Principle of Archimedes

U75-3 A wooden cork floats in the water. The ratio of its volume above the water surface to that immersed in the water is 2: 3. Find the relative density (specific gravity) of the cork.
A. 0.4 B. 0.6 C 0.67 D 0.75

U77-P3a State the principle of Archimedes.

(b) A metal block is suspended from a stretched spring balance, and a bucket half-filled with water is placed on the top of a compressed spring balance as shown in Fig.U77-P3b. The readings on the stretched spring balance and the compressed spring are 144 gf and 300 gf respectively. By lowering the stretched spring balance, the metal block is then submerged completely in the water without touching the bottom of the bucket. Find the new readings on the two spring balances.
[Take the relative density of the metal block to be 12]

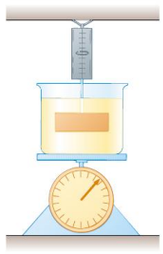

Fig.U77-P3b

(c) A lump of gold-silver alloy weighs 437 g and has a volume of 25 cm^3. If the relative densities of gold and silver are 19.3, 10.2 respectively and there is no change in the total volume during the alloying, calculate the mass of gold in the alloy.
[132 gf, 312gf; 386 g]

U78-9 Fig.U78-9 shows the arrangement of apparatus in an experiment utilizing the Principle of Archimedes and the principle of moment to find the relative density of a liquid. Assuming that all the levers in Fig.U78-9 are in equilibrium, find the relative density of the liquid.

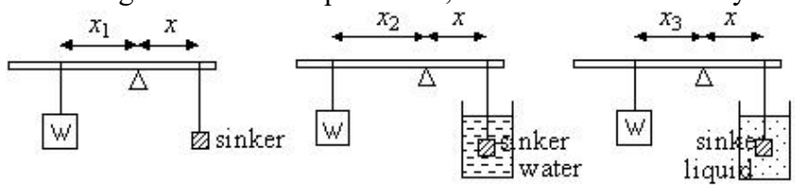

Fig.U78-9

A. $\frac{x_1 - x_3}{x_1 - x_2}$ B. $\frac{x_1 - x_3}{x_2 - x_1}$ C. $\frac{x_1 - x_2}{x_1 - x_3}$ D. $\frac{x_1 + x_3}{x_1 + x_2}$

U83-8 When ice that floats in a glass of water (both ice and water in the glass are at 0°) melts, the water level in the glass would _____.
A. rise, because when ice melts, it would produce the same volume of water
B. fall, because when ice melts into water, its volume contracts
C. remain unchanged, because the mass of ice melted is exactly equal to the mass of the resulting water that takes the place occupied by the ice in the glass of water
D. either rise, if the existing atmospheric pressure is smaller than 760 mmHg; or would fall, if the atmospheric pressure is greater than 760 mmHg
E. either rise or fall, depending on the size of the piece of ice

U84-8 A hydrometer floats in water of density 1000 kg m^{-3} with 6cm of its stem in the air. In oil of density 800 kg m^{-3}, it floats with 5 cm of its stem in the air. In a certain liquid, it floats with 7 cm of its stem in the air. The density of this liquid is thus approximately ___ kg m^{-3}.
A. 600 B. 888 C. 1122 D. 1333 E. 1456

U85-9 A hydrometer floats in water of density 1.00 g cm^{-3} with 6 cm of its stem unimmersed, in oil of density 0.80 g cm^{-3} with 4 cm unimmersed. The length of the stem unimmersed when the hydrometer is placed in a liquid of density 1.20 g cm^{-3} is _____cm.
A. 8.00 B. 7.33 C. 6.56 D. 6.00 E. 5.32

U88-P3a Explain why a small piece of iron would sink into water while a very massive ship is able to float on it.

(b) When a ship enters the mouth of a river, it would usually sink slightly. Based on the Principle of floatation, give a detailed explanation together with the relevant formula.

(c) When an ocean-going ship is loaded, its plimsolls line is lower by 6.2 m. Given that the average cross-sectional area of the ship below water is 2.223 m^2, and the relative density of seawater is 1.03, find the weight of the load. [139121.56 N]

U85-P4a A piece of ice of density 0.90 g cm^{-3} floats on the surface of water of density 1.00 g cm^{-3}. State whether the water level would rise or fall when the ice has completely melted. Justify your answer with calculations.

