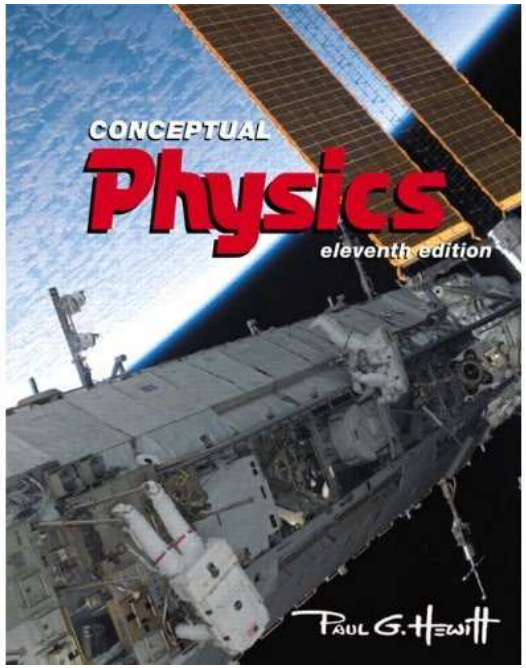
Welcome to Physics 101

Basic Concepts of Physics

Instructor: ***Georgina Olivares***

Based on the book by **Paul G. Hewitt:**



Course information

Location: Room HW 511
Lecture Times: Tu and Fr: 2.10pm - 3.25pm

Instructor: Georgina Olivares
email: golivare@hunter.cuny.edu
office: 1200 HN
Office hours: Tu 10:00am-11:00am

Text: ***Conceptual Physics,*** *11th Edition*, by Paul G. Hewitt (Pearson, Addison-Wesley, 2009).
But 9th and 10th editions are also fine.

Grading:

✓ Attendance/Participation/HW	10%
✓ Laboratory	15%
✓ Midterm Exams	40%
✓ Final Exam	35%

Attendance/Participation/HW: We will make use of "clicker technology" in this course (see more shortly!), and also have questions to discuss in class.
Laboratory: Make sure you are registered for the lab course, Physics 101 LB.
Midterms: Two mid-term in-class multiple-choice exams: Fri Oct 5 and Fri Nov 9 (Probably).
Final Exam: Fri Dec 21, last day of classes . Exam cumulative, all multiple-choice.

- Note that this is a *one-semester terminal* physics course, and it does *not* fulfill the pre-med physics requirement.

Note from the Office of Student Services:

- **All students must make sure they are registered for this class and have not been dropped.**
- **Students who are not registered and have not paid may not continue attending the class.**
- **Check your registration status on E-SIMS. You should also read your Hunter email to learn of any changes in your registration status.**

If you have any questions you can receive assistance at the OASIS, Room 217 North Building

Syllabus:

Topic	Book chapter
Introduction/Newton's First Law	1, 2
Linear Motion	3
Newton's Second Law	4
Newton's Third Law	5
Momentum	6
Energy	7
Rotation	8
Gravity	9
The Atomic Nature of Matter	11
Liquids	13
Gases and Plasmas	14
Heat	15
Vibrations and Waves	19
Sound	20
Electrostatics	22
Electric current	23
Magnetism	24
Electromagnetic Induction	25
Properties of Light	26
Color	27
Reflection and Refraction	28
Light waves	29
Light emission	30
Light Quanta	31
The Atom and the Quantum	32
The Atomic Nucleus and Radioactivity	33

Hunter College regards acts of academic dishonesty (e.g., plagiarism, cheating on examinations, obtaining unfair advantage, and falsification of records and official documents) as serious offenses against the values of intellectual honesty.
The college is committed to enforcing the CUNY Policy on Academic Integrity and will pursue cases of academic dishonesty according to the Hunter College Academic Integrity Procedures.

Clicker Technology and Peer Instruction

Almost all the lectures incorporate a few multiple-choice questions that test the concepts we are learning. You will individually enter answers via a clicker, and a bar graph will be instantly generated for you to see how you all answered.

