Gibbs SeaWater (GSW) Oceanographic Toolbox of TEOS–10

Practical Salinity (SP), PSS-78

gsw_SP_from_C	Practical Salinity from conductivity, C (incl. for SP < 2)
gsw_C_from_SP	conductivity, C, from Practical Salinity (incl. for SP < 2)
gsw_SP_from_R	Practical Salinity from conductivity ratio, R (incl. for SP < 2)
gsw_R_from_SP	conductivity ratio, R, from Practical Salinity (incl. for SP < 2)
gsw_SP_salinometer	Practical Salinity from a laboratory salinometer (incl. for SP < 2)
gsw_SP_from_SK	Practical Salinity from Knudsen Salinity

Absolute Salinity (SA), Preformed Salinity (Sstar) and Conservative Temperature (CT)

gsw_SA_from_SP	Absolute Salinity from Practical Salinity
gsw_Sstar_from_SP	Preformed Salinity from Practical Salinity
gsw_CT_from_t	Conservative Temperature from in-situ temperature

Absolute Salinity – Conservative Temperature plotting function

gsw_SA_CT_plot	function to plot Absolute Salinity – Conservative Temperature profiles on the SA-CT diagram, including the freezing line and selected potential density contours

other conversions between temperatures, salinities, entropy, pressure and height

gsw_deltaSA_from_SP	Absolute Salinity Anomaly from Practical Salinity
gsw_SA_Sstar_from_SP	Absolute Salinity & Preformed Salinity from Practical Salinity
gsw_SR_from_SP	Reference Salinity from Practical Salinity
gsw_SP_from_SR	Practical Salinity from Reference Salinity
gsw_SP_from_SA	Practical Salinity from Absolute Salinity
gsw_Sstar_from_SA	Preformed Salinity from Absolute Salinity
gsw_SA_from_Sstar	Absolute Salinity from Preformed Salinity
gsw_SP_from_Sstar	Practical Salinity from Preformed Salinity
gsw_pt_from_CT	potential temperature from Conservative Temperature
gsw_t_from_CT	in-situ temperature from Conservative Temperature
gsw_CT_from_pt	Conservative Temperature from potential temperature
gsw_pot_enthalpy_from_pt	potential enthalpy from potential temperature
gsw_pt_from_t	potential temperature
gsw_pt0_from_t	potential temperature with reference pressure of 0 dbar
gsw_t_from_pt0	in-situ temperature from potential temperature with p_ref of 0 dbar
gsw_t90_from_t48	ITS-90 temperature from IPTS-48 temperature
gsw_t90_from_t68	ITS-90 temperature from IPTS-68 temperature
gsw_z_from_p	height from pressure
gsw_p_from_z	pressure from height
gsw_z_from_depth	height from depth
gsw_depth_from_z	depth from height
gsw_Abs_Pressure_from_p	Absolute Pressure, P, from sea pressure, p
gsw_p_from_Abs_Pressure	sea pressure, p, from Absolute Pressure, P
gsw_entropy_from_CT	entropy from Conservative Temperature
gsw_CT_from_entropy	Conservative Temperature from entropy
gsw_entropy_from_pt	entropy from potential temperature
gsw_pt_from_entropy	potential temperature from entropy
gsw_entropy_from_t	entropy from in-situ temperature
gsw_t_from_entropy	in-situ temperature from entropy
gsw_adiabatic_lapse_rate_from_CT	adiabatic lapse rate from Conservative Temperature
gsw_adiabatic_lapse_rate_from_t	adiabatic lapse rate from in-situ temperature
gsw_molality_from_SA	molality of seawater
gsw_ionic_strength_from_SA	ionic strength of seawater

