, award marks if the incorrect answer has then been used correctly in the subsequent part or 'follow-on'. (GMP 16)

(e) Award marks for non-standard symbols where the symbols are defined and the relationship is correct, or where the substitution shows that the relationship used is correct. This must be clear and unambiguous. (GMP 20)

(f) Award full marks for a correct final answer (including units if required) on its own, unless a numerical question specifically requires evidence of working to be shown, eg in a 'show' question. (GMP 1)

(g) Award marks where a diagram or sketch conveys correctly the response required by the question. It will usually require clear and correct labels (or the use of standard symbols). (GMP 19)

(h) Marks are allocated for knowledge of relevant relationships alone. Do not award a mark when a candidate writes down several relationships and does not select the correct one to continue with, for example by substituting values. (GMP 1c)

(i) Do not award marks if a 'magic triangle' (eg) 

is the only statement in a candidate's response. To gain the mark, the correct relationship must be stated, for example $V = IR$ or $R = \frac{V}{I}$. (GMP 2)

(j) In rounding to an expected number of significant figures, award the mark for responses that have up to two figures more or one figure less than the number in the data with the fewest significant figures. (GMP 6)

(Note: the use of a recurrence dot, eg $0.\dot{6}$, would imply an infinite number of significant figures and would therefore not be acceptable.)

(k) The incorrect spelling of technical terms should usually be ignored and candidates should be awarded the relevant mark, provided that answers can be interpreted and understood without any doubt as to the meaning.

Where there is ambiguity, do not award the mark. Two specific examples of this would be when the candidate uses a term:

- that might be interpreted as *reflection*, *refraction* or *diffraction*, eg 'defraction'
- that might be interpreted as either *fission* or *fusion*, eg 'fussion'

The spelling of these words is similar, but the words have totally different meanings. If the spelling (or handwriting) in an answer makes it difficult for you to interpret a candidate's intention, then do not award the mark. (GMP 22)

(l) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify**, **name**, **give**, or **state**, they need only name or present in brief form.
- **describe**, they must provide a statement or structure of characteristics and/or features.
- **explain**, they must relate cause and effect and/or make relationships between things clear.
- **determine** or **calculate**, they must determine a number from given facts, figures or information.
- **estimate**, they must determine an approximate value for something.
- **justify**, they must give reasons to support their suggestions or conclusions. For example this might be by identifying an appropriate relationship and the effect of changing variables.
- **show that**, they must use physics [and mathematics] to prove something, for example a given value – *all steps, including the stated answer, must be shown*.
- **predict**, they must suggest what may happen based on available information.
- **suggest**, they must apply their knowledge and understanding of physics to a new situation. A number of responses are acceptable: award marks for any suggestions that are supported by knowledge and understanding of physics.
- **use their knowledge of physics or aspect of physics to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/ situation presented (for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation). Candidates are given credit for the breadth and/or depth of their conceptual understanding.

Standard three marker

The examples over the page set out how to apportion marks to answers requiring calculations. These are the 'standard three marker' type of questions.

Award full marks for a correct answer to a numerical question, even if the steps are not shown explicitly, **unless** it specifically requires evidence of working to be shown.

For some questions requiring numerical calculations, there may be alternative methods (eg alternative relationships) that would lead to a correct answer.

Sometimes, a question requires a calculation that does not fit into the 'standard three marker' type of response. In these cases, the detailed marking instructions will contain guidance for marking the question.

When marking partially correct answers, apportion individual marks as shown over the page.

(I) Marking in calculations

Example question

The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts. Calculate the resistance of the resistor. (3 marks)

	Example response	Mark and comment
1.	$V = IR$ $7.5 = 1.5R$ $R = 5.0\ \Omega$	1 mark: relationship 1 mark: substitution 1 mark: correct answer
2.	$5.0\ \Omega$	3 marks: correct answer
3.	5.0	2 marks: unit missing
4.	$4.0\ \Omega$	0 marks: no evidence, wrong answer
5.	$\_\_\ \Omega$	0 marks: no working or final answer
6.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 4.0\ \Omega$	2 marks: arithmetic error
7.	$R = \frac{V}{I} = 4.0\ \Omega$	1 mark: relationship only
8.	$R = \frac{V}{I} = \_\_\ \Omega$	1 mark: relationship only
9.	$R = \frac{V}{I} = \frac{7.5}{1.5} = \_\_\ \Omega$	2 marks: relationship and substitution, no final answer
10.	$R = \frac{V}{I} = \frac{7.5}{1.5} = 4.0$	2 marks: relationship and substitution, wrong answer
11.	$R = \frac{V}{I} = \frac{1.5}{7.5} = 5.0\ \Omega$	1 mark: relationship but wrong substitution
12.	$R = \frac{V}{I} = \frac{75}{1.5} = 5.0\ \Omega$	1 mark: relationship but wrong substitution
13.	$R = \frac{I}{V} = \frac{1.5}{7.5} = 5.0\ \Omega$	0 marks: wrong relationship
14.	$V = IR$ $7.5 = 1.5 \times R$ $R = 0.2\ \Omega$	2 marks: relationship and substitution, arithmetic error
15.	$V = IR$ $R = \frac{I}{V} = \frac{1.5}{7.5} = 0.2\ \Omega$	1 mark: relationship correct but wrong rearrangement of symbols