Then, you will be asked to discuss with your neighbor, and convince them of your answer*! After a few minutes, you will all re-enter answers individually and we will all see what happens to the bar graph!

- Participation in this is very important, and useful for you (and fun!).
- Attendance will also be monitored via the clickers – you will enter the last 4 digits of your SSN at some point in the lecture.
- Importantly, it is your *participation* that will give you course credit (10%) for this, NOT the correctness of your actual answers – individual answers are never correlated with individuals.

** Original idea of Eric Mazur, Harvard University, "Peer Instruction"*

Trial Clicker Question!

Please turn on your clickers.

What is Hunter's motto, translated into English?

A) Ours is to care about your future

B) The care of the future is mine

C) The care of the future is yours

D) Why do today what you can do in the future?

E) The future is yours to keep

Notes on Chapter 1: About Science

- *We will barely cover this in class, and it will **not** be examined, but I encourage you to read it on your own.*

- Main points:

Observation of physical evidence is at the basis of science.

Measurement plays a crucial role in science. This process gives you information about the system you are studying.

Terminology: **Model**= Analogy or mental image of the phenomena we are observing in terms of something we already know. (Waves)

Hypothesis = educated guess

Law = **principle** = rule

Theory = synthesis of body of info that encompasses well-tested and verifiable hypotheses about certain aspects of the natural world. Theories may change in time!

Beware of pseudoscience! Lacks evidence and falsifiability test.

- **Mathematics** provides unambiguous, compact language for science:
  - Establishes a relation between concepts,
  - and when findings in nature are expressed in mathematical way is easier to verify or disapprove by experiment.

- **Scientific method:**
  1.- Recognize a question (unexplained fact)
  2.- Make an educated guess (hypothesis)
  3.- Make prediction about the consequences of the hypothesis
  4.- Perform an experiment or make calculations
  5.- Formulate a general rule

- Concepts to pay attention (will be examined):
  - Hypothesis
  - Law
  - Scientific method
  - Theory

I’d like to take attendance now.

Please enter the last 4 digits of your SSN into your clicker, and click send..

Chapter 2: Newton's First Law of Motion – Inertia

Before getting into this, note ideas on motion *prior* to Newton *(I won't examine this)*

– **Aristotle** (c. 320 BC), all motions are due to "nature" of the object, or to "violent" influences (push or pull) .

"Normal state" = at rest, except for celestial bodies.

Heavier objects fall faster, striving harder to achieve their "proper place".

-- **Copernicus** (c. 1500's) doubted that everything revolved around earth. Formulated sun-centered system.

-- **Galileo** (c. 1600's) agreed with Copernicus, and disagreed also with Aristotle's "natural state" idea, using observation and experiment. Dropped objects from Leaning Tower of Pisa and found they fell at the same rate (apart from small effect of air resistance). Inclined planes experiments. Concept of Inertia

Read more in your book.

-- **Newton** (c. 1665) formulated Newton's Laws of Motion…

Newton's 1st Law of Motion: Inertia

- Every object in state of rest or motion, will remain in that state unless something act on it. (something=force)

Eg1: Table here, at rest. If it started moving, we'd look for what caused the motion .

Eg2: Ball at rest. Give a push (force) – it starts to roll (changes state of motion). When you let go, it continues to roll, even with no force on it – continuing in its state of motion.

- **Inertia** = property of objects to resist changes in rest or motion

Heavier (more massive) objects tend to have more inertia – eg. takes more work to move a truck than to move a chair

- **Force** = something that produces a change in motion, a push or a pull.
  - Source can be muscle effort, or gravitational, or electric, or magnetic…Often we denote force by **F**

Newton, N = standard unit of force.

