Assess Quizzes from the o-book – Explanations for the answers.

Chapter 11 Review – Support

Q	Reason
1	$f=\frac{c}{\lambda}=\frac{3\times10^{8}}{7.00\times10^{-7}}=4.29\times10^{14}\,Hz$ $E=hf=6.626\times10^{-34}\times4.29\times10^{14}$ $=2.84\times10^{-19}\,J$ $=\frac{2.84\times10^{-19}\,J}{1.6\times10^{-19}\,J/eV}$ $=1.77\,eV$
2	Photons have zero mass. If they had mass, they couldn't travel at the speed of light as they would have infinite momentum. But they do have momentum as shown by the formula (NCPQ p 320 and in the QCAA formula book): $\lambda=\frac{h}{p}$ $p=\frac{h}{\lambda}$ $(\therefore has\,momentum)$
3	See NCPQ p 306. Wiens' law: $\lambda_{\max}=\frac{b}{T}$ $\lambda_{\max}T=b$ (Wien's constant = 2.898×10^{-3} m K)
4	A description of a black body radiator is one that absorbs all radiation that falls on it. See NCPQ page 305. Note that a black body radiator will also <u>emit</u> 'black body radiation' which is the radiation emitted solely from the 'black body radiator' when it is heated. However, this second aspect is not one of the options. The other three options provided are all incorrect.
5	$\lambda_{\max}=\frac{b}{T}=\frac{2.898\times10^{-3}}{2000}=1.45\times10^{-6}\,m$
6	The energy of the incident photons is 6.25 eV. Of that, 5.6 eV is used to overcome the work function getting the electron from the metal to the surface. The rest of the energy appears as kinetic energy. In the equation below, the term *hf* stands for the energy of the incident photons in J. However, we can calculate the kinetic energy E_K in eV as well: $E_K=hf-W$ $=6.2-5.6$ $=0.6\,eV$

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7	It is the frequency of the light that determines the energy of a liberated electron. If the frequency *f* is below threshold frequency f_0 for a particular metal there will be no emitted electrons. Remember that the intensity of the light just determines the number of electrons emitted provided the frequency of the incident light is above the threshold. The intensity does NOT determine the energy of the electron. Of course, the greater the intensity the greater the TOTAL energy of all emitted electrons, but not the energy of an individual electron.
8	My mistake. The question should read "Which of the phenomena can be verified by shining light on a metal surface …" The answer is 'Einstein's photoelectric effect'. This is Einstein's pioneering work. See NCPQ U3&4 page 316.
9	The gradient is Planck's constant. You should just learn this. If we take the equation: $E_K = hf - W$ and plot E_K on the y-axis, vs *f* on the x-axis, we get a linear relationship in the form y = mx + c. Because E_K is *y*, and *f* is *x*, then *h* is *m*, and *W* is the y-intercept '*c*'.
10	The work function is the negative of the y-intercept. The rearrangement shows this: $E_K = hf - W$ $y = mx + c$ $-W$ is represented by $+c$ W is represented by $-c$ In this case metal A has a y-intercept 'c' of -1.9×10^{-19} J, so it's W is 1.9×10^{-19} J, whereas metal B has a y-intercept 'c' of -3.2×10^{-19} J, so it's W is 3.2×10^{-19} J. Hence, B has the higher work function (W).

Chapter 11 Review – Consolidate

Q	Reason
1	$\lambda = \frac{b}{T} = \frac{2.898\times10^{-3}}{5573}$ $= 5.20\times10^{-7}\,m$ $= 520\times10^{-9}\,m = 520\,nm$
2	The intensity (height of the peak) increases, and the wavelength (x-axis value of the peak) decreases.
3	The gradient is Planck's constant. You should just learn this. If we take the equation: $E_K = hf - W$ and plot E_K on the y-axis, vs *f* on the x-axis, we get a linear relationship in the form y = mx + c. Because E_K is *y*, and *f* is *x*, then *h* is *m*, and *W* is the y-intercept '*c*'.

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4	The formula $E_K = hf - W$ can be converted to $E_K = hf - hf_0$. This shows that when a metal is bombarded by photons of energy *hf*, once the threshold energy hf_0 is reached, the excess energy $hf - hf_0$ appears as kinetic energy of the escaping electrons.
5	$\begin{aligned} E_K &= hf - W \\ &= hf - hf_0 \\ &= \frac{hc}{\lambda} - \frac{hc}{\lambda_0} \\ 1.2 \times 1.6 \times 10^{-19} &= \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{\lambda} - \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{240 \times 10^{9}} \\ 1.92 \times 10^{-19} &= \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{\lambda} - 8.2825 \times 10^{-19} \\ 1.020 \times 10^{-18} &= \frac{1.9878 \times 10^{-25}}{\lambda} \\ \lambda &= 1.948 \times 10^{-7} \\ &= 195 \times 10^{-9} m \\ &= 195 nm \end{aligned}$

Chapter 11 Review – Extend

Q	Reason
1	$\begin{aligned} E_K &= hf - W \\ &= hf - hf_0 \\ &= \frac{hc}{\lambda} - 5.6 \times 1.6 \times 10^{-19} \\ &= \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{150 \times 10^{9}} - 8.96 \times 10^{-19} \\ &= 1.325 \times 10^{-18} - 8.282510^{-19} \\ &= 4.292 \times 10^{-19} J \\ &= \frac{4.292 \times 10^{-19}}{1.6 \times 10^{-19}} eV \\ &= 2.68 eV \\ &= 2.7 eV \end{aligned}$
2	The peak for T_2 has to be higher and shifted towards lower wavelengths. See NCPQ U3&4 page 306.

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3	Photons of the same wavelength means they have the same energy (*hf*). The equation $E_K = hf - W$ shows that when *W* is greater, the energy remaining for kinetic energy must be lass. Hence, as potassium has a lower *W* value, its electrons will have higher E_K.
4	$E_K = hf - W$ $E_K = E_{photon} - W$ $3.00\,eV = E_{photon} - 2.20eV$ $E_{photon} = 5.20\,eV$ $E_{photon} = 5.20 \times 1.6 \times 10^{-19}\,J$ $E_{photon} = 8.32 \times 10^{-19}\,J$ $f = \frac{E_{photon}}{h}$ $= \frac{8.32 \times 10^{-19}}{6.626 \times 10^{-34}}$ $f = 1.26 \times 10^{15}\,Hz$
5	$\lambda = 450\,nm = 450 \times 10^{-9}\,m$ $f = \frac{c}{\lambda} = \frac{3 \times 10^8}{450 \times 10^{-9}} = 6.67 \times 10^{14}\,Hz$ $For\ metal\ X:$ $f > f_0$ A PE effect is already occurring (according to the question) so an increase in intensity will produce an increase in the number of electron emitted but not in their individual KE. $For\ metal\ Y:$ $f < f_0$ There is no PE effect so increasing the intensity has no effect.