Impact of Jet The liquid comes out in the form of a jet from the outlet of a nozzle, which is fitted to a pipe through which the liquid is flowing under pressure. If some plate, which may be fixed or moving, is placed in the path of the jet, a force is exerted by the jet on the plate. This force is obtained from Newtons second law of motion or from impulse-momentum equation. Thus impact of jet means the force exerted by the jet on a plate which may be stationary or moving. In this chapter, the following cases of the impact of jet i.e., the force exerted by the jet on the plate, will be considered: Force exerted by the jet on a stationary plate when Plate is vertical to the jet, Plate is inclined to the jet, and Plate is curved. Force exerted by the jet on the moving plate, when Plate is vertical to the jet, Plate is inclined to the jet, and Plate is curved Force exerted by a jet on a stationary vertical plate : Consider a jet of water coming out of the nozzle, strikes a flat vertical plate as shown in the Figure 1. let, The jet after striking the plate will move along the plate. But the plate is at right angles to the jet. Hence the jet after striking will get deflected by 90. Hence the component of the velocity of jet, in the direction of jet, after striking will be zero. The force exerted by the jet on the plate in the direction of the jet = (initial momentum - final momentum)/ time For deriving the above equation, we have taken initial velocity minus final velocity and not final velocity minus initial velocity. If the force exerted on the jet is to be calculated then final minus the initial velocity is taken. But if the force exerted by the jet on the plate is to calculated, then initial velocity minus the final velocity is taken. Force exerted by a jet on a stationary inclined flat plate : Let a jet of water, coming out from the nozzle; strike an inclined flat plate as shown in the Figure.2. Let v = velocity of the jet in the direction of X = Angle between the jet and the plate If the plate is assumed smooth and if it is assumed that there is no loss of energy due to the impact of the jet, then the jet will move over the plate after striking with a velocity equal to initial velocity i.e., with a velocity V. Let find the force exerted by the jet on the plate In the direction normal to the plate. Let this force is represented by Fn then, Fn = Mass of the jet striking per second [initial velocity of the jet before striking in the direction of n - final velocity of the jet after striking in the direction of n If the force can be resolved into two components, one in the direction of the jet and the other perpendicular to the direction of flow. Then we have, (along the direction of the flow) and (perpendicular to flow) Force exerted by a jet on a stationary curved plate: Jet strikes the curved plate at the centre as shown in figure.3. The jet after striking the plate comes out with the same velocity if the plate is smooth and there is no loss of energy due to impact of the jet, in the tangential direction of the curved plate. The velocity at the outlet of the plate can be resolved in to two components, one in the direction of the jet and the other perpendicular to the direction of the jet. Component of velocity In the direction of the jet = (-ve sign is taken as the velocity at the outlet is in the opposite direction of the jet of water coming out from nozzle). Component of the velocity perpendicular to the jet = Force exerted by the jet In the direction of the jet, where, v2 = final velocity in the direction of jet= v cos similarly, -ve sign means the force is acting in the downward direction. In this case the angle of deflection of the jet = Jet strikes the curved plate at on e end tangentially when the plate is symmetrical Let the jet strike the curved plate at one end tangentially as shown in the figure.4. Let the curved is symmetrical about x-axis. Then the angle made by the tangents at the two ends of the plate will be same. Let V = Velocity of the jet of water = angle made by jet with x-axis at inlet tip of the curved plate. If the plate is smooth and loss of energy due to impact is zero, then the velocity of the water at the outlet tip of the curved plate will be equal to V. The force exerted by the jet of water in the direction of x and y are Jet strikes the curved plate at one end tangentially when the curved plate is unsymmetrical When the curve plate is unsymmetrical about x axis, then the angles made by the tangents drawn at the inlet and outlet tips of the plate will be different. = angle made by the tangent at the inlet tip with the x axis, = angle made by the tangent at the outlet tip with x-axis. The two component of the velocity at inlet are The two component of the velocity at outlet are The force exerted by the jet of water in the direction o x and y are Moving fluid, in natural or artificial systems, may exert forces on objects in contact with it. To analyze fluid motion, a finite region of the fluid (control volume) is usually selected, and the gross effects of the flow, such as its force or torque on an object, is determined by calculating the net mass rate that flows into and out of the control volume. These forces can be determined, as in solid mechanics, by the use of Newtons second law, or by the momentum equation. The force exerted by a jet of fluid on a flat or curve surface can be resolved by applying the momentum equation. The study of these forces is essential to the study of fluid mechanics and hydraulic machinery.2. Practical ApplicationEngineers and designers use the momentum equation to accurately calculate the force that moving fluid may exert on a solid body. For example, in hydropower plants, turbines are utilized to generate electricity. Turbines rotate due to force exerted by one or more water jets that are directed tangentially onto the turbines vanes or buckets. The impact of the water on the vanes generates a torque on the wheel, causing it to rotate and to generate electricity.3. ObjectiveThe objective of this experiment is to investigate the reaction forces produced by the change in momentum of a fluid flow when a jet of water strikes a flat plate or a curved surface, and to compare the results from this experiment with the computed forces by applying the momentum equation.4. MethodThe momentum force is determined by measuring the forces produced by a jet of water impinging on solid flat and curved surfaces, which deflect the jet at different angles.5. EquipmentThe following equipment is required to perform the impact of the jet experiment:F1-10 hydraulics bench,F1-16 impacts of a jet apparatus with three flow deflectors with deflection angles of 90, 120, and 180 degrees, andStopwatch for timing the flow measurement.6. Equipment DescriptionThe jet apparatus is a clear acrylic cylinder, a nozzle, and a flow deflector (Figure 5.1). Water enters vertically from the top of the cylinder, through a nozzle striking a target, mounted on a stem, and leaves through the outlet holes in the base of the cylinder. An air vent at the top of the cylinder maintains the atmospheric pressure inside the cylinder. A weight pan is mounted at the top of the stem to allow the force of the striking water to be counterbalanced by applied masses [5].Figure 5.1: F1-16 Impact of Jet Apparatus7. TheoryThe velocity of the water (v) leaving