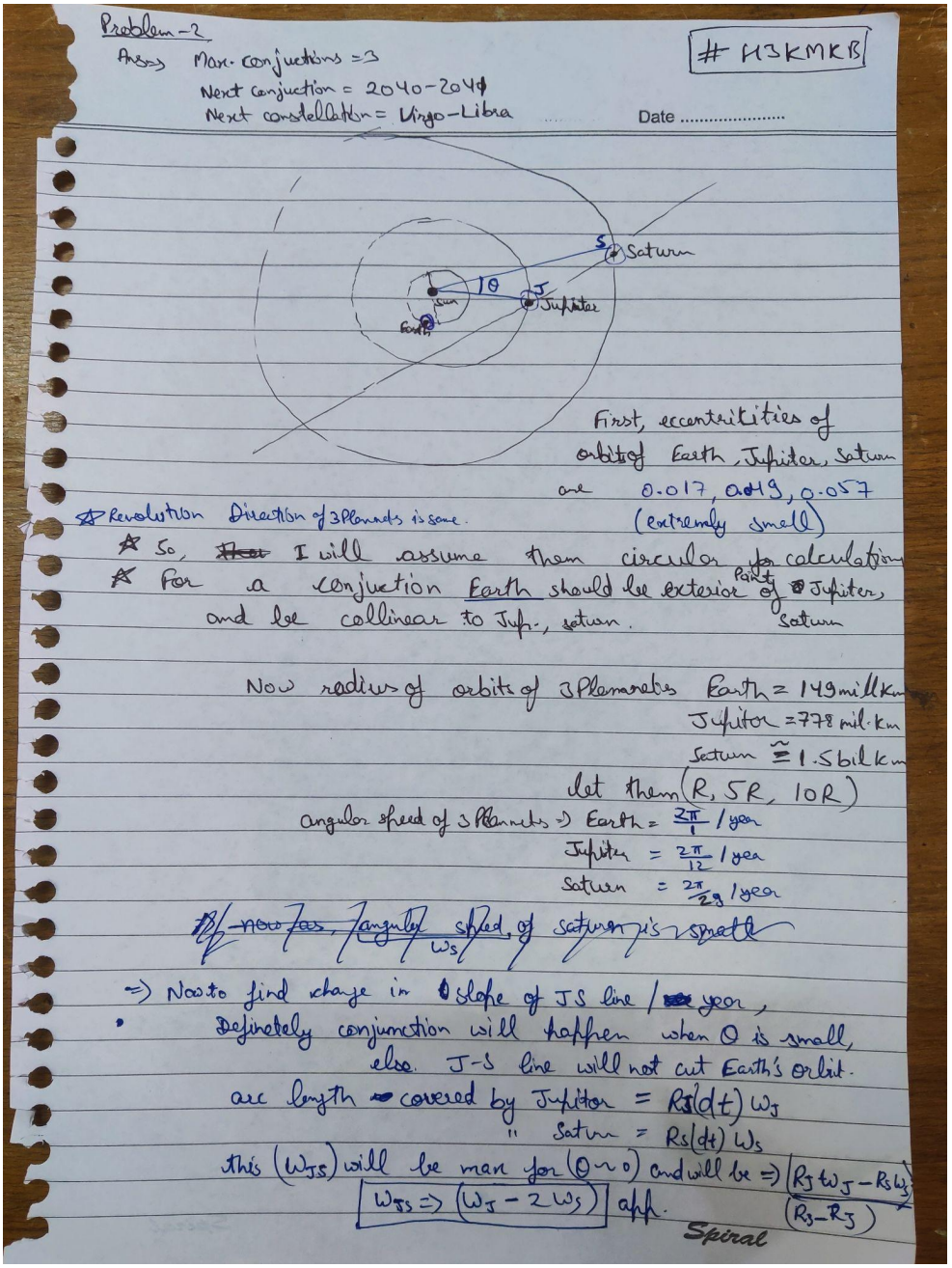
Kshatriyas Hall 2 IntraHall Takneek

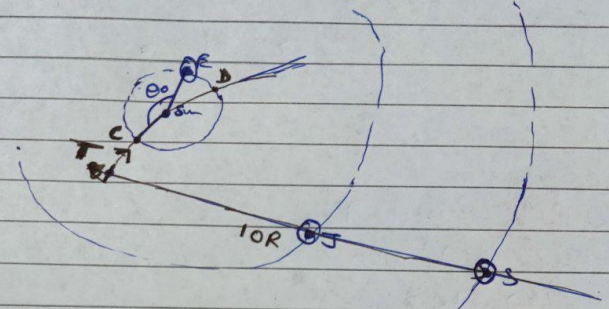
Problem 2 [Astronomy]

