10+1

E 29 040 A02

$\frac{2}{2}$,

$\left(\frac{2\pi\nu M}{\hbar}\right)^4$

$$|V_{11}|^2 = \frac{1}{3}\,\frac{\pi\alpha e^2\hbar\nu}{2^{\cancel{8}}}\,\frac{64\pi k^2}{(\alpha^2+k^2)^4} = \frac{\overset{32}{8}\pi^3 e^2\hbar\nu}{3}\,\frac{\alpha k^2}{(\alpha^2+k^2)^4}$$

$$= \frac{\overset{32}{8}\pi^3 e^2\hbar\nu}{3}\cdot\frac{\frac{\sqrt{MW}}{\hbar}\cdot\frac{2ME}{2\hbar^2}}{\left(\frac{2\pi\nu M}{\hbar}\right)^4}$$

$$= \frac{e^2\hbar^2}{3\cdot\pi\ \nu^3}\cdot M^{\frac{3}{2}}\cdot W^{\frac{1}{2}}E.$$

$\nu = \frac{\sqrt{2E}}{M^{\frac{1}{2}}}$.

$$\sigma_c = \frac{3\pi}{2\hbar}\cdot\frac{4\nu^2}{\hbar c^3}\cdot\frac{e^2\hbar^2}{3\pi\nu^3}\,\frac{M^{\frac{3}{2}}W^{\frac{1}{2}}E}{\frac{\sqrt{2E}}{M^{\frac{1}{2}}}},$$

$\hbar\nu = W + \frac{E}{2}$,

$2\pi\nu = \frac{W+\frac{E}{2}}{\hbar}$

$$= \frac{4\pi\hbar e^2}{(W+\frac{E}{2})M^2c^3}\ W^{\frac{1}{2}}\left(\frac{E}{2}\right)^{\frac{1}{2}}.$$

$\boxed{\frac{1}{8}}$

$2\pi\hbar\nu = W + \frac{E}{2}$

$\frac{4}{4\cdot 2\pi}$ $\frac{4\pi^2\nu^2 e^2\hbar}{2\ \nu}$

大阪帝國大學理學部 $\frac{Mv}{\hbar}=k$ **試驗答案用紙** (　　)

$$\sigma_c = \frac{3}{\hbar^2 c^3}\cdot 2\pi\nu^2 \cdot \frac{M}{k\hbar}\cdot |V_{21}|^2$$

$$|V_{21}|^2 = \left(\frac{e}{Mc}\right)^2 \int\cdots\int \varphi_2(\vec{r}_1\vec{r}_2)\, \vec{A}(\vec{r}_2)\, \vec{p}_2\, \psi_1(\vec{r}_1,\vec{r}_2)\, dv_1 dv_2$$

$$\cancel{\dot{x}_2} =$$

$$= \left(\frac{e}{Mc}\right)^2 \cdot \qquad (W+\tfrac{E}{2})$$

$$2\pi\hbar\nu = W+\frac{E}{2} \qquad k^2 = \left(\frac{Mv}{\hbar}\right)^2 = \frac{2M}{\hbar^2}E$$

$$|V_{21}|^2 = \frac{16\pi e^2\hbar\nu}{3}\,\frac{\alpha^2 k^2}{(\alpha^2+k^2)^4} = \frac{16\pi e^2\hbar\nu}{3}\,\frac{\frac{MW}{\hbar}\cdot\frac{2M}{\hbar^2}E}{\left(\frac{2\pi\nu M}{\hbar}\right)^4}$$

$$= \frac{16\pi e^2\hbar^2\nu}{3}\cdot\frac{WE}{(2\pi\nu)^4 M^2}$$

$$\sigma_c = \frac{3\times 2\pi\nu^2}{\hbar^2 c^3}\,\frac{M\hbar}{\sqrt{2ME}}\,\frac{WE}{(2\pi\nu)^4 M^2}\,\frac{16\pi e^2\hbar^2\nu}{3}$$

$$= \frac{2\, e^2\hbar\sqrt{E}\cdot W}{\cancel{(2\pi\hbar\nu)}\, c^3\pi^2\nu\sqrt{M}\cdot M}$$

$$= \frac{4\pi\cdot e^2\hbar^2\sqrt{E}\cdot W}{\pi^2\cdot c^3 W+\frac{E}{2}\ \sqrt{M}\cdot M}$$

