

## EDUCATION.

## ROLLO PHILOSOPHY.

## GRAVITATION.

One evening, after tea, when Rollo was a pretty big boy, he came and began to climb up into his father's lap. When he had climbed up, he took his place astride of his father's knee, as if he were riding a horse. His little brother Nathan came up and stood near, wanting to get up too, only there was no room. His cousin James was there, that evening, on a visit. He sat upon a cricket before the fire, and his mother was at the table doing some sort of work.

"O dear me!" said Rollo's father, imitating the tone in which Rollo sometimes uttered that exclamation.

"What, sir?" said Rollo.

"Why, I should like very well to hold you in my lap," said his father, "if it was not for the great mighty earth, down below us."

"How?" said Rollo. He did not know what his father meant.

"Why, when you are upon my knee, the earth, the ponderous earth, pulls you down hard and heavy upon it." So saying, he put his hands upon Rollo's shoulders, and crowded them down, by way of showing him how the earth acted upon him. "It pulls," he continued, "with a strong and steady pull, all the time; and so makes you a very heavy weight."

"Is that what makes weight?" said Rollo.

"Yes," said his father. "So, if I had a monstrous stone to move, and if I thought the earth would listen to me, and let go its hold, I might make a speech to it thus:—

"O earth, thou vast and ponderous ball, please to relax thy hold, for a few minutes, upon this stone, and leave it free to move; and then Rollo can tie a string to it, and move it easily along to the place where I want it to be; then thou mayest seize it again with thy mighty attraction, and hold it down as firmly as thou wilt."

"O father!" exclaimed Rollo; Nathan and James laughed, and Rollo's mother looked up from her work to listen to this strange apostrophe.

"It would seem," continued his father, in a pompous tone, as if still addressing the earth—"it would seem, most mighty planet, a very easy thing for thee to release this single stone, for a few minutes, from the grasp with which thou holdest all things down upon thy surface. And by it I shall gain much, while thou wilt lose nothing; for, if thou wilt not willingly give up the stone, I must get three or four yoke of strong oxen, and, by main force, pull it away."

"Is that what makes everything heavy?" said Rollo.

"Yes," said his father, answering now in his natural tone; "the attraction of the earth is what makes everything heavy, and holds it down."

"And could we move a monstrous great stone," said Rollo, "as light as a feather?"

"No," said his father, "it would not move along quick and light, like a feather. You could not move it quick. Suppose, for instance, you had two boats, floating upon the water, of the same size; one made very light indeed, of something very thin, like paper, and empty; and the other made of wood, and loaded with iron as heavily as it would bear. Now, they would both be supported upon the water, so that their weight would be neutralized; and yet they would move very differently. You could push the light one about easily, anywhere, but the heavy one would move very slowly. You would not have to push very hard upon it, but you would have to push *for some time*, to set it in motion; and then it would be hard to stop it. This is called its *inertia*."

"Yes," said Rollo, "it would go harder against the bank."

"The reason is," continued his father, "that the heavy boat contains a great many more particles of matter than the light one, and they have all got to be put in motion. So it requires greater effort, or the same effort must be continued a longer time."

"For instance, if we suppose that the light boat has one million of particles of matter, the heavy one would have, perhaps, twenty millions. Of course the effect of the pushing has to be divided among twenty times as many particles, and of course will only carry them one twentieth part as far; so that the bodies that are now large and heavy, would only move slowly, though they would move *easily*, if the attraction of the earth were to cease."

"There is another way to illustrate it," he continued. "Suppose there was a large mass of lead, as big as a load of hay, hanging by a chain; and also a great puff of feathers, or a balloon of the same size, hanging in the same way. Now, if they were both

suspended freely, they would both move easily, for their weight would be supported by the chain; but the heavy one would move very slowly. Nathan could move it, but he could only move it slowly and a little way.

"I should not think that he could move it but very little," said Rollo.

"No, he could not; because you see that, in that way of suspending any thing, the moment that it begins to move, it begins to swing off and to rise; so that it cannot be moved at all without being *lifted* a little. And the more it is moved, the higher it is lifted, so that it would take a great force to move it far away from the centre, where it was hanging. But we can hang it in a way to avoid that difficulty."

"How, sir?"

Rollo seemed to be very much interested in this conversation. He had dismounted from his father's knee, and stood by his side, listening eagerly. His mother, too, was paying close attention. As for Nathan, he sat still: though it is not by any means certain that he understood it very well.

"Let us suppose," said his father, "that the mass of lead, as big as a load of hay, is fastened to one end of a stick of timber."

"That would not be strong enough to hold it," said Rollo.

"Well, then, to a beam of iron, as large as a stick of timber," rejoined his father.

"O," said James, "you could not get such a big bar of iron."

"No," replied his father, "only an imaginary one, and that will be just as good as any. Now, suppose that great mass of lead is fastened to one end of this bar, and another one, just like it, to the other end, to balance it. Now, suppose that the lower end of the great chain is secured around the middle of the iron beam, and the upper end to be fastened to some strong support up in the air. Now, we can move the mass of lead without having to lift it at all; for, if we push against it, and make it move, it will move round and round, without rising at all, as it did before, when it was hung up directly by the chain."

Rollo's father then went on to explain to them that, in such a case as this, the weight of the two masses of lead would not prevent their moving easily, for they would exactly balance each other. A little child would be able to move them; but still they would move exceedingly slow at first, and it would be hard to stop them, when they were in motion. So, he said, if the earth should cease to attract and draw down any great, heavy body, like a large stone, for example, the smallest child could lift it, though it would come up slowly, just as a very heavy body would move, if it was suspended by a string, or was afloat upon the water.

"And so," said Rollo, "if the earth should not attract us, could we push ourselves right up off from the ground?"

"Yes," said his father, "most undoubtedly."

"What, and go about anywhere in the air?"

"Certainly."

Rollo began to laugh aloud at this idea, and looked very much interested and pleased.

"O, then I wish there was no gravitation," said Rollo; "I do, really."

"But, then," continued his father, "if you should get up into the air, you would not get down again."

"Why not?" said Nathan, beginning to look a little concerned.

"Unless," said his father, "you had something above you, to push against, so as to push yourselves down. You would be just like a boy in a boat, off from the shore, and without any paddle or pole. He could not get back again."

"We might tie a rope to something," said James, "before we went up, and so pull ourselves down."

"Yes, that you might do."

"And could not we flap our hands, like a bird, and so fly a little?"

"Perhaps you could," said his father.

Here the children all began to flap their hands, like young birds trying to fly; and Rollo said again, he wished, with all his heart, there was no gravitation; "for then," said he, "we should have strength enough to fly."

"That would lead to serious consequences," said his father.

"What consequences?" said James.

"Much more serious than you would suppose."

"Tell us what they would be, uncle," said James.

"O, I know," said Rollo; "you would not stand up straight without gravitation."

"O, we could, couldn't we, father?" said Nathan.

"What makes you think so, Rollo?" said his father, without re-