

# Chapter 12 PART A: *External* FORCES

KINESIOLOGY

Scientific Basis of Human Motion, 11th edition

Hamilton, Weimar & Luttgens

Presentation Created by

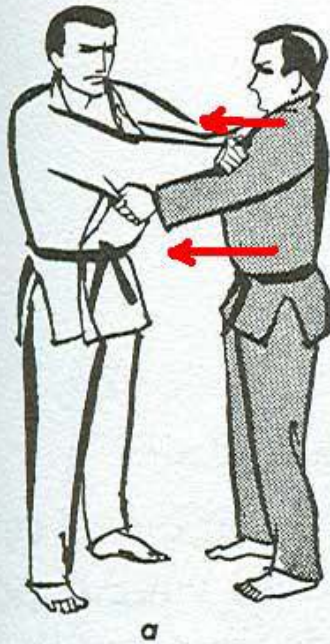
TK Koesterer, Ph.D., ATC

Humboldt State University

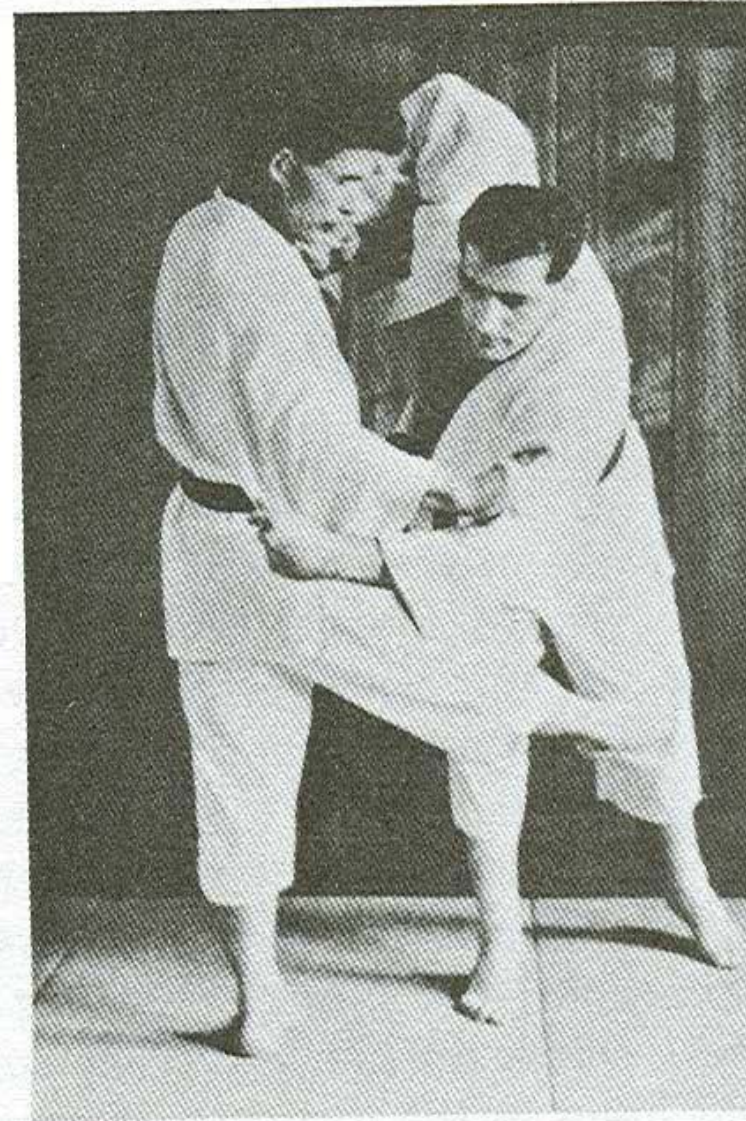
*Revised by Hamilton & Weimar*

*REVISED FOR FYS* by *J. Wunderlich, Ph.D.*

# JUDO



**KUZUSHI**  
Catch him (or get him to) charge at you.  
Pushing on him may cause this.  
Or maybe catch him coming in for a throw.



b

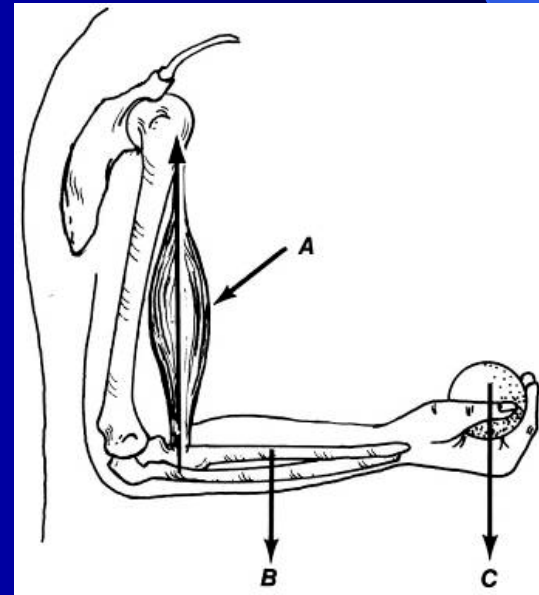
# Objectives

1. FORCES and point of application
2. Newton's laws
3. Judo FORCES



# FORCES

- External forces are outside the body:
  - Gravity (and weight)
  - Air or water resistance
  - Friction
  - Forces of other objects acting on body
- Internal forces act on *parts* of the body
  - Human biceps raising forearm
  - Not discussed in this presentation



# F O R C E

- A vector with magnitude and direction
- Need a point of application



To lift a 250 N barbell,

- Lifter applies a force greater than 250 N weight in an upward direction through the center of gravity of the barbell. Weight is mass times acceleration due to gravity:

$$w = mg$$

# Point of Application of FORCE

- For weight, point is through the center of gravity of the barbell





# Direction & Point of Application of *External* Forces

| <b>Force</b> | <b>Direction of Force</b> | <b>Point of Application</b> |
|--------------|---------------------------|-----------------------------|
| Weight (W)   | Downward                  | Center of Gravity           |
| Normal (R)   | Perpendicular             | Point of contact            |
| Friction (F) | Along surface             | Point of Contact            |
| Buoyancy (B) | Upward                    | Center of buoyancy          |
| Drag (D)     | Opposite flow             | Center of Gravity           |
| Lift (L)     | Perpendicular to drag     | Center of Gravity           |



# Free Body Diagram

- Weight ( $W$ )
- Reactive force ( $R$ )
- Friction ( $F$ )
- Force created by athlete's motion ( $H$ )