π

$$= \frac{4\pi}{\pi^2}\cdot\frac{\frac{e^2\hbar}{M^2c^3}}{W+\frac{E}{2}}$$

$v = \sqrt{\frac{2E}{M}}$

$\frac{1}{2}Mv^2 = E$　　$k = \frac{\sqrt{2ME}}{\hbar}$　　$\nu = \frac{\hbar}{2\pi M}(\alpha^2+k^2)$

$16 \; 8\pi^3 e^2 \hbar \nu$

$\frac{2\pi\alpha e^2 \hbar \nu}{3} \cdot \frac{64\pi^2 k^2}{(\alpha^2+k^2)^4} = \frac{128\pi^3 e^2 \hbar \nu \alpha k^2}{3(\alpha^2+k^2)^4}$

$2\pi\hbar\nu = W + \frac{E}{2}$

$\alpha^2+k^2 = \frac{2\pi M(W+\frac{E}{2})}{\hbar^2}$

$\sigma_c = \frac{256\pi^4 e^2 \hbar \nu^3 \alpha k^2}{\hbar c^3 \sqrt{\frac{2E}{M}}} \cdot \frac{}{(\alpha^2+k^2)^4}$

$= \frac{256\pi^4 \hbar^3}{8\pi^3 M^3 c^3} \cdot \frac{M^{\frac{1}{2}}}{\sqrt{2E}} \cdot \frac{\alpha k^2}{(\alpha^2+k^2)}$

$= \cancel{32\pi} \cdot \frac{\hbar^3}{M^3} \cdot \frac{M^{\frac{1}{2}}}{\sqrt{2E}} \cdot \frac{M^{\frac{1}{2}} W^{\frac{1}{2}}}{\hbar} \cdot \frac{2ME}{\hbar^2} \cdot \frac{\hbar^2}{M(W+\frac{E}{2})}$

$= \frac{64\pi \cdot \hbar^2}{M c^3} \frac{\sqrt{EW}}{W+\frac{E}{2}}$

$18\pi\hbar -$

$\frac{8\pi\nu^2}{\hbar^2 c^3 v} \quad \frac{2\pi\alpha e^2 \hbar \nu}{3} \quad \frac{64\pi^2 M^2 v^2 \cdot \hbar^4}{\hbar^2 (2\pi\nu M)^4}$

$= \frac{16\hbar e^2}{M^2 c^3} \cdot \frac{\alpha v}{\nu} = \frac{16\hbar e^2}{M^2 c^3} \frac{\sqrt{\frac{MW}{\hbar}} \cdot \sqrt{\frac{2E}{M}}}{\frac{W+\frac{E}{2}}{2\pi\hbar}}$

$= 64\pi \; \frac{\hbar e^2}{M^2 c^3} \; \frac{\sqrt{\frac{WE}{2}}}{W+\frac{E}{2}}$

16

$$2\pi\int_0^\infty e^{-\alpha r} r^2 dr \int_{-1}^{+1} e^{ikrx}\cdot x\,dx = 2\pi\int_0^\infty e^{-\alpha r} r^2 dr \cdot \cancel{\frac{\;}{(kr)^2}}$$

$$\times -\int_{-1}^{+1} \frac{e^{ikrx}}{ikr} dx = -2\pi\int_0^\infty e^{-\alpha r} r^2 dr \; \frac{e^{ikr}-e^{-ikr}}{(ikr)^2}$$

$$= \frac{2\pi}{k^2}\int_0^\infty \left(e^{-(\alpha-ik)r} - e^{-(\alpha+ik)r}\right) dr$$

$$= \frac{2\pi}{k^2}\cdot\left(\frac{1}{\alpha-ik} - \frac{1}{\alpha+ik}\right) = \frac{2\pi}{k^2}\,\frac{+2ik}{\alpha^2+k^2}$$

