Tan Shi Yong 0356H

Subject:

Date: ~~30-8~~ 2-3-07

1a i)
$$E = \frac{hc}{\lambda}$$
$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{200\times10^{-9}}$$
$$= 9.9\times10^{-19}\,J$$

1a ii)
$$E = \frac{hc}{\lambda}$$
$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{10\times10^{-3}}$$
$$= 2.0\times10^{-23}\,J$$

1B)

2a)
$$E = \frac{hc}{\lambda}$$
$$\lambda = \frac{hc}{E}$$
$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{5.0\times10^{6}\times1.6\times10^{-19}}$$
$$= 2.49\times10^{-13}\,m$$

2b)
$$E = \frac{hc}{\lambda}$$
$$E\lambda = hc$$
$$= 6.63\times10^{-34}\times3.0\times10^{8}$$
$$= 1.99\times10^{-25}\,Jm$$

3)
$$\cancel{E = nhf} \quad \cancel{E = nhf} \quad \cancel{f = \frac{nhf}{T}}$$
$$\cancel{f = \frac{E}{h}} \quad \cancel{1000000 = \frac{n}{T}h} \quad 1000 = nhf$$
$$\cancel{= \frac{1000000}{6.63\times10^{-34}}} \quad \cancel{\frac{n}{T} =} \quad n = \frac{1000}{6.63\times10^{-34}\times\frac{3\times10^{8}}{550\times10^{-9}}}$$
$$= 2.51\times10^{21}\,m^{-2}s^{-1}$$

4a)
$$\text{Effective } P = \frac{8}{100}\times60$$
$$= 4.8\,W$$
$$I = \frac{P}{4\pi R^2}$$
$$= \frac{4.8}{4\pi(2)^2}$$
$$= 0.0955\,Wm^{-2}\ (3s.f)$$

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4b) $P\ \cancel{E} = nhf$

$0.0955\ \cancel{4.8} = n(2 \times 1.6 \times 10^{-19})$

$n = 2.98 \times 10^{17}\ m^{-2}s^{-1}$

5a) $\cancel{E = hf_0}$ $\cancel{E = qV}$ $eV = hf - W_0$

$\cancel{f_0 =}$ $\cancel{qV = \frac{1}{2}mv^2}$

$\cancel{E = 1.6 \times 10^{-19} \times 0.25}$

$\cancel{= 4.0 \times 10^{-20}\ J}$

$W_0 = hf - eV$

$= (6.63 \times 10^{-34})(5.0 \times 10^{14}) -$

$(1.6 \times 10^{-19})(0.25)$

$= 2.92 \times 10^{-19}\ J$

5b) $\frac{1}{2}mv_{max}^2 = \cancel{eV + W_0}\ hf - \phi$

$\cancel{= (1.6 \times 10^{-19})(0.25) + 2.92 \times 10^{-19}}$

$= (6.63 \times 10^{-34})(6.5 \times 10^{14}) - 2.92 \times 10^{-19}$

$=$

$\frac{1}{2}mv_{max}^2 = eV_s$

$V_s = \frac{1}{2}mv_{max}^2 \div e$

$= 1.4 \times 10^{-19} \div 1.6 \times 10^{-19}$

$= 0.87\ V$

6a) $p = \frac{h}{\lambda}$

$= \frac{6.63 \times 10^{-34}}{0.15 \times 10^{-9}}$

$= 4.42 \times 10^{-24}\ kg\ ms^{-1}$

6b) $E_{k\,max} = \frac{p^2}{2m}$

$= 1.07 \times 10^{-17}\ J$

$V_s = \frac{E_k}{e}$

$= 67.0\ V\ (3\ s.f)$

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7ai) $I.E = 2810 eV$

7aii)
$$\frac{hc}{\lambda} = 2810 \times 1.6 \times 10^{-19}$$
$$\lambda = \frac{6.63\times10^{-34} \times 3\times10^{8}}{2810 \times 1.6 \times 10^{-19}}$$
$$= 4.42 \times 10^{-10} m \ (3s.f)$$

7aiii) ~~UV radiation~~ X-rays

7b)
$$\lambda = \frac{h}{p}$$
$$= \frac{h}{mv}$$
$$= \frac{6.63\times10^{-34}}{207\times9.11\times10^{-31}\times\frac{1}{100}\times3\times10^{8}}$$
$$= 1.07\times10^{-13} m \ (3s.f)$$

15ai)
$$E = hf$$
$$= \frac{hc}{\lambda}$$
$$E \propto \frac{1}{\lambda}$$
$$\lambda \propto \frac{1}{E}$$

$\downarrow\lambda$, $\uparrow E$, Transition: ~~1 to 5~~ 5 to 1

15aii) No. of lines = 10

15b) 4

15ci) None No transitions.

