4. Density and weight variations arise because of differing compositions of bodies
    a. The more ethereal matter there is in the body, the more that globules can slip through it, and hence the less the pressure they exert, and the less the weight
    b. Less weight for same volume: less terrestrial component, and more ethereal
5. One thing to notice here is that the evidential logic is not so weak as it first appears to be, for Descartes can defend particles of various sorts from independent considerations (III)
    a. He does manage to explain weight and Archimedes' phenomenon, at least up to a point
    b. Furthermore, what else can gravity be if not some sort of pressure, for nothing else is compatible with the mechanical philosophy
6. Newton, as well as Huygens and others, will be trying to devise a mechanical explanation of gravity along somewhat these lines even after Newton's *Principia* is published

IV. Descartes' Laws of Motion

A. Circulation and Conservation of Motion

1. The material in Part II of primary interest to us concerns the so-called Laws of Nature and the Rules on impact that follow them
    a. This section at the end of Part II and the vortex theory in Part III were the most influential, for even corpuscularеans (i.e atomists) like Huygens were affected by them
    b. The material in Part IV is of interest to us mostly to display Descartes' approach to the empirical world around us
2. Start with a cautionary note: Descartes on motion is rather more elusive than it at first seems to be, as reflected in recent scholarly disputes about him
    a. Complication: contrast between Descartes' views and what others took him to be saying
    b. Another: contrasts between *Le Monde*, the Latin *Principia*, the French *Principia*, and his subsequent letters and his (subsequently published) conversation with Burman
    c. Another: tendency to read Descartes from modern perspective, viewing him as anticipating modern ideas -- Whig history
    d. {I find myself especially influenced here by Gabbey's contrast between the geometry and metaphysics of motion}
3. According to Descartes, the primary cause of motion is God, who introduced and maintains a fixed quantity of motion in the universe
    a. Basis for the assertion is theological: the constancy or immutability of God
    b. This assertion not one of the laws of motion, but more fundamental than they are; laws concern "the secondary and particular causes of the diverse movements which we notice in individual bodies" (37)
4. This "conservation of total motion" principle appears at first glance to be a forerunner of our conservation of momentum, but this is almost surely a mistaken and misleading idea

a. Quantity of motion: B∗speed, where B represents bulk (Lat. *moles*) or quantity of matter (ultimately, volume for Descartes) and speed is a scalar

b. Our momentum, by contrast, includes an intensive quantity, mass as a measure of quantity of matter, and more important it is a vector quantity -- i.e. it is directional

5. Rationale for the principle: everything surrounded by touching bodies so that any change of place -- i.e. motion -- of one volume requires changes of place of others

a. The only way to change the total motion is to accelerate a closed circuit

b. God would not do this

6. Given this rationale, Descartes' claim is more akin to the principle of continuity in fluid mechanics than it is to conservation of momentum

a. Volume flow rate = v ∗A, where A is normal to v (in units of volume of fluid per time)

b. Picture a continuous, incompressible fluid flow through a pipe of varying cross-sectional area: v∗A everywhere a constant

c. Now "sum" across the universe, and have Descartes' principle

d. Spinoza offers just this line of interpretation (Propositions vii-xi of his *Principles of the Philosophy of Descartes*), and hence not a Whig interpretation at all

7. Not an empirical principle, but led to a serious controversy in empirical science 40 years later about what is conserved in e.g. a closed system

a. B∗v for the Cartesians, versus B∗v^2 for Leibniz (and Huygens), both scalar quantities

b. This dispute worth looking at to see how those in Descartes' wake tried to bring empirical considerations to bear, and how they still depended on non-empirical considerations

B. The First Law of Motion (i.e. Nature)

1. "Each thing, provided that it is simple and undivided, always remains in the same state as far as is in its power, and never changes except by external causes [*causis externis*]" (37)

Le Monde: "Each individual part of matter always continues to remain in the same state unless collision with others forces it to change that state." (p. 61)

a. '*Quantum in se est* ' (translated above, "as far as is in its power") is a phrase borrowed from Lucretius's *De Rerum Natura*

b. The law is a general principle of change, in the same sense that Aristotle's four causes or principles are

c. But Descartes is ruling out final and formal "causation" for simple, undivided things

2. Descartes distinguishes two states of concern, rest and motion

"If it is at rest, we do not believe that it will ever begin to move unless driven to do so by some external cause. Nor, if it is moving, is there any significant reason to think that it will ever cease to move of its own accord and without some other thing which impedes it." (37)

a. Law says it continues to move, but says nothing about how it continues to move