the nozzle with the cross-sectional area (A) can be calculated by:in which Q is the flow rate.Applying the energy equation between the nozzle exit point and the surface of the deflector shows that the magnitude of the flow velocity does not change as the water flows around the deflector; only the direction of the flow changes.Applying the momentum equation to a control volume encompassing the deflected flow results in:where:Fy: force exerted by the deflector on the fluid:fluid density: 180-,where is the flow deflection angle (Figure 5.2).Figure 5.2: Examples of flow deflection angles for flat and hemispherical deflectors From equilibrium of forces in a vertical direction, Fy is balanced by the applied weight on the weight pan, W (W = mg, where m is the applied mass), i.e., Fy = W. Therefore:Since Q = vA, this equation can be written as:8. Experimental ProcedurePerform the experiment by taking the following steps:Remove the top plate (by releasing the knurled nuts) and the transparent cylinder from the equipment, and check and record the exit diameter of the nozzle.Replace the cylinder, and screw the 90-degree deflector onto the end of the shaft.Connect the inlet tube to the quick-release connector on the bench.Replace the top plate on the transparent cylinder, but do not tighten the three knurled nuts.Using the spirit level attached to the top plate, level the cylinder by adjusting the feet.Replace the three knurled nuts, then tighten in sequence until the built-in circular spirit level indicates that the top plate is horizontal. Do not overtighten the knurled nuts, as this will damage the top plate. The nuts should only be tightened enough to level the plate.Ensure that the vertical shaft is free to move and is supported by the spring beneath the weight pan.With no weights on the weight pan, adjust the height of the level gauge until it aligns with the datum line on the weight pan. Check that the position is correct by gently oscillating the pan.Place a mass of 50 grams on the weight pan, and turn on the pump.Open the bench valve slowly, and allow water to impinge upon the target until the datum line on the weight pan is level with the gauge. Leave the flow constant. Observe and note the flow behavior during the test.Measure the flow rate, using the volumetric tank. This is achieved by closing the ball valve and measuring the time that it takes to accumulate a known volume of fluid in the tank, as measured from the sight glass. You should collect water for at least one minute to minimize timing errors.Repeat this procedure by adding an additional 50 grams incrementally, until a maximum mass of 500 grams has been applied.Repeat the entire test for each of the other two flow deflectors.9. Results and CalculationsPlease use this link for accessing excel workbook for this experiment.9.1. ResultsUse the following tables to record your measurements.Raw Data TableTest No.Deflection Angles (degree)90120180Volume(Liter)Time(s)Applied Mass(kg)Volume(Liter)Time(s)Applied Mass(kg)Volume(Liter)Time(s)Applied Mass(kg)123456789109.2. CalculationsThe nozzle should be of the following dimensions.Diameter of the nozzle: d= 0.008 mCross sectional area of the nozzle: A= 5.026510-5m2These values may be measured as part of the experimental procedure and replaced with the above dimensions.For each set of measurements, calculate the applied weight (W), flow rate (Q), velocity squared (v2), force (Fy), and theoretical and experimental slope (S) of the relationship between W and v2. The theoretical slope is determined from Equation 5, as follows:The experimental value of S is obtained from a graph Wof plotted against v2.Result TableNozzle Diameter (m)=Flow Area (m2) =Deflector Angle (degree)=Test No.Applied Weight (N)Flow Rate (m3/s)Velocity (m/s)Velocity2 (m/s)2 Force (N)Theoretical SlopeExperimental Slope1234567891010. ReportUse the template provided to prepare your lab report for this experiment. Your report should include the following:Table(s) of raw dataTable(s) of resultsGraph(s)Plot a graph of velocity squared, v2, (x-axis) against applied weight, W, (y-axis). Prepare one graph, presenting the results for all three deflectors, and use a linear trend line, setting the intercepts to zero, to show this relationship. Find the slopes of these lines. Record the slopes in the Results Table, as the experimental slope.Compare the slopes of this graph with the slopes calculated from the theoretical relationship from Equation 5.Plot the measured force from the weights (W) versus the force of the water on the deflector (Fy) that is calculated by using the momentum equation, i.e., Equation 2.Discuss your results, focusing on the following:Does this experiment provide a feasible means of verifying the conservation of momentum equation? Try to be quantitative in your comparison between the experimental and calculated results.Would the results have been different if the deflectors were closer to the nozzle? Explain.Comment on the agreement between your theoretical and experimental results, and give reasons for any differences.Comment on the significance of any experimental errors. This experiment looks at how different obstructions affect the force exerted by a water jet. To obstruct the flow of fluid vanes were used. A vane as defined by Websters dictionary is a thin flat or curved object that is rotated about an axis by a flow of fluid or that rotates to cause a fluid to flow or that redirects a flow of fluid [2]. Based on the conservation of mass, the mass flow rate of the fluid striking the vane must be equal to, the mass flow rate of the fluid bouncing off the vane as long as the vane is the control volume [1]. The conservation of linear moment is also true for this experiment. The linear moment hitting the vane must be equal to the linear momentum of the fluid being redirected. See Figure 1: vane obstructing fluid flow below. See Figure 1: vane obstructing fluid flow To begin this experiment you must select the appropriate vane. Once the vane has been set up properly, turn on the pump and open the valve to allow for free fluid flow. At this point set the systems desired volumetric flow rate. To be consistence each vane was tested at 3gpm, 4gpm and 6gpm. Afterwards refer to (Eq. 1) below to calculate the force exerted on the vane. (Eq. 1) Where M is the mass of the balance weight [kg], the mass of the weight balance is a constant 0.6kg. g is gravitational acceleration [m/s2] which, is also a known value of 9.81 m/s2. y is the balance weight position [m] and l is the distance from the vane axis to the lever pivot [m] this is also a known value of 0.15m. Once the experimental force has been calculated you need to compare this value to the theoretical value. The equation of the theoretical value varies depending on which vane is used. See Table 1: Theoretical values for F below. Table 1: Theoretical values for F Where M_dot is the mass flow rate [kg/s] and uo is the velocity of the water striking the vane [m/s]. The final variable which will need to be calculated for this experiment is the linear momentum (Lo). See (Eq. 2) below. (Eq. 2) Just as before where M_dot is the mass flow rate [kg/s] and uo is the velocity of the water striking the vane [m/s]. Once linear momentum has been calculated the relationship between the experimental force and linear momentum can be graph. To