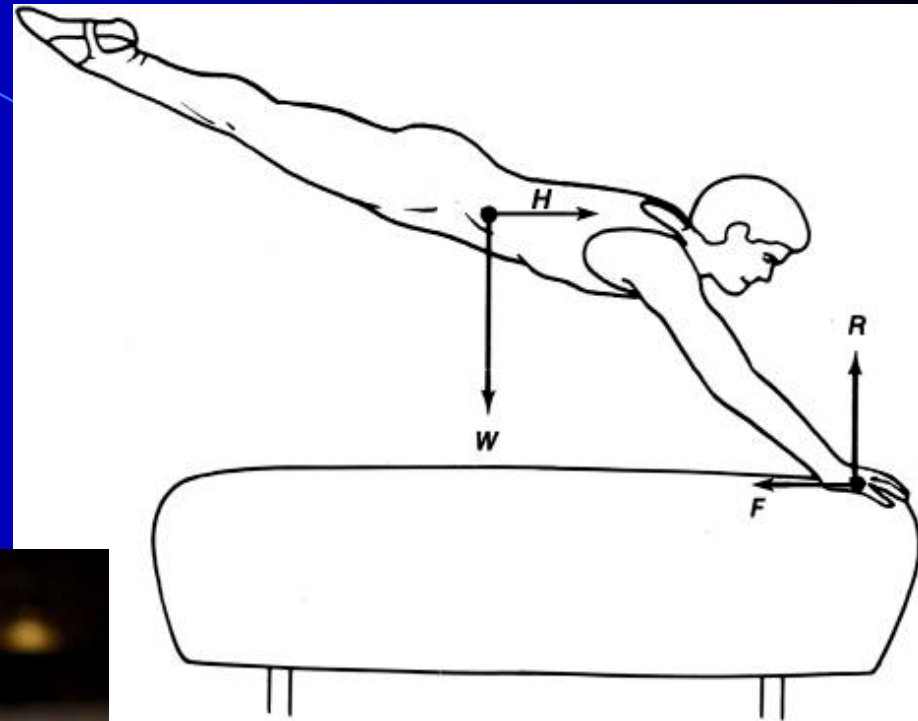


Fig 12.26



# Free Body Diagram

- Weight ( $W$ )
- Buoyancy ( $B$ )
- Drag ( $D$ )
- Force propelling swimmer (*not shown*)
- Lift (*not shown*)

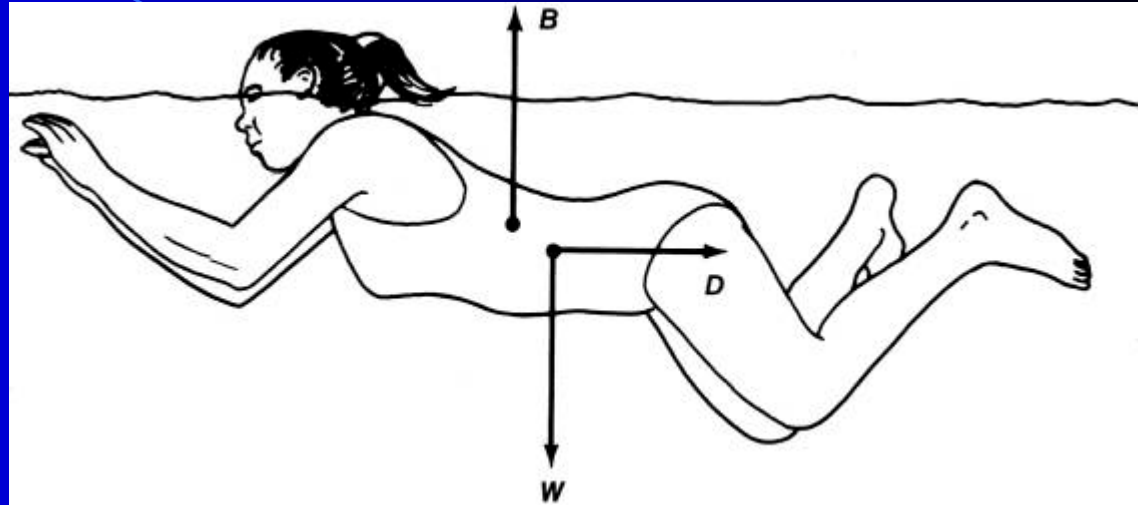


Fig 12.27



State of motion or rest depends on sum of all forces

# Fluid Forces

- Water and air are both fluids
- Buoyancy, drag, and lift apply in both mediums



# Buoyancy

- Archimedes' Principle: *“A body immersed in a liquid is buoyed up by a force equal to the weight of the liquid displaced”*
- This explains why some things float and some things sink



# Specific gravity

- Density is a ratio of weight of object to its volume
- Specific Gravity is ratio of density of object to density of water
- Object with same density as water has specific gravity = 1.0
  - An object with specific gravity  $> 1.0$  will sink
  - An object with specific gravity  $< 1.0$  will float



# Lift and Drag

Drag is resistance to forward motion through a fluid

Result of :

- Fluid pressure on leading edge of object
- Amount of backward pull produced by turbulence on trailing edge

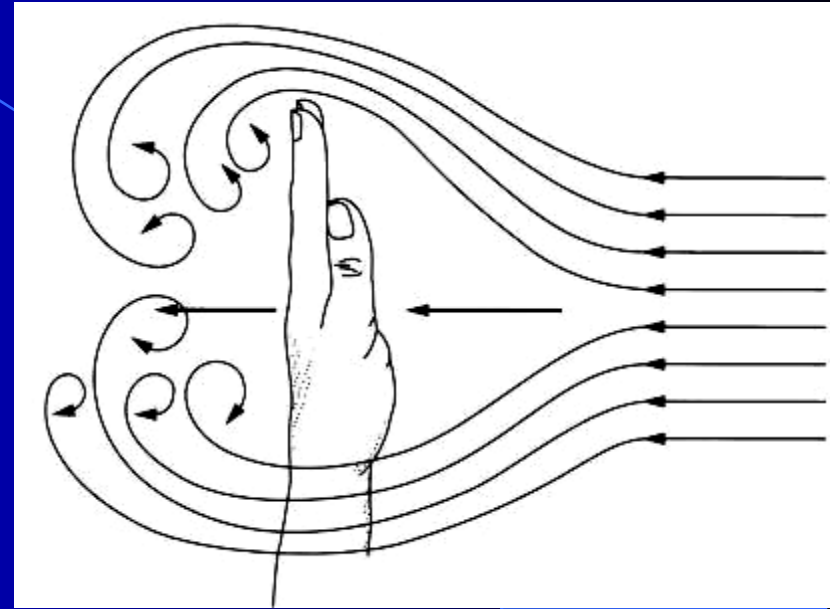


Fig 12.24 b



# Lift and Drag

Laminar flow is a smooth, unbroken flow of fluid around object

- A smooth surface will have better laminar flow than a rough surface, resulting in less drag

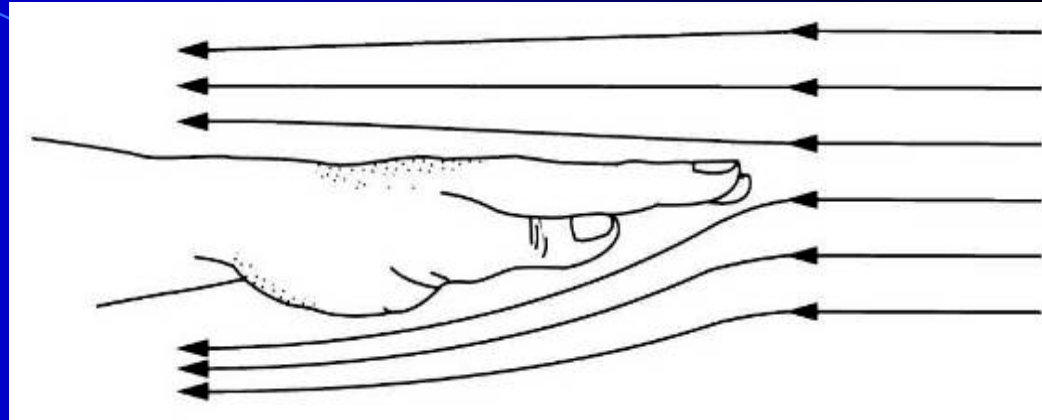


Fig 12.24 a



*“Turbulent flow” is the opposite of laminar flow*



# Lift and Drag

Lift is result of changes in fluid pressure as result of difference in air flow velocities

