UNL2207 - The Nature of Natural Law: Tutorial 2

The Riddle of Motion

1) In the old Greek fable of Achilles and the tortoise, they have a race with Achilles (since he runs much faster, say at 15 miles per hour) giving the tortoise a lead of 22 feet. For simplicity, let us assume that the tortoise is so slow that in effect he does not move at all!
Now, if space is assumed to be continuous, it must be infinitely divisible and therefore the distance between Achilles and the tortoise at the start of the race may be divided up into an infinite number of tiny segments, all of which have to be crossed by Achilles if he is to catch up with the tortoise. But one can never traverse an infinite number of segments in any finite amount of time and therefore Achilles will never catch up with the tortoise – or at least so argued Zeno who framed this famous 'paradox' that is named after him. Zeno concluded that all motion is therefore impossible! What was the fallacy in Zeno's reasoning?

2) A train travels 50 km in half an hour. It then stops at a station for 20 minutes, before traveling for 2 hours at an average speed of 90 km/h. What was the train's average speed over the whole journey?

3) Indicate on a diagram, the sum and difference of two vectors $\mathbf{v_A}$ and $\mathbf{v_B}$ and use this to analyse the following situation: two trains A and B are traveling in opposite directions along straight parallel tracks at the same speed v = 60 km/h. A light airplane crosses above them. A person on train A sees it cross at right angles, while a person on train B sees it cross the track at an angle θ_B = 30°.

(i) At what angle θ_{ground} does the airplane cross the track as seen by an observer on the ground?

(ii) What is the airplane's speed relative to the ground, v_{ground} ?

4) Compare and contrast the use of 'scientific reasoning' by Aristotle when he invokes logic to argue against the existence of empty space, with how it is employed by Galileo in his observation and study of falling objects.

5) Discuss the fundamental or crucial differences between Aristotle's description of motion and that due to Galileo, using concrete examples to illustrate your arguments.

Explain how Galileo's analysis leads to his *Principle of Inertia.*

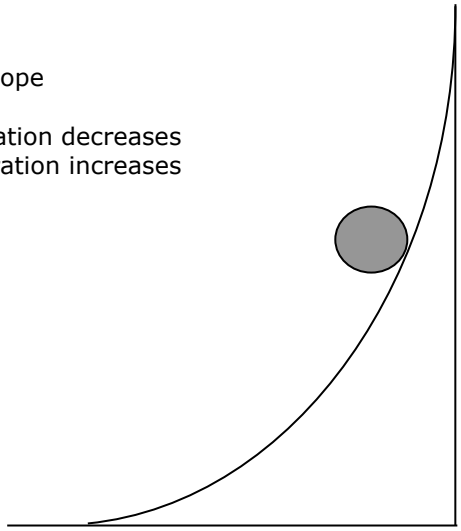
6) Suppose that both an elephant and a feather fall from a high tree. Which encounters the greatest force of air resistance in falling to the ground?

a) the elephant b) the feather c) both the same.

7) If the velocity of an object is zero, does it mean that the acceleration is zero? What about vice versa? Think of some examples.

As the ball rolls down this *curved* slope

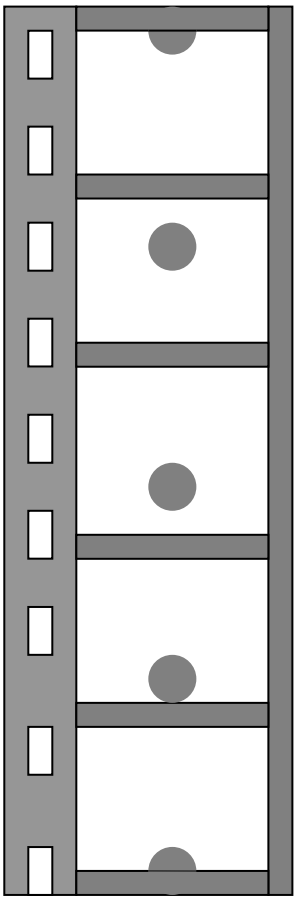
a) its speed increases and acceleration decreases
b) its speed decreases and acceleration increases
c) both increase
d) both remain constant
e) both decrease



8) A motion picture film is made of a falling object which shows the object accelerating downwards.

Now, if the film is run backwards, it will show the object accelerating

a) upward, or b) still downward?



9) An airplane flies horizontally with a constant velocity of 600 km/h, at a height of 2km. Directly over a marker it releases an empty fuel tank. Neglecting air resistance, how far ahead of the marker does the tank hit the ground? At this instant of time, is the airplane ahead or behind the tank?

What do you understand by the *Principle of Galilean Relativity* and explain how the motion of airplane and tank illustrates this.