15cii) level to 2 $n=2$

15ciii) Level 1 to level 3 $n=3$ 3 lines

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8a)

$$I = \frac{N(hf)}{t \cdot A}$$

$$\frac{Nhf}{t} = \frac{IA}{N}$$

$$\frac{Nhf}{t} = 1.0 \times 10^{3} \times 4.0 \times 10^{-4}$$

$$= 0.40 J$$

8b)

$$\cancel{P = \frac{E}{t}} \quad \cancel{P = I \times A}$$

$$\cancel{= 1.0 \times 10^{3} \times 4.0 \times 10^{-4}}$$

$$P = \frac{0.4}{2 \times 4.0 \times 10^{-4} \times 1.0 \times 10^{20}}$$

$$=$$

8c) In 1 sec each e- gains $4.0 \times 10^{-21} J$

$$\text{Time taken} = \frac{4.50 \times 1.6 \times 10^{-19}}{4.0 \times 10^{-21}}$$

$$= 0.14 s$$

8d) Expt evidence → delay $\sim 10^{-9} < 0.14 s$

⇒ assumption is not valid

Wave model cannot be used to account for expt observation

8e) Min $E = 4.50 eV$

$$E = hf_0$$

$$f_0 = \frac{4.50 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$$

$$= 1.09 \times 10^{15} Hz$$

8f)

$$\cancel{\text{No. of photons} = \frac{1.0 \times 10^{3}}{4.0 \times 10^{-4}} \quad \frac{5.0 \times 10^{-10}}{4.50 \times 10^{-19} \times 4.5 \times 1.6}} \quad I = \frac{N(hf)}{At}$$

$$\frac{N}{t} = \frac{4.0 \times 10^{-4} \times 1.0 \times 10^{3}}{4.50 \times 1.6 \times 10^{-19}}$$

$$= 5.56 \times 10^{17}$$

11a)

$$\cancel{KE} \quad hf = \phi + \frac{1}{2} m v_{max}^2$$

$$\frac{1}{2} m v_{max}^2 = hf - \phi$$

$$\cancel{= (12.2 \times 10^{-9})(6.63 \times 10^{-34}) - 6.20 \times 1.6 \times 10^{-19}}$$

$$= (6.63 \times 10^{-34})\left(\frac{3.0 \times 10^{8}}{12.2 \times 10^{-9}}\right) - 6.20 \times 10^{-19} \times 1.6$$

$$= \cancel{95.6} \; 95.7 \text{ eV } (3s.f)$$

11b)

$$V_{max} = \sqrt{95.70 \times 1.6 \times 10^{-19} \times 2 \div (9.11 \times 10^{-31})}$$

$$= 5.80 \times 10^{6} ms^{-1}$$

Subject: Date:

8g) Assuming that all the photons hitting the cathode eject electrons

$$\text{Max photocurrent} = \frac{N}{t} \times 1.6 \times 10^{-19}$$
$$= \frac{Q}{t}$$
$$= 0.0889\ A$$

9bi) Photoelectric effect

9bii) Intensity ↑, no. of photons incident on metal ↑, ∴ no. of e^- ejected ↑, plate will discharge faster.

9c) ~~The~~ Threshold frequency.
It is likely that the frequency of light from the Na lamp < threshold freq. The photon energy will be less than the ϕ of zinc, hence no photoelectrons will be ejected.

10) Red light has a lower frequency than UV light. Energy of the photon ∝ freq. If the frequency of red light is < threshold frequency it will not eject any electrons regardless of its brightness. On the other hand, freq of UV > threshold freq ∴ dim UV light will be able to eject electrons since $hf_{UV} \geq \phi$

11c)

$$p = mv$$
$$= 1.25 \times 10^{-10} \times 9.11 \times 10^{-31}$$
$$\lambda = \frac{h}{p}$$
$$= \frac{6.63 \times 10^{-34}}{5.80 \times 10^{[illegible]} \times 9.11 \times 10^{-31}}$$
$$= 1.25 \times 10^{-10}\ m$$

Since $\lambda \approx d$, spacing between molecules, diffraction occurs. From the diffraction pattern we can ~~detect the~~ determine the exact spacing between molecules and the lattice structure.

