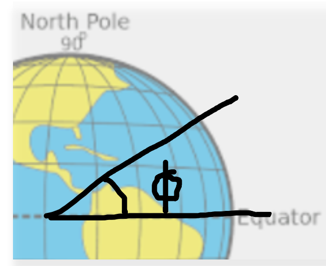
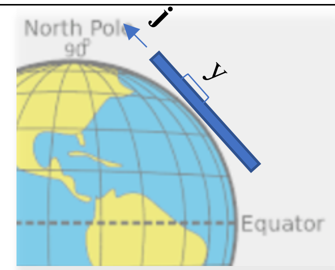
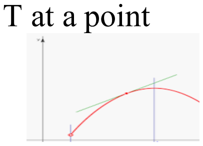
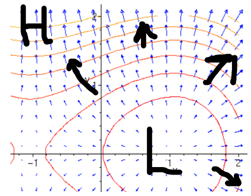
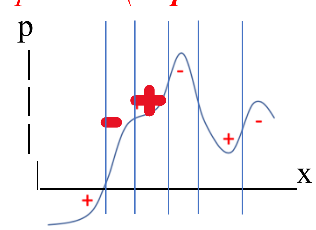
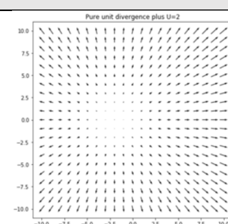
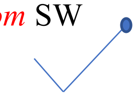
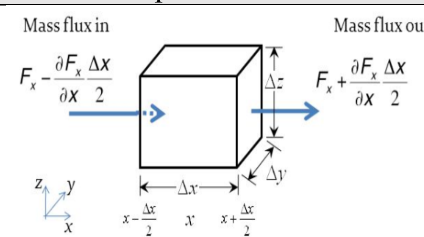
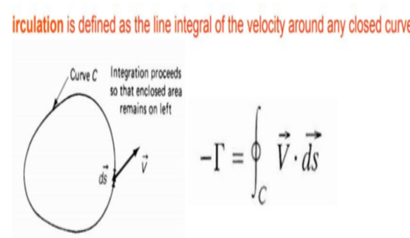
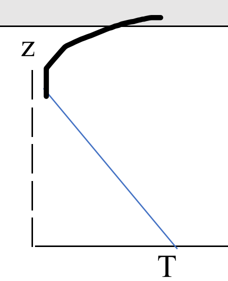
ATM 651 Exam 1: vocabulary. Name____________________

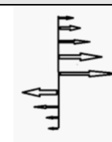
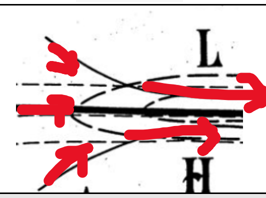
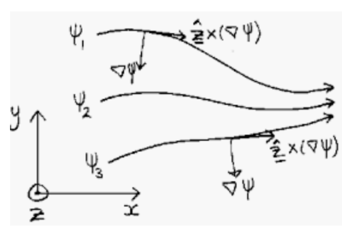
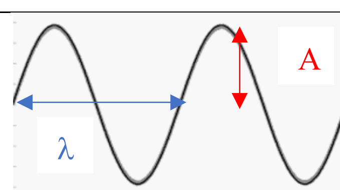
50 rows, 2 points for each row. Fill in the white boxes, 2 per row. *gray box: no response asked*

