Table of some baryons

Particle	Symbol	Quark Content	Mass MeV/c^2	Mean lifetime (s)	Decays to
Proton	p	uud	938.3	Stable	Unobserved
Neutron	n	ddu	939.6	885.7±0.8	$p + e^- + \nu_e$
Delta	Δ^{++}	uuu	1232	6×10^{-24}	$\pi^+ + p$
Delta	Δ^{+}	uud	1232	6×10^{-24}	$\pi^+ + n$ or $\pi^0 + p$
Delta	Δ^{0}	udd	1232	6×10^{-24}	$\pi^0 + n$ or $\pi^- + p$
Delta	Δ^{-}	ddd	1232	6×10^{-24}	$\pi^- + n$
Lambda	Λ^0	uds	1115.7	2.60×10^{-10}	$\pi^- + p$ or $\pi^0 + n$
Sigma	Σ^+	uus	1189.4	0.8×10^{-10}	$\pi^0 + p$ or $\pi^+ + n$
Sigma	Σ^0	uds	1192.5	6×10^{-20}	$\Lambda^0 + \gamma$
Sigma	Σ^-	dds	1197.4	1.5×10^{-10}	$\pi^- + n$
Xi	Ξ^0	uss	1315	2.9×10^{-10}	$\Lambda^0 + \pi^0$
Xi	Ξ^-	dss	1321	1.6×10^{-10}	$\Lambda^0 + \pi^-$
Omega	Ω^-	sss	1672	0.82×10^{-10}	$\Lambda^0 + K^-$ or $\Xi^0 + \pi^-$

Table of some mesons

Particle	Symbol	Anti-particle	Quark Content	Mass MeV/c^2	Mean lifetime (s)	Principal decays
Charged Pion	π^+	π^-	$u\bar{d}$	139.6	2.60×10^{-8}	$\mu^+ + \nu_\mu$
Neutral Pion	π^0	Self	$u\bar{u} - d\bar{d}$	135.0	0.84×10^{-16}	2γ
Charged Kaon	K^+	K^-	$u\bar{s}$	493.7	1.24×10^{-8}	$\mu^+ + \nu_\mu$ or $\pi^+ + \pi_0$
Neutral Kaon	K^0	$\bar{K}^0$	$d\bar{s}$	497.7		
Eta	η	Self	$u\bar{u} + d\bar{d} - 2s\bar{s}$	547.8	5×10^{-19}	
Eta Prime	η'	Self	$u\bar{u} + dd + s\bar{s}$	957.6	3×10^{-21}	

Table of leptons

particle			associated neutrino		
Name	Charge (e)	Mass (MeV)	Name	Charge (e)	Mass (MeV)
Electron (e^-)	-1	0.511	Electron neutrino (ν_e)	0	< 0.000003
Muon (μ^-)	-1	105.6	Muon neutrino (ν_μ)	0	< 0.19
Tau (τ^-)	-1	1777	Tau neutrino (ν_τ)	0	< 18.2

Problem 1: (D)

Doped semiconductors

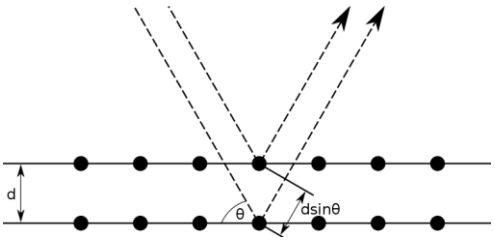
Dopants for n-type silicon or germanium semiconductors come from column 5 of the periodic table

Problem 2: (D)

Particle physics discoveries

Problem 3: (C)

Bragg reflection



$2d\sin\theta = m\lambda$

Problem 4: (D)

Conservation of lepton number

The weak interaction also conserves lepton family number.

Problem 5: (E)

Statistical Mechanics

Problem 6: (D)

Superconductors, Cooper pairs

Problem 7: (D)

Flavor-changing reactions

The weak interaction induces flavor-changing reactions, such as $p \rightarrow n + e^{+} + \nu_e$.

Problem 8: (B)

The eigenvalues of a Hermitian matrix

Denote the eigenvalues by λ. $(2 - \lambda)^2 - 1 = 0$.

Problem 9: (E)

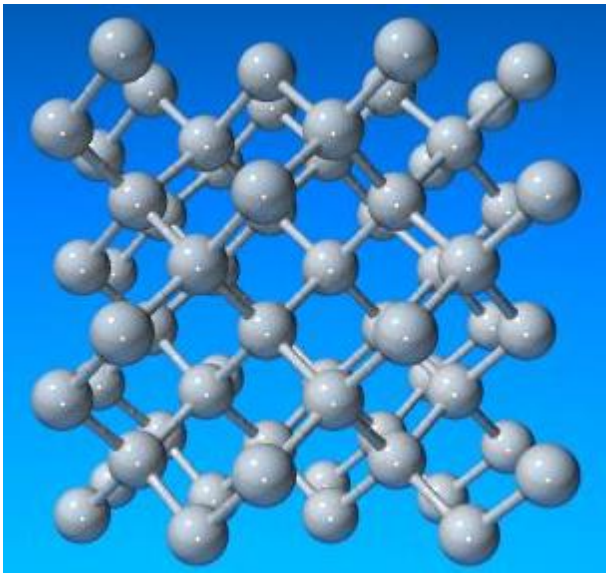
Doped semiconductors

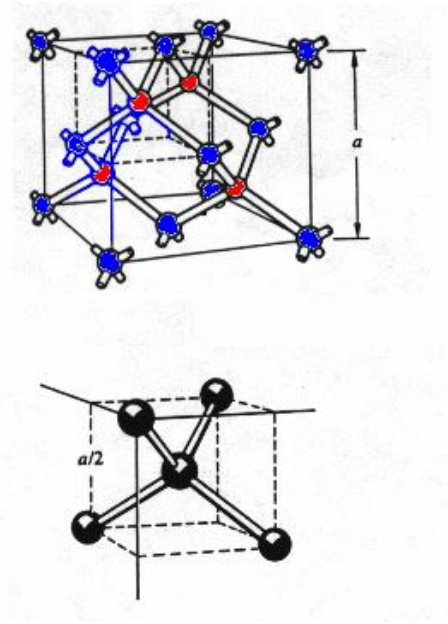
Dopants increase the conductivity.

Problem 10: (D)

Diamond Structure

The diamond lattice consists of two interpenetrating face centered cubic Bravais lattices, displaced along the body diagonal of the cubic cell by one quarter the length of the diagonal.





Problem 11: (B)

Electron capture reaction

$p + e \rightarrow n + \nu_e$.

Problem 12: (E)

Conservation of strangeness in the strong interaction

All other answers are wrong.

Problem 13: (B)

Conservation laws

All the other reactions are forbidden.

Problem 14: (A)

Wien law: $\lambda = \text{constant}/T$

When the temperature of the background was 4 times higher than now, the peak wavelength of the cosmic microwave background radiation was ¼ as large as it is now, the cosmic length scale was ¼ what it is now.

Problem 15: (A)

Energy conservation