Unit 3 · Fluid Mechanics

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

1 Key words [4]

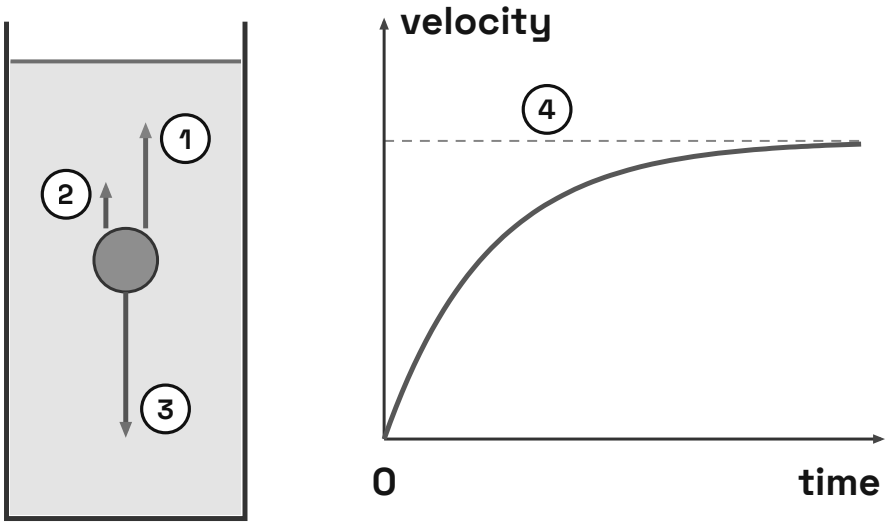
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

angle of contact	**lactometer**	**metacenter**	**Pascal's law**	**poise**	**Reynolds number**
surface tension	**terminal velocity**	**upthrust**	**viscosity**		

A pressure applied to an enclosed fluid is passed on undiminished to every part of it: this is _____. The upward force a fluid exerts on a body in it is the _____. A floating body is stable when its _____ is above its center of gravity. The force per unit length of a line drawn in a liquid's surface is its _____. The angle between the solid and the tangent to the liquid surface, measured inside the liquid, is the _____. A fluid's internal friction, which opposes the relative motion of its layers, is its _____. A small sphere falling through a liquid soon moves at a steady speed, its _____. Whether flow in a pipe is laminar or turbulent is decided by the _____.

2 Label the diagram [2]

The diagram shows a small sphere falling through a liquid, and a graph of its velocity. Write the label that belongs in place of 1 to 4. Each carries 0.5 mark.



at terminal velocity: F + U = W

1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. The SI unit of the coefficient of viscosity is: [1]

a. N/m
b. Pa s (N s/m^2)
c. N/m^2
d. poise

ii. Mercury in a clean glass tube has: [1]

a. a concave meniscus and rises in a capillary
b. a convex meniscus and falls in a capillary
c. a flat surface and neither rises nor falls
d. a concave meniscus and falls in a capillary

iii. In a hydraulic lift, a force of 150 N acts on a small piston of area 4 cm^2. The large piston has an area of 0.20 m^2. The force on the large piston is: [1]

a. 750 N
b. 7500 N
c. 75 000 N
d. 30 N

iv. An oil of density 900 kg/m^3 and viscosity 0.05 Pa s flows at 0.4 m/s through a pipe 1.0 cm across. The flow is: [1]

a. laminar, since the Reynolds number is about 72
b. turbulent, since the Reynolds number is about 7200
c. laminar, since the Reynolds number is about 7200
d. turbulent, since the Reynolds number is about 72

v. A light tin roof can be lifted off in a storm because: [1]

a. the fast wind pushes down hard on it
b. the fast air above it has a lower pressure than the still air inside
c. the air inside the house moves faster than the wind
d. the wind makes the roof lighter

4 Short answers [7]

Write short answers to the following questions.

a. Why do soap and detergents help water clean clothes? [2]

b. The viscosity of a liquid decreases when it is heated, but that of a gas increases. Why? [2]

c. A clean glass capillary tube of radius 0.40 mm is dipped in water. How high does the water rise? How high would it rise in a tube of half the radius? (T = 0.072 N/m, angle of contact 0°, ρ = 1000 kg/m^3, g = 9.8 m/s^2) **[3]**

5 Long answer **[4]**

Write a long answer to the following question.

A cylinder of height l and end area A is held upright, completely under a liquid of density σ. Using the pressures on its top and bottom, show that the upthrust on it equals the weight of the liquid it displaces.

6 Numerical problems **[8]**

Solve the following problems. Show your working. Take g = 9.8 m/s^2 and the density of water as 1000 kg/m^3.

a. A steel ball of radius 1.5 mm and density 7800 kg/m^3 is dropped into a tall jar of oil of density 950 kg/m^3 and viscosity 0.95 Pa s. Find i. its terminal velocity, and ii. the viscous drag on it once it falls at that speed. **[4]**

Answer:

b. Water flows along a horizontal pipe that narrows from 8.0 cm across to 4.0 cm across. In the wide part its speed is 1.2 m/s and its pressure 1.8×10^5 Pa. Find i. the speed in the narrow part, ii. the pressure there, and iii. the volume of water flowing each second. **[4]**

Answer: _____

7 Think **[3]**

A smooth stream of water falling from a tap gets narrower as it falls. Explain why, using the equation of continuity.

8 Activity: Watch a ball reach terminal velocity (not marked)

Fill a tall clear bottle with cooking oil or shampoo. Mark lines on it every 5 cm from near the top. Drop a small steel ball or marble in, and time it past each line (a phone video helps).

Stretch	Time (s)	Average speed (cm/s)
1st 5 cm		
2nd 5 cm		
3rd 5 cm		
4th 5 cm		

Does the speed keep rising? What forces act on the ball once it moves steadily?