$\cancel{\frac{e}{2Mc}}$

$$\boxed{\vec{\mathfrak{p}}_2 = \frac{1}{2} M\cdot(2\pi\nu i)\,\vec{r}}$$

$$\frac{\alpha}{2\pi}\cdot 4c^2\frac{\hbar}{\nu}\cdot\frac{\pi^2\nu^2 e^2}{c^2} = 2\pi\hbar\nu\alpha e^2$$

$$\frac{e\,r}{-(\alpha-ik)}\Big|\; + \int\frac{e\,dr}{(\alpha-ik)}$$

$$2\pi\int_0^\infty e^{-\alpha r} r^2 dr\,\frac{e^{ikr}+e^{-ikr}}{(ikr)} = \frac{2\pi}{(ik)}\int_0^\infty \left(e^{-(\alpha-ik)r} + e^{-(\alpha+ik)r}\right) r\,dr$$

$$= +\frac{2\pi}{(ik)}\left(\frac{1}{(\alpha-ik)^2} + \frac{1}{(\alpha+ik)^2}\right) = \pm\frac{4\pi i}{k}\,\frac{\alpha^2-k^2}{(\alpha^2+k^2)^2}$$

$$+\frac{4\pi i}{k}\cdot\frac{(\alpha^2+k^2)\pm\alpha^2+k^2}{(\alpha^2+k^2)^2} = \boxed{\frac{8\pi i\cdot k}{(\alpha^2+k^2)^2}}$$

$$4\pi \left(\frac{\alpha}{2\pi}\right) \int_0^\infty \left(\frac{e^{-\alpha r}}{r}\right)^2 r^2 dr = \int e^{-2\alpha r} dr$$

$$2\alpha \qquad \frac{1}{2\alpha}$$

$$\left(\frac{\pi \nu e}{c}\right)^2 \cdot \left(2c\sqrt{\frac{\hbar}{\nu}}\right)^2 \cdot \left(\frac{\alpha}{2\pi}\right) = \cancel{2\pi\alpha e^2 \hbar \nu}$$

$$\frac{\cancel{2}\pi\alpha e^2 \hbar \nu}{8}$$

$$\frac{\partial}{\partial \vec{r}_2} = \frac{1}{2}\frac{\partial}{\partial \vec{R}} - \frac{\partial}{\partial \vec{r}_2}$$

$$\vec{R} = \frac{\vec{r}_1 + \vec{r}_2}{2}$$

$$\vec{r} = \vec{r}_1 - \vec{r}_2$$

$$dX\,dx = \begin{pmatrix} \frac{\partial X}{\partial x_1} & \frac{\partial X}{\partial x_2} \\ \frac{\partial x}{\partial x_1} & \frac{\partial x}{\partial x_2} \end{pmatrix} = \begin{pmatrix} \frac{1}{2} & \frac{1}{2} \\ 1 & -1 \end{pmatrix}$$

$(-1, +1)$

$\boxed{(-2, +2)}$ $\quad 8. \quad = -1.$

$$dV_r\, dv_{\xi_r} = \begin{pmatrix} \frac{1}{2} & & & -1 & & \\ & \frac{1}{2} & & & -1 & \\ & & \frac{1}{2} & & & -1 \\ 1 & & & \frac{1}{2} & & \\ & 1 & & & \frac{1}{2} & \\ & & 1 & & & \frac{1}{2} \end{pmatrix}$$

