

3	<p>The only correct answer is D</p> <p>A is not correct because the oscillations may also be in the y direction</p> <p>B is not correct because this would describe the situation for a longitudinal wave</p> <p>C is not correct because this would describe the situation for a longitudinal wave</p>	1
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9	<p>The only correct answer is C (270°, 90°)</p> <p>A is not correct because $180^\circ - 90^\circ$ is 90°</p> <p>B is not correct because $270^\circ - 180^\circ$ is 90°</p> <p>D is not correct because $270^\circ - 360^\circ$ is -90°</p>	1
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9	<p>B is the correct answer as $v \propto 1/A$ when I, n and q are the same.</p> <p>A is not the correct answer as both wires have the same charge carrier density as they are both made from copper.</p> <p>C is not the correct answer as both wires have the same current as they are in series</p> <p>D is not the correct answer as the length of the wire is not related to drift velocity</p>	(1)
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10	<p>C is the correct answer</p> <p>A is not the correct answer as light transmitted is unpolarised as this is unchanged</p> <p>B is not the correct answer as light reflected must be polarised as it is absorbed by the filter</p> <p>D is not the correct answer as light reflected must be polarised as it is absorbed by the filter</p>	(1)
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2	<p>C is the correct answer</p> <p>A is not the correct answer as the intensity does not vary as the filter is rotated</p> <p>B is not the correct answer as the intensity does not vary as the filter is rotated</p> <p>D is not the correct answer as one filter will allow some oscillations to pass</p>	(1)
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1	<p>The only correct answer is C (v represents the drift velocity of the charge carriers in the sample)</p> <p>A is not the correct answer as n is the number of charge carriers per m^3</p> <p>B is not the correct answer as q is the charge per charge carrier</p> <p>D is not the correct answer as A is the cross-sectional area</p>	1
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3	<p>The only correct answer is B (JV^{-1})</p> <p>A is not correct because a coulomb is a JV^{-1}</p> <p>C is not correct because a coulomb is a JV^{-1}</p> <p>D is not correct because a coulomb is a JV^{-1}</p>	1
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2	<p>D is the correct answer (Polarised waves have oscillations in one direction and perpendicular to the direction of wave travel)</p> <p>A is not the correct answer as the single plane of polarisation includes the direction of wave travel and is not perpendicular to it</p> <p>B is not the correct answer as polarised waves do not contain many planes</p> <p>C is not the correct answer as polarised waves do not contain many directions</p>	(1)
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5	<p>A is the correct answer as $R = V/I$, and V is measured in JC^{-1} and I is measured in Cs^{-1}.</p> <p>B is not the correct answer as the units of resistance are not JC^2s^{-1} C is not the correct answer as the units of resistance are not $JC^{-1} s^{-1}$ D is not the correct answer as the units of resistance are not JCs</p>	(1)
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2	<p>The only correct answer is B 4W</p> <p><i>A is not correct because only half the intensity is transmitted</i></p> <p><i>C is not correct because this is a quarter of the original intensity</i></p> <p><i>D is not correct because one polarising filter transmits half the intensity</i></p>	1
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18(a)	<p>Light slows down when it enters the glass (1)</p> <p>This is because light has a greater density / refractive index than air (1)</p>	2
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18(b)	<p>Angle of incidence = 37° (1)</p> <p>Use of $\sin C = \frac{1}{n}$ (1)</p> <p>$C = 41^\circ$ (1)</p> <p>$37^\circ < 41^\circ$ so total internal reflection will not take place and the surface must be silvered (1)</p> <p><u>Example of calculation</u> Angle of incidence = $90^\circ - 53^\circ = 37^\circ$</p> <p>$C = \sin^{-1}\left(\frac{1}{1.52}\right) = 41.1^\circ$</p>	4
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18(c)(i)	<p>Intensity is the energy per second per metre squared (1)</p> <p>Or Intensity is the power per metre squared (1)</p> <p>Or $I = \frac{P}{A}$ with terms defined (1)</p> <p>The energy of each photon is not known (1)</p>	2
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18(c)(ii)	Use of $v = f\lambda$	(1)	5
	Use of $E = hf$	(1)	
	Determines number of photons per second arriving at sensor	(1)	
	Determines number of electrons passing a point each second in the circuit	(1)	
	83 - 88% of photons detected	(1)	
	<u>Example of calculation</u> $E = \frac{6.63 \times 10^{-34} \text{ J s} \times 3 \times 10^8 \text{ m s}^{-1}}{600 \times 10^{-9} \text{ m}} = 3.3 \times 10^{-19} \text{ J}$ no. of photons incident on sensor = $\frac{1.0 \text{ W}}{3.3 \times 10^{-19} \text{ J}} = 3.0 \times 10^{18} \text{ s}^{-1}$ no. of electrons = $\frac{0.41 \text{ A}}{1.6 \times 10^{-19} \text{ C}} = 2.6 \times 10^{18} \text{ s}^{-1}$ $\frac{2.6 \times 10^{18} \text{ s}^{-1}}{3.0 \times 10^{18} \text{ s}^{-1}} \times 100\% = 87\%$		
Total for question 18			13

12(a)(i)	Angle of incidence measured from the diagram in the range 53° - 55°	(1)	1
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12(a)(ii)	Use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$	(1)	2
	$\theta_2 = 32-33^\circ$ (allow ecf from (a)(i))	(1)	
			Only penalise unit if not penalised in part ai <u>Example of calculation</u> $1 \times \sin 53^\circ = 1.5 \times \sin \theta_2$ $\theta_2 = \sin^{-1} \left(\frac{1 \times \sin 53^\circ}{1.5} \right) = 32^\circ$

