

Name of the Student: \_\_\_\_\_

Max. Marks : 17 Marks

Time : 17 Minutes

## Mark Schemes

**Q1.**

- (a) 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 marking this question.

	Criteria
6	All three areas (as outlined alongside) covered with at least two aspects covered in some detail. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.
5	A fair attempt to analyse all three areas. If there are several errors or missing parts then 5 marks should be awarded.
4	Two areas successfully discussed, or one discussed and two others covered partially. Whilst there will be gaps, there should only be an occasional error.
3	One area discussed and one discussed partially, or all three covered partially. There are likely to be several errors and omissions in the discussion.
2	Only one area discussed or makes a partial attempt at two areas.
1	One of the three areas covered without significant error.
0	No relevant analysis.

The following statements are likely to be present.

**Area A**

Loses its charge:

- Emission of electrons from the surface (when electromagnetic

- radiation is incident on plate) (A).
- Number of surplus electrons remaining on plate decreases with time / (photo)electrons carry away negative charge(B).

### Area B

Frequency:

- Minimum energy** required /work function. (C)
- A photon must supply this energy in one interaction. (D)
- The energy of a photon is directly proportional to its frequency /  $E = hf$ . (E)
- Minimum frequency is the threshold frequency. (F)

### Area C

Intensity:

- Increased intensity (at same frequency) results in more photons per second incident on plate. (G)
- Must increase the number of photons (per second) even if frequency increases. (H)
- More electrons released from plate every second so loses charge more rapidly. (I)

6

- (b) Use of  $E = hf$  or converts their photon energy in J to eV / converts 1.1 (eV) to  $1.76 \times 10^{-19}$  (J) ✓

*For use of  $E = hf$ :*

$$6.63 \times 10^{-34} \times 1.2 \times 10^{15} / 7.956 \times 10^{-19} \text{ (J)} / 4.97 \text{ eV seen}$$

*MP2:*

*rearrangement of terms is insufficient.*

*Correct substitution in eV or J with or without rearrangement (condone one consistent POT error)*

Use of  $hf = \Phi + E_{k(max)}$  ✓

*Expect to see*

$$(\Phi \Rightarrow) 4.97 - 1.1 / \Phi + 1.1 = 4.97 /$$

$$(\Phi \Rightarrow) 7.956 \times 10^{-19} - 1.76 \times 10^{-19}$$

$$/ (\Phi \Rightarrow) 6.196 \times 10^{-19} / \Phi + 1.76 \times 10^{-19} = 7.956 \times 10^{-19}$$

*Condone **one** error in either  $hf$  or  $E_{k(max)}$  or signs but must be rearranged where  $\Phi$  would be subject.*

*Common error seen in  $E_{k(max)} = 6.875 \times 10^{18}$*

*Examples:*

$$(\Phi \Rightarrow) 7.956 \times 10^{-19} - 1.1 (= - 1.1) /$$

$$(\Phi \Rightarrow) 6.63 \times 10^{-34} \times 1.2 \times 10^{15} - 1.1 /$$

$$(\Phi \Rightarrow) 4.97 - 1.76 \times 10^{-19} (= 4.97)$$

*Condone error in*

*Accept a correctly rounded answer to 2 or more significant figure.*

**Condone answer (with working seen) = 6.1 or 6.07 for 2 marks.**

$\Phi = 3.9$  (eV) ✓

*(Calculator displays 3.8725)*

3

[9]

## Q2.

(a) Q ✓

*Talk out of Q where diffraction linked to any other location (positive plate or screen)*

Diffraction as the electron move between the layers in the graphite/ electrons spread out as they move between the layers in the graphite ✓

*Accept gaps between (graphite) atoms acts as slits for electrons to diffract through.*

*Graphite acts like a diffraction grating is not enough.*

*Talk out where particle property is used to describe interaction between the electrons and the graphite (e.g. electrons repelled by graphite).*

*Treat interference at R as neutral.*

*Treat interference at Q as neutral.*

*Allow maximum of one mark for describing particle behaviour at P or R with a reason given:*

*- acceleration is a particle phenomenon (P)*

*- fluorescence is due to a collision with atomic electron which is particle phenomenon. (R)*

2

(b) decreases (associated) wavelength / Momentum of electrons increases ✓

*Treat double slit formula as neutral*

*MP1 and MP2: talk out on use of wave equation / talk out on frequency remaining constant / talk out on frequency increases*

$$\lambda = \frac{h}{mv}$$

quotes / wavelength is inversely proportional to speed  
/ wavelength is inversely proportional to momentum ✓

less diffraction because shorter wavelength relative to the spacing between layers in the graphite / less diffraction because shorter wavelength relative to gaps (in graphite target) ✓

*Accept: less diffraction because shorter wavelength relative to size of slits*

*Where no other mark is scored allow 1 mark for:*

*less diffraction ✓*

*'Spreads out less' is insufficient here*

3

[5]

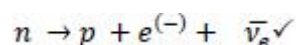
## Q3.

(a) 126 ✓

1

(b) A neutron decays into a proton

Or

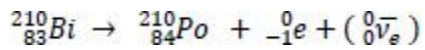


*Allow a neutron changes to a proton. (owtte) Accept the decay*

equation of a neutron / bismuth

• Statement that neutron converts to proton ✓

• all numbers correct and context ✓



Proton number **increases by one** when Bi-210 decays and describes beta minus  
*Condone missing (or incorrect) neutrino or symbol for bismuth*

OR

Bi-210 has **one fewer proton** (than Po-210) and describes beta minus in words

OR

Po-210 has **one more proton** (than Bi-210) and describes beta minus in words

Or

Proton number **increases from 83 to 84** and describes beta minus in words ✓

*Allow proton number increases where there is a clear statement that a neutron has decayed into a proton.*

2

[3]