

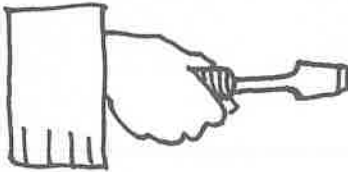
◊ CHAPTER 6 ◊ NEWTON'S THIRD LAW



SO FAR, WE HAVE LOOKED AT NEWTON'S FIRST TWO LAWS: NOW LET'S LOOK AT HIS THIRD LAW. IT IS:

1. AN OBJECT "NATURALLY" MOVES WITH CONSTANT VELOCITY. :

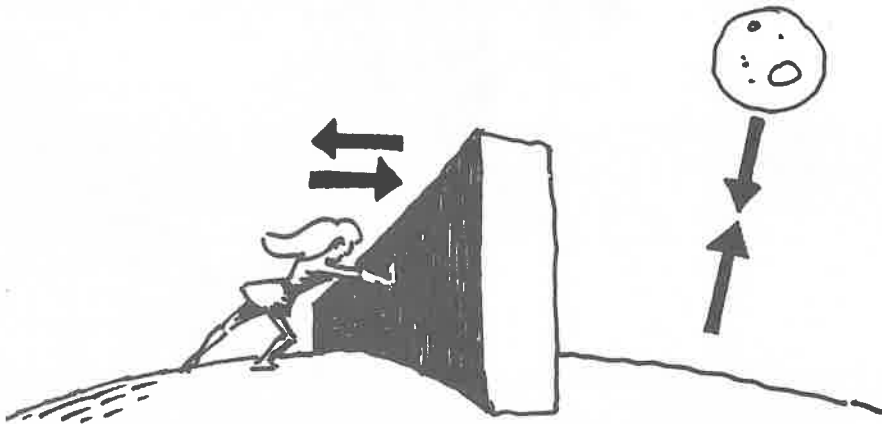
2. $F=ma$
3.



NEWTON'S THIRD LAW: WHEN ONE OBJECT EXERTS A FORCE ON A SECOND OBJECT, THE SECOND OBJECT EXERTS AN EQUAL BUT OPPOSITE FORCE ON THE FIRST.

IN OTHER WORDS,
ACTION EQUALS REACTION.

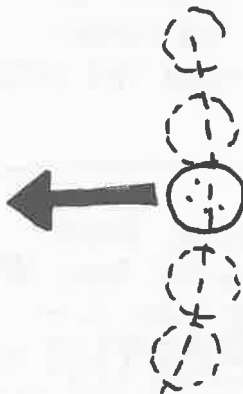
FOR EXAMPLE, WHEN I PUSH ON A WALL, THE WALL PUSHES BACK WITH EQUAL FORCE. THE EARTH'S GRAVITATIONAL PULL ON THE MOON EQUALS THE MOON'S PULL ON THE EARTH.



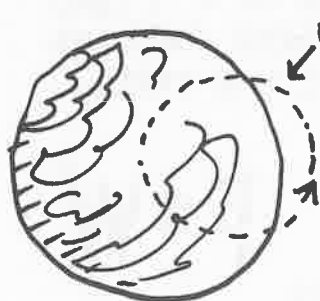
THE EARTH'S PULL ON THE MOON KEEPS THE MOON IN A (NEARLY) CIRCULAR ORBIT. BUT WHAT ABOUT THE MOON'S PULL ON THE EARTH?



FORCE ON MOON
PULLS IT AWAY
FROM STRAIGHT
LINE MOTION



IN FACT, THE MOON PULLING BACK WITH EQUAL FORCE DOES CAUSE THE EARTH TO EXECUTE A SMALL ORBIT! THE EARTH MOVES LESS THAN THE MOON—ACCELERATES LESS—BECAUSE IT IS MUCH MORE MASSIVE.

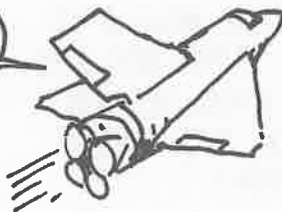


EARTH'S
ORBIT

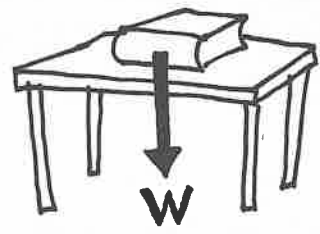
FORCE ON EARTH
PULLS EARTH
INTO CURVED
ORBIT



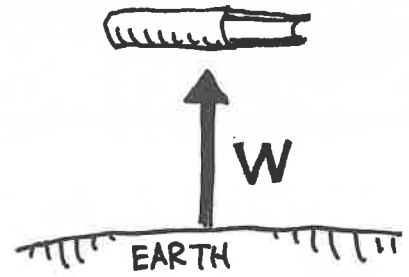
EVEN ARTIFICIAL
SATELLITES MOVE
THE EARTH
SLIGHTLY!