see full list of experimental results please refer to the appendix. The experimental force exerted on the vane vs the linear momentum is listed in Table 2. Table 2 Experimental Force vs Linear Momentum The data in Table 2 was then used to create Figure 2, which graphs the relationship between experimental force and linear momentum. See Figure 2: Experimental Force vs momentum at the top of the following page. Error bars were added to this graph to take into account the uncertainties which were carried throughout the experiment. Figure 2 Experimental Force vs Momentum. \ The results of this experiment show that there is a linear relationship between the force exerted on the vane and the linear momentum. This makes sense because by compare the equations of the theoretical force in Table 1 to Eq. 2 you see that they are the same equation, with varying coefficients. Therefor if the experimental values are correct they should also show this linear relationship to the momentum. After preforming this experiment and comparing the experimental force to the theoretical force the % errors for this experiment ranged from 0.58% 9.69% error. See Table 3: Experimental values for 60 degree vane below. Table 3: Experimental values for 60 degree Regardless of which vane was used there is a similar pattern as to what is seen in table 3. There is high accuracy in the answers as each trial has very close answer with similar % errors. The vane which has the highest % error was the 90 degree vane which had trial 1 with 8.23% error and trial 3 with 9.69% error. This error could be reduced by taking more than three trials at each flow rate setting. Even though the 90 degree vane had the highest % error, the error was still not over 10% therefor this experiment did have high precision with its result. Some of the idealizations that were made during this experiment were that h, d and l were all assumed to have a uncertainty of 0. This is assumption was made about the uncertainties because these variables were kept constant throughout the experiment and did not change. After conducting this experiment is easy to see how linear momentum and the force on the vane have a linear relationship. Possible improvements to this lab could be made when measuring the balance weight position. A few mm off while reading its position can result large error in this experiment. So if a better was found to calculate this distance the errors in this experiment could be reduced further. Table A- 1 All Experimental Results 60 degree vane Table A- 2 All Experimental Results 90 degree vane Table A- 3 All Experimental Results 120 degree vane Table A- 4 All Experimental Results 180 degree vane Area (A): Conversion (m3/s) Forceexp (N): Mass Flow Rate (M_dot): Water velocity at jet exit (u): Velocity at vane (uo): Rate of Momentum at vane entrance (Lo): Force Theretical (FTheretical): % error: 2. Impact of Jet The jet is a stream of liquid coming out fromnozzle with a high velocity under constantpressure. Impact of Jet means the force exerted by the jeton a plate which may be stationary or moving.The plate may be flat or curved. This force is obtained from Newtons 2nd lawof motion or Impulse Momentum principle. 3. Impulse-Momentum Theorem The impulse-momentum theorem states thatthe change in momentum of an object equalsthe impulse applied to it. For constant mass dm = 0. change in momentum mayoccurs due to a change in the magnitude of velocity orin its direction or due to both. 4. The following cases of the impact of jet, i.e. theforce exerted by the jet on a plate will beconsidered: Force exerted by the jet on a stationary plate1) Plate is vertical to the jet2) Plate is inclined to the jet3) Plate is curved Force exerted by the jet on a moving plate1) Plate is vertical to the jet2) Plate is inclined to the jet3) Plate is curved 5. Force exerted by the jet onVertical Flat Plate1. When the plate is stationaryLet, V =Velocity of the jet in the direction of xd = diameter of the jeta = area of c/s of the jet = 42 6. Consider a jet of water strikes a stationary vertical flat plate as shownin fig. The jet after striking the plate will deflected through 90. So finalvelocity of fluid in the direction of the jet after striking plate will bezero.The force exerted by the jet on the plate in the direction of jet.Fx = Rate of change of momentum in the direction of force= = =[ ]= Mass/sec [Velocity of jet before striking -Velocity of jet after striking]= aV (V - 0) [Mass/sec = x aV]= aV2 7. 2.When the plate is movingLet, u = Velocity of the plateConsider a jet of water strikes a vertical flat plate which is moving with auniform velocity. In this case jet strikes the plate with a relative velocity.Relative velocity of jet with respect to plate = V uFx = Rate of change of momentum in the direction of force= a (V u)[(V - u) 0]= a (V u)2 8. Fx = Rate of change of momentum in the direction of force= a (V u)[(V u) 0]= a (V u)2In this case, work is done by the jet on the plate as the plateis moving,for stationary plate the work done is zero.Work done by the jet on the flat moving plateWd/sec = Force x Distance in the direction of force/ Time= a (V u)2 x u 9. 1. When the plate is stationaryLet V =Velocity of the jet in the direction of xa = area of c/s of the jet = Angle between the jet and plateMass of water striking the plate per sec = x aVForce exerted by the jet on a Inclined Plate(90) 10. Force exerted by jet on the inclined plate in thedirection normal to the plate, FnFn = Mass of water striking/sec x [Initial velocity Final velocity]=aV (V sin 0)=aV2 sinThis normal force can be resolved into two components one in thedirection of jet and other perpendicular to the direction of jet.Fx = Component of Fn in the direction of flow= Fn cos (90) = Fn x sin = aV2 sin2Fy = Component of Fn perpendicular to the flow= Fn sin (90) = Fn x cos = aV2 sin cos 11. 2. When the plate is movingLet V =Velocity of the jet in the direction of xa = area of c/s of the jetu =Velocity of the plate = Angle between the jet and plateIn this case jet strikes the plate with a relative velocity.Relative velocity of jet with respect to plate = V uMass of water striking the plate per sec = x a(Vu) 12. Force exerted by jet on the inclined plate in the directionnormal to the plate, FnFn = Mass of water striking/sec x [Initial velocity Final velocity]=a(Vu)((Vu)sin 0)=a(Vu)2sin This normal force can be resolved into two components one in the direction ofjet and other perpendicular to the direction of jet.Fx = Component of Fn in the direction of flow= Fn cos (90) = Fn x sin = a(Vu)2sin2Fy = Component of Fn perpendicular to the flow= Fn sin (90) = Fn x cos = a(Vu)2sin cosWd/sec = Fx x u= a(Vu)2sin2 x u= a(Vu)2u sin2 13. 1. Plate is stationary and Jet strikes at the centreForce exerted by jet in the direction of jet (x axis)Fx = Mass/sec X [V1x 2]Where, V1x = Initial velocity in the direction of jet = VV2x = Final velocity in the direction of jet = V cos[ve sign indicates velocity at outlet is in opposite direction of the jet of water coming out from nozzle]Fx = aV [V (V cos)]= aV2 [1 + cos]Force exerted by the jet on a Curved Plate 14. 