$2\cancel{k}+$

$k(2^2+2) \quad 1 + \frac{1}{4} = \frac{5}{4}$

2

$= \left| \frac{1}{2} \cdot 1 \ \frac{1}{2} \right|$

大阪帝國大學理學部　**試驗答案用紙**　(　　)

$$\sigma_c = 4\pi\left(\frac{e^2}{\hbar c}\right)\left(\frac{\hbar}{Mc}\right)^2 \frac{\frac{k\hbar}{2\sqrt{M}}\cdot\frac{\alpha\hbar}{\sqrt{M}}}{2\pi\hbar\nu}$$

$$= \frac{e^2\hbar^x}{M^2c^3}\frac{k\alpha}{(\alpha^2+k^2)} \qquad 2\pi\nu = \frac{\hbar}{M}(\alpha^2+k^2)$$

$$4\pi^2\nu^2 = \frac{\hbar^2}{M^2}(\alpha^2+k^2)^2$$

$$8\pi^3\nu^3M^3 = \hbar^3(\quad)^3$$

$$= \frac{3\cdot 2\pi\nu^2}{\hbar^2c^3}\frac{M}{k\hbar}\cdot\frac{e^2k\hbar^4\alpha}{6\pi\nu^2M^3}\frac{k\alpha}{(\alpha^2+k^2)}$$

$$\times\frac{16\pi e^2\hbar\nu}{3}\times\frac{k\hbar^3}{32\pi^2\nu^3M^3}\frac{k\alpha}{(\alpha^2+k^2)}$$

$$\times\frac{\cancel{k\hbar^3\alpha}}{4\hbar^3}\frac{k^2\alpha}{(\alpha^2+k^2)^4}$$

$$\boxed{\frac{k^2\alpha}{4(\alpha^2+k^2)^4}}$$

$$\iiint\frac{e^{-\alpha r}e^{ikz}}{r}dv = 2\pi\cdot\int r\,dr\int e^{-\alpha r}\int_{-1}^{+1}e^{ikx}dx$$

$$= \int_0^\infty\frac{e^{-(\alpha-ik)r}-e^{-(\alpha+ik)r}}{k}r\,dr = \frac{1}{k(\alpha-ik)^2}-\frac{1}{k(\alpha+ik)^2}$$

$$\frac{\partial}{\partial k}(\quad) = \frac{-1}{k^2(\alpha-ik)^2}+\frac{1}{k^2(\alpha+ik)^2}-\frac{-2i}{k(\alpha-ik)^3}+\frac{2i}{k(\alpha+ik)^3}$$

$$= \frac{-(\alpha+ik)^2+(\alpha-ik)^2}{k^2(\alpha-ik)^2(\alpha+ik)^2}+\frac{2i(\alpha+ik)^3}{k(\alpha^2+k^2)^3}+\frac{2i(\alpha-ik)^3}{k(\alpha+\quad}$$

$$= \frac{4i\alpha k}{k^2(\alpha^2+k^2)^2}+\frac{4i\{\alpha^3+3\alpha k^2\}}{k(\alpha^2+k^2)^3}$$

$$= \frac{4i\alpha\{\alpha^2+3k^2-\alpha^2-k^2\}}{k(\alpha^2+k^2)^3} = \frac{8i\alpha k}{(\alpha^2+k^2)^3}$$

大阪帝國大學理學部　**試験答案用紙**　(　　)

$$\sigma_c \cong \frac{10^{-30}}{E^{\frac{1}{2}}}\frac{(4.4+E)}{(0.08+E)} \times$$

1.5 0.2 1.7　1.3

1.5 1.5 75 15 225

0.040000

$1.59 \times 10^{-6} \times$

$$\frac{3.1416}{137.3} \cancel{137}.3 \times \frac{(1.042\times10^{-27})^2}{(1.66\times10^{-24}\times 3\times10^{10})^2} \times (4.85)^2 (4.4)^{\frac{1}{2}} \left\{\frac{(2.2)^{\frac{1}{2}}}{(\cancel{4.4})} \mp (0.04)^{\frac{1}{2}}\right\}^2$$