HERE IS A BOOK ON A TABLE. WHAT IS THE FORCE OPPOSITE TO THE BOOK'S WEIGHT W ?
NOT THE SUPPORT FORCE FROM THE TABLE!

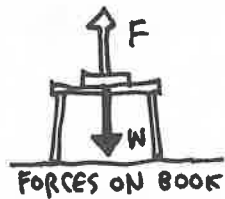


THE SECOND BODY CAUSING THE FORCE W ON THE BOOK IS —
The EARTH! THE EARTH PULLS THE BOOK WITH FORCE W , SO THE BOOK PULLS UP ON THE ENTIRE EARTH WITH FORCE W !

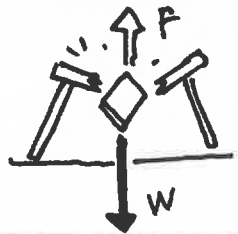


BUT DOESN'T THE TABLE PUSH UP ON THE BOOK? YES, IN THIS CASE. THE BOOK IS NOT ACCELERATING, SO, BY NEWTON'S SECOND LAW, THE TOTAL FORCE ON IT IS ZERO. SINCE THE EARTH PULLS DOWN ON THE BOOK, SOMETHING ELSE MUST BE PUSHING IT UP — NAMELY THE TABLE, AND $F = W$. BUT THIS IS A SPECIAL CASE!

IF THE TABLE WASN'T STRONG ENOUGH TO SUPPORT THE BOOK, THE UP-PUSH WOULD BE LESS THAN W , AND THE BOOK WOULD BREAK THE TABLE AND FALL!

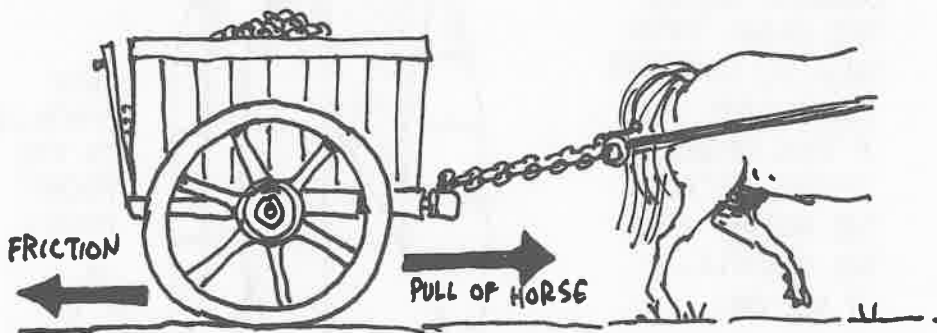


$$F = W$$

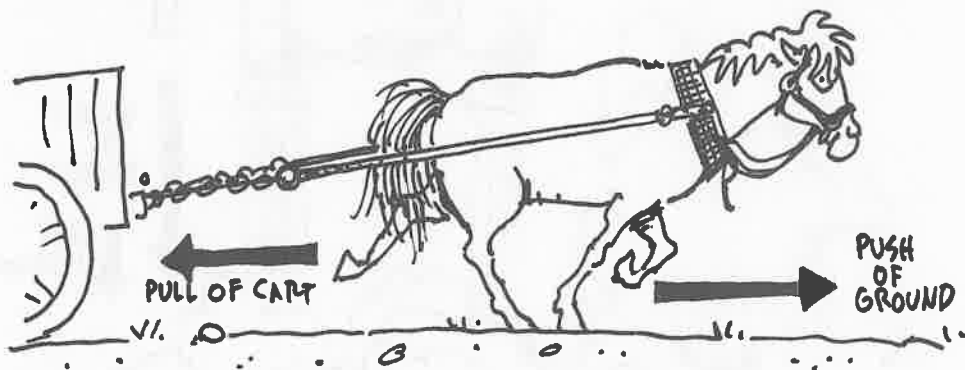


$$F < W$$

AND ANOTHER EXAMPLE. HOW CAN A HORSE PULL A CART, IF THE CART PULLS BACK WITH AN EQUAL FORCE?? TO ANALYZE THIS, WE HAVE TO LOOK AT EACH OBJECT ALONE AND THE FORCES ACTING ON IT.