12(b)(i)	Either		3
	Unpolarised light has oscillations / vibrations in all / many planes	(1)	
	polarised light has oscillations / vibrations in one plane which includes the <u>direction</u> of (wave) travel	(1)	
		(1)	
Or			
Unpolarised light has oscillations / vibrations in all / many directions	(1)		
Polarised light has oscillations / vibrations in one direction which is perpendicular to the <u>direction</u> of (wave) travel	(1)		
(MP3 dependent on MP2 being awarded)		(1)	
			(MP3 dependent on MP2 being awarded)

12(b)(ii)	Intensity of light varies	(1)	3
	from a maximum to a minimum every 90 degree rotation	(1)	
	The maximum intensity occurs when the (plane of) the polarising filter is in the same direction as the (plane of) oscillation of the light	(1)	
	Or The minimum intensity occurs when the (plane of) the polarising filter is perpendicular to the (plane of) oscillation of the light		

Question Number	Answer	Mark
18a	<p>Use of speed = distance / time (1)</p> <p>Calculates distance travelled by sound in 3s = 1020 (m) Or calculates time taken for sound to travel 1 km = 2.94 (s) Or calculates speed to travel 1000m in 3 seconds = 333 (ms⁻¹) (1)</p> <p>Time taken by light to reach 1 km is almost instantaneous / 3.3×10^{-6} s so teacher is (approximately) correct. (1)</p> <p><u>Example of calculation</u> For light, $t = d/v = 1000 \text{ m} / 3.00 \times 10^8 \text{ ms}^{-1} = 3.33 \times 10^{-6} \text{ s}$ For sound, $t = d/v = 1000 \text{ m} / 340 \text{ ms}^{-1} = 2.94 \text{ s}$ Difference in arrival time = 2.94 s \approx 3 s</p>	(3)
18bi	<p>Use of $Q = It$ (1) $Q = 0.75 \text{ C}$ (1)</p> <p><u>Example of calculation</u> $Q = It = 25,000 \text{ A} \times (30 \times 10^{-6} \text{ s}) = 0.75 \text{ C}$</p>	(2)
18bii	<p>Use of $P = VI$ (1) $P = 3.0 \times 10^{13} \text{ W}$ (1)</p> <p><u>Example of calculation</u> $P = VI = (1.2 \times 10^9 \text{ V}) \times 25,000 \text{ A} = 3.0 \times 10^{13} \text{ W}$</p>	(2)
18biii	<p>Use of $A = \pi r^2$ (1) Use of $R = \rho l/A$ (1) $\rho = 0.24 \text{ } (\Omega \text{ m})$ (1)</p> <p><u>Example of calculation</u> Cross sectional area of wire = $\pi r^2 = \pi (2.5 \times 10^{-2})^2 = 1.96 \times 10^{-3} \text{ m}^2$ $R = V/I = (1.2 \times 10^9 \text{ V}) / 25,000 \text{ A} = 48,000 \text{ } \Omega$ $\rho = RA/l = (48,000 \text{ } \Omega) (1.96 \times 10^{-3} \text{ m}^2) / 400 \text{ m} = 0.235 \text{ } \Omega \text{ m}$</p>	(3)
18biv	<p>Air in the lightning channel has been ionised Or Lightning channel unlikely to have a uniform diameter / CSA (1)</p>	(1)

18ci	Energy levels (in atoms) are discrete/specific (1)	
	(Energy makes) <u>electrons</u> move up energy levels (1)	
	Or <u>Electrons</u> are excited (1)	
	(Electrons) move back down energy levels, releasing <u>photons</u> (1)	
	Or (Electrons) are de-excited, releasing <u>photons</u> (1)	
	Energy difference (between levels) is proportional to frequency of photon (resulting in line spectrum being produced) (1)	
	Or Photon energy is proportional to frequency (resulting in line spectrum being produced) (1)	
		(4)
18cii	Different atoms/elements have different (differences in) energy levels (1)	(1)
Total for question 18		16

14(a)(i)	The resistance of a sample of the material of unit cross sectional area and unit length Or $\rho = \frac{RA}{l}$ with terms defined (1)	1
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14(a)(ii)	Measure the L using a metre rule (1)	4
	Measure the thickness of the material using a micrometer Or Measure the thickness of the material using vernier callipers (1)	
	Use an ammeter and voltmeter to determine the resistance using $R = \frac{V}{I}$ Or Use an ohmmeter to measure the resistance of the sample (1)	
	Use $\rho = \frac{RA}{l}$ to determine the resistivity (1) Or valid description of a graph and gradient calculation to determine the resistivity	

14(b)	Copper has a high concentration of charge carriers (1)	2
	$I = nAvq$ so (for a given current) drift velocity is small (1)	

14(c)	<p>The same potential difference is applied across each additional panel (1)</p> <p>So each panel dissipates the same power, and power output of the system increases (1)</p> <p>OR</p> <p>As more panels are connected, the resistance (of the system) decreases (and potential difference remains the same) (1)</p> <p>And $P = \frac{V^2}{R}$ so power output of the system increases (1)</p> <p>OR</p> <p>As more panels are connected, the current in the power supply increases (and potential difference across each panel is the same) (1)</p> <p>And $P = VI$ so power output of the system increases (1)</p> <p>OR</p> <p>As more panels are connected, the current in the power supply increases and the resistance of the system decreases by the same factor (1)</p> <p>And $P = I^2R$ so power output of the system increases (1)</p>	2
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