1.66×10^{-24}

$\times 9\times10^{20}$

$$\times \frac{1}{E^{\frac{1}{2}}}\frac{(4.4+E)}{(0.08+E)}$$

$$= \frac{3.1416 \times (1.042)^2 \times (4.85)^2 \times (4.4)^{\frac{1}{2}} \times \frac{(1.3)^2}{(1.37)^2} \times 1.59}{137.3 \times \cancel{285} \times (1.66)^3 \times 9.81} \times \frac{10^{-60}}{10^{-320}}$$

3.1416	0.49715
$(1.042)^2$	0.03574
$(4.85)^2$	1.37148
	~~1.8640~~
$(4.4)^{\frac{1}{2}}$	0.32172
1.59	0.20140
	2.42749
	2.70649
	$\bar{1}$.72100

68574 2

64345

22011

1.373	0.13767
$(1.66)^3$	0.66033
81	1.90849
	2.70649

$\boxed{5.85}$

05260
1.69
4734
3156
526
1.31510

1.7
1.7
119
17
2.89

1.3
1.3
39
13
1.69

0.5260
2.89
4734
4208
1052
1.52014
1.59
1368
760
152
2.4168

0.8
1.5

4734
3156
526
0.88794

0.78794
1.59
709146
393970
78794
1.2528246

(　)　試驗答案用紙　大阪帝國大學理學部

$$\frac{3.5\times10^{-24}}{0.45\times10^{-24}} = 8..$$

$$\frac{2.5}{0.82} = 4..$$

$$n = 7.8\times10^{22}$$

$$\frac{10^{24}}{7.8\times10^{22}\times 2\times10^{5}\times0.45} = 0.04\times10^{3}$$

$\cancel{0.45}$

2.2

3.5×10^{-24}

$$\sqrt{\frac{2\times0.025\times1.59\times10^{-12}}{1.66\times10^{-24}}} = \sqrt{0.048}\times10^{6}$$

$$= \cancel{0.19}\times10^{6}$$

0.22

0.78
0.82
156
4

1.59
0.05
$1.66)0795(48$
664
1310

39
9
351

3.9
6.3
117
234
$24.57)100.00(0.04$

$\times1.59\times10^{-6}$

$.13$
22
702
782
$7722)10000$
7722
22780

$$\frac{3.1416\times(1.042)^2\times10^{-54}\times(4.85)^2\times(4.4)^{\frac12}(1.5\mp0.2)^2\times(4.4+E)}{137.3\times(1.66)^2\times9\times10^{-28}\times E^{\frac12}\times1.66\times9\times10^{-4}\times(0.08+E)}$$

$$= \frac{10^{-30}}{E^{\frac12}}\times0.5260\times\frac{1.69}{2.89} = \frac{10^{-30}}{E^{\frac12}}\times\frac{1.3}{2.4}$$

$$E\to0:\quad \frac{10^{-28}\times0.55}{E^{\frac12}}\times\left\{\begin{matrix}1.3\\2.4\end{matrix}\right. = \quad 0.$$

$$\frac{0.55}{0.025} = \cancel{\frac{4.1}{0.05}} = 2.2\times10^{-25}\times\left\{\begin{matrix}1.3\\2.4\end{matrix}\right.$$

1.3
55
65
65
7

$\left\{\begin{matrix}1.3\\2.4\end{matrix}\right.$

0.16

$$= \left\{\begin{matrix}0.45\\0.82\end{matrix}\right.$$

1.3
55
65
65
$16)715$
45

$$55\times\frac{3}{2} = \frac{165}{2} = 0.8$$

7
55
385

24
55
120
120
$13.$

$$\left\{\begin{matrix}1.3\times10^{-4}\\0.7\times10^{-4}\end{matrix}\right.$$

大阪帝國大學理學部　**試験答案用紙**　(　　)

$$\frac{\sigma_c}{\sigma_s} = \frac{\pi \frac{e^2}{Mc^2} \frac{\hbar}{Mc} \frac{1}{Mc^2} \left(\frac{2\varepsilon}{E_0}\right)^{\frac{1}{2}} (W \mp W)^2 (\mu+\ldots)(\mu A)^2}{\frac{4\pi\hbar^2}{M}\left(\frac{3}{4} + \frac{1}{4}\right)(W' + \frac{1}{2}E_0)}$$

$$= \frac{1}{(Mc^2)^2} \frac{e^2}{\hbar c} \frac{1}{4} \left(\frac{2W}{E_0}\right)^{\frac{1}{2}} \times \frac{W}{|W'|}$$

$$\left(\frac{W}{8E_0}\right)^{\frac{1}{2}}$$

大阪帝國大學理學部　**試驗答案用紙**　(　　)