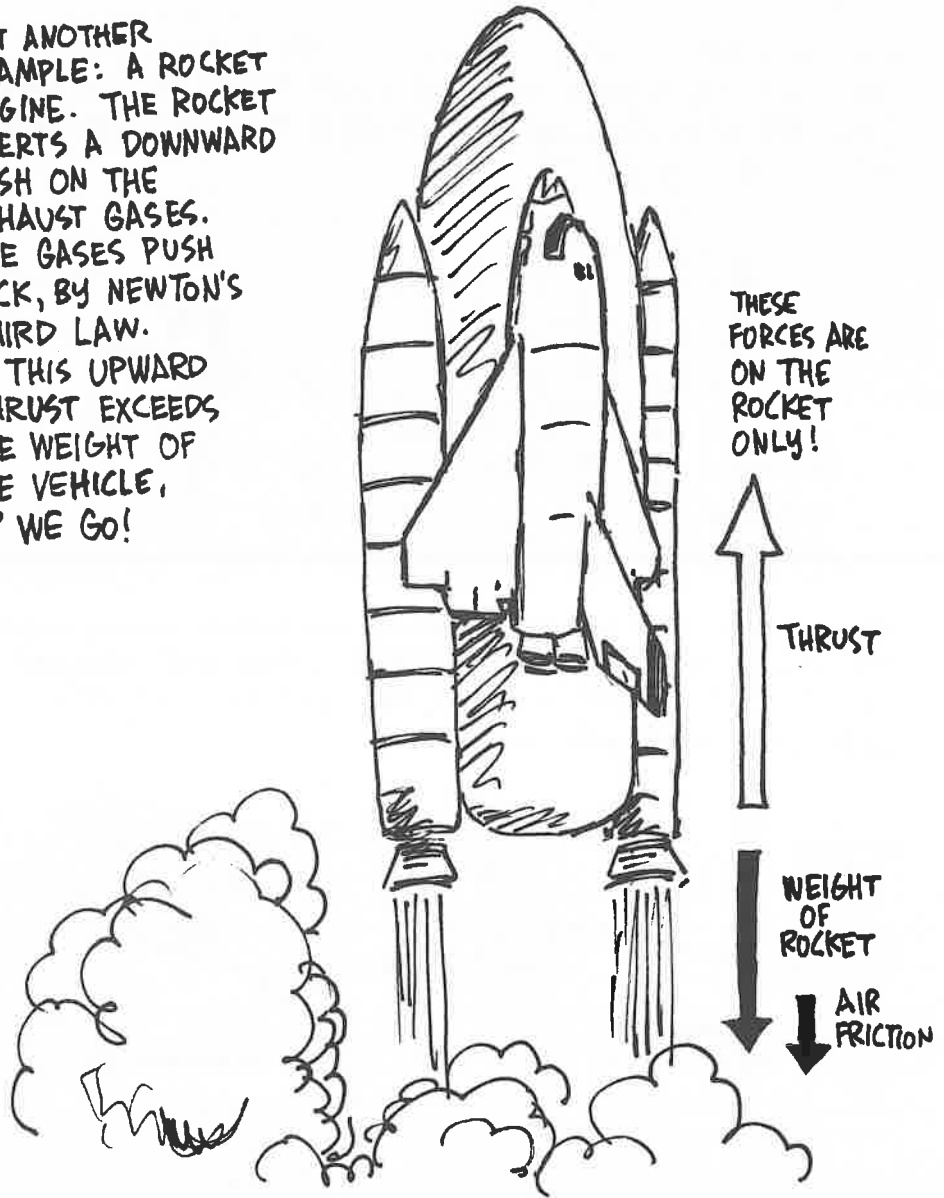


WHAT FORCES ACT ON THE CART? THE HORSE PULLS IT FORWARD, AND THERE IS A BACKWARD FORCE FROM THE GROUND: **FRICTION**. IF THE HORSE'S PULL EXCEEDS THE FRICTION, THE CART WILL ACCELERATE.



NOW THE HORSE: THE CART PULLS IT BACKWARD, BY NEWTON'S THIRD LAW. WHAT PUSHES THE HORSE FORWARD? IT'S THE GROUND!! THE HORSE PUSHES BACKWARD ON THE GROUND, SO THE GROUND PUSHES FORWARD WITH AN EQUAL FORCE. IF THE HORSE CAN PUSH BACK AGAINST THE GROUND WITH A FORCE GREATER THAN THE CART'S RESISTING FORCE, THEN THE HORSE WILL ACCELERATE!

YET ANOTHER
EXAMPLE: A ROCKET
ENGINE. THE ROCKET
EXERTS A DOWNWARD
PUSH ON THE
EXHAUST GASES.
THE GASES PUSH
BACK, BY NEWTON'S
THIRD LAW.
IF THIS UPWARD
THRUST EXCEEDS
THE WEIGHT OF
THE VEHICLE,
UP WE GO!



NOTE: IT IS NOT NECESSARY FOR THE ESCAPING GASES TO PUSH AGAINST AIR. IN FACT, AIR JUST ACTS AS A FRICTIONAL DRAG ON THE ROCKET.

YES. I NOTICED THAT.