specific volume, density and enthalpy

gsw_specvol	specific volume
gsw_alpha	thermal expansion coefficient with respect to CT
gsw_beta	saline contraction coefficient at constant CT
gsw_alpha_on_beta	alpha divided by beta
gsw_specvol_alpha_beta	specific volume, thermal expansion and saline contraction coefficients
gsw_specvol_first_derivatives	first derivatives of specific volume
gsw_specvol_second_derivatives	second derivatives of specific volume
gsw_specvol_first_derivatives_wrt_enthalpy	first derivatives of specific volume with respect to enthalpy
gsw_specvol_second_derivatives_wrt_enthalpy	second derivatives of specific volume with respect to enthalpy
gsw_specvol_anom	specific volume anomaly
gsw_specvol_anom_standard	specific volume anomaly realtive to SSO & 0°C
gsw_rho	in-situ density and potential density
gsw_rho_alpha_beta	in-situ density, thermal expansion and saline contraction coefficients
gsw_rho_first_derivatives	first derivatives of density
gsw_rho_second_derivatives	second derivatives of density
gsw_rho_first_derivatives_wrt_enthalpy	first derivatives of density with respect to enthalpy
gsw_rho_second_derivatives_wrt_enthalpy	second derivatives of density with respect to enthalpy
gsw_sigma0	sigma0 with reference pressure of 0 dbar
gsw_sigma1	sigma1 with reference pressure of 1000 dbar
gsw_sigma2	sigma2 with reference pressure of 2000 dbar
gsw_sigma3	sigma3 with reference pressure of 3000 dbar
gsw_sigma4	sigma4 with reference pressure of 4000 dbar
gsw_cabbeling	cabbeling coefficient
gsw_thermobaric	thermobaric coefficient
gsw_enthalpy	enthalpy
gsw_enthalpy_diff	difference of enthalpy between two pressures
gsw_dynamic_enthalpy	dynamic enthalpy
gsw_enthalpy_first_derivatives	first derivatives of enthalpy
gsw_enthalpy_second_derivatives	second derivatives of enthalpy
gsw_sound_speed	sound speed
gsw_kappa	isentropic compressibility
gsw_internal_energy	internal energy
gsw_internal_energy_first_derivatives	first derivatives of internal energy
gsw_internal_energy_second_derivatives	second derivatives of internal energy
gsw_CT_from_enthalpy	Conservative Temperature from enthalpy
gsw_SA_from_rho	Absolute Salinity from density
gsw_CT_from_rho	Conservative Temperature from density
gsw_CT_maxdensity	Conservative Temperature of maximum density of seawater

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vertical stability

gsw_Turner_Rsubrho	Turner angle & Rsubrho
gsw_Nsquared	buoyancy (Brunt-Väisäla) frequency squared (N^2)
gsw_Nsquared_min	minimum buoyancy frequency squared (N^2)
gsw_stabilise_SA_const_t	minimally adjust SA to produce a stable water column, keeping in-situ temperature constant
gsw_stabilise_SA_CT	minimally adjusts SA & CT to produce a stable water column
gsw_mlp	mixed-layer pressure
gsw_Nsquared_lowerlimit	specified profile of minimum buoyancy frequency squared
gsw_IPV_vs_fNsquared_ratio	ratio of isopycnal potential vorticity to f times N^2

geostrophic streamfunctions, acoustic travel time and geostrophic velocity

gsw_geo_strf_dyn_height	dynamic height anomaly
gsw_geo_strf_dyn_height_pc	dynamic height anomaly for piecewise constant profiles
gsw_geo_strf_isopycnal	approximate isopycnal geostrophic streamfunction
gsw_geo_strf_isopycnal_pc	approximate isopycnal geostrophic streamfunction for piecewise constant profiles
gsw_geo_strf_Cunningham	Cunningham geostrophic streamfunction
gsw_geo_strf_Montgomery	Montgomery geostrophic streamfunction
gsw_geo_strf_steric_height	dynamic height anomaly divided by 9.7963 m s^{-2}
gsw_geo_strf_PISH	pressure integrated steric height
gsw_travel_time	acoustic travel time
gsw_geostrophic_velocity	geostrophic velocity

isobaric evaporation enthalpy

gsw_latentheat_evap_CT	latent heat of evaporation of water from seawater (isobaric evaporation enthalpy) with CT as input temperature
gsw_latentheat_evap_t	latent heat of evaporation of water from seawater (isobaric evaporation enthalpy) with in-situ temperature, t, as input

