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Problem Set #1

1) a) $p = 1/2$ $\quad E_{S+}(S) = 20 \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = 2.5$

b) $p = 1/4$ $\quad$ d) Either $\boxed{2 \text{ or } 3}$ particles.

c) $p = 1/8$ $\quad$ e) Yes, but it's statistically inprobable

$P_{all\ 20} = (1/8)^{20} = 8.674 \cdot 10^{-19}$

2) A beam of electrons would be inpractical since they would interact heavily because of charge. Silver atoms would be better since they are electrically neutral and so would interact less.

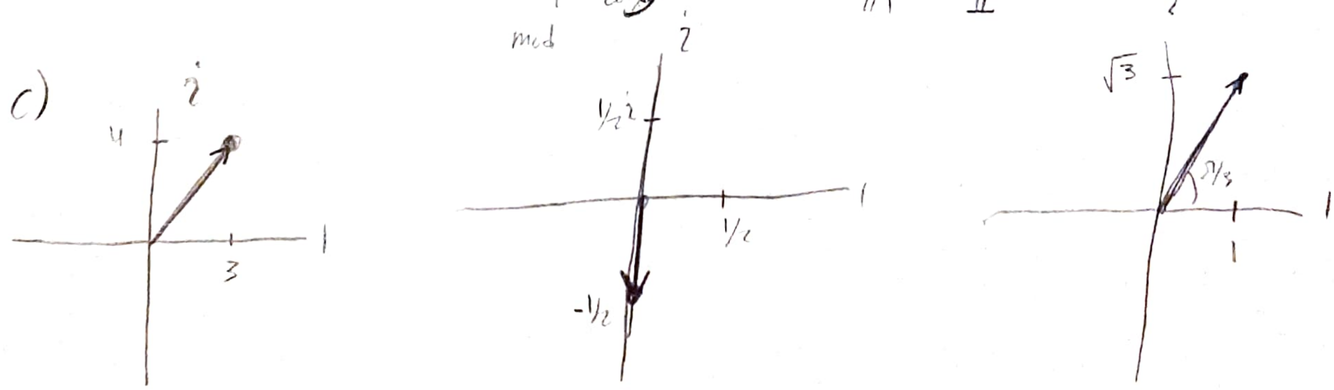
3) $c_1 = 3 + 4i$, $\quad |c_1| = 5$, $\quad \theta = \tan^{-1}(4/3) = 0.927$

$c_2 = -1/2$, $\quad |c_2| = 1/2$, $\quad \theta = \tan^{-1}(-\infty) = -\pi/4$

$c_3 = 2e^{i(\pi/3)}$, $\quad x = 2\cos(\pi/3) = 1$, $\quad y = 2\sin(\pi/3) = \sqrt{3}$

a) $c_1 = 5e^{i(0.927)}$, $\quad c_2 = \underset{\text{mod}}{\frac{1}{2}} e^{\overset{}{-i(\frac{\pi}{4})}_{\text{arg}}}$, $\quad c_3 = \underset{\mathbb{R}}{1} + \underset{\mathbb{I}}{\sqrt{3}\,i}$

c)



d) $|c_1|^2 = 25$ $\quad |c_2|^2 = 1/4$ $\quad |c_3|^2 = 4$

4) $c_1 = (2-3i)$, $c_2 = (3+4i)$

a) $c_1 + c_2 = (2+3) + i(4-3) = \boxed{5+i}$

b) $c_1 c_2 = (2-3i)(3+4i) = (6+12) + (8-9)i = \boxed{18-i}$

c) $c_1^* c_2 = (2+3i)(3+4i) = (6-12) + (8+9)i = \boxed{-6+17i}$

d) $c_1 + c_1^* = 2\,Re(c_1) = \boxed{4}$

e) $c_2 - c_2^* = 2\,Imag(c_2)i = \boxed{8i}$

5) $|\psi_1\rangle = \frac{1}{\sqrt{2}}|+\rangle + \frac{1}{\sqrt{2}}|-\rangle$, $|\psi_1|^2 = \frac{1}{2} + \frac{1}{2} = 1 \; = 1$

$|\psi_2\rangle = |+\rangle + e^{i\frac{\pi}{4}}|-\rangle$, $|\psi_2|^2 = 1 + 1 = 2 \; \neq 1$

$|\psi_3\rangle = |+\rangle - 2i|-\rangle$, $|\psi_3|^2 = 1 + 4 = 5 \; \neq 1$

a) $\boxed{\text{Only } \psi_1}$ is valid since $|\psi_1|^2 = 1$.

b)
$$\boxed{\begin{aligned} |\psi_2\rangle' &= \frac{1}{\sqrt{2}}|+\rangle + \frac{1}{\sqrt{2}}e^{i\frac{\pi}{4}}|-\rangle \\ |\psi_3\rangle' &= \frac{1}{\sqrt{5}}|+\rangle - \frac{2}{\sqrt{5}}i\,|-\rangle \end{aligned}}$$