Subject: Date:

12ai) $E = hf$

$= \frac{hc}{\lambda}$

$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{450 \times 10^{-9}}$

$= 4.42 \times 10^{-19} J$

12aii) $\cancel{P = \frac{E}{t}}$ $P = nE$

$\cancel{25 \times 10^{-6} =}$ $n = \frac{P}{E}$

$= \frac{25 \times 10^{-6}}{4.42 \times 10^{-19}}$

$= 5.66 \times 10^{13}$ photons/sec

12aiii) $I = 5.66 \times 10^{13} \times 1.6 \times 10^{-19}$

$= 9.05 \times 10^{-6} A$

12ab) $\cancel{\Delta E_{max} = hf}$

$\cancel{= \frac{hc}{\lambda}}$

$\cancel{\lambda = \frac{hc}{\Delta E_{max}}}$

$\cancel{= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{-1.3 \times 10^{-19} - (-2.2 \times 10^{-18})}}$

14a) $E = \frac{hc}{\lambda}$ $\uparrow \lambda, \downarrow E$

$\lambda = \frac{hc}{E}$

$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{-1.3 \times 10^{-19} - (-2.3 \times 10^{-18})}$

$= 1.99 \times 10^{-6} m$ (3s.f)

14b) No. of different spectral lines = 6

$\frac{1}{2} m V_{max}^2 = hf - \phi$

$= \frac{hc}{\lambda} - (\cancel{-1.3 \times 10^{-19}} \; 2.2 \times 10^{-18}))$

$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{82 \times 10^{-9}} - \cancel{2.07 \times 10^{-18}} \; 2.2 \times 10^{-18}$

$V_{max} = 7.04 \times 10^{5} ms^{-1}$

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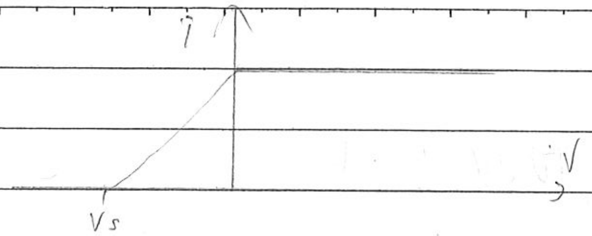
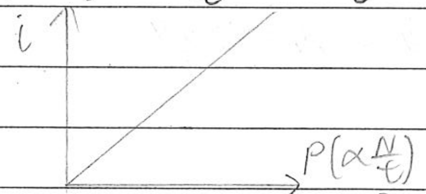
12b)



When $V > 0$, all photoelectrons emitted will be accelerated towards the anode by the E-field ∴ max current flows

When $V < 0$, there exists a retarding potential that will repel the less energetic e^- from the anode. As V becomes more negative more e^- will be repelled. At $V = V_s$ the most energetic e^- will be repelled and no i flows.

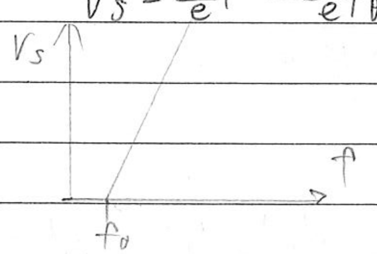
13a) $P = \frac{E}{t} = \frac{N(hf)}{t} \propto \frac{N}{t}$



Since $P \propto (\frac{N}{t}$ photons) more photons ~~will be~~ incident on surface per unit time ⇒ proportionally more e^- will be ejected ∴ $i \uparrow$

13c)

$$hf = \phi + \frac{1}{2}mv_{max}^2$$
$$hf = hf_0 + eV_s$$
$$V_s = \frac{h}{e}f - \frac{h}{e}f_0 \quad \text{—— } (*)$$



When $f < f_0$ no photoelectric emission ∵ $hf_0 < \phi$. When $f = f_0$ e^- will be ejected with 0 K.E, we do not need a stopping potential to repel the e^- hence $V_s = 0$. For $f > f_0$, (*) applies

	photon energy	$hf \geq \phi$
$n=4$ to $n=2$	8 eV	Yes
$n=2$ to $n=1$	10 eV	Yes
$n=3$ to $n=2$	5 eV	No

