Problem 1: (D)

Stern Gerlach experiment

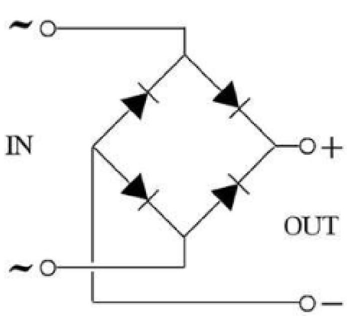
The magnetic moment **μ** of an atom is proportional to its angular momentum **J** and therefore is quantized. The Stern–Gerlach experiment involves sending a beam of particles through an inhomogeneous magnetic field and observing their deflection.

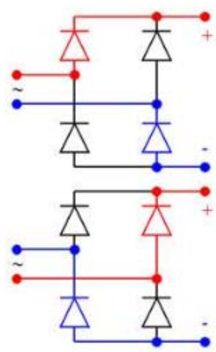
$F_z = \mu_z dB_z/dz$.

If j_z can take on 2j + 1 different values, μ_z can take on 2j + 1 different values, and we expect 2j + 1 different deflection angles. For Sodium j = s = ½. (One 3s electron outside closed shells.)

Problem 2: (A)

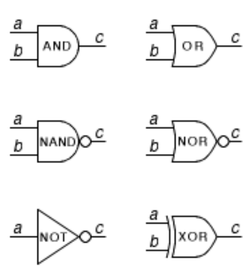
Diode-bridge rectifier





Problem 3: (C)

Logic gates (http://en.wikipedia.org/wiki/Logic_gate)



Schematic notation for digital logic gates

inputs		the output c					
a	b	*and* $a\,b$	*or* $a+b$	*nand* $\overline{a\,b}$	*nor* $\overline{a+b}$	*not* $\overline{a}$	*xor* $a \oplus b$
0	0	0	0	1	1	1	0
0	1	0	1	1	0		1
1	0	0	1	1	0	0	1
1	1	1	1	0	0		0

Boolean logic operations

AND $A \cdot B$

OR $A + B$

NOT $\overline{A}$ or $\sim A$

Problem 4: (B)

Compton scattering

$\Delta\lambda = (\lambda_f - \lambda_i) = [h/(mc)](1 - \cos\theta)$.

Problem 5: (A)

Interpreting a log-log plot

A function of the form $y = ax^b$ will appear as a straight line on a log-log plot.

Problem 6: (C)

Franck-Hertz experiment

http://hyperphysics.phy-astr.gsu.edu/hbase/FrHz.html

Problem 7: (B)

Random processes

A almost immediately decays into B. For B:

$dN/dt = -\lambda N$, $N(t) = N_0 \exp(-\lambda t)$, $\tau = 1/\lambda$ = mean life. $dN/dt = -N/\tau = -10^{22}/10\text{years} = -10^{21}/\text{year}$.

Problem 8: (B)

Stopping potential

$eV = hf - \Phi$

Problem 9: (A)

Pumps

Pump	Lowest Attainable Pressure	Typical Use
Mechanical pump	10^{-3} - 10^{-4} torr	roughing or backing pump
Diffusion pump	10^{-6} torr	vacuum lines
Turbomolecular pump	10^{-9} torr	high-vacuum systems

Problem 10: (B)

Error propagation

Weighted average = $\frac{\sum_i w_i x_i}{\sum_i w_i}$, $w_i = \frac{1}{(\Delta x)^2}$. Let a = 11, b = 10.

$$c = \frac{1 \cdot a + \frac{1}{4} \cdot b}{1 + \frac{1}{4}} = \frac{4a + b}{5} \quad , \quad \Delta c = \sqrt{\left(\frac{\partial c}{\partial a} \Delta a\right)^2 + \left(\frac{\partial c}{\partial b} \Delta b\right)^2}$$

$$\Delta c = \sqrt{\left(\frac{4}{5} 1\right)^2 + \left(\frac{1}{5} 2\right)^2} = \sqrt{\frac{16}{25} + \frac{4}{25}} = \sqrt{\frac{20}{25}} = \sqrt{\frac{4}{5}} = \frac{2}{\sqrt{5}}$$

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Problem 11: (A)

Non-contact measurement, (Planck radiation law)

Problem 12: (C)

Proportional counters

Problem 13: (D)

Gas laser

Problem 14: (E)

Conservative vector fields

Problem 15: (B)

Hermitian matrices

This is not a Hermitian matrix.