AQA Physics - 7407/7408

Module 12: Turning points in physics

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
12.1 The discovery of the electron				
12.1.1 Cathode rays				
Production of cathode rays in a discharge tube.				
12.1.2 Thermionic emission of electrons				
The principle of thermionic emission.				
Work done on an electron accelerated through a pd V; $\frac{1}{2} mv^2 = eV$				
12.1.3 Specific charge of the electron				
Determination of the specific charge of an electron, (e / m_e) by any one method.				
Significance of Thomson's determination of (e / m_e)				
Comparison with the specific charge of the hydrogen ion.				
12.1.4 Principle of Millikan's determination of the electronic charge, e				
Condition for holding a charged oil droplet, of charge Q, stationary between oppositely charged parallel plates.				
$QV / d = mg$				
Motion of a falling oil droplet with and without an electric field; terminal speed to determine the mass and the charge of the droplet.				
Stokes' Law for the viscous force on an oil droplet used to calculate the droplet radius.				
$F = 6\pi\eta rv$				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
Significance of Millikan's results.				
Quantisation of electric charge.				
12.2 Wave-particle duality				
12.2.1 Newton's corpuscular theory of light				
Comparison with Huygens' wave theory in general terms.				
The reasons why Newton's theory was preferred.				
12.2.2 Significance of Young's double slits experiment				
Explanation for fringes in general terms.				
No calculations are expected.				
Delayed acceptance of Huygens' wave theory of light.				
12.2.3 Electromagnetic waves				
Nature of electromagnetic waves.				
Maxwell's formula for the speed of electromagnetic waves in a vacuum $C = 1 / \sqrt{(\mu_0 \varepsilon_0)}$				
Where μ_0 is the permeability of free space and ε_0 is the permittivity of free space.				
Students should appreciate that μ0 relates to the electric field strength due to a charged object in free space and ε0 relates to the magnetic flux density due to a current-carrying wire in free space.				
Hertz's discovery of radio waves including measurements of the speed of radio waves.				
Fizeau's determination of the speed of light and its implications.				
12.2.4 The discovery of photoelectricity				
The ultraviolet catastrophe and black-body radiation.				
Planck's interpretation in terms of quanta.				
The failure of classical wave theory to explain observations on photoelectricity.				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
	1	2	3	4
Einstein's explanation of photoelectricity and its significance in terms of the nature of electromagnetic radiation.				
12.2.5 Wave–particle duality				
de Broglie's hypothesis: $p = h / \lambda$; $\lambda = h / \sqrt{(2meV)}$				
Low-energy electron diffraction experiments; qualitative explanation of the effect of a change of electron speed on the diffraction pattern.				
12.2.6 Electron microscopes				
Estimate of anode voltage needed to produce wavelengths of the order of the size of the atom.				
Principle of operation of the transmission electron microscope (TEM).				
Principle of operation of the scanning tunnelling microscope (STM).				
12.3 Special relativity				
12.3.1 The Michelson-Morley experiment				
Principle of the Michelson-Morley interferometer.				
Outline of the experiment as a means of detecting absolute motion.				
Significance of the failure to detect absolute motion.				
The invariance of the speed of light.				
12.3.2 Einstein's theory of special relativity				
The concept of an inertial frame of reference.				
The two postulates of Einstein's theory of special relativity: 1 physical laws have the same form in all inertial frames 2 the speed of light in free space is invariant.				
12.3.3 Time dilation				
Proper time and time dilation as a consequence of special relativity.				
Time dilation: $t = t_0 / \sqrt{(1 - (v^2 / e^2))}$				
Evidence for time dilation from muon decay.				

You should be able to demonstrate and show your understanding of:	Progress and understanding:			
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12.3.4 Length contraction				
Length of an object having a speed v				
$l = l_0\sqrt{(1 - (v^2 / e^2))}$				
12.3.5 Mass and energy				
Equivalence of mass and energy: $E = mc^2$; $E = m_0c^2 / \sqrt{(1 - (v^2 / e^2))}$				
Graphs of variation of mass and kinetic energy with speed.				
Bertozzi's experiment as direct evidence for the variation of kinetic energy with speed.				