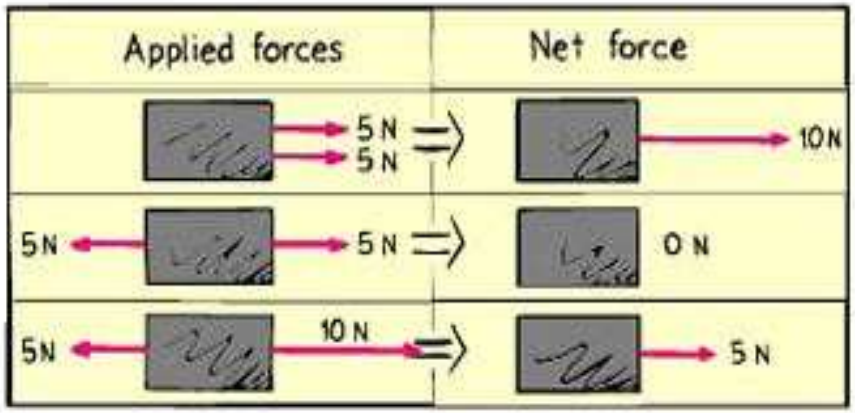
A familiar force is gravitational force = weight

Eg. 1-kg weighs 9.8-N and 2.2-lb.

Net force = resultant force when several forces are acting on an object .

Eg. Tug of War – both teams pull on opposite ends. If they each pull with the same magnitude of force, there is zero net force on the rope.

Eg:



Note that any force has a direction!

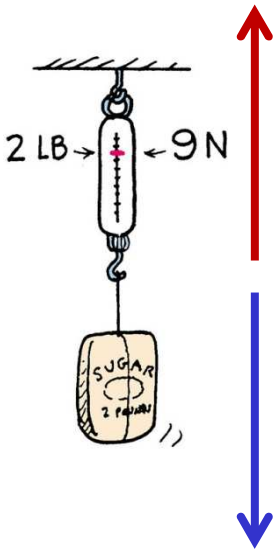
Equilibrium

- Equilibrium is when the net force on something is zero

Mathematically, $\Sigma \mathbf{F = 0}$

An object in equilibrium remains at rest or remains in uniform straight-line motion (from Newton's 1st law)

Eg. 2-lb bag of sugar hanging on a weighing scale



There are 2 forces on the bag:

(1) gravitational force downwards towards earth (F_G= 9N dow

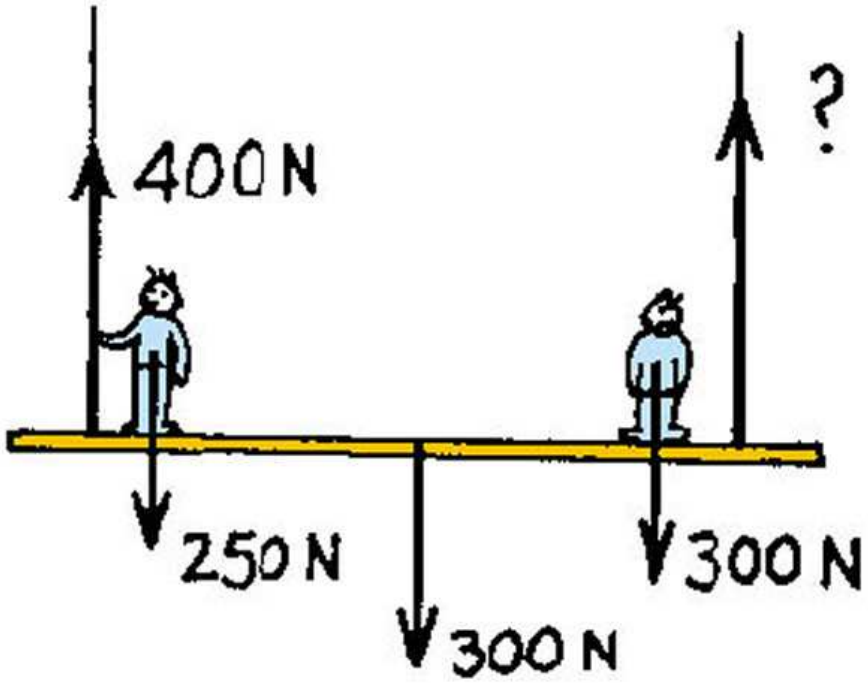
(2) tension force upwards from stretched spring (F_T = 9N up)