seawater and ice properties at freezing temperatures

gsw_CT_freezing	Conservative Temperature freezing temp of seawater
gsw_CT_freezing_poly	Conservative Temperature freezing temp of seawater (poly)
gsw_t_freezing	in-situ freezing temperature of seawater
gsw_t_freezing_poly	in-situ freezing temperature of seawater (poly)
gsw_pot_enthalpy_ice_freezing	potential enthalpy of ice at which seawater freezes
gsw_pot_enthalpy_ice_freezing_poly	potential enthalpy of ice at which seawater freezes (poly)
gsw_SA_freezing_from_CT	SA of seawater at the freezing temp (for given CT)
gsw_SA_freezing_from_CT_poly	SA of seawater at the freezing temp (for given CT) (poly)
gsw_SA_freezing_from_t	SA of seawater at the freezing temp (for given t)
gsw_SA_freezing_from_t_poly	SA of seawater at the freezing temp (for given t) (poly)
gsw_pressure_freezing_CT	pressure of seawater at the freezing temp (for given CT)
gsw_CT_freezing_first_derivatives	first derivatives of CT freezing temp of seawater
gsw_CT_freezing_first_derivatives_poly	first derivatives of CT freezing temp of seawater (poly)
gsw_t_freezing_first_derivatives	first derivatives of in-situ freezing temp of seawater
gsw_t_freezing_first_derivatives_poly	first derivatives of in-situ freezing temp of seawater (poly)
gsw_pot_enthalpy_ice_freezing_first_derivatives	first derivatives of potential enthalpy of ice at freezing
gsw_pot_enthalpy_ice_freezing_first_derivatives_poly	first derivatives of potential enthalpy of ice at freezing (poly)
gsw_latentheat_melting	latent heat of melting of ice into seawater

thermodynamic interaction between ice and seawater

gsw_melting_ice_SA_CT_ratio	SA to CT ratio when ice melts into seawater
gsw_melting_ice_SA_CT_ratio_poly	SA to CT ratio when ice melts into seawater (poly)
gsw_melting_ice_equilibrium_SA_CT_ratio	SA to CT ratio when ice melts, near equilibrium
gsw_melting_ice_equilibrium_SA_CT_ratio_poly	SA to CT ratio when ice melts, near equilibrium (poly)
gsw_ice_fraction_to_freeze_seawater	ice mass fraction to freeze seawater
gsw_melting_ice_into_seawater	SA and CT when ice melts in seawater
gsw_frazil_ratios_adiabatic	ratios of SA, CT and P changes during frazil ice formation
gsw_frazil_ratios_adiabatic_poly	ratios of SA, CT and P changes during frazil ice formation (poly)
gsw_frazil_properties	SA, CT & ice mass fraction from bulk SA & bulk enthalpy
gsw_frazil_properties_potential	SA, CT & ice fraction from bulk SA & bulk potential enthalpy
gsw_frazil_properties_potential_poly	SA, CT & ice fraction from bulk SA & bulk potential enthalpy (poly)

thermodynamic interaction between sea ice and seawater

gsw_melting_seaice_SA_CT_ratio	SA to CT ratio when sea ice melts into seawater
gsw_melting_seaice_SA_CT_ratio_poly	SA to CT ratio when sea ice melts into seawater (poly)
gsw_melting_seaice_equilibrium_SA_CT_ratio	SA to CT ratio when sea ice melts, near equilibrium
gsw_melting_seaice_equilibrium_SA_CT_ratio_poly	SA to CT ratio when sea ice melts, near equilibrium (poly)
gsw_seaice_fraction_to_freeze_seawater	sea ice mass fraction to freeze seawater
gsw_melting_seaice_into_seawater	SA and CT when sea ice melts into seawater

