[0: Assignment 4 0(4) $\begin{cases} X = r \sin \theta \cos \theta \\ Y = r \sin \theta \sin \theta \end{cases} \Rightarrow \begin{cases} r = \sqrt{x^2 + y^2 + z^2} \\ \theta = t \sin^{-1} \left(\frac{\sqrt{x^2 + y^2 + z^2}}{2} \right) \end{cases}$ ()= tan-1(美) Ix = -it & Zemni Xm 3 Xn =-ik(E231 y 2 + E321 = 2) = -ik(y 3 - 2) Ly = -it & EEmn, Xm 3xn $=-i\hbar\left(\epsilon_{132}\times\frac{\partial}{\partial z}+\epsilon_{212}z\frac{\partial}{\partial x}\right)=-i\hbar\left(z\frac{\partial}{\partial x}-\times\frac{\partial}{\partial z}\right)$ dr = >dx + +dy + =dz = sin0 cosodx + sin0 cosody + cosodz = rsing sing coso cospdx + rsing sing cos Osin p - sing dz = + cosocosp dx + + cososnødy - sino dz do = x2 ty2 dy - x2 ty2 dx = - sino dx + coso dy

$$\frac{\partial}{\partial y} = \frac{\partial r}{\partial y} \frac{\partial}{\partial r} + \frac{\partial \phi}{\partial x} \frac{\partial}{\partial \phi} + \frac{\partial \phi}{\partial x} \frac{\partial}{\partial \phi}$$

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$$\frac{\partial}{\partial z} = \frac{\partial r}{\partial y} \frac{\partial}{\partial r} + \frac{\partial \phi}{\partial x} \frac{\partial}{\partial \phi} + \frac{\partial \phi}{\partial x} \frac{\partial}{\partial \phi}$$

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int

9.

2.
$$q_{i} = \frac{\partial H}{\partial p_{i}}$$
, $p_{i} = -\frac{\partial H}{\partial q_{i}}$, $i = 1, 2, ..., N$

$$[F,G]_{PB} = \sum_{i=1}^{N} \frac{\partial F}{\partial q_{i}} \frac{\partial G}{\partial p_{i}} - \frac{\partial F}{\partial p_{i}} \frac{\partial G}{\partial q_{i}}$$

$$(a) [q_{i}, q_{i}]_{PB} = \sum_{i=1}^{N} \frac{\partial q_{i}}{\partial q_{i}} \frac{\partial q_{i}}{\partial p_{i}} - \frac{\partial q_{i}}{\partial p_{i}} \frac{\partial q_{i}}{\partial p_{i}}$$

$$= \sum_{i=1}^{N} \frac{\partial q_{i}}{\partial q_{i}} (0) - (0) \frac{\partial q_{i}}{\partial q_{i}}$$

$$= \phi$$
 (proven)

$$[P_{i}, P_{j}]_{PB} = \underbrace{\frac{\partial P_{i}}{\partial q_{i}}}_{QQ_{i}} \underbrace{\frac{\partial P_{i}}{\partial P_{i}}}_{QQ_{i}} - \underbrace{\frac{\partial P_{i}}{\partial P_{i}}}_{QQ_{i}} \underbrace{\frac{\partial P_{i}}{\partial q_{i}}}_{QQ_{i}}$$

$$= \underbrace{\frac{\partial}{\partial Q_{i}}}_{QQ_{i}} \underbrace{\frac{\partial P_{i}}{\partial P_{i}}}_{QQ_{i}} - \underbrace{\frac{\partial}{\partial P_{i}}}_{QQ_{i}} \underbrace{\frac{\partial P_{i}}{\partial q_{i}}}_{QQ_{i}}$$

$$= \underbrace{\frac{\partial}{\partial Q_{i}}}_{QQ_{i}} \underbrace{\frac{\partial P_{i}}{\partial P_{i}}}_{QQ_{i}} - \underbrace{\frac{\partial P_{i}}{\partial Q_{i}}}_{QQ_{i}} \underbrace{\frac{\partial P_{i}}{\partial q_{i}}}_{QQ_{i}}$$

$$[q_i, P_j]_{PB} = \sum_{i=1}^{N} \frac{\partial q_i}{\partial q_i} \frac{\partial P_j}{\partial P_i} - \frac{\partial q_i}{\partial P_i} \frac{\partial P_i}{\partial q_i}$$

$$= \sum_{i=1}^{N} \frac{\partial P_i}{\partial P_i} - (0) \frac{\partial P_j}{\partial q_i}$$