$\Sigma \mathbf{F} = F_T + F_G = 9N - 9N = 0$

Clicker Question

The staging shown weighs 300 N and supports two painters, one 250 N and the other 300 N.

The reading on the left scale is 400 N. what is the reading on the right-hand scale for the system to be in equilibrium?



A) 300 N

B) 400 N

C) 450 N

D) 850 N

E) None of the above

Answer

The staging shown weighs 300 N and supports two painters, one 250 N and the other 300 N.

The reading on the left scale is 400 N. what is the reading on the right-hand scale?

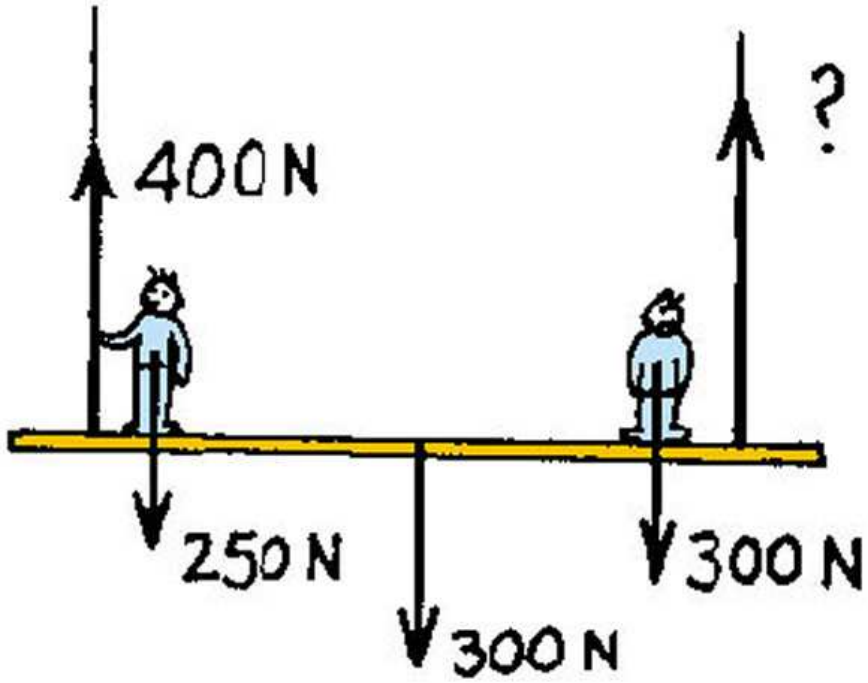
A) 300 N

B) 400 N

C) 450 N

D) 850 N

E) None of the above



The upward forces are (400 N + RH tension). By the equilibrium rule $\Sigma F = 0$, this upward total must equal the downward forces are (250 N + 300 N + 300 N) = 850 N. Hence, RH tension must be 450 N.

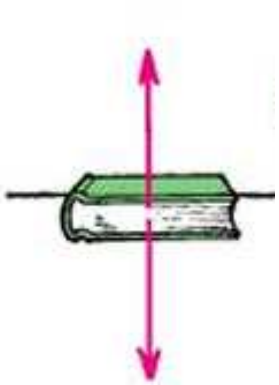
Note that although the two tensions must add to the total weight, the tension is larger in the rope nearer the heavier person.

Support Force (a.k.a. Normal Force)

What forces are acting on the book lying on the table?

Gravity (weight of book) acts downward. But since book is at rest, there must be an equal upward force.

This upward force is called the **support** force, or **normal** force, and equals the weight of the book.



