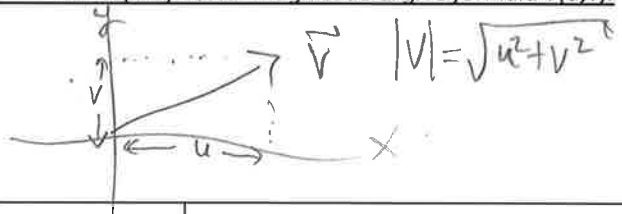
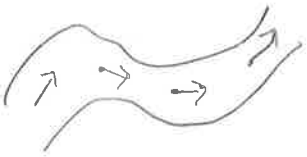
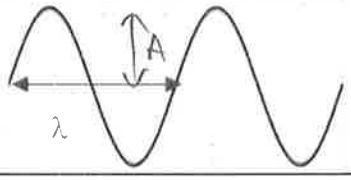
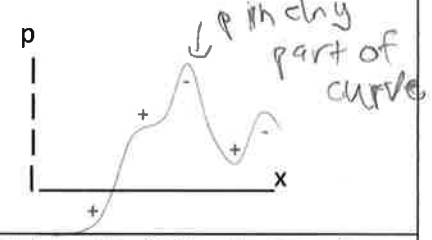
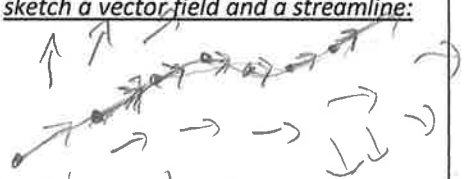
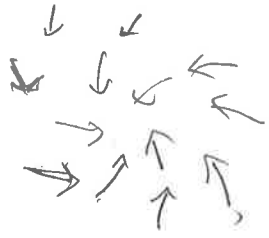
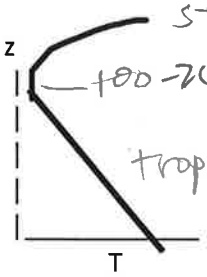
ATM 651 Exam 1 on vocabulary and concepts. Fall 2021. Name Key

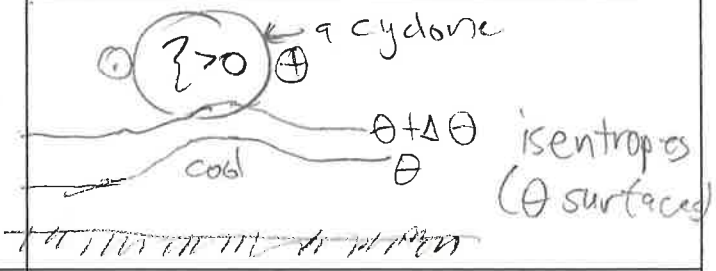
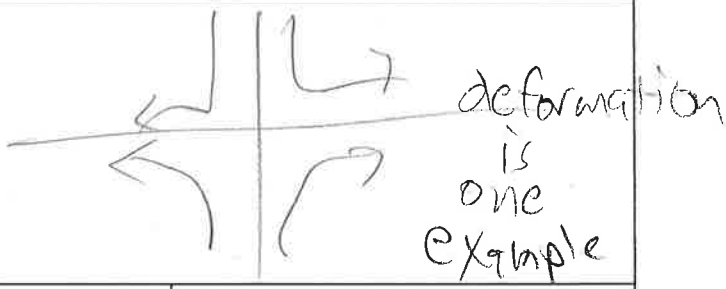
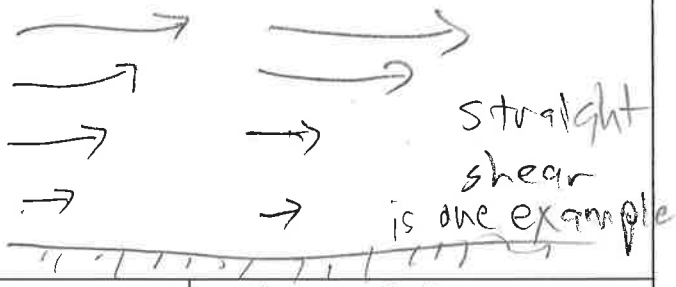
50 rows, 2 points for each row. Fill in the empty boxes or *follow* *underlined italic instructions*.