1. A conjunction is defined as an apparent meeting or passing of two or more celestial objects. For ease, let us work with two planets (i.e. apart from the one you currently are on), since a triple conjunction is astronomically rare. You witnessed the conjunction of Jupiter and Saturn during December of 2020. What is the maximum number of conjunctions of these two outer planets that can occur in 365 consecutive days? [40 marks]



$\omega_{JS} = (\omega_J - 2\omega_S)$ Date .....

Now analysis this line,



movement of T which is 10R from S is given

So, we can consider CD as straight line (Approx)

Speed of Point T = (Speed of S) + $\omega_{JS} \times (10R)$

$V_T = V_S + \omega_{JS} \times 10R$

$\Rightarrow V_T = ((\omega_S) \times 10R) + (10R \times \omega_{JS})$

Time taken to pass by Earth orbit

$T_{pass} \Rightarrow \frac{2R}{V_T} \Rightarrow \frac{2R}{\left(\frac{2\pi}{29} + \frac{2\pi}{12} - 2\left(\frac{2\pi}{29}\right)\right)10R}$

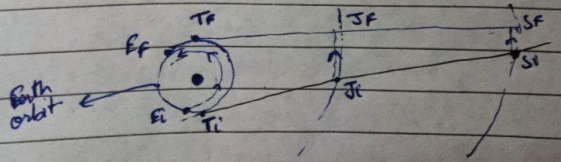
Now taking θ_0 in Prev. diagram to be 0^+ when line just intersect earth's orbit;

$\Rightarrow$ Earth can revolve $\simeq (230°)$ in (0.65 years)