Subject: Date:

16a) $E = 20eV$

16b) Possible E: 5 eV, 10 eV, 15 eV

16c) E ~~of~~ photon from $n=4$ to $n=2$ transition ✓
$= -20eV - (-10eV)$
$= 8eV$
E of photon from $n=2$ to $n=1$ transition ✓
$= -10eV - (-20eV)$
$= 10eV$ $\therefore \phi < 8eV$
E of photon from $n=3$ to $n=2$ transition X
~~16d~~ $= -5.0eV - (-10eV)$
$= 5eV$ $\therefore \phi > 5eV$
ϕ of unknown metal $5eV < \phi < 8eV$

17a) $d \sin\theta = n\lambda$
$\lambda = \frac{1.23\times10^{-10} \sin 0.169}{2}$
$= 1.02\times10^{-11}\ m$ (3s.f)

17b) $\frac{1}{2}mv^2 = eV$
$K.E = 1.6\times10^{-19}\times5000$
$= 8.0\times10^{-16} J$
$\frac{p^2}{2m} = 8.0\times10^{-16}$
$p = \sqrt{8.0\times10^{-16}\times2\times9.11\times10^{-31}}$
$= 3.82\times10^{-23}\ kgms^{-1}$

16ci) The energy difference between any excited state and the ground state does not correspond exactly to 17eV. Therefore photon will not be absorbed.

16cii) Ionisation takes place

Subject: Photon : Is $E \geq I.E$?

Date:

Yes

K.E of ejected e $= E - I.E$

No

Is $E = E_f - E_i$

No

Photon not absorbed

Yes

Photon absorbed & excitation takes place

Is $\frac{p^2}{2m} \geq IE$?

Yes

Ionisation total K.E of $2e^-$ $= \frac{p^2}{2m} - IE$

No

Is $\frac{p^2}{2m} \geq E_f - E_i$

No

Nothing happens

Yes

excitation, bombarding e^- will recede $\bar{c}$ K.E $= \frac{p^2}{2m} - (E_f - E_i)$

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Subject: Date: ~~30-8~~ 2-3-07

1a i)

$$E = \frac{hc}{\lambda}$$
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{200 \times 10^{-9}}$$
$$= 9.9 \times 10^{-19}\ J$$

1a ii)

$$E = \frac{hc}{\lambda}$$
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{10 \times 10^{-3}}$$
$$= 2.0 \times 10^{-23}\ J$$

1b)

2a)

$$E = \frac{hc}{\lambda}$$
$$\lambda = \frac{hc}{E}$$
$$= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{5.0 \times 10^{6} \times 1.6 \times 10^{-19}}$$
$$= 2.49 \times 10^{-13}\ m$$

2b)

$$E = \frac{hc}{\lambda}$$
$$E\lambda = hc$$
$$= 6.63 \times 10^{-34} \times 3.0 \times 10^{8}$$
$$= 1.99 \times 10^{-25}\ \cancel{Js}\ J\,m$$

3)

$$\cancel{E = hf} \qquad \cancel{E = nhf} \qquad \cancel{f = \frac{nhf}{T}}$$
$$\cancel{f = \frac{E}{h}} \qquad \cancel{1000000 = \frac{n}{T} h} \qquad 1000 = nhf$$
$$\cancel{= \frac{1000000}{6.63 \times 10^{-34}}} \qquad \cancel{\frac{n}{T} =} \qquad n = \frac{1000}{6.63 \times 10^{-34} \times \frac{3 \times 10^{8}}{500 \times 10^{-9}}}$$
$$= 2.51 \times 10^{21}\ m^{-2} s^{-1}$$

4a)

$$\text{Effective } P = \frac{8}{100} \times 60$$
$$= 4.8\ W$$
$$I = \frac{P}{4\pi R^2}$$
$$= \frac{4.8}{4\pi (2)^2}$$
$$= 0.0955\ W\,m^{-2}\ (3\ s.f)$$

