LESSON MAKER PRO

Underwater Forces

Use force arrows to find acceleration.

HIGH SCHOOL · P.4.d

P.4.d "Use the buoyant force acting on an object and free body diagrams to determine the acceleration of submerged objects."

NAME _____ DATE _____

FORCE, THEN MOTION

In a free-body diagram, draw an upward arrow for buoyant force and a downward arrow for weight. Subtract opposing forces to find the net force, then use $a = F_{net}/m$. The acceleration points in the direction of the net force.

WORKED EXAMPLE

A 9 kg object is submerged. Use the force chart to sketch its free-body diagram and find its acceleration.

FORCES ON THE OBJECT

Force	Magnitude
Buoyancy ↑	54 N
Weight ↓	90 N

1. Draw a 54 N arrow up and a 90 N arrow down.
2. F_{net} = 90 - 54 = 36 N down.
3. a = 36/9 = 4 m/s^2 down.

Answer: 4 m/s^2 downward

PRACTICE 4 problems

1 A submerged object has a mass of 2 kg, a buoyant force of 24 N, and a weight of 20 N. Sketch its force arrows. Find its acceleration.

ANSWER _____

2 A submerged object has a mass of 3 kg, a buoyant force of 21 N, and a weight of 30 N. Sketch its force arrows. Find its acceleration.

ANSWER _____

3 A submerged object has a mass of 6 kg, a buoyant force of 60 N, and a weight of 60 N. Sketch its force arrows. Find its acceleration.

ANSWER _____

4 A submerged object has a mass of 7 kg, a buoyant force of 35 N, and a weight of 70 N. Sketch its force arrows. Find its acceleration.

ANSWER _____

APPLY IT Show your work

1 A student tests an 8 kg underwater camera case in a pool. Buoyancy is 56 N and weight is 80 N. Sketch its force arrows. What is its acceleration?

WORK SPACE

ANSWER _____

2 A diver releases a 10 kg sealed float to mark a filming spot. Buoyancy is 130 N and weight is 100 N. Sketch its force arrows. What is its acceleration?

WORK SPACE

ANSWER _____

CHALLENGE One step up

A 12 kg underwater drone rises while water resistance acts downward. Use the force chart to sketch a free-body diagram and find the drone's acceleration.

FORCES ON THE DRONE

Force	Magnitude
Buoyancy ↑	180 N
Weight ↓	120 N
Water resistance ↓	24 N

WORK SPACE AND ANSWER

Underwater Forces

PART 1 · PRACTICE

#	PROBLEM	ANSWER
1	A submerged object has a mass of 2 kg, a buoyant force of 24 N, and a weight of 20 N. Sketch its force arrows. Find its acceleration.	**Buoyancy ↑ 24 N; weight ↓ 20 N. Acceleration: 2 m/s² upward.**
2	A submerged object has a mass of 3 kg, a buoyant force of 21 N, and a weight of 30 N. Sketch its force arrows. Find its acceleration.	**Buoyancy ↑ 21 N; weight ↓ 30 N. Acceleration: 3 m/s² downward.**
3	A submerged object has a mass of 6 kg, a buoyant force of 60 N, and a weight of 60 N. Sketch its force arrows. Find its acceleration.	**Buoyancy ↑ 60 N; weight ↓ 60 N. Acceleration: 0 m/s².**
4	A submerged object has a mass of 7 kg, a buoyant force of 35 N, and a weight of 70 N. Sketch its force arrows. Find its acceleration.	**Buoyancy ↑ 35 N; weight ↓ 70 N. Acceleration: 5 m/s² downward.**

PART 2 · APPLY IT

1. **Buoyancy ↑ 56 N; weight ↓ 80 N. Acceleration: 3 m/s² downward.** The net force is 80 - 56 = 24 N downward. Divide by 8 kg.
2. **Buoyancy ↑ 130 N; weight ↓ 100 N. Acceleration: 3 m/s² upward.** The net force is 130 - 100 = 30 N upward. Divide by 10 kg.

CHALLENGE

Draw buoyancy ↑ 180 N, weight ↓ 120 N, and water resistance ↓ 24 N. The net force is 180 - 120 - 24 = 36 N upward, so acceleration is 36/12 = 3 m/s² upward.

Accept force arrows of any length if their directions and labels are correct. Equal forces in problem 3 give zero acceleration, which has no direction.