thermodynamic properties of ice Ih

gsw_specvol_ice	specific volume of ice
gsw_alpha_wrt_t_ice	thermal expansion coefficient of ice with respect to in-situ temp
gsw_rho_ice	in-situ density of ice
gsw_pressure_coefficient_ice	pressure coefficient of ice
gsw_sound_speed_ice	sound speed of ice (compression waves)
gsw_kappa_ice	isentropic compressibility of ice
gsw_kappa_const_t_ice	isothermal compressibility of ice
gsw_internal_energy_ice	internal energy of ice
gsw_enthalpy_ice	enthalpy of ice
gsw_entropy_ice	entropy of ice
gsw_cp_ice	isobaric heat capacity of ice
gsw_chem_potential_water_ice	chemical potential of water in ice
gsw_Helmholtz_energy_ice	Helmholtz energy of ice
gsw_adiabatic_lapse_rate_ice	adiabatic lapse rate of ice
gsw_pt0_from_t_ice	potential temperature of ice with reference pressure of 0 dbar
gsw_pt_from_t_ice	potential temperature of ice
gsw_t_from_pt0_ice	in-situ temp from potential temp of ice with p_ref of 0 dbar
gsw_t_from_rho_ice	in-situ temp from density of ice
gsw_pot_enthalpy_from_pt_ice	potential enthalpy from potential temperature of ice
gsw_pt_from_pot_enthalpy_ice	potential temperature from potential enthalpy of ice
gsw_pot_enthalpy_from_pt_ice_poly	potential enthalpy from potential temperature of ice (poly)
gsw_pt_from_pot_enthalpy_ice_poly	potential temperature from potential enthalpy of ice (poly)
gsw_pot_enthalpy_from_specvol_ice	potential enthalpy from specific volume of ice
gsw_specvol_from_pot_enthalpy_ice	specific volume from potential enthalpy of ice
gsw_pot_enthalpy_from_specvol_ice_poly	potential enthalpy from specific volume of ice (poly)
gsw_specvol_from_pot_enthalpy_ice_poly	specific volume from potential enthalpy of ice (poly)

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spiciness

gsw_spiciness0	spiciness with reference pressure of 0 dbar
gsw_spiciness1	spiciness with reference pressure of 1000 dbar
gsw_spiciness2	spiciness with reference pressure of 2000 dbar

neutral versus isopycnal slopes and ratios

gsw_isopycnal_slope_ratio	ratio of the slopes of isopycnals on the SA-CT diagram for p & p_ref
gsw_isopycnal_vs_ntp_CT_ratio	ratio of the gradient of CT in a potential density surface to that in the neutral tangent plane
gsw_ntp_pt_vs_CT_ratio	ratio of gradients of pt & CT in a neutral tangent plane

derivatives of entropy, CT and pt

gsw_CT_first_derivatives	first derivatives of Conservative Temperature
gsw_CT_second_derivatives	second derivatives of Conservative Temperature
gsw_entropy_first_derivatives	first derivatives of entropy
gsw_entropy_second_derivatives	second derivatives of entropy
gsw_pt_first_derivatives	first derivatives of potential temperature
gsw_pt_second_derivatives	second derivatives of potential temperature

planet Earth properties

gsw_f	Coriolis parameter
gsw_grav	gravitational acceleration
gsw_distance	spherical earth distance between points in the ocean

TEOS–10 constants

gsw_T0	Celsius zero point; 273.15 K
gsw_P0	one standard atmosphere; 101 325 Pa
gsw_SSO	Standard Ocean Reference Salinity; 35.165 04 g/kg
gsw_uPS	unit conversion factor for salinities; (35.165 04/35) g/kg
gsw_cp0	the “specific heat” for use with CT; 3991.867 957 119 63 (J/kg)/K
gsw_C3515	conductivity of SSW at SP=35, t_68=15, p=0; 42.9140 mS/cm
gsw_SonCl	ratio of SP to Chlorinity; 1.80655 $(g/kg)^{-1}$
gsw_valence_factor	valence factor of sea salt; 1.2452898
gsw_atomic_weight	mole-weighted atomic weight of sea salt; 31.4038218... g/mol

laboratory functions, for use with densimeter measurements

gsw_SA_from_rho_t_exact	Absolute Salinity from density
gsw_deltaSA_from_rho_t_exact	Absolute Salinity Anomaly from density
gsw_rho_t_exact	in-situ density

specific volume, density and enthalpy in terms of CT, based on the exact Gibbs function