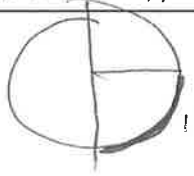
	Word/name	**Symbol**	**Units**	**Definition** math or words	**Relevant sketch** or extra space for more words
1	convergence of flux of water vapor	$-\vec{\nabla}\cdot(q\rho\vec{V})$ q is specific humidity	$\frac{\partial q}{\partial t} = \cdots$ $\frac{(kg_w/kg_{air})}{s}$	q units are: (kg_{water}/kg_{air}) (perhaps "dimensionless")	no response here
2	vertical velocity	$w = \dot{z} = dz/dt$	m/s	no response here	no response here
3	~~PBL~~ Planetary Boundary Layer	~~PBL~~	no response here	layer in contact with the surface	no response here
4	shear: give recipe in terms of div, vor, def. and what are units of those?	*shear = ...* Vor + def	s^{-1}	straight sheared flow in x,y plane	
5	*speed* of wind whose vector components are u, v	$V = \|\mathbf{V}\|$	m/s	*sketch concept of vector magnitude & give formula V(u,v):* 	
6	horizontal advection of specific humidity	$-V\cdot\nabla q$	$\frac{(kg_w/kg_{air})}{s}$ or s^{-1}	q units are: (kg_{water}/kg_{air})	no response here
7	dot product of a force and a velocity	$\vec{F}\cdot\vec{V} = (kg\frac{m}{s^2})(m/s)$	$N\cdot m/s$ $= J/s = W$	rate of kinetic energy production	no response here
8	geostrophic wind	$\mathbf{V_g}$	m s^{-1}	Force balance $f(\hat{k}\times\vec{V}_g) = -\nabla\Phi$ $\Rightarrow \vec{V}_g = \frac{1}{f}\hat{k}\times\vec{\nabla}\Phi$ components ok	*Sketch relation to Φ contours:*  (or even one component)
9	NE ward wind	fill in blanks	m s^{-1}	SW erly wind	

10	planetary vorticity	f	s^{-1}	*typical value:* $10^{-4} s^{-1}$ @ 43 N or $(2\pi/24\,\text{hr})$ at pole	no response here
11	streamfunction $\psi(x,y)$ of a nondivergent 2D horizontal flow ($\vec{V} = \hat{k} \times \nabla\psi$) $m/s = m^{-1} \cdot ?$	$\psi(x,y)$ solve for ζ	$? = m^2/s$	sketch contours and a few velocity vectors -->	
12	wavelength	λ	m	an aspect of a spatial wave as indicated	
13	amplitude	A	no response here	indicate on sketch above (2 points)	
14	radiative temperature tendency $K\ s^{-1}$	Q_{rad}	$K\,s^{-1}$	*RHS term in what equation?* First Law of thermo	no response here (conservation of thermal energy)
15	Laplacian of geopotential height Z(x,y)	$\nabla^2 Z$ m^{-2} m	m^{-1}	no response here	no response here
16	Circulation. What is it equal to (Stokes' theorem):	C	$m^2 s^{-1}$	no response here	*write theorem here:* $\oint \vec{V} \cdot d\vec{l}$ $(m/s) \cdot m$ $= \iint_A \zeta\, dA$ $(s^{-1})\, m^2$
17	Coriolis force (per unit mass)	f (**k** x **V**) s^{-1} m/s	m/s^2	no response here	*why does it exist? briefly:* Earth is rotating, But we ignore that acceleration when we say ground is "motionless" with him that rotating coordinate system.
18	del operator	∇ or $\vec{\nabla}$	m^{-1}	$\boldsymbol{i}\frac{\partial}{\partial x} + \boldsymbol{j}\frac{\partial}{\partial y} + \boldsymbol{k}\frac{\partial}{\partial z}$	no response here
19	divergence of wind field **V**	$\vec{\nabla} \cdot \vec{V}$	s^{-1}	no response here	no response here
20	a partial derivative in vorticity $\zeta = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$	$\partial v/\partial x\|_{y,z,t}$ vs. $\partial v/\partial x\|_{y,p,t}$	s^{-1}	no response here	*words here:* z held constant vs. p held constant. Along a height sfc. vs. a p surface

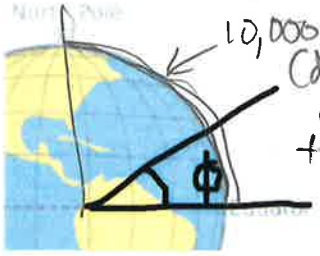
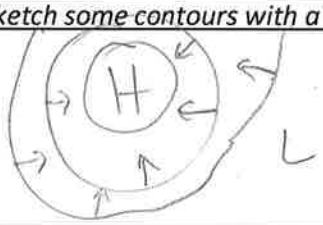
it's in there

21	**Mass** of 1 cc = 1 ml of water	M of 1cc = 10^{-6} m^3	1g	because g is defined by $1 m^3$ of H_2O	no response here
22	vertical flux of enthalpy	$(C_pT)x(\rho w)$ $\left(\frac{J}{kg}\right)\left(\frac{kg}{m^3}\right)\left(\frac{m}{s}\right)$	$J m^{-2} s^{-1}$ or $W m^{-2}$	*estimate a typical Earthly value (order of magnitude):* $C_pT \cdot \rho w$ (I'd take any number) $10^3 \cdot 273K \cdot \left\|\frac{kg}{m^3}\cdot\frac{m}{s}\right\| \approx 273{,}000\ W m^{-2}$	
23	vertical flux of meridional momentum	~~wv or~~ $(\rho w)v$	m^2/s^2 ~~or~~ $(kg\ m/s)\ m^{-2}\ s^{-1}$	amount of meridional momentum passing upward thru unit area per second	no response here
24	Laplacian of p(x) where p is pressure	d^2p/dx^2	$Pa\ m^{-2}$	indicate where it is zero, and *where is the largest value (greatest absolute value) in sketch -->*	
25	what is the difference btw. a *trajectory* vs. a *streamline*?	*explain in words here:* streamlines are tip-to-tail vectors in a spatial vector field. trajectories are parcel motions through time			*sketch a vector field and a streamline:* 
26	curl operator	$\nabla \times$	m^{-1}	del cross	no response here
27	Flow made up of one unit of pure convergence plus one unit of pure vorticity	$V_{con} + V_{vor}$	$m\ s^{-1}$	double points for sketch here -------->	
28	troposphere vs. stratosphere: label on the curve, and put approximate z or p values of the tropopause	no response	no response	 stratosphere $dT/dz > 0$ 100-200 hPa (12-15 km or so) troposphere $\frac{dT}{dz} < 0$	

