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Republic Polytechnic

A107 Physics

Problem Review Part 2 (P5-P6) – Practice Questions

1. A man is pushing a box with a force of 500 N and the box moves 2 m. What is the work done on the box?

   Work done = force × distance travelled = 500 × 2 = 1000 J.

2. Figure 13 shows that an object of 11 kg is brought up to a height of 3 m.

Figure 13

By taking g = 10 m/s^2,

a) What is the work done in bringing an object upwards by 3 m?

b) What is the gain in gravitational potential energy (GPE) of the object?

a) The minimum force required to bring the object upwards is 110 N. This is because we need a force of 110 N to counter the weight of the object to bring it up. This 110 N force will move the object by 3 m. Thus, the work done = 110 N × 3 m = 330 J.

b) The work done by the force will be converted to GPE of the object with respect to the ground. Since the work done is 330 J (as per calculated in part a), this means that the work done is converted to GPE. Thus, the GPE gained is just simply 330 J. Alternatively, use the relation GPE = mgh = 11 × 10 × 3 = 330 J, which also gives the same result.

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3. A ball is dropped from a height of 5 m as shown in Figure 14.

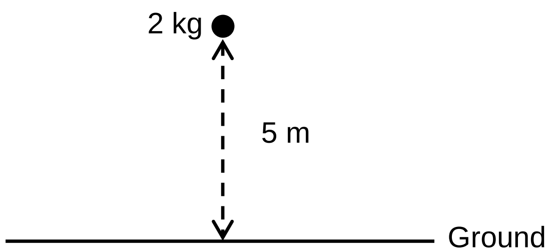

Figure 14

Assuming there is no air resistance and taking g = 10 m/s^2, what is the velocity of the ball just before it hits the ground?

Using the conservation of energy, loss in gravitational potential energy = gain in kinetic energy

$mgh = ½ \times m \times v^2$

$2 \times 10 \times 5 = ½ \times 2 \times v^2$

v = 10 m/s

4. Figure 15 shows an object of 30 kg moving at a constant speed of 1.5 m/s.

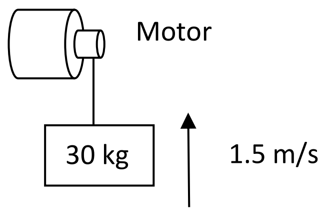

Figure 15

Determine the power of the motor.

Power = force × speed = 30 × 10 × 1.5 = 450 W.

5. Figure 16 shows a continuous column of water flowing in the tube in the direction indicated with no leakage.

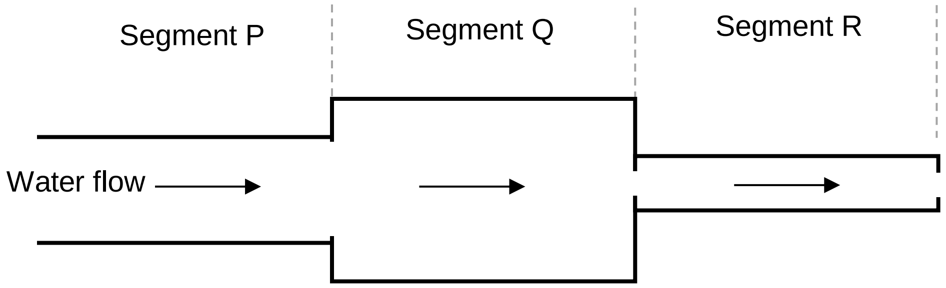

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Figure 16

Arrange the speed of water flow in segments P, Q and R in ascending order (i.e. from the smallest to the largest).

From the continuity equation, we have $A_p v_p = A_q v_q = A_r v_r$

Since $A_q < A_p < A_r$, we can deduce that $v_r > v_p > v_q$.

Therefore, the answer is QPR.

6. There is a continuous column of air blowing in between the two cans as depicted in Figure 17.

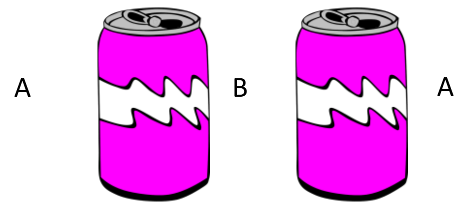

Figure 17

Assume the cans are filled with some liquid,

a) Which region (A or B) would the speed of the streamline flow be faster? Explain your answer.

b) Explain what will happen to the two cans.

a) The flow at region B is faster because the air is blowing in between the two cans.

b) Since region B has a higher streamline flow speed, it will have a lower pressure than region A by Bernoulli's principle. The higher pressure at A will push the cans closer to each other.

7. A liquid enters a non-uniform tube with speed of 0.5 m/s as shown in Figure 18. The tube has a starting cross-sectional area of 5 cm^2 and ending cross-sectional area of 2.5 cm^2. The liquid pressure at the start of the tube is 2000 Pa and the tube is lying horizontally on the ground.

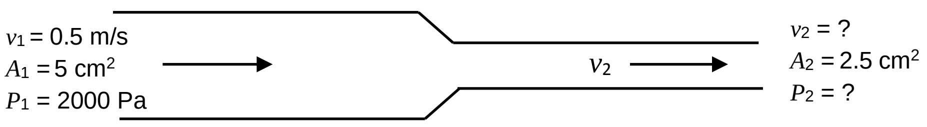

Figure 18

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If the density of the liquid is 1000 kg/m^3 and assuming no leakage,

a) What is the flow speed of the liquid out of the tube?

b) What is the liquid pressure at the end of the tube?

a) From the continuity equation $A_1v_1 = A_2v_2$, we have $5 \times 0.5 = v_2 \times 2.5$, thus, $v_2 = 1$ m/s.

b) From Bernoulli's equation $\frac{1}{2}\rho v_1^2 + \rho g h_1 + P_1 = \frac{1}{2}\rho v_2^2 + \rho g h_2 + P_2$, we know that two end of the tube is on the same height, thus the equation is reduced to $\frac{1}{2}\rho v_1^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2$ since $h_1 = h_2$.