2. Plate is moving and Jet strikes at the centreRelative velocity of jet with respect to plate = V uForce exerted by jet in the direction of jet (x axis)Fx = Mass/sec X [V1x 2] Where, V1x = V u , V2x = (V u) cosFx = a(V u)[(V u) ((V u)cos)]= a(V u)2 [1 + cos]Wd/sec = Fx x u = a(V u)2 u [1 + cos] 15. Jet strikes the curved Plate at one end tangentially The curved plate is symmetrical about x-axis. So the angle made by tangents at the twoends of the plate will be same.Let,V =Velocity of the jet = Angle made by jet with x-axis at inlet tip of the plateForce exerted by jet in the direction of jetFx = Mass/sec X [V1x 2]Fx = aV [V cos (V cos)]= aV [V cos +V cos)]= 2aV2cosForce exerted by the jet on a StationaryCurved Plate (Symmetrical Plate) 16. Jet strikes the curved Plate at one end tangentially The curved plate is unsymmetrical about x-axis. So the angle made by tangents at thetwo ends of the plate will be different.Let, = Angle made by jet with x-axis at inlet tip of the plate = Angle made by jet with x-axis at outlet tip of the plateForce exerted by jet in the direction of jetFx = Mass/sec X [V1x 2]Fx = aV [V cos (V cos)]= aV [V cos +V cos)]= aV2[cos + cos)]Force exerted by the jet on a StationaryCurved Plate (Unsymmetrical Plate) 17. Force exerted by the jet on anunsymmetrical Moving Curved Plate 18. V1 = Absolute velocity of the jet at inlet u1 =Velocity of the vane at inlet Vr1= Relative velocity of the jet and plate at inlet = Angle between the direction of the jet and direction of motion of theplate at inlet = Guide blade angle = Angle made by the relative velocity , with the direction of motion of thevane at inlet =Vane/blade angle at inlet Vw1 and Vf1=The components of the velocity of the jet , V1 in the direction ofmotion and perpendicular to the direction of motion of the vane respectively. Vw1 =Velocity of whirl at inlet Vf1 =Velocity of flow at inlet V2 = Absolute velocity of the jet at outlet u2 =Velocity of the vane at outlet Vr2= Relative velocity of the jet and plate at outlet = Angle made by the velocity V2 with the direction of motion of the vane at outlet = Angle made by the relative velocity, Vr2 with the direction of motion of the vane atoutlet =Vane/blade angle at outlet Vw2 =Velocity of whirl at outlet Vf2 =Velocity of flow at outlet 19. If the vane is smooth and having velocity in the direction of motion at inlet andoutlet equal then we have,u1 = u2 = u =Velocity of vane in the direction of motion of vaneand Vr1 = Vr2Mass of water striking the vane per second, m = aVr1Force exerted by the jet in the direction of motion,Fx = mass of water striking per sec X [Initial velocity with which jet strikes inthe direction of motion Final velocity of jet in the direction of motion]Initial velocity with which jet strikes the vane = Vr1 andcomponent of Vr1 in the direction of motion = Vr1cos = (Vw1 u1)Similarly, component of Vr2 at outlet = Vr2cos = (Vw2 + u2)Fx = aVr1 [Vr1cos (Vr2cos)]Fx = aVr1 [(Vw1 u1) + (Vw2 + u2)]As we know u1 = u2Fx = aVr1 [Vw1 + Vw2]Work done per second on the vane by the jet,W = Fx x uW = aVr1 u [Vw1 + Vw2] 20. Force exerted by a jet of water on aseries of vanes 21. The force exerted by a jet of water on a single movingplate is not practically feasible. Its only a theoretical one. In actual practice, a large number of plates/blades aremounted on the circumference of a wheel at a fixeddistance apart as shown in Fig. The jet strikes a plate and due to the force exerted by thejet on the plate, the wheel starts moving and the 2nd platemounted on the wheel appears before the jet, which againexerts the force on the 2nd plate. Thus each plate appears successively before the jet and jetexerts force on each plate and the wheel starts moving ata constant speed. 22. Let, V =Velocity of jet,d = Diameter of jetu =Velocity of vane In this case the mass of water coming out from the nozzle per second is always incontact with the plates, when all the plates are considered. Hence, mass of water per sec striking the series of plates = aV Also, The jet strikes a plate with velocity =V u After striking, the jet moves tangential to the plate and hence the velocity componentin the direction of motion of plate is equals to zero.Force exerted by the jet in the direction of motion of plate,Fx = aV [(V u) 0]Fx = aV (V u)Work done by the jet on the series of plates per second,W = Fx x uW = aV (V u) x uW = aV u (V u) Moving fluid, in natural or artificial systems, may exert forces on objects in contact with it. To analyze fluid motion, a finite region of the fluid (control volume) is usually selected, and the gross effects of the flow, such as its force or torque on an object, is determined by calculating the net mass rate that flows into and out of the control volume. These forces can be determined, as in solid mechanics, by the use of Newtons second law, or by the momentum equation. The force exerted by a jet of fluid on a flat or curve surface can be resolved by applying the momentum equation. The study of these forces is essential to the study of fluid mechanics and hydraulic machinery.2. Practical ApplicationEngineers and designers use the momentum equation to accurately calculate the force that moving fluid may exert on a solid body. For example, in hydropower plants, turbines are utilized to generate electricity. Turbines rotate due to force exerted by one or more water jets that are directed tangentially onto the turbines vanes or buckets. The impact of the water on the vanes generates a torque on the wheel, causing it to rotate and to generate electricity.3. ObjectiveThe objective of this experiment is to investigate the reaction forces produced by the change in momentum of a fluid flow when a jet of water strikes a flat plate or a curved surface, and to compare the results from this experiment with the computed forces by applying the momentum equation.4. MethodThe momentum force is determined by measuring the forces produced by a jet of water impinging on solid flat and curved surfaces, which deflect the jet at different angles.5. EquipmentThe following equipment is required to perform the impact of the jet experiment:F1-10 hydraulics bench,F1-16 impacts of a jet apparatus with three flow deflectors with deflection angles of 90, 120, and 180 degrees, andStopwatch for timing the flow measurement.6. Equipment DescriptionThe jet apparatus is a clear acrylic cylinder, a nozzle, and a flow deflector (Figure 5.1). Water enters vertically from the top of the cylinder, through a nozzle striking a target, mounted on a stem, and leaves through the outlet holes in the base of the cylinder. An air vent at the top of the cylinder maintains the atmospheric pressure inside the cylinder. A weight pan is mounted at the top of the stem to allow the force of the striking water to be counterbalanced by applied masses [5].Figure 5.1: F1-16 Impact of Jet Apparatus7. 