U86-P4a State the *Principle of Archimedes*.

(b) A body of weight W and density σ is totally immersed in a liquid of density ρ. Find the buoyancy in term s of W, σ and ρ.

(c) A solid weighs 2.3275 N in air and 0.1225 N in a liquid of density 900 kg m^{-3}.

(i) Find the density of the solid.

(ii) Find the density of a liquid B in which the solid would float with $\frac{1}{5}$ of its volume exposed above the liquid surface.

(iii) If the solid is suspended and is weighed in liquid B by a spring balance, what would the reading of the spring balance be?

[$\frac{\rho}{\sigma}W$; 950 kg m^{-3}, 1187.5 kg m^{-3}, 0]

U90-2 When a wooden block is placed in a liquid of density ρ, it floats with $\frac{1}{4}$ of its volume above the surface. If the same block is placed in a liquid X whose density is to be ascertained, then it is floating with $\frac{1}{8}$ of its volume above the surface. Hence, the density of the liquid X is _____.

A. $\frac{1}{8}\rho$ B. $\frac{1}{4}\rho$ C. $\frac{6}{7}\rho$ D. $\frac{21}{32}\rho$ E. N.O.T.A.

U91-7 Two objects P and Q, having the same volume but of different masses, are put into a basin of water. P floats on water but Q sinks in water. Which of the following statements about the buoyancy on the two objects is **correct**?

A. The buoyancy on P is larger than that on Q
B. The buoyancy on P is smaller than that on Q
C. The buoyancy on both P and Q are the same.
D. To determine their relative buoyancy, the shapes of both P and Q must first be known.
E. To determine their relative buoyancy, the relative densities of P, Q and water must first be known.

U93-12 A wooden ball of volume 1000 cm^3 is made of a certain kind of pure wood of density 300 kg m^{-3}. It displaces 250 cm^3 of water when floating in it. Which of the following conclusions is/are **true**? [Take g = 10 m s^{-2}]

I. The buoyancy of ball in water is 2.5 N
II. The weight of the ball in air is 3.0 N
III. The wooden ball is hollow

A. I B. I, III C. II, III D. I, II, III

U94-10 When a hydrometer is placed in turn in liquids of densities 800 kg m^{-3} and 1000 kg m^{-3}, the lengths of its stem above the liquid surfaces are 8 cm and 10 cm respectively. What will be the length of its stem above the surface when it is placed in a liquid of density 900 kg m^{-3}?

A. $9\frac{1}{9}$ cm B. 9 cm C. $8\frac{7}{9}$ cm D. $7\frac{1}{9}$ cm

U93-P5a State **Archimedes' Principle**.

(b) A student wishes to make a hydrometer out of a bamboo stem, to be suitable for measuring the relative densities of liquids ranging from 0.8 to 1.0. If the effective cross-sectional area of the hydrometer made is 2 cm^2 and the total weight of the bamboo stem used and the lead shots in it is 0.4 N, try to help the student

(i) to work out the distance between the marks of 0.8 and 1.0 on the hydrometer;

(ii) to draw a diagram of the hydrometer, and label the marks 0.8, 0.9 and 1.0 accurately. [Take g to be 10 m s^{-2}] [25 cm, 20 cm, 22 cm]

U2k-10 A floating body setup is moved from the earth to another planet. If the gravitational acceleration of the planet is double that of the earth, then _____.

A. the floating body will completely sink into the water
B. the volume of the floating body above water will remain unchanged
C. the volume of the floating body above water will double
D. the volume of the floating body above water will decrease by half

U97-P5a A lead block and an aluminium block are of equal weight in air.

(i) Which is heavier in vacuum, lead or aluminium block? Give reason?

(ii) Which is of greater mass, lead or aluminium block?

