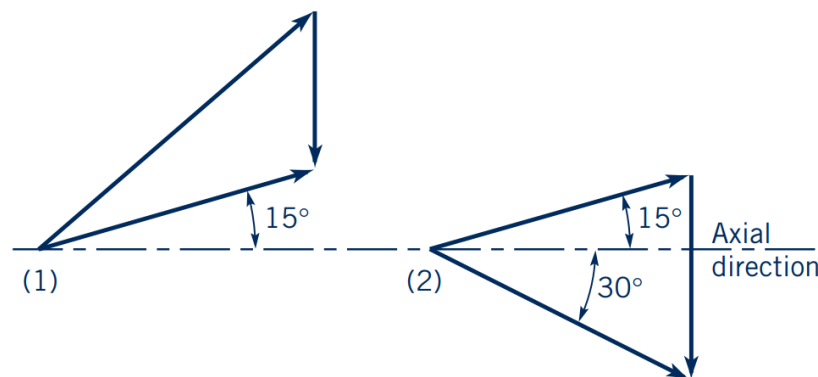




- 1- The following figure shows the upstream [section (1)] and downstream [section (2)] velocity triangles at the arithmetic mean radius for flow through an axial-flow turbomachine rotor. The axial component of velocity is 40 ft/s at sections (1) and (2).  
(a) Label each velocity vector appropriately. Use  $V$  for absolute velocity,  $W$  for relative velocity, and  $U$  for blade velocity.  
(b) Are you dealing with a turbine or a fan?  
(c) Calculate the work per unit mass involved.  
(d) Do you think that the actual blade exit angle will need to be less or greater than 15? Why?



- 2- A centrifugal water pump designed to operate at 1200 rpm has the following dimensions

Parameter	Inlet	Outlet
Radius, $r$ (mm)	90	150
Blade width, $b$ (mm)	10	7.5
Blade angle, $\beta$ (deg)	25	45

- (a) Determine the flow rate at which the entering velocity has no tangential component.  
(b) Draw the outlet velocity diagram, and determine the outlet absolute flow angle measured relative to the normal direction at this flow rate.  
(c) Evaluate the hydraulic power delivered by the pump if its efficiency is 70 percent.  
(d) Determine the head developed by the pump.

- 3- Water to run a Pelton wheel is supplied by a penstock of length  $l$  and diameter  $D$  with a friction factor  $f$ . If the only losses associated with the flow in the penstock are due to pipe friction, show that the maximum power output of the turbine occurs when the nozzle diameter,  $D_1$ , is given by  $D_1 = \frac{D}{\left(\frac{2fl}{D}\right)^{\frac{1}{4}}}$ .
- 4- A centrifugal pump having an impeller diameter of 1 m is to be constructed so that it will supply a head rise of 200 m at a flowrate of  $4.1 \frac{m^3}{s}$  of water when operating at a speed of 1200 rpm. To study the characteristics of this pump, a 1/4 scale, geometrically similar model operated at the same speed is to be tested in the laboratory. Determine the required model discharge and head rise. Assume that both model and prototype operate with the same efficiency (and therefore the same flow coefficient).
- 5- Francis and Kaplan turbines are often provided with draft tubes, which lead the exit flow into the tail water region, as in the Figure. Explain at least two advantages in using a draft tube.