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4b) $P\ \cancel{E} = nhf$

$0.0955\ \cancel{4.8} = n(2\times 1.6\times10^{-19})$

$n = 2.98\times10^{17}\ m^{-2}s^{-1}$

5a) $\cancel{E = hf_0}$ $\cancel{f_0 =}$ $\cancel{E = qV}$ $eV = hf - W_0$

$\cancel{qV = \frac{1}{2}mv^2}$

$\cancel{E = 1.6\times10^{-19}\times 0.25}$

$\cancel{= 4.0\times10^{-20}\ J}$

$W_0 = hf - eV$

$= (6.63\times10^{-34})(5.0\times10^{14}) - (1.6\times10^{-19})(0.25)$

$= 2.92\times10^{-19}\ J$

5b) $\frac{1}{2}mv_{max}^2 = \cancel{eV + W_0}\ hf - \phi$

$\cancel{= (1.6\times10^{-19})(0.25) + 2.92\times10^{-19}}$

$= (6.63\times10^{-34})(6.5\times10^{14}) - 2.92\times10^{-19}$

$=$

$\frac{1}{2}mv_{max}^2 = eV_s$

$V_s = \frac{1}{2}mv_{max}^2 \div e$

$= 1.4\times10^{-19} \div 1.6\times10^{-19}$

$= 0.87\ V$

6a) $p = \frac{h}{\lambda}$

$= \frac{6.63\times10^{-34}}{0.15\times10^{-9}}$

$= 4.42\times10^{-24}\ kg\ ms^{-1}$

6b) $E_{k\,max} = \frac{p^2}{2m}$

$= 1.07\times10^{-17}\ J$

$V_s = \frac{E_k}{e}$

$= 67.0\ V\ (3s.f)$

Subject: Date:

7ai) $K.E = 2810\,eV$

7aii) $\frac{hc}{\lambda} = 2810 \times 1.6 \times 10^{-19}$

$\lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{2810 \times 1.6 \times 10^{-19}}$

$= 4.42 \times 10^{-10}\, m$ (3s.f)

7aiii) ~~UV radiation~~ X-rays

7b) $\cancel{\lambda_{dB}}\ \lambda = \frac{h}{p}$

$= \frac{h}{mv}$

$= \frac{6.63 \times 10^{-34}}{207 \times 9.11 \times 10^{-31} \times \frac{15}{100} \times 3 \times 10^{8}}$

$= 1.07 \times 10^{-13}\, m$ (3s.f)

15 ~~8~~ ai) $E = hf$

$= \frac{hc}{\lambda}$

$E \propto \frac{1}{\lambda}$

$\lambda \propto \frac{1}{E}$

$\downarrow \lambda$, $\uparrow E$, Transition: ~~1 to 5~~ 5 to 1

15aii) No. of lines = 10

15b) 4

15ci) None No transitions.

15cii) Level 1 to 2 $n=2$

15ciii) Level 1 to level 3 $n=3$ 3 lines

or

Subject: Date:

8a) $I = \frac{N(hf)}{t \cdot A}$

$\frac{Nhf}{t} = \frac{IA}{N}$

$\frac{Nhf}{t} = 1.0 \times 10^{3} \times 4.0 \times 10^{-4}$

$= 0.40 J$

8b) ~~$P = \frac{E}{t}$ $P = I \times A$~~

~~$= 1.0 \times 10^{3} \times 4.0 \times 10^{-4}$~~

$P = \frac{0.4}{2 \times 4.0 \times 10^{-4} \times 1.0 \times 10^{20}}$

$=$

8c) In 1 sec each e^- gains $4.0 \times 10^{-21} J$

Time taken $= \frac{4.50 \times 1.6 \times 10^{-19}}{4.0 \times 10^{-21}}$

$= 0.14 s$

8d) Expt evidence → delay ~ $10^{-9} < 0.14 s$

⇒ assumption is not valid

Wave model cannot be used to account for expt observation

8e) Min $E = 4.50 eV$

$E = hf_0$

$f_0 = \frac{4.50 \times 1.6 \times 10^{-19}}{6.63 \times 10^{-34}}$

$= 1.09 \times 10^{15} Hz$

8f) ~~No. of photons $= \frac{1.0 \times 10^{3} A}{4.50 \times 10^{-19} \times 1.6}$ $\frac{5.0 \times 10^{-18}}{4.50 \times 10^{-19} \times 4.5 \times 1.6}$~~ $I = \frac{N(hf)}{A t}$

$\frac{N}{t} = \frac{4.0 \times 10^{-4} \times 1.0 \times 10^{3}}{4.50 \times 1.6 \times 10^{-19}}$

