ϕ507, PROBLEMS ; Spr. 1995.

507 (95)

#	PTS	SUBJECT	REMARKS
(14) (44)	20	2-level problem : exact energies & eigenfcns of $\mathcal{H} = \mathcal{H}_0 + V$.	#(50), ϕ507('94).
(40) (45)	20	2-level problem : $V_{kk} = \begin{pmatrix} -\alpha & \gamma \\ \gamma & \beta \end{pmatrix} U$. Establish level-crossing thm.	#(51), ϕ507('94).
(15) (46)	20	Transition lineshape for "chirped" pulse : $U = \mathcal{E}(t)\exp\{i[\theta(t) - \nu]t\}$.	#(52), ϕ507('94).
(40) (47)	20	Analyse $O(V^2)$ processes for pulse ; $V = 2\hbar\Omega(x)\cos\omega t$, $0 \le t \le \tau$.	#(53), ϕ507('94).
(16) (48)	20	tD pert^n ; $V(t) = 2\hbar\Omega\cos\omega t$. Exact resonance $\omega = \omega_{km}$.	#(54), ϕ507('94).
(40) (49)	10	$V(t) = (\hbar A/\tau\sqrt{\pi})e^{-t^2/\tau^2}$. Show : $P(\text{gnd}\to\text{out}) = (A^2)_{00} - (A_{00})^2$, as $\tau\to 0$.	-new-
(50)	10	1D SHO : spring cnst $k \to Nk$, suddenly. Gnd-state probability?	#(56), ϕ507('94).
(17) (51)	10	2-particle system : $m_1 + m_2$. Find $\hat{\mathbb{R}}$, $\hat{\mathbb{L}}$ & $\hat{\mathbb{K}}$ in CM cds $\mathbb{r}$ & $\mathbb{R}$.	#(59), ϕ507('94).
(45) (52)	15	$V(r) = -B/r + A/r^2$. Show $E_{n\ell} = -\frac{1}{2}E_0/(n+\Delta_\ell)^2$. Analyse $\Delta_{n\ell}$.	#(60), ϕ507('94).
(53)	10	Show $[J_x, J_y] = i\hbar J_z$ follows from relations between rotation operators.	-new-
(54)	10	Prove Dirac Identity : $(\boldsymbol{\sigma}\cdot\mathbb{A})(\boldsymbol{\sigma}\cdot\mathbb{B}) = \mathbb{A}\cdot\mathbb{B} + i\boldsymbol{\sigma}\cdot(\mathbb{A}\times\mathbb{B})$.	#(63), ϕ507('94).
(18) (55)	10	Explicit Clebsch-Gordan transform for H : $2P_{3/2}$ & $2P_{1/2}$.	#(65), ϕ507('94).
(45) (56)	15	Find CG coefficients for $s = 1/2$ and arbitrary ℓ.	#(66), ϕ507('94).
(57)	10	Derive Landé g-factor. Apply to 2P & 2S states in H.	#(67), ϕ507('94).
(58)	10	Find relative transition rates for $2P_{3/2} \to 2S_{1/2}$ in H via $\mathcal{E}\cdot\mathbb{r}$.	#(68), ϕ507('94).
(19) (59)	10	$\mathcal{H} = -\boldsymbol{\mu}\cdot\mathbb{H}$ for spin 1/2 : eigenenergies & eigenspinors.	#(69), ϕ507('94).
(40) (60)	10	For spin 1/2, analyse : $\mathcal{E} = g_1 g_2(\mu_0^2/r^3)[\mathbb{S}_1\cdot\mathbb{S}_2 - 3(\mathbb{S}_1\cdot\hat{\mathbb{r}})(\mathbb{S}_2\cdot\hat{\mathbb{r}})]$.	#(70), ϕ507('94).
(61)	20	Derive hfs energies : $\mathcal{E}_{hfs} = \zeta_{hfs}(\mathbb{I}\cdot\mathbb{J})$. Find ζ_{hfs} for 1e- atoms.	#(71), ϕ507('94).
(20) (62)	15	KG Eqtn : two-component formulation for a free particle.	#(74), ϕ507('94)
(40) (63)	15	Classical scattering : relation of lab & CM scattering χs.	#(18), ϕ507('93).
[290] (64)	10	Verify $G(\mathbb{r}, t; \mathbb{r}_0, t_0) = -i\theta(t-t_0)\sum_n(\text{states})$ is Schrödinger's G-fcn.	#(76), ϕ507('94)
MID TERM (1)	40	Atomic tritium decay : ${}^3H_1 \to {}^3He_2 + e + \bar{\nu}$. Probability of He^+ ground state.	-new-
(2)	40	Moments $\langle r^N\rangle$ for 1e atom gnd state. r_{mp} & variance Δr.	-new-
(200 pts) (3)	40	For $\mathbb{A}$ & $\mathbb{B}$ as $\mathbb{T}$-vectors, show : $[\mathbb{J}, \mathbb{A}\cdot\mathbb{B}] \equiv 0$. Why is $\mathbb{A}\cdot\mathbb{B}$ an invt?	#(64), ϕ507('94).
(4)	40	Find the Schrödinger limit for Klein-Gordon planewaves.	#(2), ϕ507('92) MidT.
(5)	40	Analyse scattering from ptl. : $V(r) = V_0 a\,\delta(r-a)$, via Born Approxn.	#(5), ϕ507('93) Final.
(21) (65)	20	Scattering by a sph. well via Born approxn : total σ & validity.	(19)-(20), ϕ507('93).
(45) (66)	15	e-Atom Scattering via Born approxn. Notion of form-factor.	#(22), ϕ507('93).
(67)	10	Scattering from a screened Coulomb potl via phase shifts.	#(24), ϕ507('93).
(22) (68)	30	e-H atom scattering : form of $V(r)$ & total cross-section.	#(23), ϕ507('93).
(40) (69)	10	2N identical particles in a SHO potl : boson v. fermion energies & sizes.	-new-
(23) (70)	10	Singlet-triplet splitting for 2e system : Dirac's Exchange Potl.	#(82), ϕ507('94).
(40) (71)	15	Average sizes in the Thomas-Fermi atom : Z-scaling.	#(83), ϕ507('94).
(72)	15	Size of the e-e repulsion term in the Thomas-Fermi atom.	#(84), ϕ507('94).
(24) (73)	25	Ground-state of 2e-atom w/ nucleus = Ze : variational calcn.	#(85), ϕ507('94).
(40) (74)	15	For Dirac matrices : $\{\gamma_\mu, \gamma_\nu\} = 2\delta_{\mu\nu}$, find eigenvalues, Tr & rank.	#(86), ϕ507('94).
(25) (75)	10	Continuity eqtn for Dirac particle in an external field $(\mathbb{A}, i\phi)$.	#(87), ϕ507('94).
(35) (76)	10	Dirac (q, m) in $(\mathbb{A}, i\phi)$. Show, by charge conj^n : $\psi(q,\beta) \to \psi_c(-q,\beta)$.	#(88), ϕ507('94).
[490] (77)	15	Dirac free particle : analyse $p_k = mc\alpha_k$ as a momentum operator.	#(89), ϕ507('94).

