Introduction to Philosophy of Physics   Homework 1

Introduction, Zeno's paradoxes, and topology   Due: 22 March 2018

1. Around 1604, Galileo has proposed the following thought experiment: a heavy and a light objects are tied together and dropped from a tower. How can one use this thought experiment to refute the Aristotelian thesis according to which the acceleration of freely falling bodies is proportional their mass?

2. Is the game of Life past-deterministic? Explain your answer. *Extra credit*: come up with your own toy theory similar to Life, which is (non-trivially) past-deterministic and future-indeterministic.

3. A marble is shuttled back and forth between two trays, 'L' on the left and 'R' on the right, according to the following schedule:

Stage	Time	Action
1	1 minute to midnight	Transfer marble from L to R.
2	1/2 minute to midnight	Transfer marble from R to L.
3	1/4 minute to midnight	Transfer marble from L to R.
4	1/8 minute to midnight	Transfer marble from R to L.
etc.		

   Assume that the marble moves continuously (i.e., it does not jump instantaneously from one place to another without going through intermediate points), that the marble cannot evaporate or pop out of existence, and also that the marble and the two trays are confined to a finite box with impenetrable walls. Show that, on pain of contradiction, the above schedule cannot be carried out. Hints: Consider any position P that the marble might occupy, and show that if the above schedule is carried out, the marble cannot be at P at midnight. To do that use the fact that if the track of the marble is continuous and the marble occupies position P at time t, then no matter how small a neighbourhood of P is chosen, as time t is approached, the marble enters and remains within that neighbourhood.

4. Suppose that billiard balls can be made as small as you like. Then an infinite number of billiard balls, each with unit mass, could be fitted into a finite spatial interval.

   (a) Describe how this can be done by indicating the locations of the balls.
   (b) Describe what would happen if a cue ball, also of unit mass, collided with this collection of billiard balls.
   (c) Why would there be a violation of conservation of energy?
   (d) What would the time reverse if this process look like? Why would the time reverse process violate determinism? (As part of your answer, say what determinism means.)

5. Suppose John Earman starts running at 23:00 in one direction in an infinitely extended three-dimensional space and accelerate such that, while he always travels at finite speed at any moment before midnight, he has no top speed. In other words, he accelerates such that for any finite speed whatever, there is some time before midnight at which he reaches that speed. Using a spacetime diagram of his run, show that at midnight and for times after, he is no longer in that space. Second, draw the diagram of the run with the direction of time inverted and offer an interpretation of that diagram.