Bernoulli's Principle:  
*"Pressure in a moving fluid decreases as speed increases"*

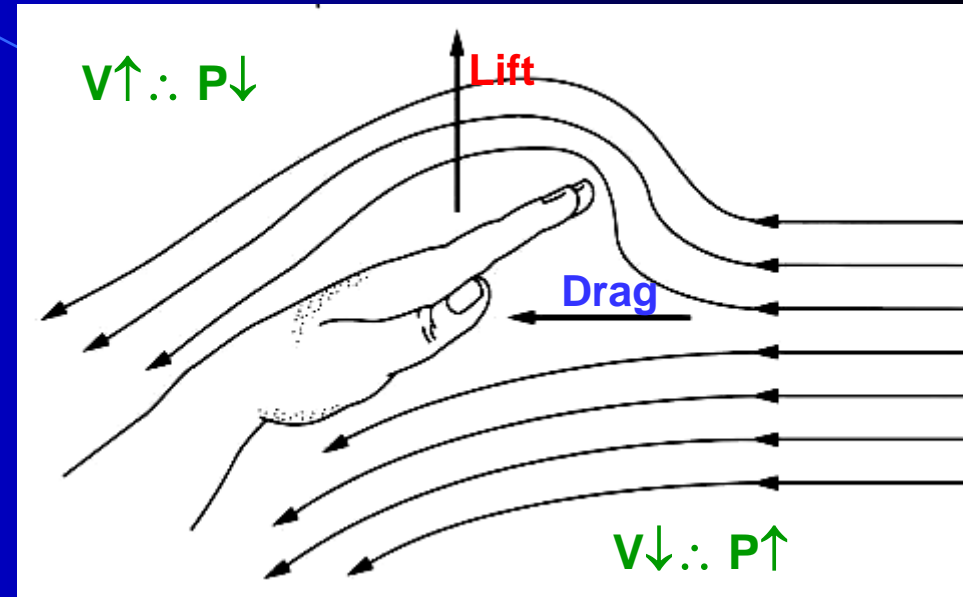


Fig 12.24 c





# Ball Spin (*Magnus Effect*)

- Bernoulli's Principle applies here also
- A ball will move in direction of least air pressure
- A ball spinning drags a boundary layer of air with it, causing air to move faster & reducing pressure on one side

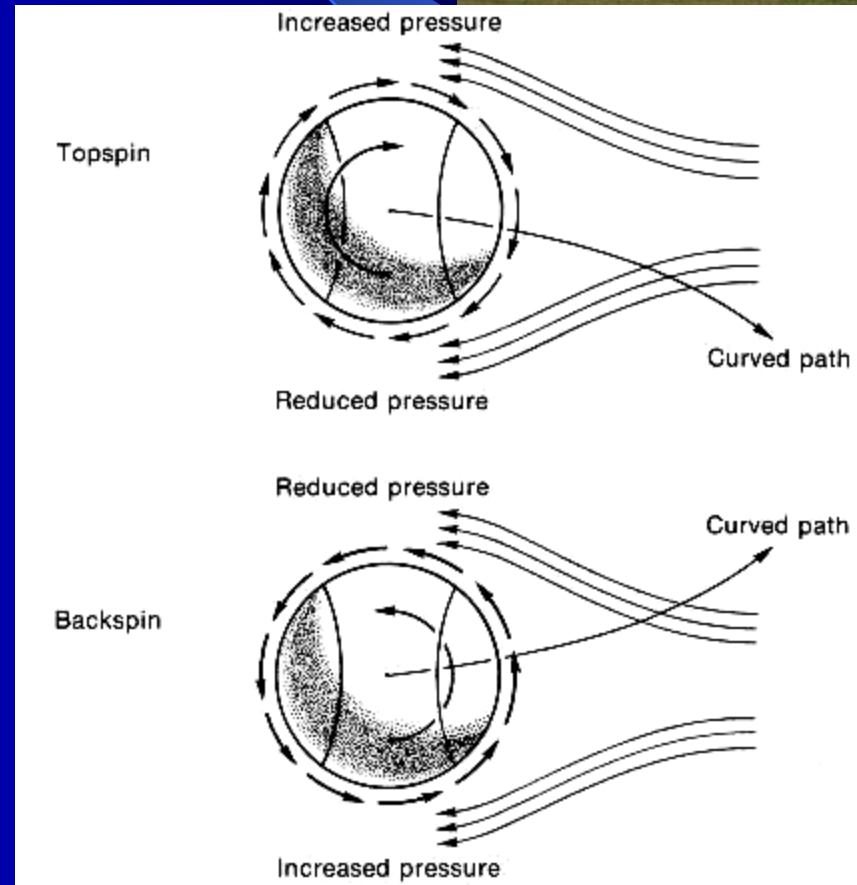


Fig 12.25

# Concurrent Forces

- Act at same point of application

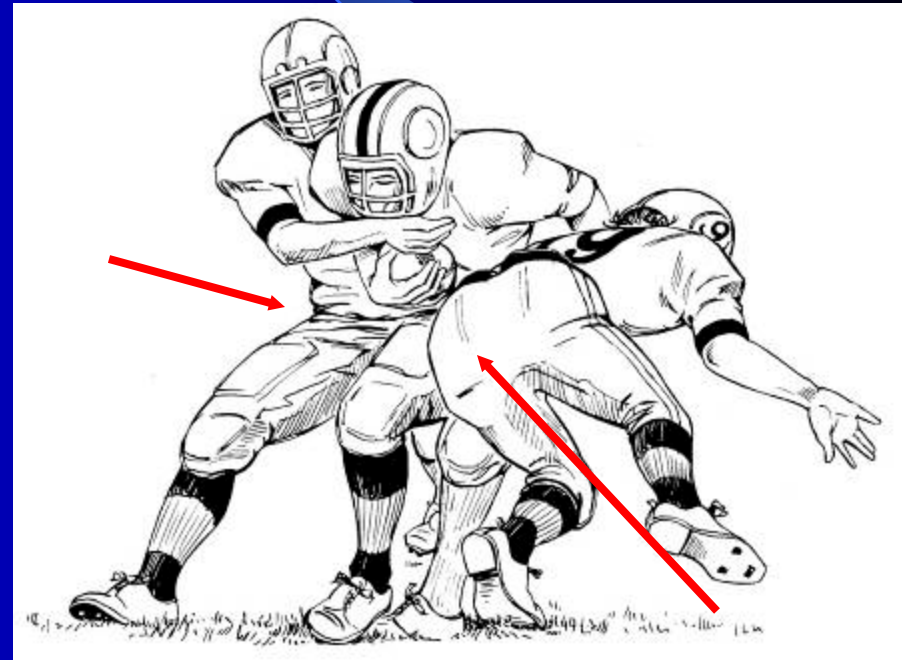
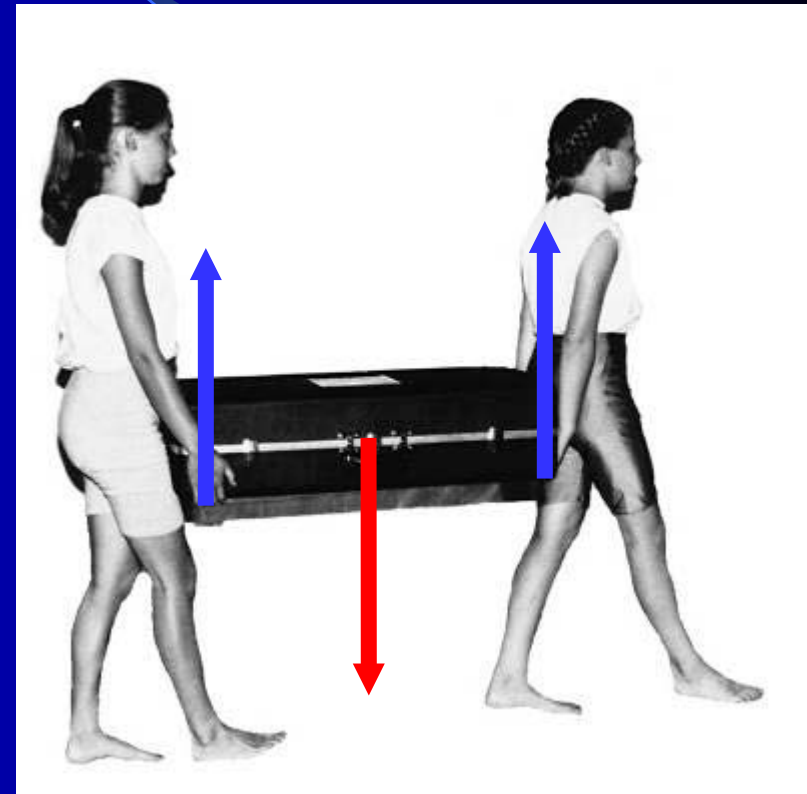


