RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
First Year - Semester I Examination – March 2021

PHY 1201 – GENERAL PHYSICS

Time: Two (02) hours

Answer ALL Questions

Take g = 9.81 m/s^2 and ρ_{water} = 1000 kg/m^3 (density of water).

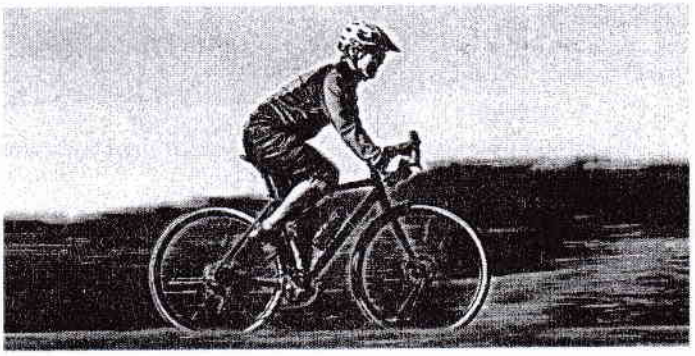
Provide detailed solutions to ensure total points.

Calculators will be provided

1.

a) The image shows a cyclist cruising on flat ground. The bicycle plus the rider has a mass of 80.0 kg, and the gauge pressure in the tires is 690 $\times 10^5$ Pa. What is the surface area of a single tire that stays in contact with the ground under these conditions? (indicate the assumptions you make)

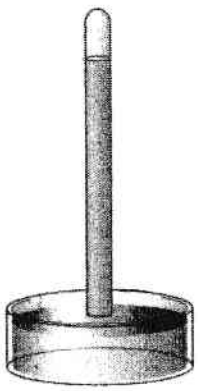
(3 marks)



b) Would you expect the contact surface area of a particular wheel to change if the bicycle is accelerating on the flat ground? Make a claim and justify your claim with the use of appropriate physics relationships and diagrams.

(3 marks)

2. The image shows a mercury column barometer. It contains a glass tube standing on a mercury bath.



a) What is the purpose (use) of the barometer (what it is used for)?

(1 marks)

b) Which special features in the design of the mercury column barometer helps to correctly obtain its intended use?

(2 marks)

c) Write the mathematical steps to explain how the mercury column barometer is utilized to obtain its intended use. (Define all the terms you use)

(2 marks)

3. An object submerged in a fluid experiences a vertically upward force from the fluid whose magnitude equals to the weight of the fluid volume displaced by the submerged object. This upward force is known as the Buoyant force, or the up thrust, $\vec{F}_U$.

a) Base on the above statement only, derive an expression for $|\vec{F}_U|$, the magnitude of the upthrust. (Limit your answer to the question. Do not write unnecessary details)

(3 marks)

b) A standard basketball (B) of mass 624 grams and diameter 24.3 cm) is held fully under water.

i. What is $|\vec{F}_{U(W,B)}|$, the magnitude of the buoyant force on the basketball from water (W)?

ii. What magnitude $|\vec{F}_{appl(X,B)}|$, is required for an external (X) force to hold the basketball fully under water?

(Calculate the values showing the processes that establish the results)

(4 marks)

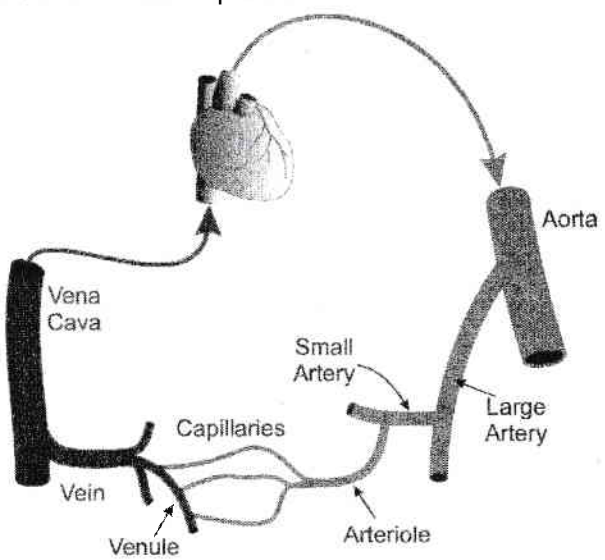
4. Use the expression obtained in question 3 for $|\vec{F}_U|$ to establish a criterion for buoyancy in terms of the density of the fluid and the density of the object. Here you are expected to establish conditions that leads to an object being:

   i. afloat- partially submerged,
   ii. afloat-fully submerged, and
   iii. sunk into the fluid medium.

   Clearly explain your method with force diagrams and the laws of physics applied in the process.

   (7 marks)

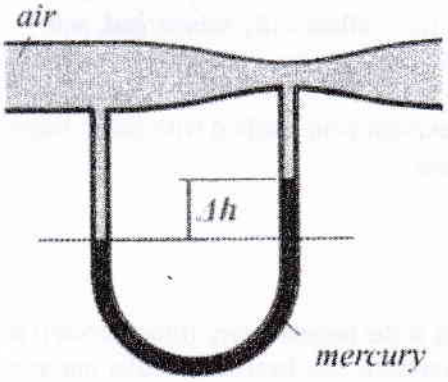
5. The aorta is the largest artery (blood vessel) in the body. The aorta begins at the top of the left ventricle, the heart's muscular pumping chamber. The heart pumps blood from the left ventricle into the aorta through the aortic valve. Then the aorta distribute blood through its branches down to thin capillaries.



   The radius of the aorta is about 1.0 cm and the blood passing through it has a speed of about 30 cm/s. A typical capillary has a radius of about 4×10^{-4} cm and blood flows through it at a speed of about 5×10^{-4} m/s. What is N, the approximate number of capillaries in the body?

   (4 marks)

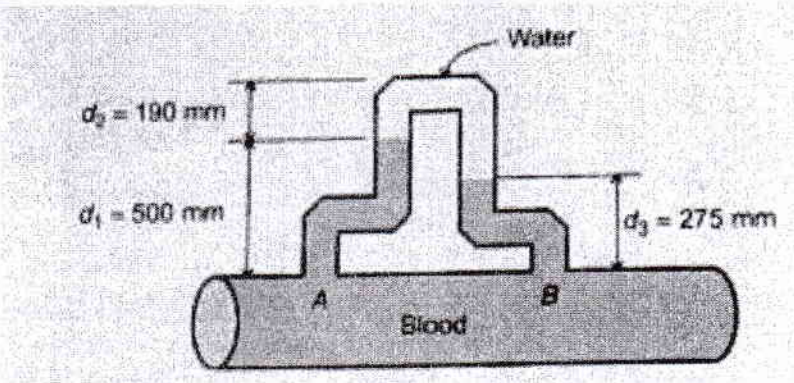
6. Air of density 1.3 kg/m^3 enters from left at 15 m/s speed into a horizontal Venturi tube. The radius of the tube where it is wide is 1.0 cm; and the radius of the tube where it is thin is 0.5 cm. A U-tube manometer that contains mercury of density 13600 kg/m^3 connects the wide and thin parts of the Venturi tube (see the image).



What is Δh, the height of the mercury column where it is taller, above the mercury level in the other arm?

(5 marks)

7. A two fluid manometer is used to measure the pressure difference between two points A and B in a tube that carry blood in an experimental apparatus. The heights of fluid levels are as shown in the image. Density of blood is 1060 kg/m^3, and that of water is 1000 kg/m^3.



a) What is Δp, the pressure difference between the points A and B?

(3 marks)

b) How fast the blood moves passing the point B relative to the point A?

(3 marks)

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