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You should collect water for at least one minute to minimize timing errors.Repeat this procedure by adding an additional 50 grams incrementally, until a maximum mass of 500 grams has been applied.Repeat the entire test for each of the other two flow deflectors.9. Results and CalculationsPlease use this link for accessing excel workbook for this experiment.9.1. ResultsUse the following tables to record your measurements.Raw Data TableTest No.Deflection Angles (degree)90120180Volume(Liter)Time(s)Applied Mass(kg)Volume(Liter)Time(s)Applied Mass(kg)Volume(Liter)Time(s)Applied Mass(kg)123456789109.2. CalculationsThe nozzle should be of the following dimensions.Diameter of the nozzle: d= 0.008 mCross sectional area of the nozzle: A= 5.026510-5m2These values may be measured as part of the experimental procedure and replaced with the above dimensions.For each set of measurements, calculate the applied weight (W), flow rate (Q), velocity squared (v2), force (Fy), and theoretical and experimental slope (S) of the relationship between W and v2. The theoretical slope is determined from Equation 5, as follows:The experimental value of S is obtained from a graph Wof plotted against v2.Result TableNozzle Diameter (m)=Flow Area (m2) =Deflector Angle (degree)=Test No.Applied Weight (N)Flow Rate (m3/s)Velocity (m/s)Velocity2 (m/s)2 Force (N)Theoretical SlopeExperimental Slope1234567891010. ReportUse the template provided to prepare your lab report for this experiment. 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In both cases the same amount of water is hitting both surfaces with the same velocity at the same angle (which would be vertically upwards in this case). So why does the angle of deflection determine the force applied by the water? Take a look at the structure of that equation. What happens when Beta is 90 degrees? What happens when it is 180? Think of this equation as a sum of forces (as that's what it is). The plate resists the force imparted by the incoming water stream and the water is deflected 90 degrees (no horizontal force, since there's no horizontal component to the stream). So, after the water is deflected, there's no additional force for the plate to resist.With the cup, the surface must first resist the stream (m_dot*V_initial) and then experiences an equal and opposite reaction from the horizontal component of redirected water stream. jim hardy When the math and intuition agree you are probably getting someplace. At least it's easier to remember the equation when they agree... Nice job there T_K. Simply put - the plate just stops the water but the cup throws it back. Imagine a similar experiment measurement with a baseball. Try it yourself in a rocking chair. Excellent explanation, both of you. Thanks you very much for clearing this up for me. Moving fluid, in natural or artificial systems, may exert forces on objects in contact with it. To analyze fluid motion, a finite region of the fluid (control volume) is usually selected, and the gross effects of the flow, such as its force or torque on an object, is determined by calculating the net mass rate that flows into and out of the control volume. These forces can be determined, as in solid mechanics, by the use of Newtons second law, or by the momentum equation. The force exerted by a jet of fluid on a flat or curve surface can be resolved by applying the momentum equation. 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Try to be quantitative in your comparison between the experimental and calculated results.Would the results have been different if the deflectors were closer to the nozzle? Explain.Comment on the agreement between your theoretical and experimental results, and give reasons for any differences.Comment on the significance of any experimental errors. Hi all, my first post on here and just wanted to check something I'm working on for a project. The project is to use a pump to create a jet of water to manouvre small boat. I have found a formula to work out the jet reaction force in a fire fighting textbook which gives: R = 0.157 * P * d^2 where R = Reaction force in Newtons P = Pressure in bar d = nozzle diameter in mm To avoid buying and testing different pumps and nozzles empirically to find the best reaction force I wanted to link a given pumps flow and pressure to find nozzle diameter and then using this and the pressure and the above formula to get the reaction force. I have been using L = 2/3 * d^2 * sqrt P where L = flow l/min d = nozzle diameter in mm P = pressure in bar re-arranged to give d = sqrt (L/ (2/3 * sqrt P)) this gives d in mm then putting this and the same pressure back into the above reaction formula to get reaction in Newtons. as an example: a pump giving P = 1.52 Bar Q = 450 l/min d = sqrt (450/ (2/3 * sqrt 1.52)) = 23.4 mm then R = 0.157 * P * d^2 = 0.157 *1.52 *23.4^2 =130 N Questions: Are the formulas I'm using valid? If so could someone show me how to get to them from first principles or just tell me they're ok :) If not then why?Other losses: I have thought about losses due to pipe work friction but if the nozzle is underwater what sort of losses could I expect due to reduced flow because of higher pressure at/just after outletThanks in advance for any help. Andrew Mason Welcome to PF acebaraka! You could try using: F = dp/dt = d(mv)/dt = v(dm/dt) + m(dv/dt). If the speed of the water jet is constant (ie. dv/dt=0), the force is given by f = v(dm/dt) where v is the speed of the water exiting the nozzle and dm/dt is the mass flow rate out of the nozzle. The mass flow rate is the volume flow rate x mass/unit volume of water (1 kg/l). You can determine the speed of the water using Bernoulli's principle: ##\Delta \frac{1}{2}\rho v^2 = -\Delta P## (the change in kinetic energy per unit volume is equal and opposite to the change in pressure).AM Welcome to PF acebaraka! You could try using: F = dp/dt = d(mv)/dt = v(dm/dt) + m(dv/dt). If the speed of the water jet is constant (ie. dv/dt=0), the force is given by f = v(dm/dt) where v is the speed of the water exiting the nozzle and dm/dt is the mass flow rate out of the nozzle. The mass flow rate is the volume flow rate x mass/unit volume of water (1 kg/l). You can determine the speed of the water using Bernoulli's principle: ##\Delta \frac{1}{2}\rho v^2 = -\Delta P## (the change in kinetic energy per unit volume is equal and opposite to the change in pressure).AM Thanks for your reply, do I have this right ? delta P would be: system pressure at or just before the nozzle - (for the sake of ease at the moment) atmospheric pressure which would be 1.52bar but in SI so SqRt (P / (0.5*density)) would give v sov = SqRt (152000 / (0.5*1000)) =17.43 m/s Then F= v * (dm/dt) for 450l/min (dm/dt) = 450/60 = 7.5 kg/s = 17.43 * 7.5 = 130Nwhich rather wonderfully comes out to the same as what I had with the other equation, to good to be true? :) Andrew Mason Thanks for your reply, do I have this right ? sov = SqRt (152000 / (0.5*1000)) =17.43 m/s Then F= v * (dm/dt) for 450l/min (dm/dt) = 450/60 = 7.5 kg/s= 17.43 * 7.5= 130Nwhich rather wonderfully comes out to the same as what I had with the other equation, to good to be true? :) Not at all. I expect that the formulas you had were derived the same way.AM 1. A plane has a velocity of 280 m/s at an angle below the horizontal. When the altitude of the aircraft is 2.15km, it releases a water bomb, which subsequently hits a target on the ground. The magnitude of the displacement from the point of release of the bomb to the target is 3.25km. Find angle Please help! I've tried drawing the diagram and even that is ending up confusing. I'm quite sure the second triangle coming off the airplane has a y component of 2.15km, and a hypotenuse of 3.25km but I can't determine how the of the plane from the horizontal relates to this second triangle. Last edited by a moderator: Sep 25, 2012 Ibix A plane capable of doing a substantial fraction of the speed of sound being used for water bombing? Hm. From your description of your diagram, I think you are assuming that the bomb travels in a straight line after being released. This isn't the case - it curves towards the ground. You've been given initial velocities in the horizontal and vertical directions (in terms of) and distances traveled in the horizontal and vertical directions after some time. Can you relate these pieces of information? A plane capable of doing a substantial fraction of the speed of sound being used for water bombing? Hm.From your description of your diagram, I think you are assuming that the bomb travels in a straight line after being released. This isn't the case - it curves towards the ground. You've been given initial velocities in the horizontal and vertical directions (in terms of) and distances traveled in the horizontal and vertical directions after some time. Can you relate these pieces of information? I think the problem is stating that if you would draw a direct line from where the bomb was dropped to where it landed it would have traveled 3.25km, not saying the total distance the bomb traveled. 