Fig 12.8

# Parallel Forces

- Example, three parallel forces:
  - two upward
  - one downward



# NEWTONS' LAWS OF MOTION

- First law: *"A particle will stay at rest or continue at a constant velocity unless acted upon by an external unbalanced net force"*
- Second law: *" $F = ma$ : the net force on an object is equal to the mass of the object multiplied by its acceleration"*
- Third law: *"Every action has an equal and opposite reaction"*

First law: *"A particle will stay at rest or continue at a constant velocity unless acted upon by an external unbalanced net force"*

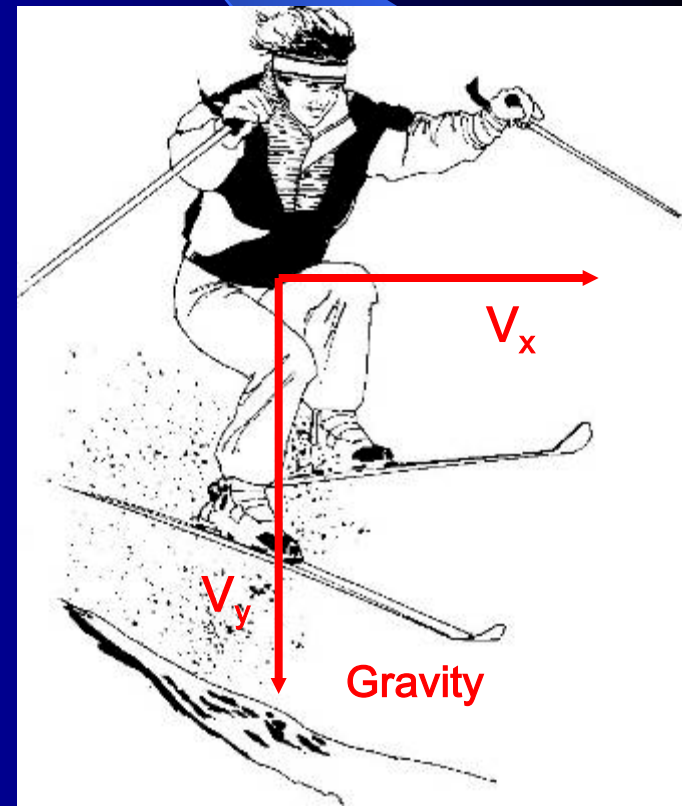


Fig 12.11

Second law: ***" $F = ma$ : the net force on an object is equal to the mass of the object multiplied by its acceleration"***

Acceleration **directly** proportional to force causing it and **inversely** proportional to mass

What force needed to produce a given acceleration?

- Since  $m = w/g$ ,  $F = (w/g) \times a$
- Force to accelerate a 300 N object  $2 \text{ m/sec}^2$
- $F = (300 \text{ N} / 9.8 \text{ m/s}^2) \times 2 \text{ m/s}^2 = 61 \text{ N}$



