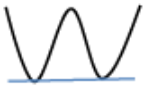
Physics

Turning Points in Physics - 2 - Answers

1.

(a)

Answers	Additional Comments/Guidance	Mark
Pattern shows: Maximum at start and shows minimum of zero (never negative)✓ Correct periodicity zeros/maxima 180° apart✓ (ie angles in right places) Curvature rather than spikes ie  ✓  × (The graph should fall to zero – (NB First and last parts should ideally be curved not as illustrated here)	**If negative then can get second mark only** Assume that bottom of graph grid is zero unless otherwise stated Must be numbers on x-axis Ignore if graph shows what happens beyond 360 If only one minimum shown then loses this mark Allow if shown starting at zero Freehand sketch so allow if clear attempt to show curvature in most of sketch or arches	3

(b)

Correct substitution leading to a calculation of the speed of electromagnetic wave. $\frac{1}{\sqrt{(4\pi\times10^{-7})(8.85\times10^{-12})}}$ = 3.0 (2.9986) x 10^8 m s^{-1}		1
Comment that this speed agrees with the measured speed of light Or speed determined from experiments Or similar to Fizeau's result		1

2.

(a)

Answers	Additional Comments/Guidelines	Mark
		1

	Tick (✓) if correct
Beta particle emission	
Electron diffraction	
Photoelectric effect	
Thermionic emission	✓

(b)

Use of $\lambda = \frac{h}{\sqrt{(2mE)}}$ seen including correct substitution		1
$\lambda = 2.4 \times 10^{-11}$ (m)	Condone missing unit	1
Statement to the effect that this is similar to or less than 0.1 nm/atomic dimension/diameter of the atom (so individual atoms can be resolved).	Allow a correct conclusion that follows from an incorrect value of λ	1

(c)

The mark scheme gives some guidance as to what statements are expected to be seen in a 1 or 2 mark (L1), 3 or 4 mark (L2) and 5 or 6 mark (L3) answer.

Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria	QoWC
6	At least six of the likely statements will be covered to a good standard including at least three from image formation and at least three from quality and detail.	The student presents relevant information coherently, employing structure, style and SP&G to render meaning clear. The text is legible.
5	At least five of the likely statements will be covered to a good standard including at least two from image formation and at least one from quality and detail.	
4	At least three of the likely statements will be covered to a good standard. The response must include one of both image formation and factors affecting quality and detail.	The student presents relevant information and in a way which assists the communication of meaning. The text is legible. SP&G are sufficiently accurate not to obscure meaning.
3	At least two of the likely statements will be covered to a good standard. The response must include one of both image formation and factors affecting quality and detail.	
2	At least two of the likely statements	The student presents

The following statements are likely to be present.

<u>Process of Image formation</u>

- Electrons through the middle of the lenses are undeviated
- Electrons on the edges are deflected by magnetic fields toward the axis of the TEM
- The condenser lens deflects the electrons into a wide parallel beam incident uniformly on the sample.
- The objective lens then forms an image of the sample.
- The projector lens then casts a second image onto the fluorescent screen.

<u>Factors affecting the quality and level of detail</u>

- Wavelength depends on speed of the electrons
- Lower the wavelength gives greater the detail.
- Emitted electrons come from a heated cathode and therefore have a speed distribution dependent on temperature.
- The speed of the electrons is not always the same which causes different pathways through the lens and so aberration.
- The sample thickness reduces the speed of the electrons increasing the wavelength and decreasing the detail.

6

3.

(a)

Answers	Additional Comments/Guidance	Mark
Weight/gravitational force AND electric/electrostatic force ✓ Equal (magnitudes) and opposite directions, AND one direction at least specified✓	The second mark is conditional on the first. First mark is for naming the two forces. Condone 'electromagnetic' for 'electric' Do not allow field or potential for force. Allow "force due to electric field"; "force due to magnetic field" Penalise additional forces in MP2. The second mark is for the relationship between them. Must include idea of size and direction. e.g. weight down equals E force up/towards positive plate/away from negative plate. Do not allow 'balanced' or 'in equilibrium' for equals The forces can be in the form of formulae for MP1 and MP2 (e.g. Eq, EV/d, mg)	2

(b)

$m = 4\pi r^3\rho/3$ **and** $mg = 6\pi\eta rv$ seen✓ $r^2 = 18\ \eta v / 4\ \rho g$ is seen in in some form, in symbols or through substituted data,✓ Correct use of equations to obtain $r = 9.7 \times 10^{-7}$ m ✓	Do not allow backward calculaton Can be seen by substitution. Can be seen in single equation: $4\pi r^3\rho g/3 = 6\pi\eta rv$ Do not award if v and V confused Do not condone 1sf answer. Must be clear answer refers to r, not r^2 for example. If no other mark given MP1 can be awarded if F used for mg, and/or volume AND density equations seen separately	3

(c)

The number of excess electrons on the droplet is 3 ✓ In order for each half to remain stationary, the charge would have to split equally OR Due to the quantisation of charge, the charge cannot split equally ✓ It is not possible for both droplets to remain stationary / the student is wrong ✓	May be seen in terms of values of charge or e Award for idea that charge would have to be 1.5e Evidence for MP1 and MP2 may be seen together. E.g. charge on drops are e and 2e, OR 1.6×10^{-19} **and** 3.2×10^{-19} Ignore reference to particles repelling each other	3