ϕ507 ('95) PROBLEMS (cont'd)

ϕ507 (95)

#	PTS	SUBJECT	REMARKS
(26) (34) (35) (39)	35	$2S_{1/2}$ - $2P_{1/2}$ system : measure S by rf & DC experiments. ~~~ no problem ~~~	~#(42), ϕ507 ('92).
FINAL EXAM (300 pts) (1)		Detailed balancing via 1st order time-dept. pert^{n} theory.	-new-
(2)		For ℓ mom^{m} ladder operators : $J_{\pm}\|\ell m\rangle = \{^{A}_{B}\}\|\ell m\pm1\rangle$, find A & B.	#(4), ϕ507('94) MT.
(3)		Spectroscopic features of μ^+e^- : Balmer α shift & $\Delta\nu$(hfs).	#(2), ϕ507('93) FE.
(4)		Scattering from a periodic potential : $V(R+a) = V(R)$, via 1st Born.	#(3), ϕ507('93) MT.
(5)		2 identical particles in N levels : count symm. & antisymm. states.	-new-
(6)		Free neutrino via the Dirac Eqtn : ℓ mom^{m} conserved? helicity?	#(5), ϕ507('94) FE.
(7)		SHO quantization of scalar (π meson) field : proof of commutator.	#(7), ϕ507('92) FE.

TOTALS : 35 homework problems, worth 525 pts (51%)

12 exam problems, worth 500 pts. (49%)

47 1025 pts