$= 5.56 \times 10^{17}$

11a) $hf = \phi + \frac{1}{2} m v_{max}^2$

$\frac{1}{2} m v_{max}^2 = hf - \phi$

~~$= (12.2 \times 10^{-9})(6.63 \times 10^{-34}) - 6.20 \times 1.6 \times 10^{-19}$~~

$= (6.63 \times 10^{-34})\left(\frac{3.0 \times 10^{8}}{12.2 \times 10^{-9}}\right) - 6.20 \times 10^{-19} \times 1.6$

$=$ ~~95.6~~ $95.7 eV$ (3s.f)

11b) $v_{max} = \sqrt{95.70 \times 1.6 \times 10^{-19} \times 2 \div (9.11 \times 10^{-31})}$

$= 5.80 \times 10^{6} m s^{-1}$

Subject: Date:

8g) Assuming that all the photons hitting the cathode eject electrons

$$\text{Max photocurrent} = \frac{N}{t} \times 1.6 \times 10^{-19}$$
$$= \frac{Q}{t}$$
$$= 0.0889\ A$$

9bi) Photoelectric effect

9bii) Intensity ↑, no. of photons incident on metal ↑, ∴ no. of e^- ejected ↑, plate will discharge faster.

9c) ~~The~~ Threshold frequency.
It is likely that the frequency of light from the Na lamp < threshold freq. The photon energy will be less than the $\emptyset$ of zinc, hence no photoelectrons will be ejected.

10) Red light has a lower frequency than UV light. Energy of the photon $\propto$ freq. If the frequency of red light is < threshold frequency it will not eject any electrons regardless of its brightness. On the other hand, freq of UV > threshold freq ∴ dim UV light will be able to eject electrons since $hf_{UV} \geq \emptyset$

11c)

$$p = mv$$
$$= 1.25 \times 10^{-10} \times 9.11 \times 10^{-31}$$
$$\lambda = \frac{h}{p}$$
$$= \frac{6.63 \times 10^{-34}}{5.80 \times 10^{\text{[illegible]}} \times 9.11 \times 10^{-31}}$$
$$= 1.25 \times 10^{-10}\ m$$

Since $\lambda \approx d$, spacing between molecules, diffraction occurs. From the diffraction pattern we can ~~detect the~~ determine the exact spacing between molecules and the lattice structure.

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12ai)
$$E = hf$$
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$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{450\times10^{-9}}$$
$$= 4.42\times10^{-19}\,J$$

12aii)
$$\cancel{P = \frac{E}{t}} \quad P = nE$$
$$\cancel{25\times10^{-6} =} \quad n = \frac{P}{E}$$
$$= \frac{25\times10^{-6}}{4.42\times10^{-19}}$$
$$= 5.66\times10^{13} \text{ photons/sec}$$

12aiii)
$$I = 5.66\times10^{13}\times1.6\times10^{-19}$$
$$= 9.05\times10^{-6}\,A$$

12b)
$$\cancel{\Delta E_{max} = hf}$$
$$\cancel{= \frac{hc}{\lambda}}$$
$$\cancel{\lambda = \frac{hc}{\Delta E_{max}}}$$
$$\cancel{= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{-1.3\times10^{-19}-(-2.2\times10^{-18})}}$$

14a)
$$E = \frac{hc}{\lambda} \quad \uparrow \lambda, \downarrow E$$
$$\lambda = \frac{hc}{E}$$
$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{-1.3\times10^{-19}-(-2.3\times10^{-19})}$$
$$= 1.99\times10^{-6}\,m \ (3s.f)$$

14b) No. of different spectral lines = 6

~~14c~~
$$\frac{1}{2}mv_{max}^2 = hf - \phi$$
$$= \frac{hc}{\lambda} - (2.2\times10^{-18})$$
$$= \frac{6.63\times10^{-34}\times3.0\times10^{8}}{82\times10^{-9}} - \cancel{2.07\times10^{-18}}\ 2.2\times10^{-18}$$
$$v_{max} = 7.04\times10^{5}\,ms^{-1}$$