gsw_specvol_CT_exact	specific volume
gsw_alpha_CT_exact	thermal expansion coefficient with respect to CT
gsw_beta_CT_exact	saline contraction coefficient at constant CT
gsw_alpha_on_beta_CT_exact	alpha divided by beta
gsw_specvol_alpha_beta_CT_exact	specific volume, thermal expansion and saline contraction coefficients
gsw_specvol_first_derivatives_CT_exact	first derivatives of specific volume
gsw_specvol_second_derivatives_CT_exact	second derivatives of specific volume
gsw_specvol_first_derivatives_wrt_enthalpy_CT_exact	first derivatives of specific volume with respect to enthalpy
gsw_specvol_second_derivatives_wrt_enthalpy_CT_exact	second derivatives of specific volume with respect to enthalpy
gsw_specvol_anom_CT_exact	specific volume anomaly
gsw_specvol_anom_standard_CT_exact	specific volume anomaly realtive to SSO & 0°C
gsw_rho_CT_exact	in-situ density and potential density
gsw_rho_alpha_beta_CT_exact	in-situ density, thermal expansion and saline contraction coefficients
gsw_rho_first_derivatives_CT_exact	first derivatives of density
gsw_rho_second_derivatives_CT_exact	second derivatives of density
gsw_rho_first_derivatives_wrt_enthalpy_CT_exact	first derivatives of density with respect to enthalpy
gsw_rho_second_derivatives_wrt_enthalpy_CT_exact	second derivatives of density with respect to enthalpy
gsw_sigma0_CT_exact	sigma0 with reference pressure of 0 dbar
gsw_sigma1_CT_exact	sigma1 with reference pressure of 1000 dbar
gsw_sigma2_CT_exact	sigma2 with reference pressure of 2000 dbar
gsw_sigma3_CT_exact	sigma3 with reference pressure of 3000 dbar
gsw_sigma4_CT_exact	sigma4 with reference pressure of 4000 dbar
gsw_cabbeling_CT_exact	cabbeling coefficient
gsw_thermobaric_CT_exact	thermobaric coefficient
gsw_enthalpy_CT_exact	enthalpy
gsw_enthalpy_diff_CT_exact	difference of enthalpy between two pressures
gsw_dynamic_enthalpy_CT_exact	dynamic enthalpy
gsw_enthalpy_first_derivatives_CT_exact	first derivatives of enthalpy
gsw_enthalpy_second_derivatives_CT_exact	second derivatives of enthalpy
gsw_sound_speed_CT_exact	sound speed
gsw_kappa_CT_exact	isentropic compressibility
gsw_internal_energy_CT_exact	internal energy
gsw_internal_energy_first_derivatives_CT_exact	first derivatives of internal energy
gsw_internal_energy_second_derivatives_CT_exact	second derivatives of internal energy
gsw_CT_from_enthalpy_exact	Conservative Temperature from enthalpy
gsw_SA_from_rho_CT_exact	Absolute Salinity from density
gsw_CT_from_rho_exact	Conservative Temperature from density
gsw_CT_maxdensity_exact	Conservative Temperature of maximum density of seawater

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dissolved gasses

gsw_Arsol	argon solubility from SA and CT
gsw_Arsol_SP_pt	argon solubility from SP and pt
gsw_Hesol	helium solubility from SA and CT
gsw_Hesol_SP_pt	helium solubility from SP and pt
gsw_Krsol	krypton solubility from SA and CT
gsw_Krsol_SP_pt	krypton solubility from SP and pt
gsw_N2sol	nitrogen solubility from SA and CT
gsw_N2sol_SP_pt	nitrogen solubility from SP and pt
gsw_Nesol	neon solubility from SA and CT
gsw_Nesol_SP_pt	neon solubility from SP and pt
gsw_O2sol	oxygen solubility from SA and CT
gsw_O2sol_SP_pt	oxygen solubility from SP and pt

basic thermodynamic properties in terms of in-situ *t*, based on the exact Gibbs function