$T_{pass} \Rightarrow \frac{2R}{(2\pi)(10R)(17)} \times 348$

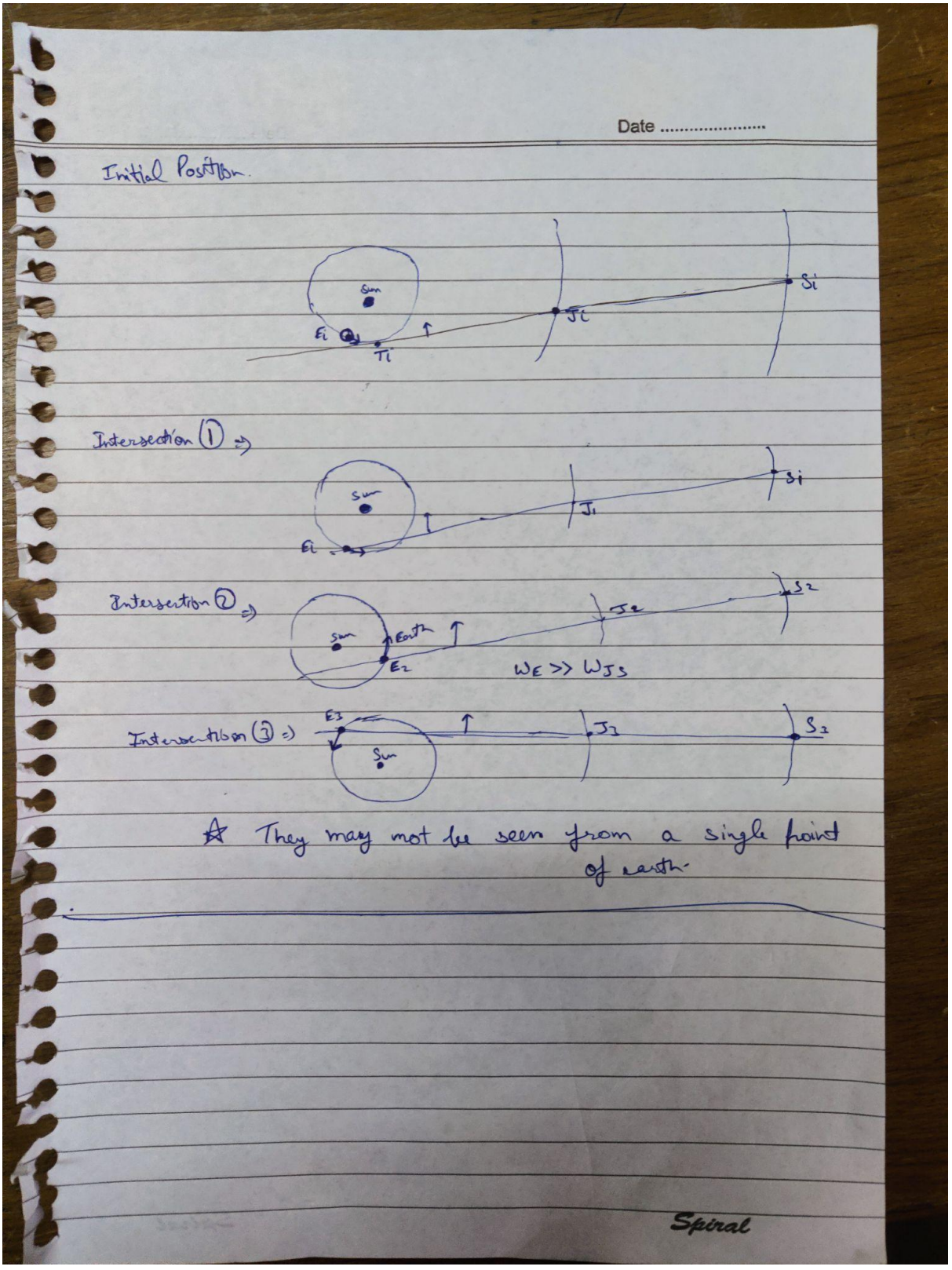
$T_{pass} = \frac{348}{170\pi} \simeq 0.65$ years

$\Rightarrow$ For this initial positions of Earth, Jupiter, Saturn ~~3 conjunctions~~ 3 conjunctions will occur



means This line can intersect earth's orbit for atleast (0.65 years) for some positions of J, S