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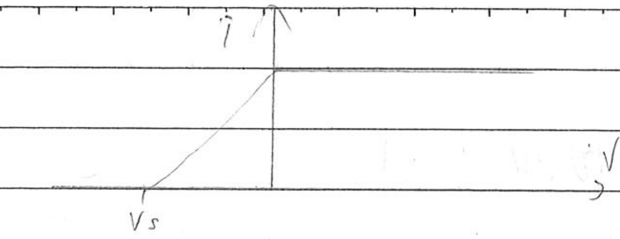
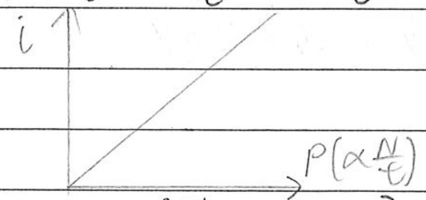
12b)



When $v > 0$, all photoelectrons emitted will be accelerated towards the anode by the E-field $\therefore$ max current flows

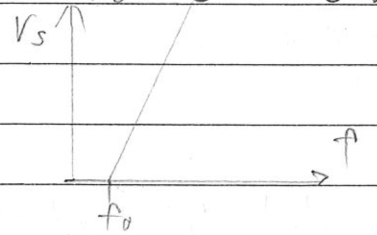
When $V < 0$, there exists a retarding potential that will repel the less energetic e^- from the anode. As V becomes more negative more e^- will be repelled. At $V = V_s$ the most energetic e^- will be repelled and no i flows.

13a) $P = \frac{E}{t} = \frac{N(hf)}{t} \propto \frac{N}{t}$



Since $P \propto (\frac{N}{t}$ photons) more photons ~~will be~~ incident on surface per unit time $\Rightarrow$ proportionally more e^- will be ejected $\therefore i \uparrow$

13c)
$$hf = \phi + \frac{1}{2}mv_{max}^2$$
$$hf = hf_0 + eV_s$$
$$V_s = \frac{h}{e}f - \frac{h}{e}f_0 \quad \text{—— } (*)$$



When $f < f_0$ no photoelectric emission $\therefore hf_0 < \phi$. When $f = f_0$ e^- will be ejected with 0 K.E, we do not need a stopping potential to repel the e^- hence $V_s = 0$. For $f > f_0$, (*) applies

	photon energy	$hf \geq 0$
$n=4$ to $n=2$	8eV	Yes
$n=2$ to $n=1$	10eV	Yes
$n=3$ to $n=2$	5eV	No

Subject: Date:

16a) $\mathcal{E} = 20eV$

16b) Possible $\mathcal{E}$: 5 eV, 10 eV, 15 eV

16d) $\mathcal{E}$ ~~of~~ photon from $n=4$ to $n=2$ transition ✓
$= -20eV - (-10eV)$
$= 8eV$
$\mathcal{E}$ of photon from $n=2$ to $n=1$ transition ✓
$= -10eV - (-20eV)$
$= 10eV$ $\therefore \phi < 8eV$
$\mathcal{E}$ of photon from $n=3$ to $n=2$ transition X
~~16d)~~ $= -5.0eV - (-10eV)$
$= 5eV$ $\therefore \phi \; 5eV$
ϕ of unknown metal $5eV < \phi < 8eV$

17a) $d \sin\theta = n\lambda$
$\lambda = \frac{1.23\times10^{-10} \sin 0.164}{2}$
$= 1.02 \times 10^{-11}$ m (3s.f)

17b) $\frac{1}{2}mv^2 = eV$
$KE = 1.6\times10^{-19} \times 5000$
$= 8.0 \times 10^{-16}J$
$\frac{p^2}{2m} = 8.0\times10^{-16}$
$p = \sqrt{8.0\times10^{-16}\times 2\times 9.11\times10^{-31}}$
$= 3.82 \times 10^{-23} kgms^{-1}$

16ci) The energy difference between any excited state and the ground state does not correspond exactly to 17eV. Therefore photon will not be absorbed.

16cii) Ionisation takes place

Subject: Photon : Is $E \geq I.E$?

Yes

No

K.E of ejected e $= E - I.E$

Is $E = E_f - E_i$

No

Yes

Photon not absorbed

Photon absorbed & excitation takes place

Is $\frac{p^2}{2m} \geq IE$?

yes

No

Ionisation total K.E of $2e^-$ $= \frac{p^2}{2m} - IE$

Is $\frac{p^2}{2m} \geq E_f - E_i$

No

yes

Nothing happens

excitation, bombarding e^- will recede $\bar{c}$ $K.E = \frac{p^2}{2m} - (E_f - E_i)$

Subject: Date: