Exercise	Area	Goal	Difficulty	Solution	Status
Chapter 1: Special Relativity *Schutz(2022) has same section and equation numbers as Schutz(2009)* *No new exercises*					
1.1(c,e,g)	*convert to natural units from SI*	*practice*	*straightforward*	*full solution in Student Manual, and Mathematica Notebook*	*double checked*
1.1(b,d,f,h)	*convert to natural units from SI*	*practice*	*straightforward*	*full solution in Instructors' Manual*	*double checked*
1.2(a,c,e)	*convert from natural units to SI*	*practice*	*straightforward*	*full solution in Student Manual, and Mathematica Notebook*	*double checked*
1.2(b,d)	*convert from natural units to SI*	*practice*	*straightforward*	*full solution in Instructors' Manual*	*double checked*
1.3(c,g,h,i)	*spacetime diagrams, construction of axes*	*practice*	*straightforward*	*full solution in Student Manual (support in notebook)*	*added (g)*
1.4	*algebra, notation*	*practice*	*straightforward*		
1.5	*spacetime diagrams*	*practice*	*straightforward*	*hints for (c), (d) in Student Manual*	*improved hints*
1.6	*interval of SR is a symmetric quadratic form*	*follow text*	*Intermediate*	*full solution in Student Manual*	*clarified*
1.7	*interval of SR*	*follow text*	*straightforward*	*full solution in Instructors' Manual*	*Alexsandr found typo.*
1.8	*interval of SR*	*follow text*	*straightforward*	*full solution in Student Manual*	*made more succinct*
1.9	*spacetime diagrams*	*follow text*	*straightforward*	*full solution Student Manual*	*more detail, new figure*
1.10	*timelike, spacelike, null*	*practice*	*straightforward*	*full solution in Instructors' Manual*	*new solution*
1.11	*spacetime diagrams*	*follow text*	*straightforward*	*hint in Student Manual*	
1.12	*consistency of time dilation*	*follow text*	*Intermediate*	*full solution in Student Manual*	*rewrote solution*
1.13	*time dilation in particle physics*	*deepen*	*straightforward*	*hint in Student Manual*	*expanded*

1.14	*small-velocity approximation, time dilation, length contraction, velocity addition*	*extend*	*straightforward*	*full solution in Student Manual (support in Notebook)*	*double checked, indexed*
1.15(a,b)	*very-large-velocity approximation, time dilation, length contraction*	*extend*	*straightforward*	*full solution Instructors' Manual*	*typo in Schutz's question*
1.15(c)	*very-large-velocity approximation, velocity addition*	*extend*	*difficult*	*full solution Instructors' Manual*	*Schutz's answer assumes v>0.*
1.16	*derive time dilation, length contraction*	*extend*	*straightforward*	*full solution in Student Manual*	*double checked, indexed*
1.17	*pole-vault in barn problem*	*deepen*	*Intermediate*	*no solution*	
1.18	*velocity addition with hyperbolic functions*	*extend*	*Intermediate*	*full solution in Student Manual*	*minor clarification*
1.19	*Lorentz transformation for a boost using velocity parameter (hyperbolic functions)*	*extend*	*straightforward*	*full solution in Instructors' Manual*	*minor clarification of question, improved solution*
1.20	*Lorentz transformation for a boost, matrix form*	*extend*	*straightforward*	*full solution in Student Manual*	*clarified question, provided reference*
1.21	*timelike and spacelike separated events*	*extend*	*Intermediate*	*full solution for (a) in Instructors' Manual*	*minor improvements*

Chapter 1: supplementary problems

SP1.1	*inertial frames in SR*	*deepen*	*Intermediate*	*full solution in Student Manual*	*verifed*
SP1.2	*inertial frames in GR*	*extend*	*Intermediate*	*full solution in Instructor's Manual*	*rewrote*
SP1.3	*Minkowski diagram*	*follow text*	*straightforward*	*full solution in Student Manual*	*minor improvement*
SP1.4	*Lorentz transformation of a boost*	*practice*	*straightforward*	*full solution in Instructor's Manual*	*fixed minor typo*
SP1.5	*Newton's first law*	*extend*	*straightforward*	*full solution in Student Manual*	*verified, indexed*
SP1.6	*Lorentz transformation*	*deepen*	*straightforward*	*Hint in Instructor's Manual*	
SP1.7	*Lorentz transformation*	*extend*	*advanced*	*full solution in Student Manual*	*improved solution*

SP1.8	*spacetime isotropy*	*follow text*	*straightforward*	*full solution in Instructor's Manual*	*verified*
SP1.9	*spacetime diagram*	*deepen*	*straightforward*	*full solution in Student Manual*	*minor improvements*
SP1.10	*explicit c in Lorentz transformation*	*practice with units*	*straightforward*	*full solution in Instructor's Manual*	*minor improvements*
SP1.11	*clock synchronization*	*practice*	*straightforward*	*hint in Student Manual*	*verified*
SP1.12	*small velocity limit of Lorentz transformation , Galilean transformation asymmetry*	*extend*	*straightforward*	*full solution in Instructor's Manual*	*expanded*
SP1.13	*spacetime diagram, geometric construction*	*deepen*	*straightforward*	*full solution in Student Manual*	*minor improvement*
SP1.14	*simultaneity in moving frame*	*follow text*	*straightforward*	*hint in Student Manual* *full solution in Instructor's Manual*	*wrote solution*
SP1.15	*time dilation*	*follow text*	*straightforward*	*full solution in Student Manual*	*minor improvement*

Chapter 2: Vector analysis in special relativity

Schutz (2022) has the same section and equation numbers as Schutz(2009)

Exercise	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
2.1	*practice summation convention*	*practice*	*straightforward*	*full solution in Instructor's Manual (e) in Maple Workbook*	*wrote solution*
2.2	*identify free and dummy indices*	*practice*	*straightforward*	*full solution in Student Manual*	*verified*
2.3	*practice summation convention*	*practice*	*straightforward*	*full solution in Instructor's Manual*	*verified*
2.4	*practice linear combinations of vectors*	*practice*	*straightforward*	*full solution in Instructor's Maple Workbook*	*verified*

2.5	*linear independence*	*deepen*	*straightforward*	*full solution in Student Manual*	*minor improvements, citation to Boas(2006)*
2.6	*spacetime diagram, basis vectors*	*deepen*	*straightforward*	*description in instructors' manual*	*verified*
2.7	*basis vectors, Kronecker delta*	*follow text*	*straightforward*	*full solution in Student Manual*	*minor improvements*
2.8	*zero vector frame invariance*	*follow text*	*Intermediate*	*full solution in Instructor's Manual*	*verified*
2.9	*summing over indices*	*deepen*	*straightforward*	*full solution in Student Manual*	*fixed typo, minor improvements*
2.10	*careful reasoning about equality of a sum of elements*	*follow text*	*Intermediate*	*full solution in Student Manual*	*minor improvements*
2.11	*Lorentz transformation applied to 4-vectors*	*follow text*	*Intermediate*	*full solution in Instructor's Manual*	*clarified question, fixed typo*
2.12	*magnitude of 4-vectors, invariance under Lorentz transformation*	*practice*	*straightforward*	*hints in Student Manual*	*verified*
2.13	*Lorentz transformationof consecutive boosts*	*deepen*	*straightforward*	*solution in Instructor's Manual, calculations in Maple*	*minor improvements*
2.14	*boost in z direction*	*deepen*	*straightforward*	*full solution in Student Manual*	*verified, indexed*
2.15	*four-velocity, Lorentz transformation*	*convert between 3- and 4-velocity*	*Intermediate*	*full solution in Instructor's Manual*	*Alexsandr helped*
2.16	*Einstein law of composition of velocities*	*deepen*	*straightforward*	*full solution in Student Manual*	*Added warning about four-velocity in GR*
2.17	*four-vector, requirement to be four-velocity*	*extend*	*difficult*	*full solution in Instructor's Manual*	*fixed*
2.18	*Sum of orthogonal spacelike vectors is spacelike; timelike and null vectors not orthogonal*	*extend*	*Intermediate*	*full solution in Student Manual*	*improved*
2.19	*uniform acceleration*	*extend*	*difficult*	*full solution in Instructor's Manual*	*more rigorous, verified calculations*

2.20	*compute components of four-velocity and four-acceleration*	*practice*	*straightforward*	*full solution in Student Manual*	*Verified*
2.21	*hyperbolic motion*	*extend*	*Intermediate*	*full solution in Instructor's Manual*	*significantly simplified*
2.22	*particle energy, four-momentum, rest mass, three-velocity, CM-frame*	*practice*	*straightforward*	*full solution in Student Manual*	*minor improvements*
2.23	*particle energy, binomial series*	*practice*	*straightforward*	*full solution in Instructor's Manual*	*minor improvements*
2.24	*four-momentum conservation applied to electron-positron annihilation*	*deepen*	*straightforward*	*full solution in Student Manual*	*minor improvements*
2.25	*Doppler shift*	*extend*	*straightforward*	*full solution in Student Manual*	*minor improvements, fixed typo*
2.26	*energy of a relativistic massive particle*	*extend*	*straightforward*	*full solution in Instructor's Manual*	*Fixed*
2.27	*rest mass affected by temperature*	*deepen*	*straightforward*	*full solution in Student Manual*	*minor improvements, fixed typo (introduced by typesetter)*
2.28	*invariance of dot product under Lorentz transformation, timelike, spacelike, null*	*practice*	*straightforward*	*full solution in Instructor's Manual and Maple.*	*new solution*
2.29	*time derivative of the norm of the four-velocity*	*follow text*	*straightforward*	*full solution in Student Manual*	*minor improvements*
2.30	*energy of a particle using four-velocity of frame*	*practice*	*straightforward*	*full solution in Instructor's Manual and Maple.*	*minor improvements*
2.31	*photon reflecting from (or absorbed by) mirror*	*deepen*	*Intermediate*	*full solution in Student Manual*	*added figure, minor improvements*
2.32	*Compton scattering*	*extend*	*difficult*	*hints in Student Manual* *full solution in Instructor's Manual and Maple.*	*New solution*

2.33	*Compton scattering of CMB photon with cosmic ray*	*extend*	*difficult*	*full solution in Student Manual*	*more rigorous solution*
2.34	*prove properties of scalar product*	*deepen*	*straightforward*	*hint in Student Manual* *partial solution in Instructor's Manual*	*New hint*
2.35	*transformation of basis vectors, relation to metric*	*deepen*	*straightforward*	*full solution in Student Manual*	*Minor improvements*

Chapter 2: supplementary problems

SP 2.1	*three-velocity, four-velocity relation*	*extend*	*straightforward*	*full solution in Student Manual*	*Verified*
SP 2.2	*Lorentz transformation, symmetry*	*deepen*	*straightforward*	*full solution in Instructor's Manual and Maple.*	*minor improvements*
SP 2.3	*Lorentz transformation, boost in arbitrary direction*	*extend*	*Intermediate*	*full solution in Student Manual*	*fixed typo*
SP 2.4	*photon reflection from mirror, four-momentum*	*deepen*	*Intermediate*	*hint in Student Manual* *full solution in Instructor's Manual*	*New hint, improved solution significantly*
SP 2.5	*four-acceleration, orthogonal to four-velocity*	*extend*	*Intermediate*	*full solution in Student Manual*	*clarified question, minor improvements*
SP 2.6	*Doppler shift*	*extend*	*Intermediate*	*full solution in Instructor's Manual*	*clarified question*
SP 2.7	*difference between two four-velocities not a four-velocity*	*deepen*	*straightforward*	*full solution in Student Manual*	*fixed typo*
SP 2.8	*particle total relativistic energy*	*deepen*	*straightforward*	*full solution in Instructor's Manual*	*clarified question*
SP 2.9	*future directed*	*extend*	*straightforward*	*full solution in Student Manual*	*clarified question, improved solution*
SP 2.10	*Photon direction transforms under a boost. Two frames with*	*Extend*	*advanced*	*full solution in*	*New supplementary problem*

	the same photon four-vector representation			*Instructor's Manual*	
SP 2.11	*Lorentz transformation for a boost in a general direction*	*Extend*	*intermediate*	*full solution in Student Manual*	*New supplementary problem*
SP 2.12	*Compton scattering*	*Extend*	*advanced*	*full solution in Instructor's Manual*	*New supplementary problem*
SP 2.13	*Two-particle system, centre-of-momentum energy and mass*	*Extend*	*intermediate*	*full solution in Student Manual*	*New supplementary problem*
SP 2.14	*two-photon system, mass*	*Extend*	*intermediate*	*full solution in Instructor's Manual*	*New supplementary problem*

Chapter 3: Tensor analysis in special relativity

Schutz(2022) inserted a new section 3.4. As a result:

Old section 3.4 is new section 3.5 and this applies for remaining sections until
Old section 3.9 is new section 3.10 (Bibliography)

Schutz(2022) has the same equation numbers as Schutz(2009) and no new exercises.

Exercise	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
3.1	*tensor contraction*	*follow text*	*straightforward*	*full solution in Instructor's Manual*	*more detailed solution*
3.2	*one-forms a vector space*	*deepen*	*straightforward (but abstract)*	*full solution in Student Manual*	*doubled checked, added reference*
3.3	*linearity of one-form acting on vector*	*worked example*	*straightforward*	*full solution in Instructor's Manual and calculations in Maple*	*more detailed solution and added Maple solution*
3.4(a,c)	*linear independence, one-form, vector algebra*	*worked example*	*straightforward*	*full solution in Instructor's Manual and calculations in Maple*	*doubled checked, more succinct*
3.4(b,d)	*linear independence, one-form, vector algebra*	*worked example*	*straightforward*	*full solution in Student Manual*	*doubled checked, more succinct*
3.5	*transformation of one-forms and vectors*	*follow text*	*straightforward*	*full solution in Student Manual*	*doubled checked, minor improvement*

3.6(a)	*one-form basis non-standard*	*deepen*	*Intermediate*	*full solution in Student Manual*	*doubled checked, minor improvement*
3.6(b)	*one-form basis non-standard*	*worked example*	*Intermediate*	*full solution in Instructor's Manual and calculations in Maple*	*doubled checked, minor improvement*
3.7	*transform one-form basis*	*follow text*	*straightforward*	*full solution in Student Manual*	*doubled checked*
3.8	*visualization of one-form basis*	*deepen*	*straightforward*	*full solution in Instructor's Manual*	*added figure*
3.9	*worked example of temperature gradient*	*deepen*	*straightforward*	*full solution in Instructor's Manual*	*added calculations, added error estimates in Maple*
3.10(a)	*coordinate systems, independent coordinates*	*deepen*	*straightforward*	*full solution in Student Manual*	*doubled checked*
3.11	*notation for partial derivatives*	*follow text*	*very straightforward*	*full solution in Instructor's Manual*	*double checked*
3.12(a,c)	*one-form normal to a surface, 3D Euclidean space*	*deepen*	*straightforward*	*full solution in Student Manual*	*improved*
3.12(b)	*one-form normal to a surface, 3D Euclidean space*	*deepen*	*straightforward*	*full solution in Instructor's Manual*	*fixed*
3.12(d)	*one-form normal to a surface, 4D Minkowksi space*	*extend*	*straightforward*	*full solution in Instructor's Manual*	*added*
3.13	*gradient of a scalar field normal to surface of constant value*	*follow text*	*straightforward*	*full solution in Student Manual*	*much improved*
3.14	*outer (tensor) product not commutative*	*follow text*	*straightforward*	*full solution in Instructor's Manual*	*minor improvements*
3.15	*components of the standard two-form basis*	*follow text*	*straightforward*	*full solution in Student Manual*	*verified (nothing to improve)*
3.16	*symmetric and antisymmetric tensor from a general (0,2) tensor, independent components of*	*extend*	*straightforward*	*full solution in Instructor's Manual*	*improved*
3.17	*tensors as linear mappings between vectors and one-forms*	*deepen*	*Intermediate*	*full solution in Student Manual*	*improved solution substantially*

					(found error in Schutz)
3.18	*Find one-form corresponding to a given vector. Find the vector corresponding to a given one-form*	*practice*	*straightforward*	*full solution in Instructor's Manual*	*completed*
3.19(a)	*inverse metric tensor*	*practice*	*straightforward*	*full solution in Instructor's Manual*	*verified*
3.19(b)	*inner product of one-forms*	*follow text*	*Intermediate*	*full solution in Student Manual*	*verified*
3.20(a)	*one-forms and vectors in Euclidean space*	*deepen*	*Intermediate*	*Hint in Student Manual*	
3.20(a)				*full solution in Instructor's Manual*	*major improvement*
3.20(b)	*one-forms and vectors in Euclidean space*	*deepen*	*Intermediate*	*Full solution in Student Manual*	*minor addition*
3.21(a)	*unit outward normal one-forms on timelike and spacelike boundaries.*	*practice*	*straightforward*	*Full solution in Instructor's Manual*	*minor improvements*
3.21(b)	*outward normal one-forms on null boundary.*	*practice*	*Intermediate*	*Full solution in Instructor's Manual*	*fixed error*
3.22	*duality of one-forms and vectors as vector spaces*	*deepen*	*Intermediate*	*Full solution in Instructor's Manual*	*Verified.*
3.23	*general rank tensors, components and basis of*	*extend*	*difficult*	*Full solution in Student Manual*	*completely rewritten*
3.24(a)	*symmetric, antisymmetric tensors, index raising and lowering*	*practice*	*straightforward*	*Full solution in Instructor's Manual*	*Fixed numerical mistake.*
3.24(b)	*symmetric, antisymmetric parts of a (1,1) tensor*	*deepen*	*Intermediate*	*Full solution in Student Manual*	*Verified*
3.24(c)	*index raising and lowering, metric tensor inverse*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*Verified, cleaned up cross references*
3.25	*frame invariance of contraction of two (2,0) and (0,2) tensors*	*deepen*	*straightforward*	*Full solution in Student Manual*	*Verified, cleaned up notation*
3.26	*contraction of symmetric and antisymmetric (2,0) and (0,2) tensors*	*extend*	*straightforward*	*Full solution in Instructor's Manual*	*Simplified significantly*

3.27	*metric as a mapping between vectors and one-forms (antisymmetry preserved, unique)*	*extend*	*straightforward*	*Full solution in Student Manual*	*Minor improvements*
3.28	*gradient of a tensor*	*follow text*	*Intermediate*	*Full solution in Instructor's Manual*	*Significantly improved*
3.29	*tensor differential obeys Leibniz rule*	*extend*	*Intermediate*	*Full solution in Student Manual*	*Verified*
3.30	*tensor algebra and derivative*	*practice*	*straightforward*	*Full solution in Instructor's Manual*	*Fixed error, improved notation*
3.31	*projection operator*	*extend*	*Intermediate*	*Full solution in Student Manual*	*referenced Hassani to put into broader context, more complete proof, referenced Carroll on roles of metric*
3.32	*transformation of tensor components, more general definition of Lorentz transformation*	*extend*	*straightforward*	*Full solution in Instructor's Manual*	*Added reference to Hassani, similarity transformation*
3.33	*Lorentz group*	*extend*	*advanced*	*Full solution in Student Manual*	*significant improvements (more complete, references to latest edition of Hassani's text)*
3.34	*null basis*	*extend*	*advanced*	*Full solution in Instructor's Manual*	*Fixed errors*

Chapter 3: supplementary problems

SP3.1	*dummy index raising and lowering*	*deepen*	*straightforward*	*Full solution in Student Manual*	*added to index*
SP3.2	*dummy index raising and lowering*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*added to index*
SP3.3	*one-form, component-wise addition*	*follow text*	*straightforward*	*Full solution in Student Manual*	*completely changed, more rigorous*

SP3.4	*one-form scalar product*	*follow text*	*straightforward*	*Hint in Student Manual*	*added to index*
				Full solution in Instructor's Manual	*added solution*
SP3.5	*basic vector tensor algebra*	*follow text*	*Intermediate*	*Full solution in Student Manual*	*completely changed, more rigorous*
SP3.6	*frame-invariance of scalar product*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*added to index*
SP3.7	*transformation of one-form components*	*deepen*	*straightforward*	*Full solution in Student Manual*	*verified*
SP3.8	*contraction, trace of an antisymmetric tensor*	*extend*	*straightforward*	*Full solution in Instructor's Manual*	*New solution, added to index*
SP3.9	*find dual basis from basis, involves system of equations*	*deepen*	*Intermediate*	*Full solution in Student Manual*	*verified (fixed typo that did NOT appear in print)*
SP 3.10	*contraction of (the product of) two tensors*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*verified added to index*
SP 3.11	*frame invariance of a second-rank tensor*	*deepen*	*straightforward*	*Full solution in Student Manual*	*fixed cross references*
SP 3.12	*contraction of (the product of) two tensors*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*improved notation added to index*
SP 3.13	*tensor symmetry is frame invariant*	*deepen*	*straightforward*	*Full solution in Student Manual*	*minor improvement, added to index*
SP 3.14	*standard basis as a tensor*	*deepen*	*Intermediate*	*Full solution in Instructor's Manual*	*minor improvements*
SP 3.15	*Leibniz rule for tensor product*	*follow text*	*Intermediate*	*Full solution in Student Manual*	*verified*
SP 3.16	*symmetric matrix represents a symmetric tensor*	*extend*	*straightforward*	*Full solution in Instructor's Manual*	*New supplementary problem, new solution*
SP 3.17	*basis for an arbitrary tensor*	*extend*	*advanced*	*Full solution in Student Manual*	*New supplementary problem, new solution*
SP 3.18	*metric tensor as a mapping between one-forms and vectors*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*New supplementary problem, new solution*

Chapter 4: Tensor analysis in special relativity

Schutz (2022) has same equation numbers as Schutz (2009), but one extra section, 4.6
There are no new exercises.

Exercise	Area	Goal	Difficulty	Solution	Status
4.1	continuum approximation	deepen	straightforward	Full solution in Student Manual	Verified
4.2	flux across a surface contracting flux vector with normal one-form to a surface	deepen	Intermediate	Full solution in Instructor's Manual	Significantly improved solution
4.3	three-velocity, three-momentum vs four-velocity, four-momentum	deepen	Intermediate	Full solution in Student Manual	minor improvement added reference
4.4	number density from N and U	extend	straightforward	Full solution in Instructor's Manual	improved cross references
4.5	stress-energy tensor is linear in the arguments	follow text	straightforward	Full solution in Student Manual	minor improvements
4.6	stress-energy tensor for dust	follow text	straightforward	Full solution in Instructor's Manual	Minor improvements
4.7	stress-energy tensor for dust	follow text	straightforward	Full solution in Student Manual	Added significantly to solution
4.8	first law of thermodynamics	extend	advanced	Full solution in Instructor's Manual	Expanded on Schutz (1985) solution
4.9	Newton's second law and stress tensor divergence	extend	Intermediate	Full solution in Student Manual	minor improvements
4.10	Particle flux 4-vector divergence and conservation	extend	Intermediate	Full solution in Instructor's Manual	Significantly improved the solution. More rigorous.
4.11(a)	Identity matrix preserved	extend	Intermediate	Full solution in Instructor's Manual	Minor improvements
4.11(b)	Any isotropic matrix is a scalar multiple of the identity	extend	difficult	References to full solution	Added explanation of terminology and references.
4.12	Perfect fluid stress tensor	follow text	straightforward	Full solution in Student Manual	minor improvements

4.13	*Perfect fluid stress tensor, conservation law*	*follow text*	*straightforward*	*Full solution in Instructor's Manual*	*Minor improvements*
4.14	*Perfect fluid stress tensor, conservation law*	*follow text*	*straightforward*	*Full solution in Student Manual*	*minor improvements*
4.15	*Conservation of entropy*	*follow text*	*straightforward*	*Full solution in Instructor's Manual*	*Verified*
4.16	*MCRF applies at an event*	*follow text*	*straightforward*	*Full solution in Student Manual*	*minor improvements*
4.17	*Total advective time derivative in fluid mechanics*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Minor improvements*
4.18	*Pressure gradient force per unit volume*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Verified*
4.19	*Gauss' law derivation*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Minor improvements*
4.20(a)	*Particle conservation law with sources*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*Fixed typo.*
4.20(b)	*Energy momentum conservation with mass sources and body forces*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Improved*
4.21	*Stress-energy tensor example (torus particle accelerator)*	*Practice*	*Straightforward*	*Full solution in Instructor's Manual*	*Minor improvements*
4.22	*Physical systems treated as perfect fluid; equation of state of perfect fluid and photon gas*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Improved*
4.23(a)	*Energy momentum conservation results*	*Extend*	*Straightforward*	*Full solution in Instructor's Manual*	*Minor improvements*
4.23(b)	*Energy momentum conservation results*	*Extend*	*Intermediate*	*Hint in Student Manual*	*New hint.*
4.23(b)				*Full solution in Instructor's Manual*	*Improved*
4.23(c)	*Energy momentum conservation results*	*Extend*	*Difficult*	*Hint in Student Manual*	*New hint.*
4.23(c)				*Full solution in*	*Improved*

				Instructor's Manual	
4.24	Stellar observations	Extend	Difficult	Full solution in Student Manual	Minor improvements
4.25(a)(b)(c)	Maxwell's Equations	Extend	Straightforward	Full solution in Student Manual	Minor improvements
4.25(d) to (h)	Maxwell's Equations	Extend		Not answered.	

Chapter 4: supplementary problems

Exercise	Area	Goal	Difficulty	Solution	Status
SP4.1	Number flux	Follow text	Straightforward	Full solution in Student Manual	Minor improvements
SP4.2	Number flux four-vector	Follow text	Straightforward		
SP4.3	Perfect fluid stress tensor	Deepen	Straightforward	Full solution in Student Manual	Verified
SP4.4	Stellar observations	Deepen	Straightforward		
SP4.5	Weak energy condition	Extend	Advanced	Full solution in Student Manual	Verified
SP4.6	Number flux four-vector	Follow text	Straightforward		New supplementary problem.
SP4.7	Number flux four-vector	Follow text	Intermediate	Full solution in Student Manual	New supplementary problem.
SP4.8	Four-velocity definition	Deepen	Intermediate		New supplementary problem.
SP 4.9	Conservation of momentum; divergence of the stress-energy tensor	Follow text	Straightforward	Full solution in Student Manual	New supplementary problem.
SP4.10	Moment of inertia	Follow text (correct error)	Straightforward	Full solution in Instructor's Manual	New supplementary problem.

Chapter 5: Preface to curvature

Schutz (2022) has same equation numbers and section numbers as Schutz (2009) throughout chapter 5.
There are no new exercises.

Exercise	Area	Goal	Difficulty	Solution	Status
5.1	gravitational redshift, argument from energy conservation	deepen	Intermediate	Full solution in Student Manual	minor improvement

5.2	*uniform gravitational field, no tidal force*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*unchanged*
5.3	*singular coordinate transformations, various examples*	*practice*	*straightforward*	*Full solution in Student Manual*	*minor improvements*
5.4	*tangent vector to a parameterized curve*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*unchanged*
5.5	*compare curves and paths*	*practice*	*straightforward*	*Full solution in Student Manual*	*Minor improvement*
5.6	*Visualization of basis vectors and one-forms*	*deepen*	*straightforward*	*Full solution in Instructor's Manual*	*unchanged*
5.7	*transformation (jacobian) matrices from Cartesian to polar*	*deepen*	*straightforward*	*Full solution in Student Manual*	*very slight rewording*
5.8	*practice computing components of vectors and one-forms in cartesian and polar coordinates*	*practice*	*straightforward*	*Full solution in Instructor's Manual*	*unchanged*
5.9	*visualization of Christoffel symbols*	*deepen*	*straightforward*	*Full solution in Student Manual*	*unchanged*
5.10	*gradient of a vector is a (1,1) tensor*	*follow text*	*Intermediate*	*Full solution in Instructor's Manual*	*unchanged*
5.11	*covariant derivative and divergence of a vector field in cartesian and polar coordinates*	*practice*	*straightforward*	*Full solution in Student Manual*	*unchanged*
5.12	*covariant derivative a one-form field in cartesian and polar coordinates*	*practice*	*straightforward*	*Full solution in Instructor's Manual*	*unchanged*
5.13	*index lowering with metric*	*practice*	*straightforward*	*Full solution in Student Manual*	*unchanged*
5.14	*covariant derivative a rank (0,2) tensor field*	*practice*	*straightforward*	*Full solution in Instructor's Manual*	*unchanged*
5.15	*2nd covariant derivative of a vector field*	*practice*	*straightforward*	*Full solution in Student Manual*	*unchanged indexed*
5.16	*Derive relation between Christoffel symbols and metric components*	*follow text*	*straightforward*	*discussion in Instructor's Manual*	*unchanged*
5.17	*Covariant derivative of a vector is a tensor*	*Deepen*	*Straightforward*	*Hint and discussion in*	*unchanged*

				Student Manual	
5.18	Noncoordinate basis, orthonormal example	Follow text	Straightforward	Full solution in Instructor's Manual	unchanged
5.19	Coordinate basis for polar coordinate system	Follow text	Straightforward	Full solution in Student Manual	unchanged indexed
5.20	relation between Christoffel symbols and metric components, case of noncoordinate basis		Intermediate (or long and straightforward)	Full solution in Instructor's Manual	unchanged
5.21	uniform acceleration, Rindler spacetime	Extend	Intermediate	Full solution in Student Manual	unchanged indexed
5.22	Covariant derivative along a curve	Extend	Straightforward	Full solution in Instructor's Manual	unchanged

Chapter 5: supplementary problems

Problem	Area	Goal	Difficulty	Solution	Status
SP 5.1	One-form basis associated with a vector basis	follow text	Straightforward	Full solution in Student Manual	minor improvements, indexed
SP 5.2	Partial derivative of the product of a transformation and its inverse	Extend	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 5.3	Metric maps between vectors and one-forms	Deepen	Intermediate	Full solution in Student Manual	Slight rewording of the question
SP 5.4	Covariant derivative of a vector field	Deepen	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 5.5	Torsion tensor, torsion-free connection	Extend	Intermediate	Full solution in Student Manual	Unchanged
SP 5.6	Tensor density, non-invariant scalars	Extend	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 5.7	Kronecker delta is a (0,2) tensor	Deepen	Straightforward	Full solution in Student Manual	Unchanged
SP 5.8	Passive and active transformations, e.g. of a rotation	Extend	Straightforward	Full solution in Instructor's Manual	Very slight rewording of the problem.
SP 5.9	Pound-Rebka-Snider experiment	Extend	Intermediate	Hint and discussion in	unchanged

				Student Manual	
SP 5.10	Free-falling reference frame in Pound-Rebka-Snider experiment	Deepen	Intermediate	Partial solution in Instructor's Manual	Unchanged
SP 5.11	Transformation of the Christoffel symbols	Deepen	Intermediate	Full solution in Student Manual	Unchanged
SP 5.12	Christoffel symbols, diagonal metric	Extend	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 5.13	Basis vector notation in other texts like MTW.	Extend	Advanced	Full solution in Student Manual	Unchanged
SP 5.14	Schutz Eq.(2.31) for the four-velocity not valid in GR.	Deepen	Straightforward	Full solution in Instructor's Manual	New supplementary problem

Chapter 6: Curved manifolds

Schutz (2022) has same equation numbers and section numbers as Schutz (2009) throughout chapter 6. And there are no new exercises.

Exercise	Area	Goal	Difficulty	Solution	Status
6.1	Identify sets as manifolds	Deepen	Straightforward	Hint and full solution in Student Manual	Updated a reference.
6.2	Metric of manifolds in Exer. 6.1	Deepen	Intermediate to advanced	Full solution in Instructor's Manual	Unchanged.
6.3	Linear algebra necessary to transform metric to Minkowski at an event	Follow text	Intermediate	Full solution in Student Manual	Unchanged.
6.4	Local flatness theorem	Follow text	Intermediate	Full solution in Instructor's Manual	Unchanged.
6.5	Relation between metric and Christoffel symbols	Follow text	Intermediate	Hint for 6.5(a) and full solution for 6.5(b) in Student Manual	Unchanged.
6.6	double contraction of symmetric and antisymmetric tensors vanishes	Follow text	Straightforward	Full solution in Instructor's Manual	Unchanged.

6.7	*Derivative of the determinant of the metric tensor*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged.*
6.8	*Covariant derivative of a vector using metric determinant*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged.*
6.9	*Divergence of a vector*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Unchanged.*
6.10	*Parallel transport of a vector around a triangle on a sphere*	*Extend*	*Intermediate*	*Full solution in Instructor's Manual*	*Unchanged.*
6.11	*Globally parallel vector field*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged.*
6.12	*affine parameter for a curve*	*Deepen*	*Intermediate*	*Full solution in Instructor's Manual*	*Updated reference to page number.*
6.13	*parallel transport, dot product, spacelike geodesics remain spacelike*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Improved the index.*
6.14	*proper distance an affine parameter for geodesic*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged.*
6.15	*Proper length of a geodesic, unchanged to first order by small changes in the path*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged.*
6.16	*Intrinsic curvature*	*Follow text*	*Straightforward*	*Outline of solution for (a) and full solution for (b) in Instructor's Manual*	*Unchanged.*
6.17	*Local inertial frame, derive expression for Riemann tensor in terms of metric*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged.*
6.18	*Independent components of the Riemann tensor*	*Follow text*	*Advanced*	*Full solution in Instructor's Manual*	*Unchanged*
6.19	*Riemann tensor vanishes, polar coordinates on flat plane*	*Practice*	*Straightforward*	*Full solution in Student Manual*	*Unchanged.*
6.20	*Second covariant derivative of a vector field*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
6.21	*Covariant derivative of vector and one-form fields*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged.*

6.22	Geodesic deviation	Follow text	Straightforward	No solution	
6.23	result needed for Bianchi identity	Follow text	Straightforward	Full solution in Student Manual	Unchanged.
6.24	Bianchi identity	Follow text	Straightforward	Full solution in Instructor's Manual	Unchanged
6.25	Independent contractions of Riemann tensor, Ricci tensor symmetry	Follow text	Intermediate	Full solution in Student Manual	Unchanged.
6.26	Covariant derivative of the metric (and metric inverse) vanish	Follow text	Straightforward	Full solution in Instructor's Manual	Minor improvements,
6.27	Bianchi identities and Einstein tensor is divergence-free.	Follow text	Intermediate	Full solution in Student Manual	Unchanged.
6.28	Metric of 3D Euclidian space in spherical coordinates, metric of a sphere	Follow text	Straightforward	Full solution in Instructor's Manual	Unchanged
6.29	Riemann curvature tensor of a sphere	Practice	Straightforward	Full solution in Student Manual	Unchanged.
6.30	Riemann curvature tensor of a cylinder	Practice	Straightforward	No solution	
6.31	Product rule and covariant derivative	Deepen	Intermediate	Full solution in Student Manual	Slight modification of the question.
6.32	signature +2 and flatness imply Minkowski	Deepen/practice example	Intermediate	Full solution in Instructor's Manual	Unchanged.
6.33	three-sphere, definition, metric	Extend	Straightforward	Full solution in Student Manual	More complete solution.
6.34	metric tensor (and Christoffel symbol) identities	Extend	Straightforward (maybe (b) is Intermediate)	Full solution in Instructor's Manual	Unchanged.
6.35	Riemann tensor	Practice	Straightforward (but you need to have solved Exer. 6.18)	Full solution in Student Manual	Unchanged.
6.36	Local inertial coordinate system	Extend	Intermediate	Full solution in Instructor's Manual	Unchanged.
6.37	Proper area of a sphere, proper volume of a three-sphere	Practice	Straightforward	Full solution in Student Manual	Unchanged.
6.38	Lengths on a sphere	Practice	Straightforward	No solution	
6.39	Lie Bracket, Lie derivative	Extend	Advanced	Full solution in Student Manual	Unchanged.

Chapter 6: supplementary problems

Problem	Area	Goal	Difficulty	Solution	Status
SP 6.1	Riemann tensor symmtries and implications	Deepen	Straightforward	Full solution in Student Manual	Unchanged.
SP 6.2	Geodesics have an extremal length	Deepen	Advanced	Hint in Student Manual No solution	Unchanged.
SP 6.3	Second covariant derivative applied to rank (1,1) tensors in a Local Inertial Frame (LIF)	Deepen	Straightforward	Full solution in Student Manual	Unchanged.
SP 6.4	Physical meaning of the Riemann tensor	Deepen	Intermediate	Full solution in Instructor's Manual	Unchanged.
SP 6.5	Covariant derivative commutator	Deepen	Straightforward	Full solution in Student Manual	Unchanged.
SP 6.6	Global basis does not exist for some spacetimes	Extend	Advanced	Outline of a solution in Instructor's Manual	Unchanged.
SP 6.7	Riemann tensor symmetries	Extend	Straightforward	Full solution in Student Manual	Unchanged.
SP 6.8	Ricci tensor and Ricci scalar of static spherically symmetric spacetime	Extend	Straightforward	Partial solution in Instructor's Manual	Unchanged.
SP 6.9	Geodesic deviation in terms of the Riemann tensor	Follow text	Straightforward	Full solution in Student Manual	Unchanged.
SP 6.10	Riemann tensor - careful which equation you use	Follow text	Straightforward	Full solution in Instructor's Manual	Unchanged.
SP 6.11	Non-affine parameter, magnitude of tangent vector changes	Extend	Intermediate	Full solution in Student Manual	Fixed typo
SP 6.12	Lie derivative	Extend	Intermediate	No solution	
SP 6.13	Einstein tensor symmetry	Extend	Straightforward	Full solution in Student Manual	Unchanged.
SP 6.14	Divergence in spherical coordinates	Deepen	Straightforward	Full solution in Instructor's Manual	Improved presentation in Instructor's Manual
SP 6.15	Subtlety in the notation of a derivative of a vector	Follow text	Intermediate	Full solution in Student Manual	Unchanged.

SP 6.16	*Metric with one index up and one down*	*Extend*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged.*
SP 6.17	*Gauss' theorem--address confusion in bad notation*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Slight rewording of the question*

Chapter 7: Physics in a curved spacetime

Schutz (2022) has same equation numbers and section numbers as Schutz (2009) throughout chapter 7. And there are no new exercises.

Exercise	Area	Goal	Difficulty	Solution	Status
7.1	*Number flux divergence*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
7.2	*Inverse metric, weak gravitational field*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
7.3	*Christoffel symbols for the weak gravitational field*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
7.4	*g_xx not important, in the weak field, low velocity limit*	*Deepen*	*Straightforward*	*Partial solution in Instructor's Manual*	*Improved.*
7.5(a)	*Derive the Euler equation*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
7.5(b)	*Time component of divergence of stress-energy tensor*	*Extend*	*Intermediate*	*Hint with references in Student Manual*	*Unchanged*
7.5(c)	*Hydrostatic equation*	*Extend*	*Intermediate*	*Hint and full solution in Student Manual*	*Unchanged*
7.5(d)	*g_00 and the Newtonian gravitational potential*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
7.6	*Geodesic equation manipulation*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
7.7	*Conserved components of four-momentum*	*Practice*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
7.8	*Metric symmetry and stress-energy tensor divergence, angular momentum*	*Extend*	*Intermediate*	*Partial solution in Instructor's Manual*	*Unchanged*
7.9	*Weak gravitational field, Riemann tensor, geodesic deviation*	*Extend*	*Intermediate*	*No solution*	

7.10	*Killing fields*	*Extend*	*Advanced*	*Full solution in Student Manual*	*Unchanged*

Chapter 7: supplementary problems

SP 7.1	*Four-velocity normalization*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Slight rewording*
SP 7.2	*Dot product in curved spacetime*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 7.3	*Divergence of the stress-energy tensor*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*Slight rewording*
SP 7.4	*Relation between proper and coordinate time*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 7.5	*Clock synchronization/global time in a stationary spacetime*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
SP 7.6	*Keplerian orbits in Schwartzschild*	*Extend*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 7.7	*Proper distance and induced metric on a hypersurface*	*Extend*	*Advanced*	*Full solution in Student Manual*	*Unchanged*
SP 7.8	*Radial coordinate vs distance*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 7.9	*Finding Killing vector fields*	*Extend*	*Advanced*	*Full solution in Student Manual*	*Unchanged*
SP 7.10	*Ricci scalar in a centrifuge*	*Deepen*	*Intermediate*	*Hint in Student Manual* *Full solution in Instructor's Manual*	*Unchanged*
SP 7.11	*Four-acceleration, geodesic equation, vector property*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
SP 7.12	*Ricci scalar for photon gas, frustrated experimentalist*	*Extend*	*Straightforward*	*Hint in Student Manual* *Full solution in Instructor's Manual*	*Unchanged*

SP 7.13	*Killing vector fields in Robertson-Walk*	*Extend*	*Advanced*	*Full solution in Student Manual*	*Unchanged*
SP 7.14	*Velocity scale in gravitational potential*	*Extend*	*Intermediate*	*Hint in Student Manual Pointer to solution in Instructor's Manual*	*Unchanged*
SP 7.15	*Conserved quantities along a null geodesic*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*New supplementary problem*

Chapter 8: Einstein field equations

Schutz (2022) has same equation numbers and section numbers as Schutz (2009) throughout chapter 8. And there are no new exercises.

Exercise	Area	Goal	Difficulty	Solution	Status
8.1	*Newtonian potential*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Slight rewording*
8.2	*Geometrized units, and fundamental constants, (c G, hbar) and Planck length, time etc.*	*Deepen*	*Intermediate (requires basic particle physics)*	*Full solution in Instructor's Manual, see Maple Worksheet*	*Fixed Planck time*
8.3	*Typical Newtonian potential, velocities, in Solar System in Geometrized units*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
8.4	*Inverse of matrix close to identity*	*Follow text*	*Intermediate*	*Full solution in Instructor's Manual*	*Unchanged*
8.5	*Weak-field Riemann tensor gauge invariance*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
8.6	*Weak-field, inverse metric*	*Deepen*	*Straightforward*	*No solution*	
8.7	*Weak-field metric perturbation trace reverse*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Slight rewording, indexed*
8.8	*Weak-field Einstein tensor*	*Follow text*	*Intermediate*	*Full solution in Instructor's Manual*	*Unchanged*
8.9	*Einstein constraint equations*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
8.10	*Weak-field Einstein tensor in the Lorenz gauge*	*Follow text*	*Straightforward*	*Full solution in*	*Unchanged*

				Instructor's Manual	
8.11	*Gauge transformation of Maxwell's equations*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Replaced ``Lorentz" with ``Lorenz"*
8.12	*Gauge transformation, effect on metric*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
8.13	*Stress-energy tensor, order of magnitude of terms*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Slight rewording*
8.14	*Newtonian limit, metric in cartesian pseudo-coordinates*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
8.15	*Measurable quantities of a circular, weak-field orbit*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
8.16	*Newtonian limit of Einstein field equations leads to weak-field metric*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
8.17	*Failure of Newtonian limit for close-in orbits*	*Practice, Deepen*	*Straightforward*	*Full solution in Student Manual, Maple worksheet*	*Slightly more detail, fixed typo, indexed*
8.18	*Cosmological constant*	*Deepen*	*Intermediate*	*Full solution in Instructor's Manual*	*Improved solution*
8.19	*Rotating source*	*Extend*	*Advanced*	*Hint and full solution in Student Manual, Maple worksheet*	*Unchanged*
8.20	*Active gravitational mass, post-Newtonian effects*	*Extend*	*Advanced*	*No solution*	

Chapter 8: supplementary problems

SP 8.1	*Ricci scalar, weak field*	*Practice*	*Straightforward*	*Full solution in Student Manual*	*unchanged*
SP 8.2	*Trace reverse of metric perturbation*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 8.3	*Einstein in weak-field*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*unchanged, indexed*

SP 8.4	*A step in deriving the linearized Einstein field equations.*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 8.5	*Dimensions of Christoffel symbols, Riemann tensor, Ricci tensor, Einstein field equations*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*slight rewording*
SP 8.6	*Ricci scalar for photon gas, frustrated experimentalist*	*Extend*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 8.7	*Rotating source, orbital angular momentum*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
SP 8.8	*Details of previous SP*	*Follow this text*	*Intermediate*	*Full solution in Instructor's Manual*	*Unchanged*

Chapter 9: Fundamentals of gravitational radiation

New in Schutz(2022): Section 9.1 inserted, as a result:
Old Section 1 = New Section 2
Old Section 4 = New Section 5

Old Section 5 "astrophysical sources" replaced by New Section "Standard sirens"

Figures are the same.

Equations 9.1 through 9.99 are the same.

New in Schutz(2022): Equation (9.100) inserted, as a result:

Exercise	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
9.1	*Basic calculus*	*Follow text*	*Straightforward*	*Hint in Student Manual*	*Unchanged*
9.2	*Complex analysis*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*New solution.*
9.3	*Plane wave solutions of the 3D wave equation via Fourier transform.*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Updated reference.*
9.4	*TT gauge transformation of plane wave solutions*	*Follow text*	*Straightforward*	*No solution*	

9.5	*TT gauge transformation of plane wave solutions*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Slight rewording, indexed.*
9.6	*TT gauge transformation of plane wave solutions*	*Follow text*	*Straightforward*	*No solution*	*No solution.*
9.7	*TT gauge free particles at rest*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
9.8	*Acceleration of free particles due to GW*	*Deepen*	*Intermediate*	*No solution*	
9.9	*Acceleration of free particles due to GW*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
9.10	*Find gauge transformation between identical spacetimes in different coordinates*	*Practice*	*Intermediate*	*No solution*	
9.11	*Riemann tensor TT gauge*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
9.12	*Proper distance unaffected along direction of travel of the GW*	*Deepen*	*Straightforward*	*No solution*	
9.13	*Rotation about z-axis (background Lorentz transformation)*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
9.14	*Wave polarization*	*Follow text*	*Intermediate*	*No solution*	
9.15	*Wave polarization, elliptical polarization*	*Extend*	*Intermediate*	*No solution*	
9.16					
9.17					
9.18					
9.19					
9.20					
9.21					
9.22					
9.23	*Resonant bar detector, stretch amplitude*	*Follow text*	*Intermediate (basic ODE)*	*Full solution in Student Manual*	*Unchanged*
9.24					
9.25	*Quality factor of the bar detector*	*Follow text*	*Intermediate (used results of Exer. 9.23)*	*Full solution in Student Manual*	*Unchanged*
9.26					
9.27	*Measuring distance with light*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Minor improvements*
9.28					
9.29					
9.30					
9.31					
9.32					
9.33					
9.34					
9.35					

9.36					*Eq. number changed.*
9.37					
9.38					
9.39	*Gravitational radiation from unequal mass binary*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New to this edition*
9.40					*New to this edition.*
9.41(a)	*Chirp mass, orbital frequency and its rate of change*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New to this edition*
(b)			*Very straightforward*	*Hint*	
9.42					*New to this edition.*
9.43	*Scaling relations for chirp time, merger time, remaining phase*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New to this edition*
9.44					*New to this edition.*
9.45	*Black hole merger luminosity, compare to stellar luminosity of observable Universe*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*New to this edition*
9.46					*Old Exer. 9-39, new notation; L->J Eq.106->107.*
9.47					*Old Exer. 9-40, Eq.101->102*
9.48					*Old Exer. 9-41, Eq.n->n+1*
9.49					*Old Exer. 9-42, Eq.n->n+1*
9.50					
9.51					
9.52					
9.53					
9.54					
9.55					
9.56					*Old Exer. 9-49, Eq.n->n+18* *(c) 9.144->9.146 (enormous typo to signal in Schutz Eq.9.147)*

Chapter 9: Supplementary Problems

Problem	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
SP 9.1	*Dispersion relation, group and phase velocities*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*

SP 9.2	*Ricci scalar, stress-energy tensor, vacuum field equations*	*Deepen*	*Straightforward*	*No solution*	
SP 9.3	*Geodesic deviation and the vacuum field equations*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*Clarified the question*
SP 9.4	*Radar distance in Schwarzschild*	*Deepen*	*Straightforward*	*Hint in Student Manual, no solution*	
SP 9.5	*Quality factor of the bar detector, direct calculation*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Slight rewording of the problem*
SP 9.6	*Fourier transforms, mathematical subtleties*	*Extend*	*Advanced*	*No solution*	
SP 9.7	*Free and dummy indices. Fix error in Schutz.*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New supplementary problem*
SP 9.8	*Order of magnitude of gravitational waves from Jupiter's largest moon*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual*	*New supplementary problem*
SP 9.9	*Gravitational wave generation from a simple oscillator*	*Practice*	*Straightforward*	*Full solution in Student Manual*	*New supplementary problem*
SP 9.10	*Details of the wave generation calculation*	*Follow text*	*Intermediate*	*Hint in Student Manual, No solution*	*New supplementary problem*

Chapter 10: Spherical Solutions for Stars

Equations numbers unchanged.
Section numbers unchanged.
Figures unchanged.
Exercises: still 19.

