Mark scheme for Extension Worksheet – Option G, Worksheet 3

1 $\frac{hc}{\lambda} = eV \Rightarrow \lambda = \frac{hc}{eV}$; $\lambda = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{1.6\times10^{-19}\times28\times10^{3}} = 4.4\times10^{-11}$ m [2]

2 From $\frac{hc}{\lambda} = eV \Rightarrow \lambda = \frac{hc}{eV}$, increasing the voltage decreases the minimum wavelength. [1]

3 The minimum wavelength only depends on the accelerating voltage and not the nature of the metal surface; so no change. [2]

4 The characteristic wavelengths only depend on the nature of the metal and not on the accelerating voltage; so no change. [2]

5 **a** There is a phase change of π upon reflection from the top face; and the condition is $2d = k\frac{\lambda}{n}$ where *k* is an integer and *n* is the refractive index of the film. [2]

b Consider a soap film surrounded by air. The condition for destructive interference is $2d = k\frac{\lambda}{n}$ gives $\frac{k}{2n} = \frac{d}{\lambda}$; if the thickness of the film is **much less** than a wavelength ($d << \lambda$) then $\frac{d}{\lambda} \approx 0$ and so $\frac{k}{2n} \approx 0$. This condition is always satisfied for all wavelengths for $k = 0$; Thus all wavelengths will undergo destructive interference in this case and the film appears dark. [3]

c From $2d = k\frac{\lambda}{n}$ with $k = 1$; we get $2\times0.190\times10^{-6} = 1\times\frac{\lambda}{1.45}$; and so $\lambda = 5.5\times10^{-7}$ m [3]

6 $2d\sin5^{\circ} = 1\times\lambda$; so $2d\sin\theta = 2\times\lambda \Rightarrow \sin\theta = \frac{2\lambda}{2d} = 2\times\sin5^{\circ} \Rightarrow \theta = 10^{\circ}$ [2]

7 See page 637 of *Physics for the IB Diploma* or page 121 of *Physics for the IB Diploma Exam Preparation Guide*. [2]

8 $2d\sin\theta = \lambda \Rightarrow d = \frac{\lambda}{2\sin\theta}$; $d = \frac{2.2\times10^{-10}}{2\sin22^{\circ}} = 2.9\times10^{-10}$ m [2]

9 The separation of the fringes is $\frac{3.0}{25} = 0.12$ cm; the angle of the wedge is therefore $\tan\theta = \frac{\lambda}{2\times0.12} = \frac{5.6\times10^{-7}}{2\times0.12\times10^{-2}} = 2.33\times10^{-4}$; hence the thickness is $2.33\times10^{-4}\times3.0 = 7.0\times10^{-4}$ cm $= 7.0\times10^{-6}$ m [3]