(b) When a metal block is put in water, it sinks with an acceleration of 5 m s^{-2}. When it floats in liquid x, $\frac{1}{5}$ of its volume is above the liquid level. Find the density of the metal and the density of liquid x. [Take g = 10 m s^{-2}]

(c) The metal stated in (b) is made into a uniform rectangle plate PQRS of 0.4 m in length, 0.3 m in width and 24 N in weight. The plate is hung by a cord at the point P and when immersed in the liquid x, its diagonal QS coincides with the liquid level as shown in Fig.97-P5a. What is the tension in the cord?

[$m_{Pb} < m_{Al}$; 2000 kg m^{-3} ; 2000 kg m^{-3}, 2500 kg m^{-3}; 9 N]

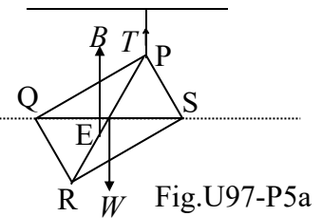

Fig.U97-P5a

U2k-P5a A metal block weighs 12 N in air and 10 N in water.

(i) What is the buoyancy of the metal block in water?

(ii) What is the volume of the metal block if the density of water is 1000kg m^{-3}?

[2 N, 2.04×10^{-4} m^3]

U2k1-11 An object of density ρ is floating at the boundary layer of two liquids of densities ρ_1 and ρ_2 as shown in Fig.U2k1-11. The ratio of volume of the object in the top liquid (V_1) and that in the bottom liquid (V_2) is _____ .

A. $\frac{\rho_2}{\rho_1}$ B. $\frac{\rho+\rho_1}{\rho_2+\rho}$ C. $\frac{\rho-\rho_1}{\rho_2-\rho}$ D. $\frac{\rho_2-\rho}{\rho-\rho_1}$

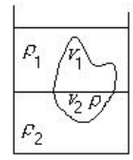

Fig.U2k1-11

U2k1-P5 (b) A wooden ball of density 0.6×10^3 kg m^{-3} falls freely from a height of 5 m above the water surface. The ball sinks into the water and then floats on water again. If the resistance of water to the ball is neglected, calculate

(i) the speed of the ball when it falls onto the water surface;

(ii) the greatest depth that the ball can sink into the water;

(iii) the time taken by the ball to sink into the water and refloat.

[Note: The density of water is 1000 kg m^{-3} and take g = 10 m s^{-2}]

[10 m s^{-1}, 7.5 m, 3 s]

U2k2-10 An object of mass 0.8 kg is put into a cup filled with a liquid. If 4 N of the liquid overflows, then the object _____.

A. must float on the liquid B. must sink to the bottom of the cup

C. will bob in the liquid at any position

D. floats in the liquid initially and sinks to bottom after shaking the cup

U2k05-P4 (a) A crown weighs 27.56 N in air and 25.85 N in water. What is the density of the crown? [16116.96 kg m^{-3}] [3%]

U2k06-P5(a) State Archimedes' principle and give an example of an application of this principle. [2%]

U2k03-9 In Fig.U2k03-9a, two copper blocks x and y are each suspended at the ends of a lever. When the lever is pivoted at the point O, it is in equilibrium with l_x: l_y = 4: 5. If the blocks x and y are immersed into alcohol and water respectively as shown in Fig.U2k03-9b and the ratio between the densities of water and alcohol is ρ_w: ρ_A = 5: 4, which of the following expressions is true?

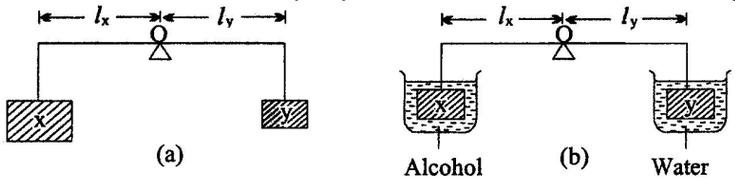

Fig.U2k03-9

A. the end with x turns downwards

B. the end with y turns downwards

C. the lever remains in equilibrium

D. it cannot be determined as the conditions given are insufficient

U2k07-1 As shown in Fig. U2k07-1, a beaker containing water was placed on a weighing scale, a metal ball was then placed in different ways (neglecting the mass of the string and effect of the air). If the scale readings of J, K, L, M are *a*, *b*, *c*, *d* respectively, which of the following is **true**?