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Hopefully you get the gist of it Ibix I read the problem as saying that 3.25km is the horizontal distance, not the hypotenuse. In any case, the point is that the bomb does not follow the hypotenuse to the target. In your diagram, the pilot has pointed the nose of the plane at the target and released the bomb. If he doesn't change course, he will fly into the target and the bomb, dropping downwards under gravity, will drop short. In other words, theta is not the angle you appear to think that it is. You need to think about the motion of the bomb, not the plane. Perhaps a simpler question: if the plane were traveling horizontally at 280m/s at 2.15km altitude and released its bomb, how far along the ground would the bomb travel? I figured it out. It ends up as projectile motion with an initial velocity, thanks :) Ibix I figured it out. It ends up as projectile motion with an initial velocity, thanks :) I am working on the same problem. When you do the problem, did you have to solve for time in order to be able to move forward in the question? Yes but you'll get an expression with theta in it, not a numerical value What equation did you use to start? I solved the question for myself, but I am wondering if I have done it properly. Mind if I ask what your answer was? I got 48 degrees Knowns=x, y , u and g. Unknowns= Taking downward as positive. y=xTan\theta+\frac{gx^2}{2u^2Cos^2\theta} Cos2=1-Sin2 1/Cos2=1+tan2 Last edited: Sep 26, 2012 Knowns=x, y , u and g. Unknowns= Taking downward as positive. y=xTan\theta+\frac{gx^2}{2u^2Cos^2\theta} Cos2=1-Sin2 1/Cos2=1+tan2 azizlwl can you please elaborate? y=vyt + 1/2 at2 ...(1) x=vxt => t=x/vx...(2) Sub (2) to (1) y=vy(x/vx) + 1/2 a(x/vx)2 y=xTan+1/2 a(x/vCos)2 Ok I understand how you formulated this equation. Now I can plug my numbers in and I get y=xTan+1/2 a(x/vCos)2 2150 = 3250Tan + 9.8(3250)2) / 2(280)2cos2 How do I get rid of the tan and cos? Ok I understand how you formulated this equation. Now I can plug my numbers in and I get y=xTan+1/2 a(x/vCos)2 2150 = 3250Tan + 9.8(3250)2) / 2(280)2cos2 How do I get rid of the tan and cos? Knowns=x, y , u and g. Unknowns= Taking downward as positive. y=xTan\theta+\frac{gx^2}{2u^2Cos^2\theta} Cos2=1-Sin2 1/Cos2=1+tan2 Just subtitute 1/Cos2 with 1+tan2 then you have a quadratic equation. Azizlwl's got it right, solve that using trig identities he stated below. As for my answer, I got =23 Just subtitute 1/Cos2 with 1+tan2 then you have a quadratic equation. Azizlwl's got it right, solve that using trig identities he stated below. As for my answer, I got =23 for your Quadratic Equation did you get 660.2Tan2 + 3250Tan - 1489.8 My number's were slightly off (within like 1 digit range) So yes This one is actually for a lab assignment. In the experiment you shoot a jet of water upward vertically at a variety of targets with different geometries (a flat plate, various cups). The target is suspended from a rod, and on top of the rod is a cup where you can add weights, held up by a spring. With the jet impacting the cup you determine the force two ways, first, by measuring the mass of the weight it takes to push the target apparatus back down to y=0 against the force of the water. Second, by calculating the theoretical value of the force given the density of water, nozzle cross-sectional area, volume of water through flowmeter, and time. I think the formula given by the professor on the lab sheet is incorrect, or perhaps I don't understand it enough and am missing something. In all we repeated the process 12 times, so I'll just post the data for one repetition. The process should be the same for each one. Homework Statement Problem: 1. Assuming the impact velocity is the same as nozzle exit velocity, calculate the theoretical impact velocity. 2. Using the theoretical equation for the impact force of a jet, calculate the impact force. 3. Compare the theoretical and measured values. Data: = 1000 kg/m^3 = 90 (flat plate) m = 159g (mass required to "zero" the target against the force) vol = 0.018927 m^3 t = 56.40 s D = 1cm Homework Equations F = A(V^2)cos(+1) F = mg where V is jet velocity, A is nozzle cross-sectional area, is fluid density, is the angle of the target (given by professor), and g is the constant of gravitation. The Attempt at a Solution Experimental force = m*g = 159g(.001kg/g)(9.8m/s^2) = 1.5582 N Jet area: A = r^2 = ((1cm*.01 m/cm)/2)^2 = 7.854e-5 m^2 Jet velocity: V = (vol / t) / A = (0.018927 m^3 / 56.4 s) / (7.854e-5 m^2) = 4.2728 m/s Impact force: F = A(V^2)cos(+1) = (1000kg/m^3)(7.854e-5 m^2)(4.2728 m/s)^2(cos(90 + 1) - or - = (1000kg/m^3)(7.854e-5 m^2)(4.2728 m/s)^2(cos(/2 + 1)) I have tried it both ways -- radians and degrees, it does not specify in the lab sheet -- and both of them are incorrect. For this one I get a value of -1.2065 N. This in itself wouldn't trouble me, except that for the next experiment, a 0 "dome" target I get a positive 0.46963N theoretical value versus a measured value of 1.7444N. The values alternate between positive and negative as we go across the chart. I'm guessing the problem lies in the cos(+1). +1 what? It doesn't make sense to me. I've tried Google to see if an alternative form of the equation exists but no luck so far. For the 90 target, which is just a flat plate, the jet force should be the full force of the jet...or F = A(V^2). That means the cos() would have to go to 1, which would mean cos() or, in this case, cos(+ /2). Don't see how +1 plays in. Thanks for any help on this one in advance. I'm trying to get the data done so I can pass it along to my lab partners for the lab write-up but I've been scratching my head on this all day and they have no suggestions either, and, sine it's Saturday, the professor is not in his office. Hopefully I've explained it well enough to pinpoint where I've gone wrong. So I did this lab on momentum on jets and the theory is that "a force is applied on the plate due to change of momentum" the jet both impacted on a flat plate and on a hemispherical plate; now i understand that the greater the angle of deflection of the water jet, the greater the change of momentum. I also understand that the force acting on the hemispherical plate will be double of that acting on the flat plate. I also understand