Third law: *"Every action has an equal and opposite reaction"*

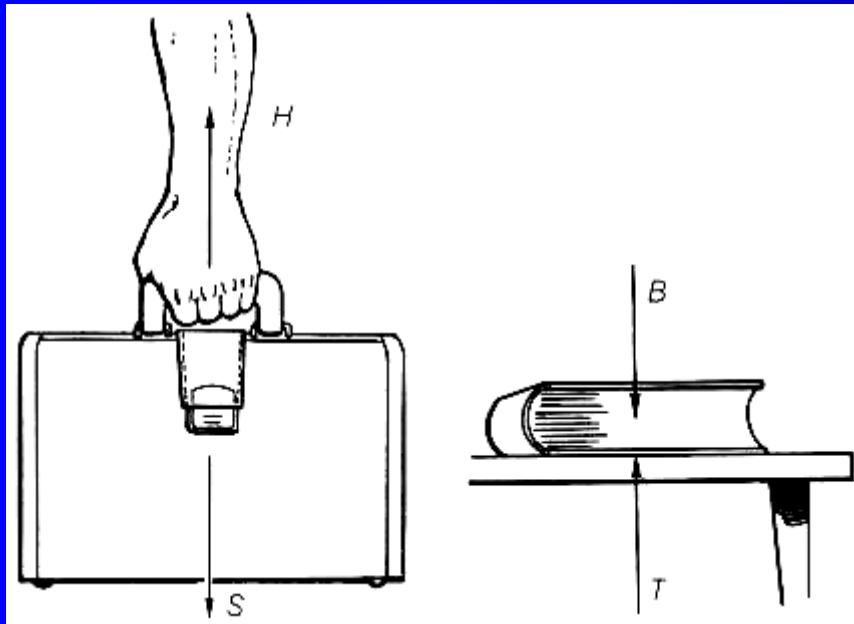


Fig 12.13 & 12.14

Third law: *"Every action has an equal and opposite reaction"*

- The jumper pushes off the ground and the ground pushes back

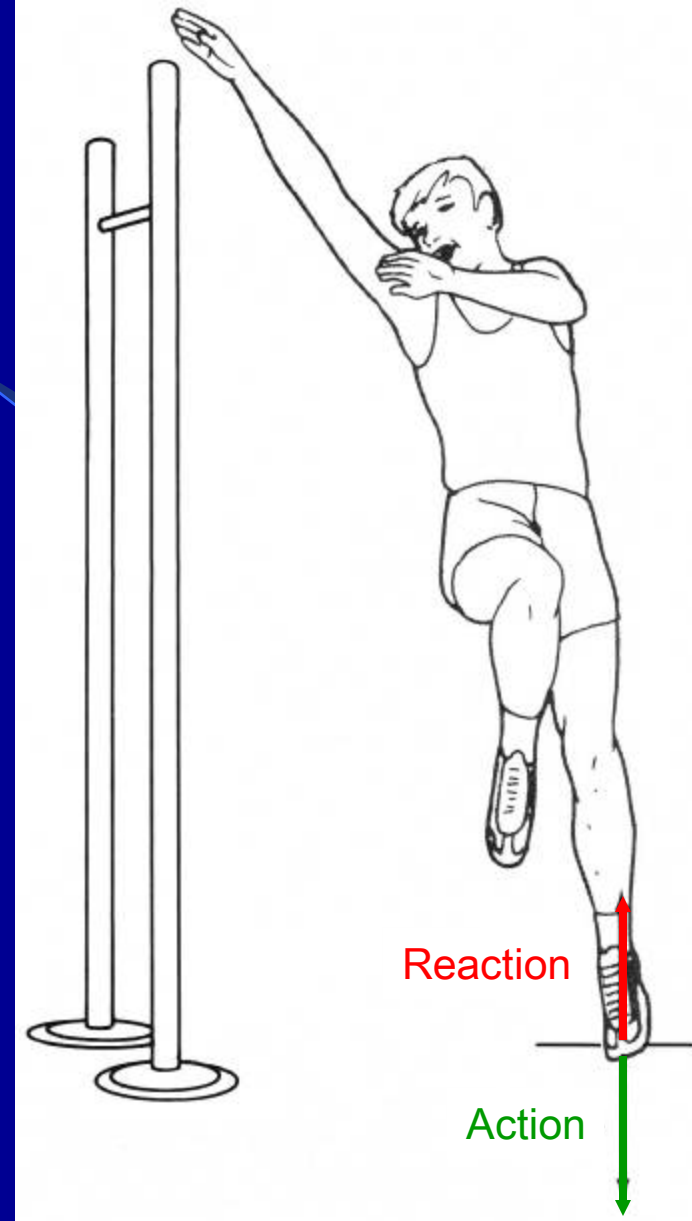


Fig 12.17



# Contact Forces: Friction

Proportional to force  
pressing surfaces  
together

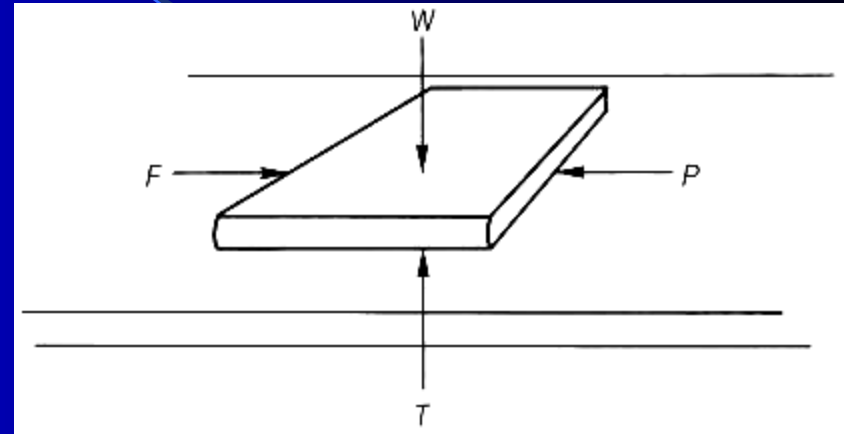


Fig 12.18

$W$  = weight

$T$  = reactive force of table

$P$  = force needed to move

$F$  = force resisting motion



# Coefficient of *static* friction, $\mu_s$

- Found by placing object on another and tilt until first begins to slide
  - Tangent of angle with horizontal is coefficient of *static* friction

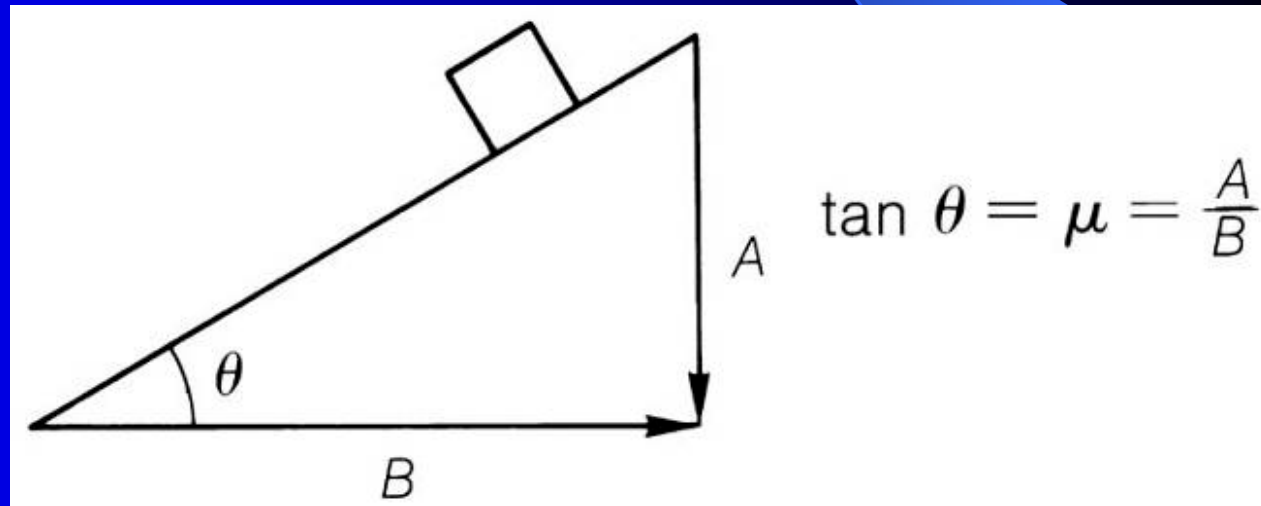


Fig 12.19

Note: once you are moving, the frictional force is related to the coefficient of *kinetic* friction,  $\mu_K$



# Angle of Rebound



- For a perfectly elastic object, angle of incidence (striking) is equal to angle of reflection (rebound)
- As coefficient of elasticity varies, variations will occur (*see next lecture*)