$\Sigma F = 0$, since at rest

What creates the normal force? The atoms in the table behave like tiny springs, so push back on anything (eg book) trying to compress them.

Question

Say a 120-lb person steps on some bathroom scales.

(i) How much is gravity pulling on her ?

120-lb (=weight)

(ii) What is the net force on her?

0 (since she's at rest)

(iii) Now suppose she stands on two bathroom scales, with weight evenly divided between them. What will each scale read?

60 –lb each, since the sum of the scale readings must balance the weight.

Clicker Question

Consider again the 120-lb person who steps on the bathroom scales.

What is the net force on the bathroom scales?

A) 0

B) 120-lb

C) 120 N

D) None of the above

Answer

Consider again the 120-lb person who steps on some bathroom scales.

What is the net force on the bathroom scales?

A) 0

B) 120-lb

C) 120 N

D) None of the above

Because the scales are at rest .

There are two forces on the scales: the downward weight of the person, exactly balanced by the support force from the floor.

Equilibrium of Moving Things

- An object moving at constant speed in a straight line is also in equilibrium, $\Sigma F = 0$.

Question: Can any object on which only **one** force is acting, be in equilibrium?

No!

Consider pushing a box across a floor.

(1) What forces are acting on the box?

Weight downward, support force upward, your push across, and friction between the floor and the box opposing your push.

(2) What can you say about the relative magnitudes of the forces if is moving with unchanging speed across the floor ?

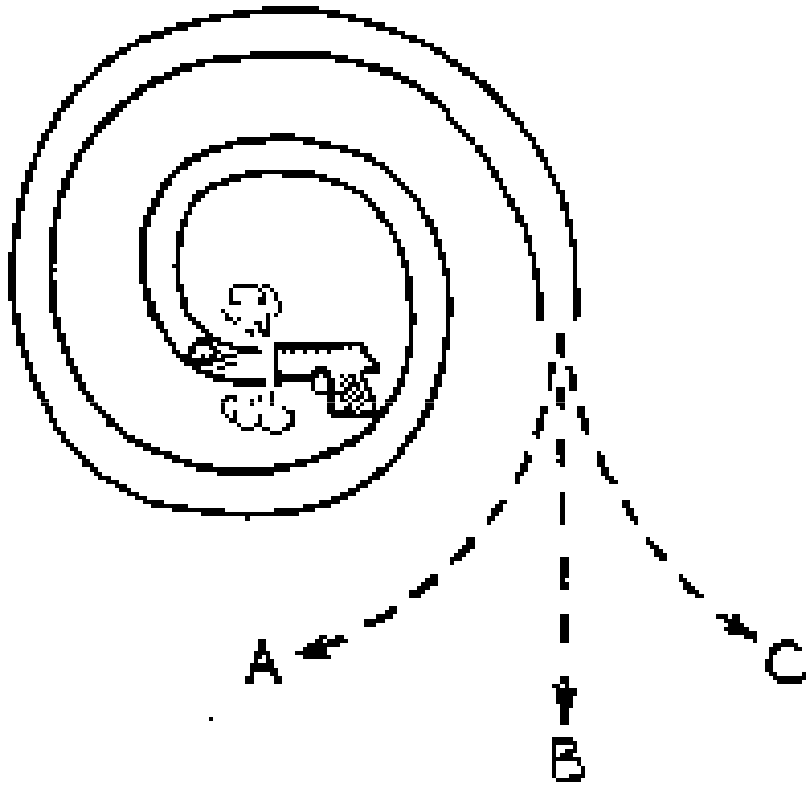
Magnitude of weight = support force.

Your push = friction, if speed unchanging.

(If it is speeding up, then your push > friction.)