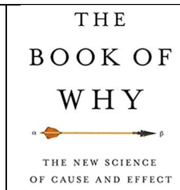
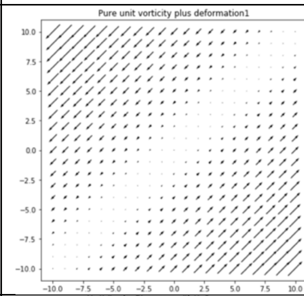
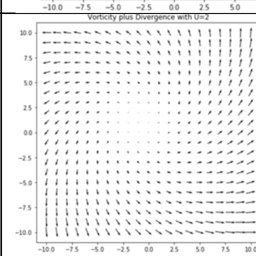
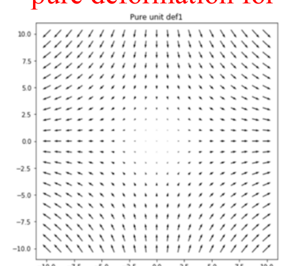
Word	**Symbol**	**Units**	**Math definition or concept (explained)**	**Relevant sketch** or extra space for more words
latitude	ϕ (a scalar coordinate varying only in one spatial direction)	degrees (or radians)	Latitude is an angle from the center of the Earth. That's why we take its sine and cosine.	
distance north from origin	y (Cartesian coordinate used similar to the above)	meters	distance on a tangent plane, in the direction of the **j** unit vector	
Temperature	T(x,y,t)	K or °C (accepted Joules)	a measure of the energy of molecular motion ("heat")	
del operator	∇	m^{-1}	$\boldsymbol{i}\frac{\partial}{\partial x}+\boldsymbol{j}\frac{\partial}{\partial y}+\boldsymbol{k}\frac{\partial}{\partial z}$	<-- write **i,j,k** to the *left*, since things on the right of the derivative get *operated on.* A *sum*.
Local or Eulerian tendency of T(x,y,t)	$\left.\frac{\partial T}{\partial t}\right]_{x,y}$	$K\ s^{-1}$		
Local or Eulerian tendency of T(x,y,t)			Rate of change of T with time *for a thermometer at a given location*	T at a point  time *Slope* of T(t) curve

Gradient of p(x,y) where p is pressure	∇p	Pa/m Kg m^{-2} s^{-2}	sketch some contours with H and L, & indicate vectors that illustrate --> concept	
Gradient of Φ(x,y,t) (Φ = gZ)		m s^{-2}	$\boldsymbol{i}\frac{\partial \Phi}{\partial x}+\boldsymbol{j}\frac{\partial \Phi}{\partial y}+\boldsymbol{k}\frac{\partial \Phi}{\partial z}$	<-- use **i,j,k** (Cartesian unit vectors). This is the *geopotential*.
Laplacian of T(x,y,t)	(use nabla): $\nabla^2 T$	K m^{-2}		
Laplacian of p(x)			using p(x) notation: d not ∂ because *p is a function of one variable only* $\frac{d^2p}{dx^2}$	***curvature***. *Smile-like is positive (**slope increasing**)* 
speed of wind whose components are u(x,y), v(x,y)		m s^{-1}	Speed = $\sqrt{u^2+v^2}$	
vector velocity of a baseball in x,y,z coordinates	**V**	m s^{-1}	(use $\dot{x}, \dot{y}, \dot{z}$) $\boldsymbol{V}=\boldsymbol{i}\,\dot{x}+\boldsymbol{j}\,\dot{y}+\boldsymbol{k}\,\dot{z}=\dot{x}\boldsymbol{i}+\dot{y}\boldsymbol{j}+\dot{z}\boldsymbol{k}$	
vector velocity *field* of pure divergence	$\mathbf{V}_{\mathbf{div}}$(x,y)	m s^{-1}		 outward
omega	ω	Pa s^{-1}	$\dot{p}$, vertical velocity of air in p coord.	~~draw vector~~ for ω>0: *downward* motion
Laplacian of Z(x,y)	divergence of the	m^{-1}	$\nabla^2 Z$	

	gradient of Z(x,y)			
vector velocity	**V**	m s^{-1}	**i**u+**j**v+**k**w	
		m s^{-1} (or knot)	10 knot southwesterly wind	*from* SW 
Flux of specific momentum (velocity)		(*m/s*) m^{-2} s^{-1}	How much momentum (per unit mass) carried through a unit area per second	(*quantity in parentheses*) per square meter per second
Energy flux (e.g. an *irradiance*)		W m^{-2} (Joules) m^{-2} s^{-1}	How much (energy) passing through per unit area per second	
Vertical velocity	w ($intent: \dot{z}$)	m s^{-1}	other answers accepted	like a humidity measure from another chapter
Mass flux	ρV	(*kg*) m^{-2} s^{-1}	How much (mass) moving through a unit area per second	
vertical component of vector vorticity	ζ	s^{-1}	use nabla & **k**: $\boldsymbol{k} \cdot \nabla \times \mathbf{V}$	
Circulation, the **path integral** around a closed curve of the ***curve-tangential component*** of the flow	C		$\oint_{loop} V_s\, ds$	
Circulation. *What is it* <u>*equal to*</u> *(Stokes' theorem):*	C	m^2 s^{-1}	**area-integrated vorticity** = $\iint_{area\ bounded\ by\ loop} \zeta\, dA$	
dot product of a force and velocity	suggest W	(Nm) s^{-1} Joule s^{-1} Watts	$\vec{\boldsymbol{F}}_{PGF} \cdot \vec{\boldsymbol{V}}$	took any rational MKS answer and of course any letter, explained. Few if any saw the