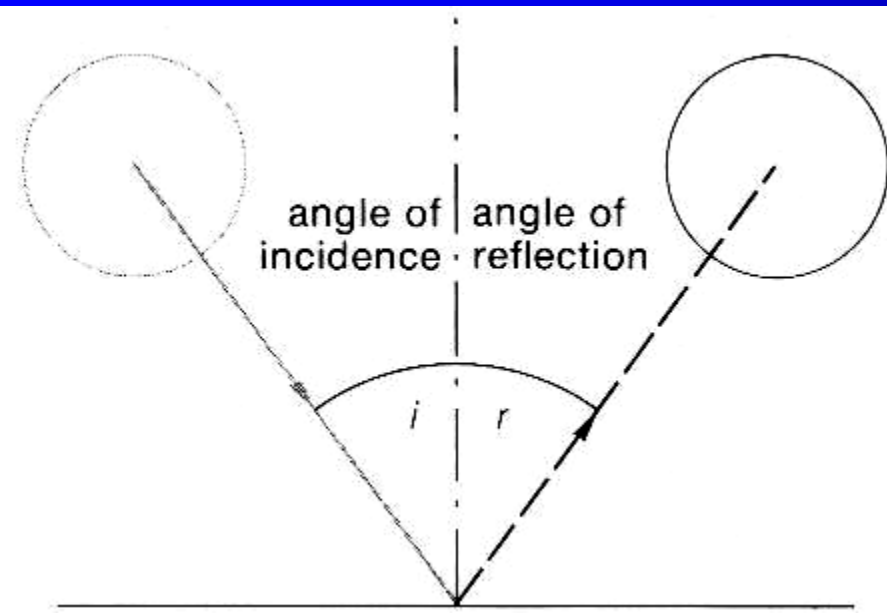
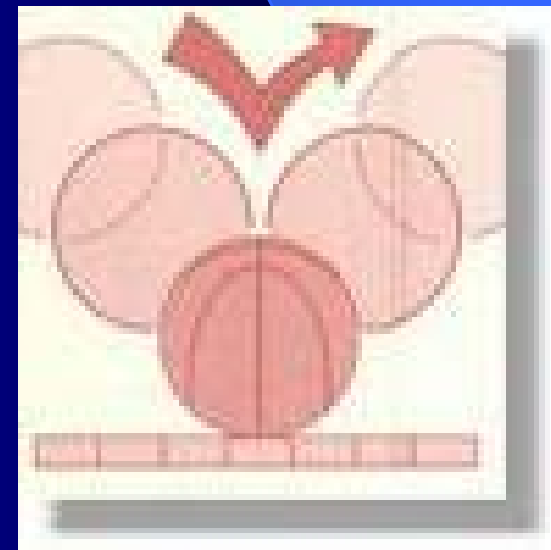
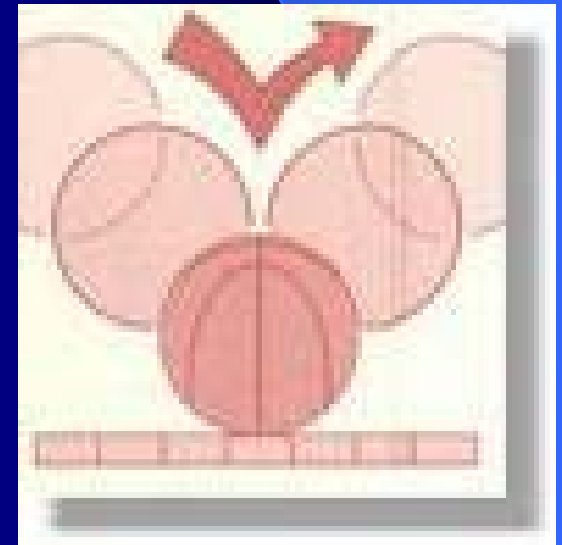


Fig 12.22



# Effects of Spin on Bounce

- Ball with TOPSPIN:
  - Rebounds from horizontal surface lower and with more horizontal velocity
  - Will gain more topspin
- Ball with NO SPIN will develop TOPSPIN
- Ball with BACKSPIN:
  - Rebounds higher and with less horizontal velocity
  - May be stopped or reversed



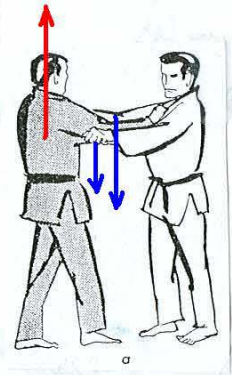
*Spinning balls hitting vertical surfaces react in the same manner*



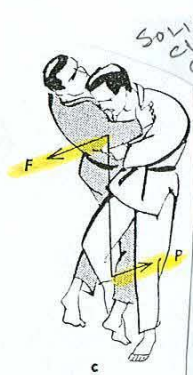
# REAPS

☆ F-15

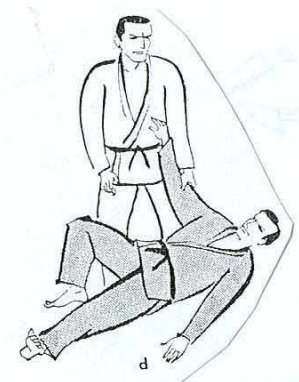
**KUZUSHI**  
pull him down  
to get him to pop  
up.  
And get ready to  
pull his right arm  
out to his right to  
get it out of the  
way.



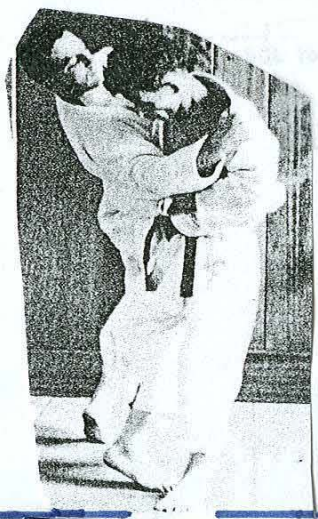
STAND HIM  
UP STRAIT



REAP  
WITH  
A  
STRAIT  
LEG

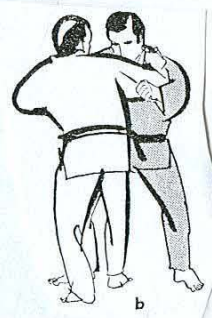
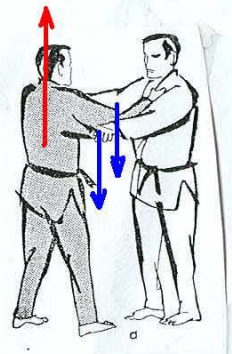


*O-soto-gari* (major external reaping).

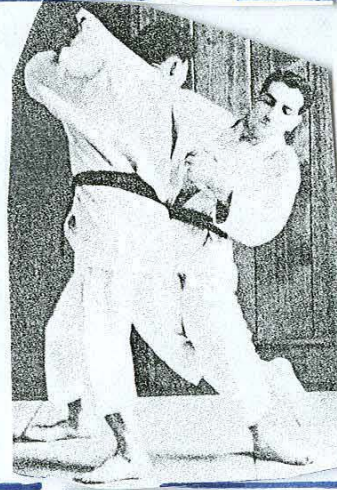


☆ F-15

**KUZUSHI**  
pull him down  
to get him to pop  
up.  
And get ready to  
lunge at him like  
a fencer.

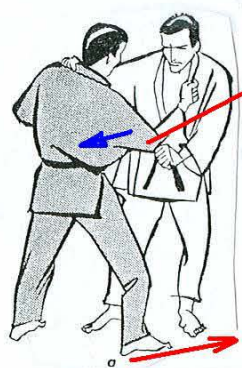


*O-uchi-gari* (major inner reaping)



☆ F-15

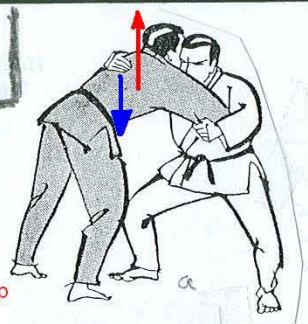
**KUZUSHI**  
Get him to (or  
catch him)  
stepping forward  
and to his right.  
Try pushing on



# HIP THROWS

☆ F-15

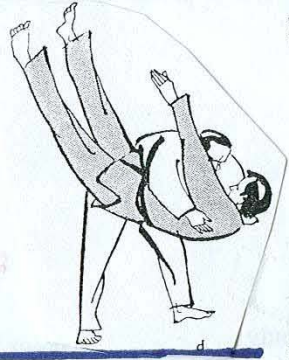
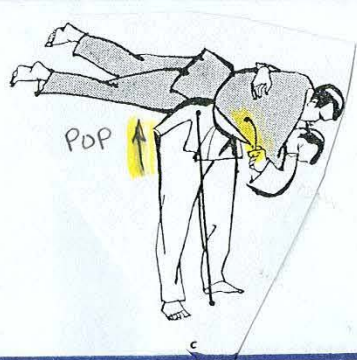
**KUZUSHI**  
Push down on him  
to get him to pop up  
or catch him trying to  
hit you over the head  
with something



O-goshi (major hip throw).