Clicker Question

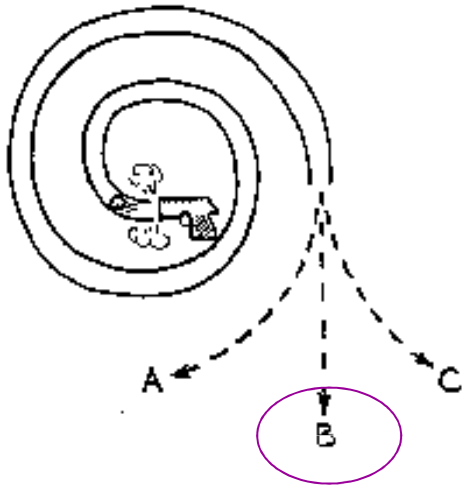
When the pellet fired into the spiral tube emerges, which path will it follow? (Neglect gravity).



Answer

When the pellet fired into the spiral tube emerges, which path will it follow?

(Neglect gravity).

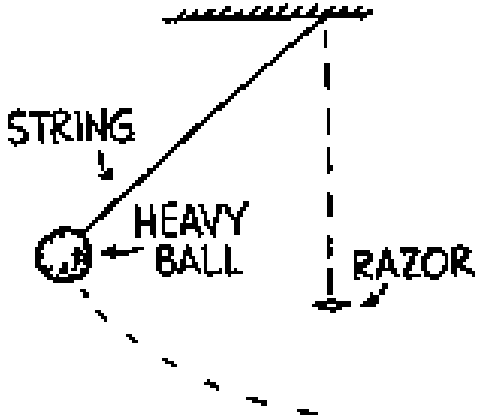


B:

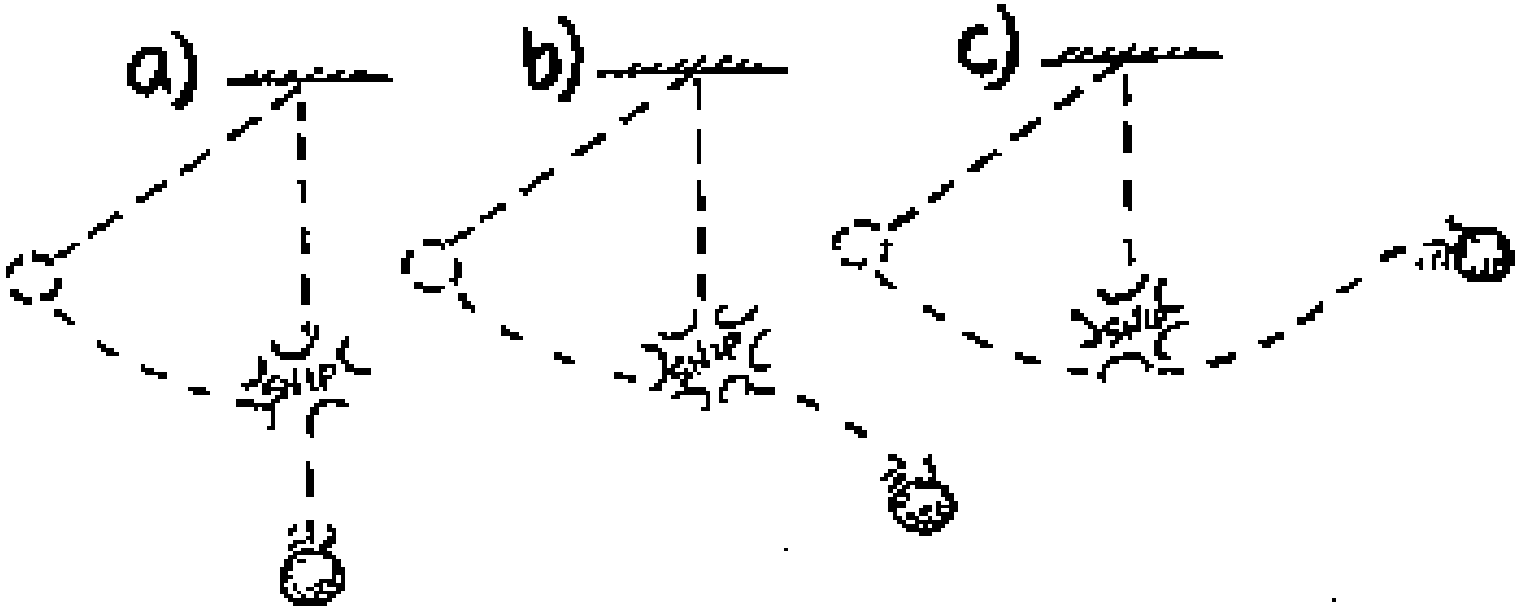
While in the tube, the pellet is forced to curve, but when it gets outside, no force is exerted on the pellet and (law of inertia) it follows a straight-line path – hence, B.