$\left(\frac{e\hbar}{2Mc}\right)^2 (g_n - g_p)^2 \cdot \quad \left(2c\sqrt{\frac{\hbar}{\nu}} \cdot \frac{2\pi\nu}{c}\right)^2 \cdot \frac{8\pi^2}{2\hbar} \cdot \frac{4\nu^2}{\hbar c^3}$

$= \frac{32\pi^3 e^3 \hbar \nu^3}{M^2 c^5} \cdot (g_n - g_p)^2 \cdot \quad \frac{4\pi^2 \hbar^3 \nu}{M^2 c^2} = \left(\frac{e\hbar}{2Mc}\right)^2 16\pi^2 \cdot \hbar\nu.$

$\vec{H}_z = \sigma \frac{\partial}{\partial x_1}$ $\quad \left(\frac{e\hbar}{2Mc}\right)^2 \cdot \frac{128\pi^3 \nu^3}{\hbar c^3}$.

$-\mu_n(\mathrm{curl}\,\vec{H})(\vec{\nu}_1) - \mu_p(\mathrm{curl}\,\vec{H})(\vec{\nu}_2)$ $\quad \frac{2}{3} \times \frac{64\pi^4\nu^3}{\hbar c^3}$

$=$

$\sigma_c = \pi \frac{3.1416}{137.3} \frac{(2.09\times 10^{-14})^2 (4.85)^2 (4.4)^{\frac{1}{2}}}{E^{\frac{1}{2}}}$

$\times \frac{\{2.2 \mp \sqrt{0.004}\}^2 (E+4.4)}{931\ (E + 0.0018)}$

$= 0.54\times 10^{-30} \frac{1}{E^{\frac{1}{2}}} \times \frac{1.69}{2.89}$

$\frac{0.55\times 10^{-28}}{E^{\frac{1}{2}}} \times \frac{0.9}{1.5}$

1.69
0.54
676
845
8.?26
0.91

2.89
0.54
1156
1445
1.5606

4.85
4.85
2425
3880
1940
23.5225

23.5
2.1
235
47
49.35

3.1416

1.5
0.2

2.09
2.09
1881
418
4.3681
3.14
17472
4368
13104
2)13.71552
6.858

E = 1 eV.
0.55
0.9
0.495　0.5

0.55
1.5
275
55
0.825

0.16)0.5 → 3
48

0.16)0.82 → 5

0.7
931)685.8
6517
3410

0.54
128)68.6
640
460

1.3243
931
13243
4119
12357
1278.26

大阪帝國大學理學部　**試験答案用紙**　(　　)

$n = 7.8 \times 10^{22}$

$v = \sqrt{\frac{2kT}{M}} = \sqrt{\frac{2 \times 0.025 \times 1.59 \times 10^{-12}}{1.66 \times 10^{-24}}} = 0.22 \times 10^{6}$

1.59
0.05
1.66) 0.0795 (0.048
830
664
1310

0.22
0.22
44
44
0.0484

$\tau = \frac{1}{7.8 \times 10^{22} \times 0.22 \times 10^{6} \times 3 \times 10^{-25}}$

$= \frac{1}{0.78 \times 0.22 \times 3} \times 10^{-4} = 2 \times 10^{-4}$

1.2×10^{-4}

0.234
0.23
468
468
0.5 . . .

~~0.5~~

.78
5
390
22
78
78
0.8580

12
0.858) 1.000
858
1420

$\frac{35}{3} = 120$

$\frac{35}{5} = 7$