YOUR  
C.O.G.  
BELOW  
HIS



☆ F-15

**KUZUSHI**  
Catch him reaching  
for you (or around  
you) with his right  
arm

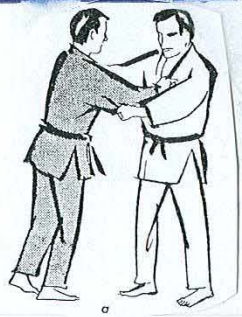
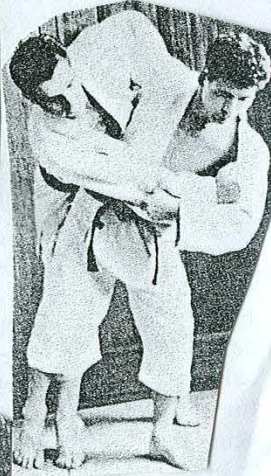
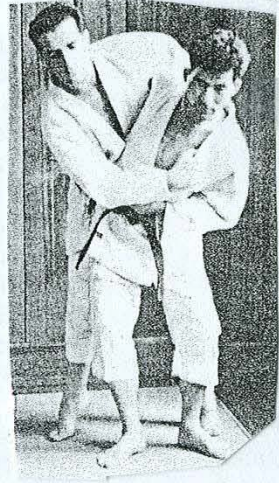
or catch him throwing a  
punch



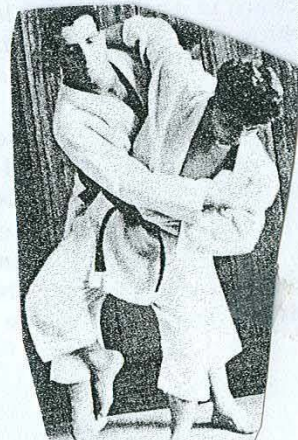
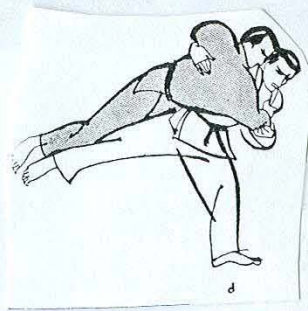
Uki-goshi (hip throw).



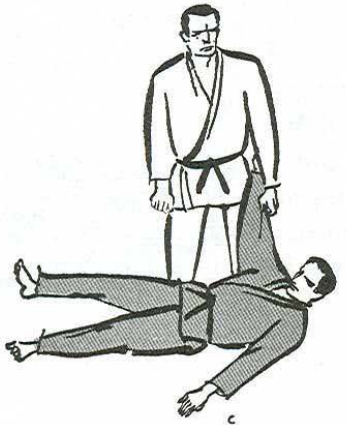
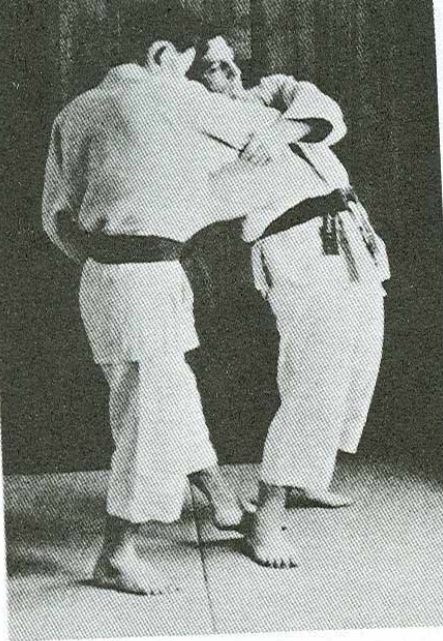
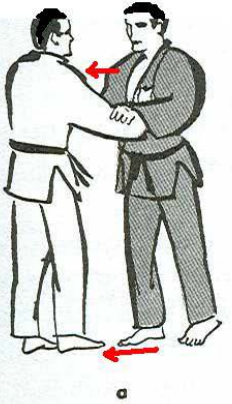
BUMP HIM  
AS YOU STEP  
PAST HIM  
SIDEWAYS



Harai-goshi (sweeping loin throw)



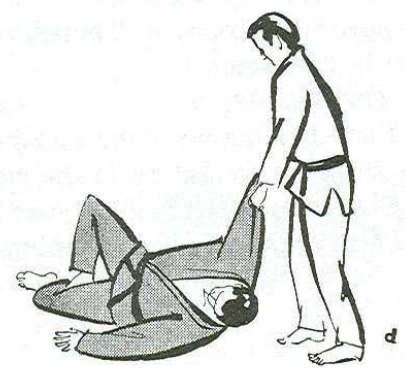
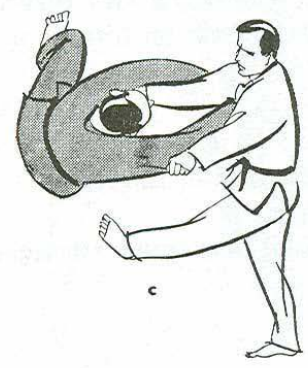
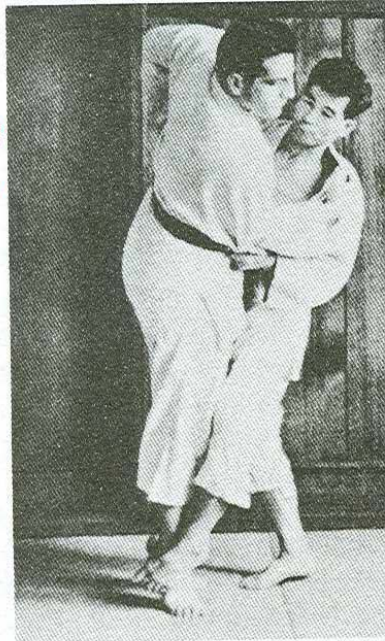
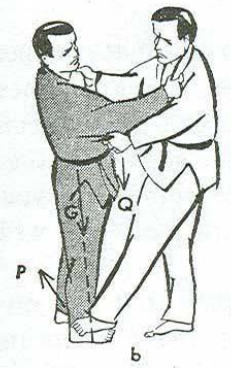
**KUZUSHI**  
 Catch him (or get him to) step forward.  
 Try pushing and pulling -- and walking backwards and forwards.  
 You may catch him coming in for a throw or a wrestling-type leg-take-down



*De-ashi-harai* (advanced foot sweep).