gsw_specvol_t_exact	specific volume
gsw_alpha_wrt_CT_t_exact	thermal expansion coefficient with respect to Conservative Temperature
gsw_alpha_wrt_pt_t_exact	thermal expansion coefficient with respect to potential temperature
gsw_alpha_wrt_t_exact	thermal expansion coefficient with respect to in-situ temperature
gsw_beta_const_CT_t_exact	saline contraction coefficient at constant Conservative Temperature
gsw_beta_const_pt_t_exact	saline contraction coefficient at constant potential temperature
gsw_beta_const_t_exact	saline contraction coefficient at constant in-situ temperature
gsw_specvol_anom_standard_t_exact	specific volume anomaly realtive to SSO & 0°C
gsw_rho_t_exact	in-situ density
gsw_pot_rho_t_exact	potential density
gsw_sigma0_pt0_exact	sigma0 from pt0 with reference pressure of 0 dbar
gsw_enthalpy_t_exact	enthalpy
gsw_dynamic_enthalpy_t_exact	dynamic enthalpy
gsw_CT_first_derivatives_wrt_t_exact	first derivatives of Conservative Temperature with respect to t
gsw_enthalpy_first_derivatives_wrt_t_exact	first derivatives of enthalpy with respect to t
gsw_sound_speed_t_exact	sound speed
gsw_kappa_t_exact	isentropic compressibility
gsw_kappa_const_t_exact	isothermal compressibility
gsw_internal_energy_t_exact	internal energy
gsw_SA_from_rho_t_exact	Absolute Salinity from density
gsw_t_from_rho_exact	in-situ temperature from density
gsw_t_maxdensity_exact	in-situ temperature of maximum density of seawater
gsw_cp_t_exact	isobaric heat capacity
gsw_isochoric_heat_cap_t_exact	isochoric heat capacity
gsw_chem_potential_relative_t_exact	relative chemical potential
gsw_chem_potential_water_t_exact	chemical potential of water in seawater
gsw_chem_potential_salt_t_exact	chemical potential of salt in seawater
gsw_t_deriv_chem_potential_water_t_exact	temperature derivative of chemical potential of water
gsw_dilution_coefficient_t_exact	dilution coefficient of seawater
gsw_Helmholtz_energy_t_exact	Helmholtz energy
gsw_osmotic_coefficient_t_exact	osmotic coefficient of seawater
gsw_osmotic_pressure_t_exact	osmotic pressure of seawater

Library functions of the GSW toolbox *(internal functions; not intended to be called by users)*

The GSW functions call the following library functions:

gsw_gibbs	the TEOS-10 Gibbs function of seawater and its derivatives
gsw_gibbs_ice	the TEOS-10 Gibbs function of ice and its derivatives
gsw_SAAR	Absolute Salinity Anomaly Ratio (excluding the Baltic Sea)
gsw_Fdelta	ratio of Absolute to Preformed Salinity, minus 1
gsw_deltaSA_atlas	Absolute Salinity Anomaly atlas value (excluding the Baltic Sea)
gsw_SA_from_SP_Baltic	Calculates Absolute Salinity in the Baltic Sea
gsw_SP_from_SA_Baltic	Calculates Practical Salinity in the Baltic Sea
gsw_infunnel	"oceanographic funnel" check for the 75-term equation
gsw_entropy_part	entropy minus the terms that are a function of only SA
gsw_entropy_part_zerop	entropy_part evaluated at 0 dbar
gsw_interp_ref_cast	linearly interpolates the reference cast
gsw_linear_interp_SA_CT	linearly interpolates (SA,CT,p) to the desired p
gsw_rr68_interp_SA_CT	Reiniger & Ross (1968) interpolation of (SA,CT,p) to the desired p
gsw_gibbs_pt0_pt0	gibbs(0,2,0,SA,t,0)
gsw_gibbs_ice_part_t	part of gibbs_ice(1,0,t,p)
gsw_gibbs_ice_pt0	part of gibbs_ice(1,0,pt0,0)
gsw_specvol_SSO_0	specvol(35.16504,0,p)
gsw_enthalpy_SSO_0	enthalpy(35.16504,0,p)
gsw_Hill_ratio_at_SP2	Hill ratio at a Practical Salinity of 2

The GSW data set:

gsw_data_v3_0	*This file contains:* (1) the global data set of Absolute Salinity Anomaly Ratio, (2) the global data set of Absolute Salinity Anomaly Ref., (3) a reference cast (for the isopycnal streamfunction), (4) two reference casts that are used by gsw_demo (5) three vertical profiles of (SP, t, p) at known long & lat, plus the outputs of all the GSW functions for these 3 profiles, and the required accuracy of all these outputs.

documentation set

gsw_front_page	front page to the GSW Oceanographic Toolbox
gsw_check_functions	checks that all the GSW functions work correctly
gsw_demo	demonstrates many GSW functions and features
gsw_ver	displays the GSW version number
gsw_licence	creative commons licence for the GSW Oceanographic Toolbox

The GSW Toolbox is available from

www.TEOS–10.org

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