Clicker Question

When the ball at the end of the string swings to its lowest point, the string is cut by a sharp razor.

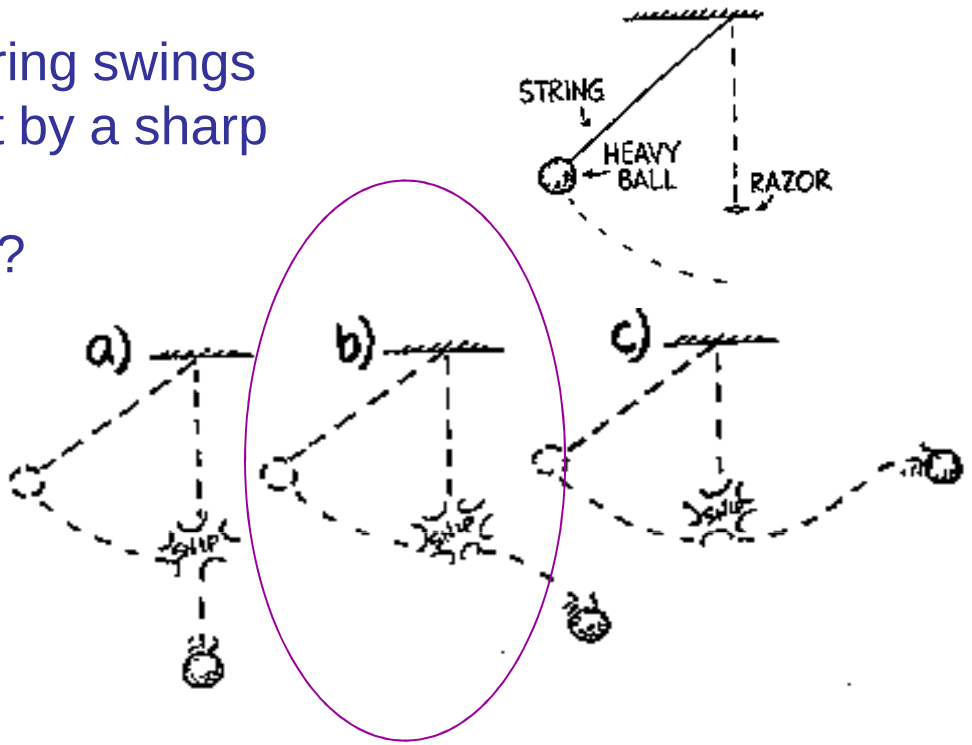


What path will the ball then follow?



Answer

When the ball at the end of the string swings to its lowest point, the string is cut by a sharp razor.
What path will the ball then follow?



b) At the moment the string is cut, the ball is moving horizontally. After the string is cut, there are no horizontal forces, so the ball continues horizontally at constant speed. But there is the force of gravity which causes the ball to accelerate downward, so the ball gains speed in the downward direction. The combination of constant horiz. speed and downward gain in speed produces the curved (parabolic) path..

Concepts to study

- Newton´s first law of motion
- Inertia
- Force
- Net Force
- Mechanical equilibrium
- Equilibrium rule