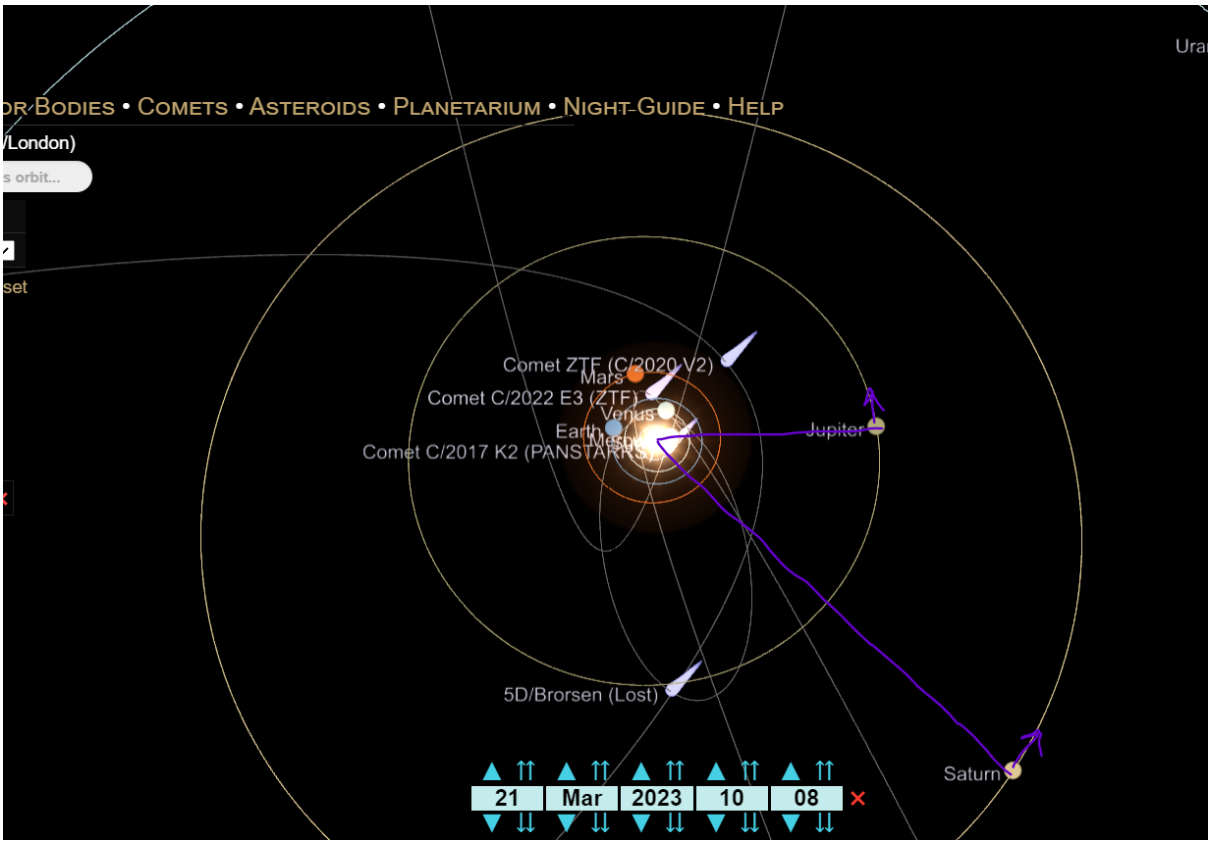
Spiral



Answer= 3 conjunctions can happen max in consecutive 365 days

2. Let's say you get the number as k, with k € Z+. During which year(s) will it happen next and in what constellation(s) will this (these) conjuction(s) happen in during that time? [40 + 20 marks]
NOTE: You are free to consult the internet for the information regarding the details such
as orbital radius of Jupiter and Saturn, etc.

Current plannetery situation:



Date .....

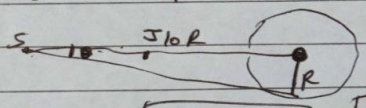
Analysing current situation of Jupiter, saturn, earth.

angular separation between them in Dec, 2020

$\approx [0, +\frac{1}{10}\text{ Radian}]$

⇒ Jupiter was ahead of saturn

$(\frac{1}{10})$ kaise nikala?



$R = \theta \times 10R$ $\quad \theta \approx \frac{1}{10}$

now to get this angular sep $(\Delta\theta)$ again in range of $[-\frac{1}{10}, \frac{1}{10}]$

is that conjuction happen.

Relative angular speed of Planets J, S ⇒

$\Delta\omega \Rightarrow \left(\frac{2\pi}{12} - \frac{2\pi}{29}\right)$

Time req. to get $\Delta\theta$ in $[\frac{1}{10}, 0]$ ⇒

$$\frac{\Delta(\Delta\theta)}{\Delta\omega} = \frac{2\pi - \frac{1}{10}}{\frac{2\pi}{12} - \frac{2\pi}{29}} \Rightarrow \frac{1 - \frac{1}{20\pi}}{\frac{17}{348}}$$

$$\Rightarrow \left[\frac{(20\pi - 1)(348)}{17 \times 20\pi}\right]$$

⇒ [20 years Aftr.]

So, next conjunction may happen in (2040 - 2041)

⇒ Previous constellation was happened in between (Capricornus - Aquarius)

next conjuction will happen

$$\left[(2\pi) \times \left(\frac{\frac{2\pi}{12}}{\frac{2\pi}{12} - \frac{2\pi}{29}}\right)\right] \bmod 2\pi$$

ahead of Aquarius

⇒ (254°) ahead of Aquarius

in means [Virgo - Libra]

Spiral

Answer a/ 2040-2041

Answer b/ Virgo-Libra