that the force acting on the plate will be equal to the rate of momentum. Now having calculate that change of momentum i got values for both the plate and the hemispherical shell but the results that I obtained show that the rate of change of momentum for the flat is actually double that of the hemispherical shell which is not what the theory predicted and this is where i get confused as the shell deflect the water by 180 degrees whereas the flat plate deflects it by 90 degrees. I then used this formula Fv = Mjgb/a where Mj is the mass of the jockey weight, g is acceleration due to gravity, b the distance of the jockey to the neutral position and "a" the distance from the neutral position to the pivot. And that force Fv is meant to be the vertical force acting on the fluid due to the jockey. The aim to compare the forces acting on the two plates but I'm not sure how to do when the theory is being defied.PS: i cheated with my other mates and their results showed a similar patternsomeone help please JBA Without seeing a clear and complete description the problem(s) and your attempted solution(s) there is no way to evaluate your difficulties. Without seeing a clear and complete description the problem(s) and your attempted solution(s) there is no way to evaluate your difficulties. Introduction This experiment uses water jets impacting on metal plates to look at Newtons second law.AimThe aim of the experiment is to compare the forces acting on the two metal plates.Background and AnalysisNewtons second law of motion states that the force acting on a body is equal to the rate of change of momentum. You may be familiar with the special case , which is only true when the mass is constant.In this experiment, we have fluid flowing, and so there is not a fixed mass. Newtons second law, in this case, can be writtenwhere: is the (vertical) force acting on the fluid, is the mass flow rate,and are the initial and final fluid velocities vectors (positive for upwards, negative for downwards), is a momentum flux.Suppose the water exits the nozzle with a vertical velocity of , i.e. .In the case of the flat plate, the water spreads out horizontally; the final vertical velocity is zero, . The force acting on the fluid is . Note the minus sign means that the force acting on the fluid is downwards.In the case of the hemispherical shell, the water comes off the plate traveling vertically downwards. If we assume that the fluid speed is constant ( ) and only changes direction, then final velocity is ; note the minus sign because the fluid is going downwards. The force acting on the fluid in this case is double that of the flat plate.Procedure Starting with the flat plate, move the jockey weight 2cm along the lever arm. Open the control valve and change the flow rate until the lever arm is level. Measure the mass flow rate of water by measuring the length of time taken to collect a volume of water. Repeat each measurement moving the jockey weight further down the lever arm in 2cm increments. Each time note the distance of the jockey weight, the mass of water collected, and the time taken (there is atable at the back of the lab sheet for you to record your measurements). You can repeat each measurement several times to find an average. Repeat the test for the hemispherical shell. Analysis of Results For each measurement, calculate the mass flow rate dot/t Where: m dot is the mass flow ratem is the mass of water collectedt is the time of collection If you took multiple measurements, find the average mass flow rate (add them up and divide by the number of values) Calculate the force acting downwards due to the jockey weight Fv = mjgb/a ///page2image3816 where: Fv is the vertical force acting on the fluidmj = 0.61kg is the mass of the jockey weight, g = 9.81 m/s^2 is acceleration due to gravity, a = 152.4 mm is the distance of the neutral position from the pivot, b is the distance of the jockey weight from the neutral position I can't insert the image but is that of the setup of the hydraulic bench (jockey and plate part)Figure 1: The forces acting on the balance beam in equilibrium when (a) there is no force on the plate and (b) the water jet produces a force on the plate and the jokey mass is moved to re-establish equilibrium. Note that in figure a) the torque produced from the spring force, S, cancels the torque from the jockey mass and the pass of the beam. Presentation of results On the same graph, plot against for both sets of results Find the line of best fit for each set of results Discussion How do the lines of best fit compare with the theory above?What are the sources of error in the experiment? Could these be reduced or eliminated? Quantify the effect of the errors on your results. Conclusions Report your best fit equations and summarise the important points that arose in your discussion. that's the problem I just need to understand why is that the results from the calculation of the average rate of change of momentum for the flat place are double that of the hemispherical plate when the theory says the opposite. Last edited by a moderator: May 8, 2017 We need that image to understand what the problem is . Did you use the UPLOAD button bottom right of reply box ? We need that image to understand what the problem is . Did you use the UPLOAD button bottom right of reply box ? We need that image to understand what the problem is . Did you use the UPLOAD button bottom right of reply box ? There you go that's the overall set up and the jockey part JBA I don't see in the problem statement the requirement to calculate the change in momentum, only the forces resulting from it for each case and then plotting those forces. Below is a sample of an experiment essentially identical to yours and equation 4.5 is what relates the impact force to the fluid momentum.Unless your test measurements indicate that the flow rates for the flat plate are lower than those for the hemisphere for identical jockey weight positions I think this should help resolve your problem. gerry/class/EAS361/lab/pdf/lab4_impactOfJet.pdf I don't see in the problem statement the requirement to calculate the change in momentum, only the forces resulting from it for each case and then plotting those forces. Below is a sample of an experiment essentially identical to yours and equation 4.5 is what relates the impact force to the fluid momentum.Unless your test measurements indicate that the flow rates for the flat plate are lower than those for the hemisphere for identical jockey weight positions I think this should help resolve your problem. gerry/class/EAS361/lab/pdf/lab4_impactOfJet.pdf What I don't understand is that it says that the force acting on the fluid for the hemispherical she'll should be twice that of the plate so (2mu) but the results I got shows the inverse the force acting in the flat plate (mu) are twice the one acting on the hemispherical plate and like I said I checked with some classmates and they got the same pattern I have attached the first page of the report and my results JBA Your posted data results page is basically not readable you might try photographing 90 from what you used and that may help but a simple plot of flow rate vs calculated force would be much easier to review.If I understand what you are saying, your test results indicate that for the same jockey weight the flow rate