Exercise	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
10.1	*Minkowski in spherical coordinates*	*Follow text*	*Straightforward*	*Hint in Student Manual*	*Unchanged*
10.2	*Spherical symmetry*	*Follow text*		*No solution*	
10.3	*Particle energy in the weak field limit*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Minor improvements*
10.4	*Einstein tensor in static spherically symmetric spacetime*	*Follow text*	*Straightforward*	*Full solution in Maple Worksheet*	*Removed my solution*
10.5	*Static star, fluid four-velocity*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Very minor changes (uniform notation)*
10.6	*Stress-energy tensor static perfect fluid (in*	*Follow text*	*Straightforward*		

	static spherically symmetric spacetime)				
10.7	*Static stellar model*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
10.8	*Derive ODEs for pressure, p(r), and mass, m(r)*	*Follow text*	*Straightforward*	*Partial solution (just (a) and (b)) in Instructors manual*	
10.9	*Isotropic coordinates*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
10.10	*Uniform density star redshift*	*Follow text, practice*	*Straightforward*	*No solution*	*Slight rewording from 2nd edition.*
10.11	*Buchadhl's interior solution, causality requirements, p<p*,rho<7p**	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
10.12	*Buchadhl's interior solution, solutions to Einstein field equations*	*Follow text*	*Straightforward*	*No solution*	
10.13	*Buchahl's model, surface redshift*	*Follow text*	*Intermediate (nasty integral)*	*Full solution in Student Manual*	*Unchanged*
10.14	*Newtonian polytropes*	*Extend*	*Intermediate*	*No solution*	
10.15	*Power series for numerical solution B.C. of stellar model*	*Extend*	*Intermediate*	*Full solution in Student Manual and in Mathematica Notebook*	*More complete error analysis, fixed typo in question.*
10.16	*White dwarfs and neutron stars*	*Deepen*	*Advanced*	*No solution*	
10.17	*Numerical solution of stellar model*	*Extend*	*Advanced*	*Partial solution in Student Manual Complete solution in Mathematica Notebook*	Slight rewording from 2nd edition. Fixed error in inverse EOS, changed 4/3 to 3/4 in power! New figure, new interpretation!
10.18	*Pressure of nuclei*	*Follow text*	*Intermediate*	*No solution*	
10.19	*Rotating Sun, neutron star of solar mass, angular momentum and "centrifugal force", magnetic field*	*Deepen*	*Straightforward*	*Full solution in Student Manual Computations in Mathematica Notebook*	*Fixed typo in Sun's radius, results unchanged.*

Chapter 10: Supplementary Problems

Problem	Area	Goal	Difficulty	Solution	Status
SP 10.1	g_00 of interior, constant density, static spherically symmetric star	Follow text	Intermediate	Hint in Student Manual No solution	Unchanged
SP 10.2	Static spherically symmetric star, detail of the derivation of the metric	Follow text	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 10.3	Energy measured by local observer	Follow text and deepen	Straightforward	Full solution in Student Manual	Minor improvement
SP 10.4	Gravitational redshift	Extend	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 10.5	Einstein tensor	Follow text	Straightforward	Full solution in Mathematica Notebook	Removed false claim that Schutz made a sign error
SP 10.6	Requirement on m(r) as r-->0	Extend	Intermediate	Full solution in Instructor's Manual	Unchanged
SP 10.7	3D volume	Follow text	Straightforward	Full solution in Maple Worksheet	Unchanged
SP 10.8	Buchdahl's interior solution, beta parameter at the surface	Follow text	Straightforward	Full solution in Instructor's Manual	Improved, more detail.
SP 10.9	Power series for numerical solution B.C. of stellar model	Extend	Intermediate	Full solution in Student Manual	Slight rewording
SP 10.10	SI units for stellar model equations: G_00 and T-O-V	Deepen	Straightforward	Full solution in Instructor's Manual	Unchanged
SP 10.11	Numerical solution of stellar model, EOS parameters in SI units	Extend	Intermediate	Full solution in Student Manual	Unchanged
SP 10.12	Ricci scalar for neutron star, frustrated experimentalist	Extend	Intermediate	Hint in Student Manual No solution	Unchanged
SP 10.13	Relativistic gravity inside a spherical shell	Follow text	Intermediate	Full solution in Student Manual	Unchanged
SP 10.14	Static fluid four-velocity (nit-pick that Schutz ignores the negative root)	Follow text	Straightforward	Outline of solution in Instructor's Manual	New supplementary problem

Chapter 11: Schwartzschild Geometry and Black Holes

Several new exercises, including 11.1, which pushed all the others to n+1.

Schutz(2022) has same section and equation numbers as Schutz(2009)
(though 11.5 has a more detailed name in Schutz(2022))

Exercise	Area	Goal	Difficulty	Solution	Status
11.1	Not necessarily high density to form black hole	Follow text	Straightforward	No solution	New to this edition
11.2	Collision impact parameter	Extend	Intermediate	Full solution in Student Manual	Updated notation.
11.3	Massive particle and photon orbits in Schwarzschild, Effective potential	Follow text	Intermediate	Hint in Student Manual, Full solution in Instructor's Manual	Unchanged
11.4	Effective potential plots	Deepen	Intermediate (plotting software skills)	Full solution in Student Manual	Updated notation
11.5	Possible orbits, stars of various radii	Practice	Straightforward	Full solution in Instructor's Manual	Unchanged
11.6	Distance from super massive black hole to radius where almost Newtonian	Deepen	Straightforward	No solution,	Slight wording change.
11.7	Gravitational redshift	Practice	Straightforward	No solution	Slight wording change.
11.8	Time dilation in circular orbits	Practice	Intermediate	Hint and full solution in Student Manual	Fixed index
11.9	(a) Angular momentum and velocity, stable circular orbit, Schwarzschild spacetime, (b) non-circular orbit	Follow text	Intermediate	No solution	Unchanged
11.10	Numerical solution, non-circular orbit , periastron shift, Schwarzschild spacetime	Extend	Intermediate (numerical techniques)	Full solution in Student Manual	Updated notation, slight wording change

11.11	*Parameters for a massive particle to reach the horizon, Schwarzschild spacetime*	*Deepen*	*Intermediate*	*No solution*	*New notation, reference to previous exercise (number changed)*
11.12	*Non-circular orbit in Schwarzschild, explain the u^3 term, relate to redshift and max in effective potential*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Unchanged*
11.13	*Elliptical orbits in Newtonian gravity*	*Follow text*	*Straightforward*	*No solution*	*Unchanged*
11.14	*Nearly circular orbits in Schwarzschild*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Updated notation, Slight wording change*
11.15	*Perihelion shift*	*Practice*	*Straightforward*	*No solution*	*Unchanged*
11.16	*Nearly circular orbits in Schwarzschild*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*New solution*
11.17	*Deflection of a null geodesic*	*Extend*	*Intermediate*	*No solution*	*Slight wording change*
11.18	*Timing problem of binary pulsar system*	*Extend*		*No solution*	*Wording change in the intro*
11.19	*Distance on a sphere, degenerate point*	*Deepen*	*Straightforward*	*No solution*	*Unchanged*
11.20	*Particle falling radially in from infinity, in Schwarzschild*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New solution*
11.21	*Schwarzschild spacetime: Christoffel symbols, Riemann tensor, orthonormal basis, singularity at origin*	*Practice, extend, deepen*	*Intermediate*	*No solution*	*Unchanged (except ref to section 6.8 (old 6.9))*
11.22	*Particle falling radially in from infinity, red shift, in Schwarzschild*	*Practice*	*Straightforward*	*No solution*	*Unchanged*
11.23					*New to this edition*
11.24	*Advanced Eddington-Finkelstein coordinates*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*New to this edition (Signalled error in Schutz.)*
11.25				*No solution*	*Old 11.22, unchanged*
11.26				*No solution*	*Old 11.23, unchanged*
11.27				*No solution*	*Old 11.24, Fig number changed (old Fig 11, new fig 12)*
11.28				*No solution*	*Old 11.25, cites new Exer 11.25*

					(old Exer 11.22)
11.29				*No solution*	*Old 11.26*
11.30				*No solution*	*Old 11.27*
11.31				*No solution*	*Old 11.28*
11.32	*Kerr, equatorial plane*			*No solution*	*Old 11.29*
11.33				*No solution*	*Old 11.30*
11.34				*No solution*	*Old 11.31*
11.35	*Penrose process, angular momentum*			*No solution*	*Old 11.32*
11.36				*No solution*	*Old 11.33*
11.37	*area theorem, black hole merger, energy release*			*No solution*	*Old 11.34*
11.38	*Kerr, the Sun, an electron*			*No solution*	*Old 11.35*
11.39	*Kerr, largest area, smallest mass*			*No solution*	*Old 11.36*
11.40	*Kerr, red shift, ZAMO*			*No solution*	*Old 11.37, slight wording change*
11.41	*Equatorial orbit, Kerr*	*Extend*	*Intermediate*	*Partial solution in Student Manual*	*Old 11.38*
11.41				*Full solution in Instructor's Manual*	
11.42	*Angular separation of the Sagittarius A Schwarzschild radius.*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*New to this edition (Signalled error in Schutz.)*
11.43				*No solution*	*Old 11.39*

Chapter 11: Supplementary Problems

Problem	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
SP 11.1	*Schwarzschild geometry, g_00 = -exp(2phi) approximation*	*Follow text (understand Exer.11.6)*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
SP 11.2	*Orbits planar in Schwarzschild*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 11.3	*Orbit in Schwarzschild*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
SP 11.4	*Equatorial orbit in Kerr*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*Unchanged*
SP 11.5	*Twin paradox, circular orbits, Schwarzschild*	*Deepen*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*

