27-3-20

D-I (Hons.)

the relative velocity v is small compared with the velocity of light c.

Inverse Lorentz transformation:-

To obtain the inverse transformation, primed and unprimed quantities in eqn (6) to (9) are exchanged, and v is replaced by $-v$.

$$x = \frac{x' + vt'}{\sqrt{1 - v^2/c^2}}$$

$$y = y'$$

$$z = z'$$

$$t = \frac{t' + vx'/c^2}{\sqrt{1 - v^2/c^2}}$$

Time dilation:-

If someone in a spacecraft finds that the time interval b/w two events in the spacecraft is t_0, we on the ground would find that the same interval has the longer duration t. The quantity t_0 is called the proper time of the interval b/w the events.

When the events that mark the begining and end of the time interval occur at different places, and in consequence the duration of the interval appears longer than the proper time. This effect is called time dilation. Let us consider two clocks. In each clock a pulse of light is reflected back and forth b/w two mirrors L_0 apart.

Fig 1 shows the Lab clock in operation

The time interval b/w ticks is the proper time t_0 and the time needed for the light pulse to travel b/w the mirrors at the speed of light c is $t_0/2$.

Hence. $t_0/2 = \frac{L_0}{c}$ and

$$t_0 = \frac{2L_0}{c} \qquad (1)$$

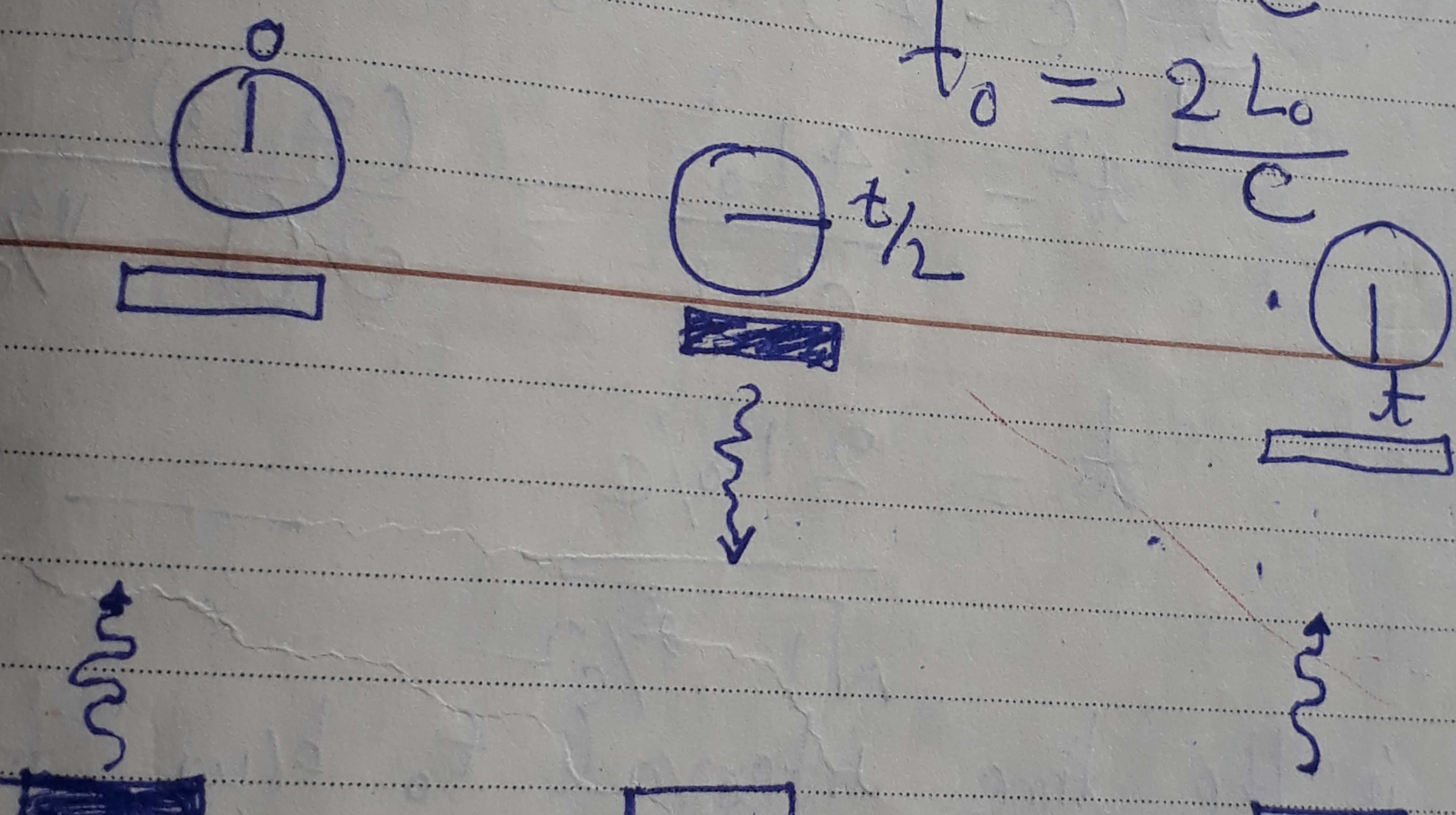