for the hemisphere is twice that as for the flat plate. JBA This morning I managed, with a bit more effort, to review the data sheet you posted and the the sheet shows that the fluid flow and therefore the momentum of the fluid flow for a given jockey position is lower for the hemisphere than for the flat plate, which is exactly how it should be because (as per the equation I referred you to indicates) the reaction force for a given fluid momentum is greater for the hemisphere than for for the flat plate. Likes Brenda Moving fluid, in natural or artificial systems, may exert forces on objects in contact with it. To analyze fluid motion, a finite region of the fluid (control volume) is usually selected, and the gross effects of the flow, such as its force or torque on an object, is determined by calculating the net mass rate that flows into and out of the control volume. These forces can be determined, as in solid mechanics, by the use of Newtons second law, or by the momentum equation. The force exerted by a jet of fluid on a flat or curve surface can be resolved by applying the momentum equation. The study of these forces is essential to the study of fluid mechanics and hydraulic machinery.2. Practical ApplicationEngineers and designers use the momentum equation to accurately calculate the force that moving fluid may exert on a solid body. For example, in hydropower plants, turbines are utilized to generate electricity. Turbines rotate due to force exerted by one or more water jets that are directed tangentially onto the turbines vanes or buckets. The impact of the water on the vanes generates a torque on the wheel, causing it to rotate and to generate electricity.3. ObjectiveThe objective of this experiment is to investigate the reaction forces produced by the change in momentum of a fluid flow when a jet of water strikes a flat plate or a curved surface, and to compare the results from this experiment with the computed forces by applying the momentum equation.4. MethodThe momentum force is determined by measuring the forces produced by a jet of water impinging on solid flat and curved surfaces, which deflect the jet at different angles.5. EquipmentThe following equipment is required to perform the impact of the jet experiment:F1-10 hydraulics bench,F1-16 impacts of a jet apparatus with three flow deflectors with deflection angles of 90, 120, and 180 degrees, andStopwatch for timing the flow measurement.6. Equipment DescriptionThe jet apparatus is a clear acrylic cylinder, a nozzle, and a flow deflector (Figure 5.1). Water enters vertically from the top of the cylinder, through a nozzle striking a target, mounted on a stem, and leaves through the outlet holes in the base of the cylinder. An air vent at the top of the cylinder maintains the atmospheric pressure inside the cylinder. A weight pan is mounted at the top of the stem to allow the force of the striking water to be counterbalanced by applied masses [5].Figure 5.1: F1-16 Impact of Jet Apparatus7. TheoryThe velocity of the water (v) leaving the nozzle with the cross-sectional area (A) can be calculated by:in which Q is the flow rate.Applying the energy equation between the nozzle exit point and the surface of the deflector shows that the magnitude of the flow velocity does not change as the water flows around the deflector; only the direction of the flow changes.Applying the momentum equation to a control volume encompassing the deflected flow results in:where:Fy: force exerted by the deflector on the fluid:fluid density: 180-,where is the flow deflection angle (Figure 5.2).Figure 5.2: Examples of flow deflection angles for flat and hemispherical deflectors From equilibrium of forces in a vertical direction, Fy is balanced by the applied weight on the weight pan, W (W = mg, where m is the applied mass), i.e., Fy = W. Therefore:Since Q = vA, this equation can be written as:8. Experimental ProcedurePerform the experiment by taking the following steps:Remove the top plate (by releasing the knurled nuts) and the transparent cylinder from the equipment, and check and record the exit diameter of the nozzle.Replace the cylinder, and screw the 90-degree deflector onto the end of the shaft.Connect the inlet tube to the quick-release connector on the bench.Replace the top plate on the transparent cylinder, but do not tighten the three knurled nuts.Using the spirit level attached to the top plate, level the cylinder by adjusting the feet.Replace the three knurled nuts, then tighten in sequence until the built-in circular spirit level indicates that the top plate is horizontal. Do not overtighten the knurled nuts, as this will damage the top plate. The nuts should only be tightened enough to level the plate.Ensure that the vertical shaft is free to move and is supported by the spring beneath the weight pan.With no weights on the weight pan, adjust the height of the level gauge until it aligns with the datum line on the weight pan. Check that the position is correct by gently oscillating the pan.Place a mass of 50 grams on the weight pan, and turn on the pump.Open the bench valve slowly, and allow water to impinge upon the target until the datum line on the weight pan is level with the gauge. Leave the flow constant. Observe and note the flow behavior during the test.Measure the flow rate, using the volumetric tank. This is achieved by closing the ball valve and measuring the time that it takes to accumulate a known volume of fluid in the tank, as measured from the sight glass. You should collect water for at least one minute to minimize timing errors.Repeat this procedure by adding an additional 50 grams incrementally, until a maximum mass of 500 grams has been applied.Repeat the entire test for each of the other two flow deflectors.9. Results and CalculationsPlease use this link for accessing excel workbook for this experiment.9.1. ResultsUse the following tables to record your measurements.Raw Data TableTest No.Deflection Angles (degree)90120180Volume(Liter)Time(s)Applied Mass(kg)Volume(Liter)Time(s)Applied Mass(kg)Volume(Liter)Time(s)Applied Mass(kg)123456789109.2. 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Try to be quantitative in your comparison between the experimental and calculated results.Would the results have been different if the deflectors were closer to the nozzle? Explain.Comment on the agreement between your theoretical and experimental results, and give reasons for any differences.Comment on the significance of any experimental errors. Moving fluid, in natural or artificial systems, may exert forces on objects in contact with it. To analyze fluid motion, a finite region of the fluid (control volume) is usually selected, and the gross effects of the flow, such as its force or torque on an object, is determined by calculating the net mass rate that flows into and out of the control volume. These forces can be determined, as in solid mechanics, by the use of Newtons second law, or by the momentum equation. The force exerted by a jet of fluid on a flat or curve surface can be resolved by applying the momentum equation. 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Impact of jet numericals. Impact of jet formula. Impact of jet on vanes experiment calculations. Impact of jet experiment calculation. What is impact of jet.

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