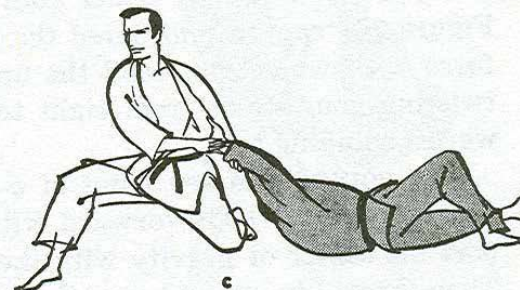
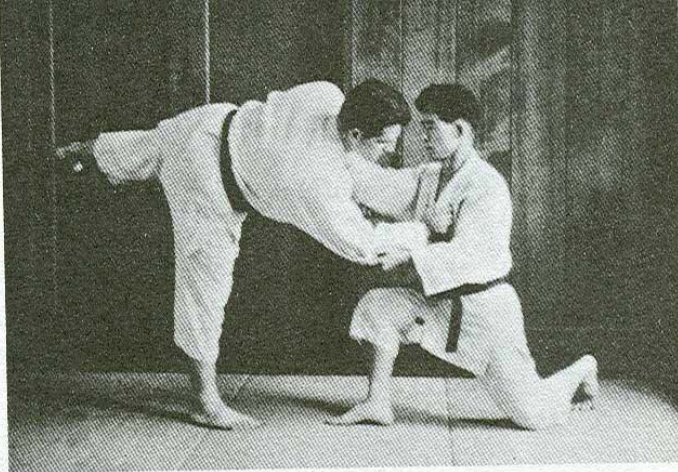
**KUZUSHI**  
 Get him moving to his left so all his weight is on his left foot.  
 Also, try to get him to stand up straight (try pushing down on his left shoulder)



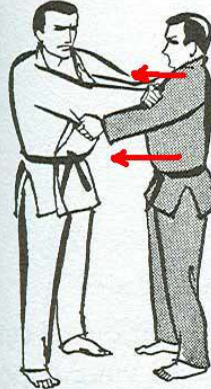
*Okuri-ashi-harai* (sweeping ankle throw).

## KUZUSHI

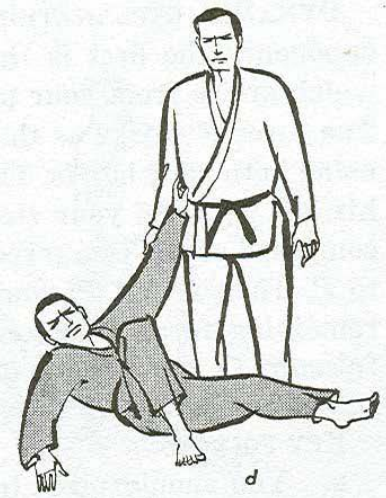
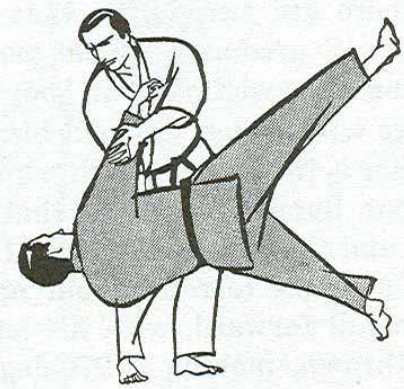
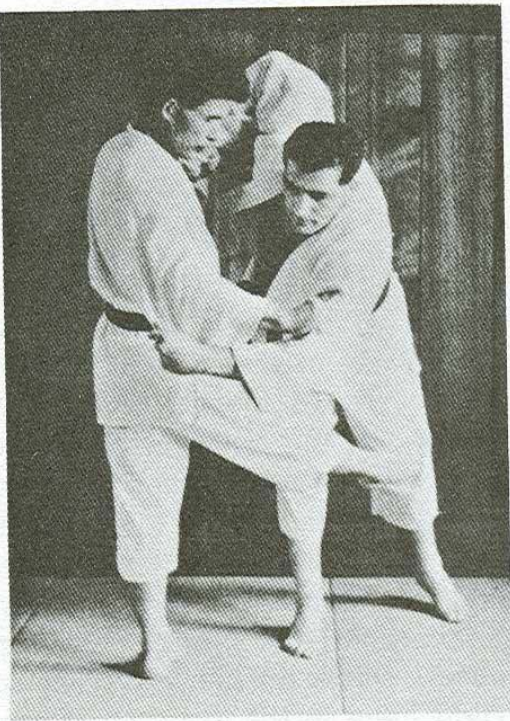
Get him to (or catch him) charging you.  
Try to get him moving around you in big circles.  
Or push on him while charging you so that he then charges you next.



75. *Uki-otoshi* (floating drop).



**KUZUSHI**  
Catch him (or get him to) charge at you.  
Pushing on him may cause this.  
Or maybe catch him coming in for a throw.



*Hiza-guruma* (knee wheel).

# SOME Links for Judo Videos

- DE ASHI HARAI (ADVANCING FOOT SWEEP)
  - <http://www.youtube.com/watch?v=VFgPK3l5d9U>
  - [http://www.youtube.com/watch?v=GKgTOHSNM\\_Q](http://www.youtube.com/watch?v=GKgTOHSNM_Q)
- HIZA GURUMA (KNEE WHEEL)
  - <http://www.youtube.com/watch?v=TDrSEH0tt-w>
  - <http://www.youtube.com/watch?v=nc27NHrIRp8>
- UKI GOSHI (FLOATING HIP)
  - <http://www.youtube.com/watch?v=Nc8Bwk8brtk>
  - <http://www.youtube.com/watch?v=71rRKIEwqiw> *In FYS, don't land on opponent*
- O SOTO GARI (LARGE OUTER REAP)
  - <http://www.youtube.com/watch?v=mjifBnTMn1c>
  - <http://www.youtube.com/watch?v=oeKQHnFSV84> *In FYS, "clean sweep" leg*
- O GOSHI (LARGE HIP)
  - <http://www.youtube.com/watch?v=PqLGjRU2kr0>
  - <http://www.youtube.com/watch?v=vxSwC7ID1K8> *In FYS, don't land on opponent*
- O UCHI GARI (LARGE INNER REAP)
  - <http://www.youtube.com/watch?v=mEStMTIE3OM>
  - <http://www.youtube.com/watch?v=w1DlETHmcks> *In FYS, don't land on opponent*

# SOME Links for Judo Videos

- KO UCHI GARI (SMALL INNER REAP)
  - <http://www.youtube.com/watch?v=-SuAzlYzpJk>
  - <http://www.youtube.com/watch?v=8JXzCDCclG0> *In FYS, don't land on opponent*
- OKURI ASHI HARAI (SLIDING FOOT SWEEP)
  - <http://www.youtube.com/watch?v=mUnkPZSgHCY>
  - <http://www.youtube.com/watch?v=6aVTihg2ELM>
- UTSURI GOSHI (SHIFT HIP)
  - <http://www.youtube.com/watch?v=cudRtrcMxaA>
  - <http://www.youtube.com/watch?v=cTw8uzXFvyU> *In FYS, don't land on opponent*
- UKI OTOSHI (FLOATING DROP)
  - [http://www.youtube.com/watch?v=RBR\\_Lsbj3YM](http://www.youtube.com/watch?v=RBR_Lsbj3YM)
  - [http://www.youtube.com/watch?v=ctwQOUd\\_pS4](http://www.youtube.com/watch?v=ctwQOUd_pS4)
- USHIRO GOSHI (BACK HIP)
  - <http://www.youtube.com/watch?v=IUXwnGUIHtw>
  - <http://www.youtube.com/watch?v=mr2AAecMbWU>

Don't forget that for FYS final exam you must know everything highlighted on the Judo web page :

[http://users.etaown.edu/w/wunderjt/syllabi/JUDO\\_TERMS9%20FYS.htm](http://users.etaown.edu/w/wunderjt/syllabi/JUDO_TERMS9%20FYS.htm)

Don't forget that for Basketball exam you must know everything SOON TO BE highlighted on the Basketball web page :

[http://users.etaown.edu/w/wunderjt/syllabi/BASKETBALL\\_FYS.htm](http://users.etaown.edu/w/wunderjt/syllabi/BASKETBALL_FYS.htm)

*NOTE: Those who opt out of Judo or basketball skills tests (or miss many class participations due to sports injuries, etc.) will need to complete more detailed written questions on exams*