SP 11.6	*Effective potential diagram, reaching infinity*	*Deepen*	*Straightforward*	*Hint in Student Manual, Full solution in Instructor's Manual*	*Unchanged*
SP 11.7	*Photon orbits in Kerr*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Unchanged*
SP 11.8	*Doppler shift and gravitational redshift in Schwarzschild*	*Deepen*	*Intermediate*	*No solution*	*Minor change in question*
SP 11.9	*Relation between gravitational and SR time dilation*	*Deepen*	*Intermediate*	*Full solution in Student Manual*	*Slight rewording, more complete answer*
SP 11.10	*Relation between gravitational and SR time dilation*	*Deepen*	*Intermediate*	*No solution*	*Very minor wording change*
SP 11.11	*Tortoise coordinate, Eddington-Finkelstein coordinates*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New supplementary problem*
SP 11.12	*Polar coordinate form of a straight line. Impact parameter "b" can be negative.*	*Follow this text*	*Straightforward (but requires software)*	*Partial solution in Student Maple Worksheet, Remaining solution in Instructors' Manual*	*New supplementary problem*

Chapter 12: Gravitational wave astronomy

Exercise	Area	Goal	Difficulty	Solution	Status
12.1	*GW frequency at merger*	*Practice*	*Straightforward*	*Full solution in Student Manual Calculations in Mathematica notebook*	*New exercise*
12.3	*GW detector response*	*Practice*	*Straightforward*	*Full solution in Student Manual*	*New exercise*
12.5	*Probability of false detection*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*New exercise*
12.7	*Solving for the inclination angle*	*Deepen*	*Straightforward*	*Full solution in Student Manual, Calculations for (f) and (g)*	*New exercise (Schutz error in part (g))*

				in Mathematica notebook	
12.9	*Computing resources for pulsar search*	*Follow text*	*Straightforward but long*	*Full solution in Student Manual Calculations in Mathematica notebook*	*New exercise (Schutz error in part (c))*
12.11	*Uncertainty in component masses of binary merges*	*Deepen*	*Intermediate*	*Full solution in Student Manual Calculations for (d) in Mathematica notebook*	*New exercise*

Chapter 12: Supplementary Problems

Exercise	*Area*	*Goal*	*Difficulty*	*Solution*	*Status*
SP 12.1	*Component mass convention, m1>m2.*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*New supplementary problem*
SP 12.2	*Sensitivity of final in spiral frequency to phi remaining*	*Deepen*	*Straightforward*	*Full solution in Instructor's Manual and Maple Worksheet*	*New supplementary problem*
SP 12.3	*Earth movement during binary merger detection event*	*Deepen*	*Straightforward*	*Full solution in Student Manual Calculations in Mathematica notebook*	*New supplementary problem*
SP 12.4	*Tensor basis for gravitational wave detector and source*	*Follow text*	*Intermediate*	*No solution*	*New supplementary problem*
SP 12.5	*Combining heating and computation*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*New supplementary problem*

Chapter 13: Cosmology

There are no new exercises.

Schutz(2022) has same section numbers as Schutz(2009)

Schutz(2022) has a new equation 13.1, which caused old equation 1 to be new equation 2.

Old Eq 12.24 becomes new Eq. 13.25

this propagates to the final two:

Old 12.64 is new 13.65
Old 12.65 is new 13.66

Exercise	Area	Goal	Difficulty	Solution	Status
13.1	Hubble-Lemaître expansion	Follow text	Straightforward	Full solution in Student Manual	Slight rewording of question. Minor improvements in solution
13.2	The unit parsec	Deepen	Straightforward	Full solution in Instructor's Manual, calculation in Maple Worksheet	Fixed cross-references
13.3	Newtonian cosmology	Extend	Straightforward	Partial solution in Instructor's Manual	Fixed little error
13.4	Hubble-Lemaître expansion, develop FRWL metric	Follow text	Advanced	Full solution in Student Manual	Completely rewrote the solution, it's a critic of the exercise
13.5	Develop FRWL metric	Follow text	Intermediate	Hint in Student Manual, No solution	
13.6(a)	Develop FRWL metric, homogeneous Ricci scalar	Follow text	Straightforward	Full solution in Student Manual and calculations in Mathematica notebook	No change
(b)				Hint in Student Manual	

13.7	*Develop FRWL metric, local flatness at r=0*	*Follow text*	*Straightforward*	*Full solution in Student Manual and calculations in Mathematica notebook*	*No change*
13.8	*Hyperbolic FRW metric*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*No change*
13.9	*Cosmological redshift*	*Follow text*	*Intermediate*	*Full solution in Student Manual*	*Improved*
13.10	*Cosmological redshift approximately a Doppler shift*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*No change*
13.11	*Cosmological redshift*	*Follow text*	*Straightforward*	*Full solution in Student Manual*	*Very minor changes*
13.12	*Steps in deriving luminosity distance and redshifts relation*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual*	*No change*
13.13	*Absolute and apparent magnitude of a star, redshift-magnitude relation*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*No change*
13.14	*Matter equation, fluid equation*	*Follow text*	*Straightforward*	*Full solution in Instructor's Manual and Maple Worksheet*	*Slight rewording* *Warning: Sign error in Schutz Eq. (13.72)*
13.15	*T proportional to 1/R*	*Follow text*	*Straightforward*	*Full solution in Student Manual and integral in Mathematica notebook*	*No change*
13.16	*Time component of Einstein tensor*	*Follow text*	*Straightforward*	*Full solution in Maple Worksheet*	*No change*
13.17	*Equation of motion for scale factor*	*Follow text*	*Straightforward*	*Full solution in Student Manual and Maple Worksheet*	*No change*
13.18	*Cosmological constant*	*Deepen*	*Intermediate*	*Full solution in Maple Worksheet*	*No change*
13.19	*Scale factor as a function of time, age of the universe.*	*Extend*	*Intermediate*	*Full solution in Student Manual calculations in*	*Expanded question.*

				Mathematica notebook	
13.20	Static universe	Extend		No solution	
13.21	Negative cosmological constant	Extend	Intermediate	Full solution in Student Manual	Much more complete solution
13.22	More realistic EOS	Extend	Advanced	No solution	
13.23	Redshift of decoupling	Extend	Straightforward	Full solution in Student Manual, calculations in Mathematica notebook	Minor improvements, explicit temperature
13.24	Minimum density given Hubble constant	Extend		No solution	
13.25	Uncertainty in laws of physics near the singularity	Extend	Straightforward	Full solution in Student Manual, calculations in Mathematica notebook	very minor improvement

Chapter 13: Supplementary Problems

SP 13.1	Einstein clock synchronization	Deepen	Straightforward	Full solution in Student Manual	No change
SP 13.2	Hubble expansion, order of magnitude	Deepen	Straightforward	No solutions	
SP 13.3	Conservation of covariant component of four-momentum along a geodesic	Follow text	Intermediate	Full solution in Student Manual	Improved (removed misleading tau, used general affine parameter)
SP 13.4	Hubble velocity greater than c?	Deepen	Intermediate	No solution	
SP 13.5	Fluid equation	Deepen	Intermediate	Full solution in Student Manual	Minor change
SP 13.6	Divergence of stress-energy tensor, isotropy	Deepen	Intermediate	Full solution in Instructor's Manual	Minor improvements
SP 13.7	Geometry of a three-sphere	Extend	Intermediate	Full solution in Student Manual, integration in Mathematica notebook	Minor change
SP 13.8	Ricci scalar for cosmological fluid, frustrated experimentalist	Extend	Straightforward	Full solution in Instructor's Manual	No change

SP 13.9	*Ricci scalar for cosmological fluid, frustrated experimentalist*	*Extend*	*Straightforward*	*Full solution in Student Manual*	*Indexed*
SP 13.10	*Cosmological redshift, with velocities*	*Extend*	*Straightforward*	*No solution*	
SP 13.11	*CMB and black body spectrum*	*Extend*	*Advanced*	*Full solution in Student Manual*	*No change*
SP 13.12	*Galaxies moving with Hubble flow, geodesics in FRW with pressure*	*Extend*	*Advanced*	*No solution*	
SP 13.13	*Gödel Universe*	*Extend*	*Intermediate*	*Full solution in Student Manual*	*No change*
SP 13.14	*Negative cosmological constant*	*Extend*	*Intermediate*	*Hint in Student Manual, full solution for (a) and (b) in Instructor's Manual*	*New supplementary problem*