Fig. 1 A light pulse Clock at rest on the ground as seen by observer

Fig. 2

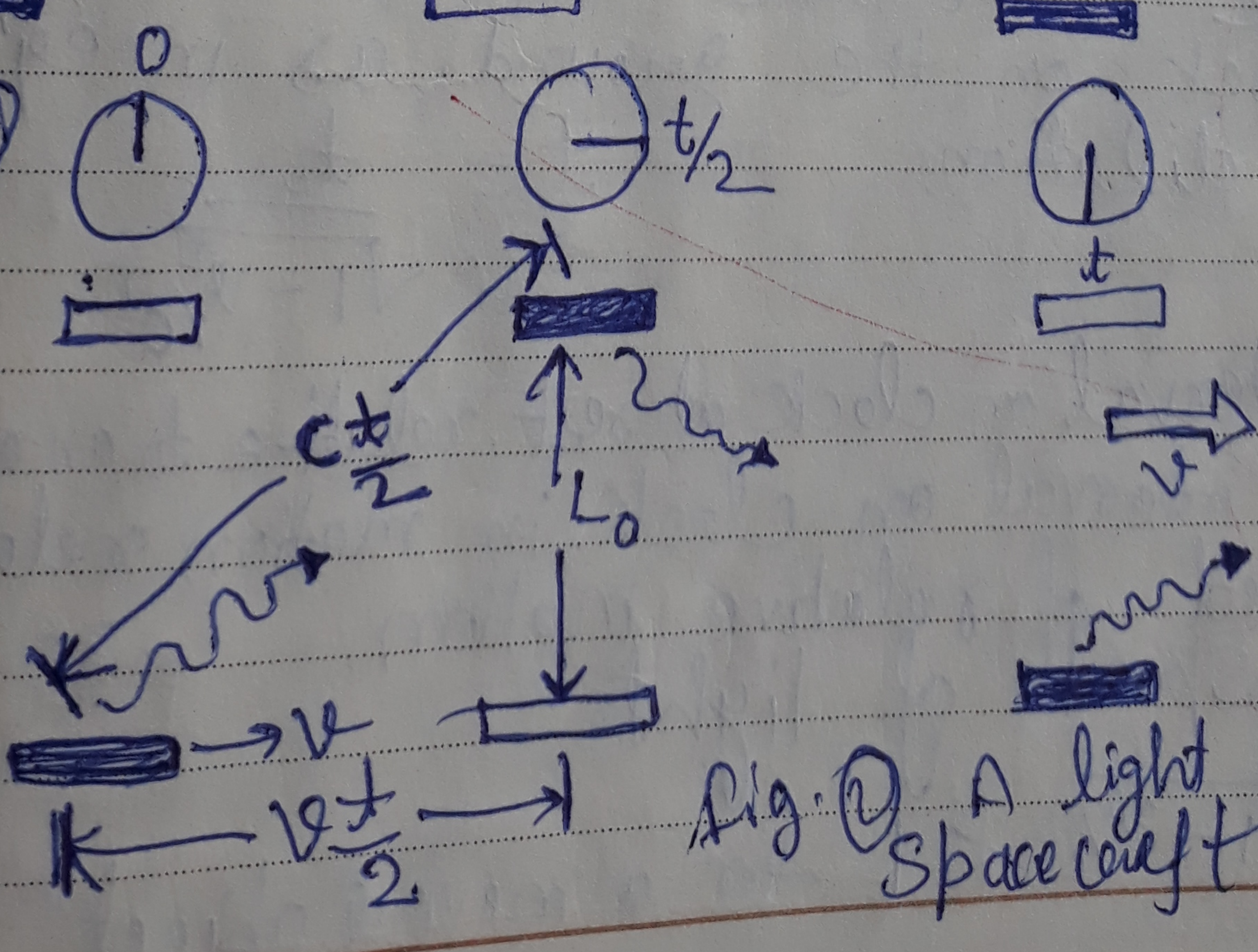

Fig. 2 A light pulse clock in a spacecraft as seen by an observer

Fig ② shows the moving clock with its mirrors perpendicular to the direction of motion relative to the ground, the time interval b/w ticks is t. Bcoz the clock is moving, the light pulse follows a zigzag path. from the lower mirror to the upper one in the time $t/2$, the pulse travels a horizontal distance of $v(t/2)$ and a total distance of $c(t/2)$. Since L_0 is the vertical distance b/w the mirrors.

$$\left(\frac{ct}{2}\right)^2 = L_0^2 + \left(\frac{vt}{2}\right)^2$$

$$\frac{t^2}{4}(c^2 - v^2) = L_0^2$$

$$t^2 = \frac{4L_0^2}{c^2 - v^2} = \frac{(2L_0)^2}{c^2(1 - v^2/c^2)}$$

$$t = \frac{2L_0/c}{\sqrt{1 - v^2/c^2}} \quad \text{— ②}$$

But, $2L_0/c$ is the time interval t_0 b/w ticks on the clock on the ground, as in eqn ① and so

Time dilation $$t = \frac{t_0}{\sqrt{1 - v^2/c^2}} \quad \text{— ③}$$

t_0 = time interval on clock at rest relative to an observer = proper

t = time interval on clock in motion relative to an observ

v = Speed of relative motion

c = Speed of light

Bcoz, ~~the~~ $\sqrt{1 - v^2/c^2} < 1$ for a moving object, $t > t_0$.