(explain letter you choose -->	for work rate, or power P	kg m^2 s^{-3}		energy = force*distance or work = force*velocity. That's physics, not math/vocab.
meridional flux of *zonal momentum*	ρuv or just uv	(*momentum*) m^{-2} s^{-1} or just m^2 s^{-2}	amount of zonal momentum passing northward through a unit area in the x-z plane, per second	Positive for southwesterly wind, negative for northeasterly wind. See below.
vertical advection of meridional momentum	$-w\frac{\partial}{\partial z}(v)$	m s^{-2}	rate of change of v due to advection by vertical wind component	Yes unfair!! Simon didn't say "specific" momentum! Get used to fluid physics presuming *per unit mass*.
curl operator		m^{-1}	(use nabla) $\nabla\times$	Just the operator. It has units.
PGF		m s^{-2}	$\frac{-1}{\rho}\nabla p$ or $-\nabla\Phi$	
troposphere the layer of air that radiation cools, so that surface solar heating must warm it with weather motion			the lowest ~10km of the atmosphere; where most weather occurs. dT/dz < 0	
Coriolis force (per unit mass)	C_o f **k x V**	m s^{-2}		
Coriolis *parameter*	f	s^{-1}	$f = 2\Omega\sin(\varphi)$	
planetary vorticity	f	s^{-1}		
temperature *anomaly*	T'(t,x,y)	K or °C or °F	*Deviation* from *time-averaged* T	not "trend" or "tendency", not "change", not "variance", ...
(name) Planetary boundary layer	(acronym) PBL		the layer of air in contact w/ the surface	
horizontal advection of	$-\vec{V}\cdot\vec{\nabla}q$	(units of q) s^{-1}	<-- (kg_{water}/kg_{air})	<-- is q "dimensionless"? formally yes, I suppose,...

specific humidity q				
horizontal convergence of horizontal flux of (moisture) q	$-\vec{\nabla}\cdot(q\rho\vec{V})$	(units of q) s^{-1}	"	Hey, does it mean anything that $\vec{\nabla}$ is sometimes written with/without an arrow over it? No, it is just one thing.
local (Eulerian) tendency of q	$\frac{\partial q}{\partial t}$	(units of q) s^{-1}	"	Hey, don't I sometimes see some subcript on $\vec{V}$ or $\vec{\nabla}$? Yes, like $\vec{V}_h$ for horizontal wind, or $\vec{\nabla}_p$(__) for partial space derivatives taken @constant p
total (Lagrangian) tendency of q	$\frac{dq}{dt}$	(units of q) s^{-1}	"	"
vertical shear of zonal wind		s^{-1}	$\partial u/\partial z$	
confluence without convergence			sketch --> carefully (streamlines and isotachs)	
Mass of 1 cc = 1 ml of water in MKS	(<--oops my typo)	1 g	1cc = 10^{-6} m^3 mass 10^{-3} kg	
streamfunction $\psi(x,y)$ of a nondivergent 2D horizontal flow ($\vec{\boldsymbol{V}} = \hat{\boldsymbol{k}}\times\boldsymbol{\nabla}\psi$)	$\psi(x,y)$	$m^2\ s^{-1}$ $m^2\ s^{-1}$	sketch contours and a few velocity vectors -->	
wavelength	λ	m	a number measuring something about a *spatial* sinusoid -->	
amplitude	A	freebie	indicate on sketch above	(see above)
cause and effect				https://xkcd.com/552/

			"correlation is not causation"	
Shear	One unit of vorticity plus one unit of deformation			
Splat with a twist	One unit of divergence plus one unit of vorticity	poor ask but it's a velocity field, m s^{-1}		
A flow field with curvature but not vorticity. Sketch it carefully as vectors at the indicated points.	Remember, arrows for vectors apply at their tail point, and length is proportional to speed.		Practice on the back of page, then Just do it -->	pure deformation for instance 
Radius of earth in MKS units	a	m	$(10^7 m) / (\pi/2)$ = 6341 km	