29	Gradient of geopotential $\Phi(x,y,t) = gZ$ of a pressure surface	∇Z	m/s^2	$\hat{i}\left.\frac{\partial \Phi}{\partial x}\right\|_p + \hat{j}\left.\frac{\partial \Phi}{\partial y}\right\|_p$	no response here <-- use **i,j,k** (Cartesian unit vectors).
30	vertical shear of zonal wind	$\frac{\partial u}{\partial z}$	s^{-1}	no response here	 this is a u(z) profile
31	cool core cyclone	no response here	no response here	*sketch a cross section, labeling your icons and isopleths:* 	
32	A flow field with curvature but not vorticity	arrows for vectors apply at their tail point, and length is proportional to speed.	no response here		
33	tendency or rate of change of merid. wind	$\frac{\partial v}{\partial t}$	$m\,s^{-2}$	no response here	no response here
34	A flow field with vorticity but no curvature	arrows for vectors apply at their tail point, and length is proportional to speed.	no response here		
35	*one name:* Coriolis parameter	f	s^{-1}	$f = 2\Omega \sin(\varphi)$	*another name for it:* Planetary Vorticity
36	*one name:* meridional flux of zonal momentum	ρuv $= (\rho u)v$ $= (\rho v)u$	(m/s) per square meter per second	*another name:* zonal flux of meridional momentum	flux of momentum (be specific about direction of both the momentum being carried, and the direction of the flux)
37	Radius of earth in MKS units	a	m	*recall that circumference defined the meter:* $2\pi r = 4 \times 10^7 m$, $r = \frac{4 \times 10^7 m}{2\pi}$	



4 of these is circumference
10,000 km is eq-pole distance

38	vertical component of vector vorticity	ζ	s^{-1}	$\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$	*vertical* component, measures *horizontal* swirling motion
39	Explain the meanings of *group velocity* vs. *phase velocity* of waves	c and c_g	m/s	• phase velocity is the speed of phase features (crests & troughs) • group velocity is the speed of energy propagation (a group or packet of waves)	
40	latitude	ϕ (scalar coordinate of spherical coordinates)	deg, radians	*how many km per 1 degree at the surface?* $\frac{10,000\ km}{90^\circ} = 111.111111\ \frac{km}{}$	
41	Gradient of p(x,y) where p is pressure	∇p	Pa/m	*sketch some contours with a H and L, & vectors:*  gradient points uphill	
42	rate of change of Coriolis parameter with time *following the flow*	Df/Dt = df/dt	s^{-2}	what *one term* is it equal to? $\frac{df}{dt} = \frac{\partial f}{\partial t} + u\frac{\partial f}{\partial x} + v\frac{\partial f}{\partial y} + w\frac{\partial f}{\partial z}$	
43	PGF	$-\frac{\nabla p}{\rho}$ or $-\nabla_p \Phi$	could be Newtons, but $m s^{-2}$ (force per unit mass)	no response here	no response here
44	vertical advection of meridional momentum	$w\frac{\partial v}{\partial z}$	$m s^{-2}$	rate of change of v due to advection by vertical wind	of course, I mean *momentum per unit mass*. (V)
45	*what is it equal to?* $-\nabla_p \cdot V$ $= -\frac{\partial u}{\partial x}\Big\|_p - \frac{\partial v}{\partial y}\Big\|_p$	$\partial\omega/\partial p$	s^{-1}	a term in mass continuity equation	no response here
46	confluence without convergence	no response here	no response here	*sketch carefully (streamlines and isotachs):* 	

47	Temperature	T(x,y,z,t)	K, °C, °F	a measure of warmth	
48	omega	ω	Pa/s	$\frac{dp}{dt}$	ω>0 indicates ↓ *downward* motion
49	Local or Eulerian tendency of T(x,y,z,t)	$\frac{\partial T}{\partial t}$	K/s ↕ K/s	Rate of change of T with time *for a thermometer at a given location*	graph of T at a point: time. *Slope* of T(t) curve at a point
50	Diffusive tendency of temperature T	$-\vec{\nabla} \cdot (K\vec{\nabla}T)$ $= -K\nabla^2 T$		convergence of a flux (that is, a *tendency due to transport*)	*what are the units of diffusivity K:* $\left(\frac{K}{s}\right) = ? \cdot (K/m^{-2})$? = m^2/s units of diffusivity K

$K m^{-2}$