Solving the equation $\frac{1}{2} \times 1000 \times 0.5^2 + 2000 = \frac{1}{2} \times 1000 \times 1^2 + P_2$, we get $P_2 = 1625$ Pa.

8. A section of a non-uniform tube placed horizontally is completely filled with water as shown in Figure 19. The speed of water at segment 1 and segment 2 are v_1 and v_2, respectively.

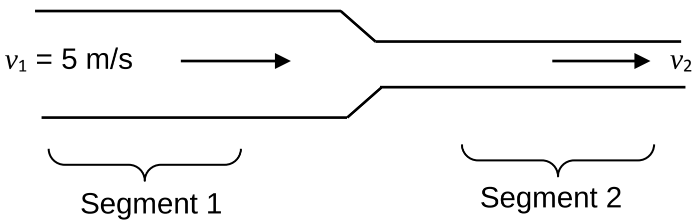

Figure 19

It is known that the cross-sectional area of segment 1 is two times the cross-sectional area of segment 2. Determine the speed (v_2) of the water in segment 2 assuming there is no leakage.

From the continuity equation $A_1v_1 = A_2v_2$, we have $5 \times 2A_2 = v_2 \times A_2$, thus, $v_2 = 10$ m/s.

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9. Figure 20 shows water flowing through a tube. The tube consists of two segments with different cross-sectional areas and the segments are positioned at different heights from the ground as depicted in Figure 20.

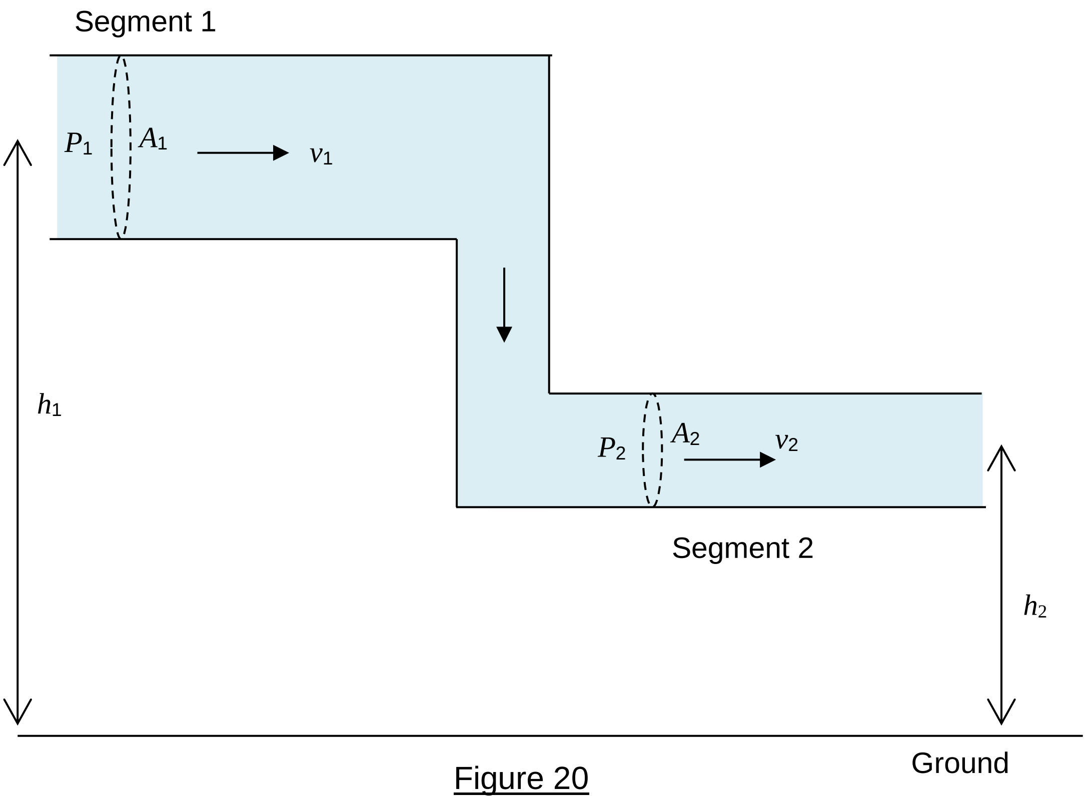

Figure 20

It is known that the density of water is 1000 kg/m^3 and g = 10 m/s^2.

a) Given that the v_1 = 3 m/s and v_2 = 9 m/s, determine the ratio of A_1/A_2.
b) Given that the h_1 = 5 m, h_2 = 1 m and P_1 = 5000 Pa, determine the pressure P_2.
a) From the continuity equation $A_1v_1 = A_2v_2$, we have $A_1 \times 3 = A_2 \times 9$, thus A_1/A_2 = 3.

b) We will use Bernoulli's equation $\frac{1}{2}\rho v_1^2 + \rho g h_1 + P_1 = \frac{1}{2}\rho v_2^2 + \rho g h_2 + P_2$.
$(\frac{1}{2} \times 1000 \times 3^2) + (1000 \times 10 \times 5) + 5000 = (\frac{1}{2} \times 1000 \times 9^2) + (1000 \times 10 \times 1) + P_2$
Therefore, we have P_2 = 9000 Pa.

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