A. $b > d > c > a$
B. $b = c = d > a$
C. $d > b > c > a$
D. $d > b > c = a$

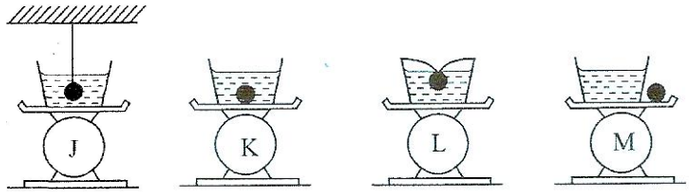

Fig.U2k07-1

U2k07-P2a Deep sea explorers discovered a 1500 kg giant solid statue from a sunken ship (as shown in Fig.U2k07-P2a) in the Indian Ocean. To make sure the statue is safely hauled up from the sea, the team members need to determine the tension in the hoisting cable,

(i) when the statue is at rest and completely immersed in the sea;
(ii) when the statue is at rest and out of the sea surface.

(density of gold statue: 19.3×10^3 kg m^{-3}, density of sea water: 1.03×10^3 kg m^{-3}, density of air: 1.2 kg m^{-3})

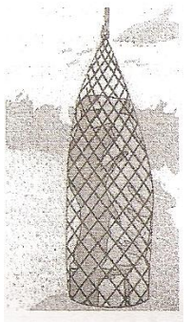
Fig.U2k07-P2a

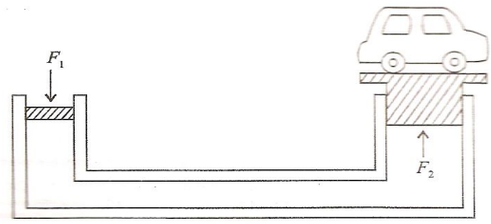

Fig.U2k07-P2b

(b) Fig.U2k07-P2b shows a hydraulic lift used in a service station. It consists of a small piston of circular cross-section with a radius of 8 cm, and a large piston of radius 16 cm fixed inside two- cylindrical tubes. The bottom of the tubes are connected and filled with a liquid. While a compressed air exerts a force on the small piston, the pressure is transmitted by liquid to the larger, piston in order to lift the car.

(i) What force must the compressed air exert in order to lift a car weighing 15500 N?
(ii) Determine the air pressure to produce this force.

[13915.5 N, 14699.1 N; 3875 N, 1.93×10^5 Pa]

U2k09-11 Given two solid objects A and B. Object A floats on water with ⅓ of its volume above the water. Object B sinks into the water and the force it exerts on the bottom of the container is 1/5 its weight. The ratio of the density of A to B is _____.

A. 3: 5 B. 6: 5 C. 8: 15 D. 15: 8

U2k15-10 As shown in Fig.U2k15-10, a metal ball with density of 7200 kg m^{-3} is tied at the bottom of a cubical block. When the system floats in water, one-third of the volume of the cubical block is above the water surface. Given that that weight of the block is 12 N, and the weight of the metal ball is 48 N, find the density of the cubical block. (Given g = 10 m s^{-2})

A. 75 kg m^{-3} B. 150 kg m^{-3}
C. 330 kg m^{-3} D. 225 kg m^{-3}

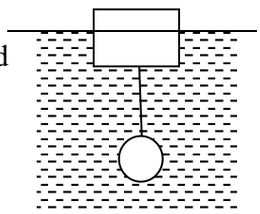
Fig.U2k15-10

U2k17-P1(c) A cube of height 15 cm is floating in water of density 1000 kg m^{-3} with $\frac{2}{5}$ of its volume above the water surface, as shown in Fig.U2k17-P1ci. Some oil of density 800 kg m^{-3} is added slowly on the top of the water surface. The thickness of oil layer is 7 cm, as shown in Fig.U2k17-P1cii. Find the height *h* of the cube above the liquid surface. [3%]

[4.6 cm]

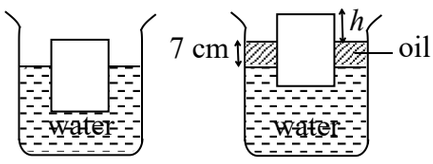

Fig.U2k17-P1ci Fig.U2k17-P1cii