$$= \sum_{i=1}^{N} \frac{\partial P_i}{\partial P_i}$$

$$= S_i \text{ (proven)}$$

(b)
$$dF = \frac{\partial F}{\partial q} \frac{\partial q}{\partial t} + \frac{\partial F}{\partial p} \frac{\partial p}{\partial t} + \frac{\partial F}{\partial t}$$

$$= \frac{\partial F}{\partial q} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial p} \left(-\frac{\partial H}{\partial q} \right) + \frac{\partial F}{\partial t}$$

$$= \frac{\partial F}{\partial q} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial p} \left(-\frac{\partial H}{\partial q} \right) + \frac{\partial F}{\partial t}$$

$$= \frac{\partial F}{\partial q} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial p} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial t} \frac{\partial H}{\partial q} \right) + \frac{\partial F}{\partial t}$$

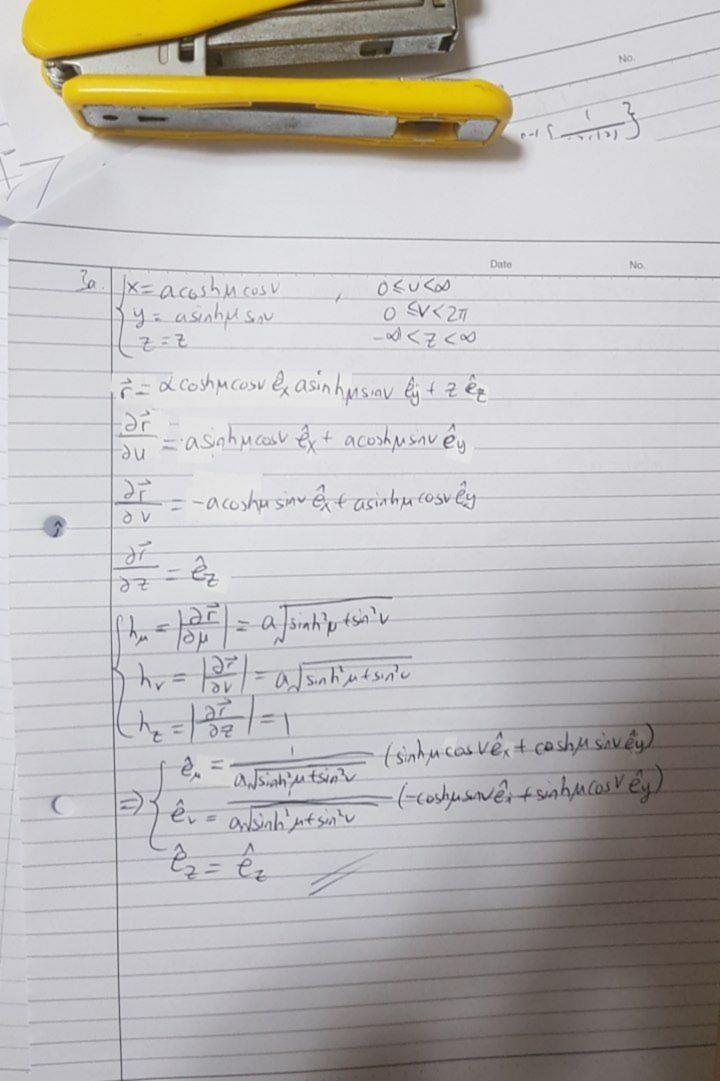
$$= \frac{\partial F}{\partial q} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial p} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial t} \left(\frac{\partial hown}{\partial p} \right)$$

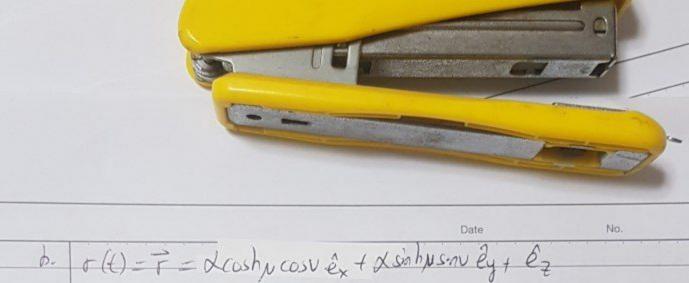
$$= \frac{\partial F}{\partial q} \frac{\partial H}{\partial p} + \frac{\partial F}{\partial t} \left(\frac{\partial hown}{\partial p} \right)$$

Since, H(p,q) does not depend on time, 2H = 0

$$=\phi_{//}$$

Since It = 0, H(p,q) is a constant of motion





V(t) = 2 d coshu cosvên + 3t dsinhu sinvêr tot êz a(t) = 2x Xcoshucosv en + 34 Xsinhusov ev + 22 Ez