ANSWERS - AP Physics Multiple Choice Practice – Fluids

	Solution	Answer
1.	FBD has F_t pointing down F_b pointing up and weight (mg) down. $F_{net} = 0$ $F_b - F_t - mg = 0$ The buoyant force is given by the weight of the displaced water. Since the waters displaced volume is equal to the corks displaced volume and the water weight for the same volume would be 4 times heavier (based on the given cork weight = 25% water weight) compared to the cork, the buoyant force is equal to 4 x the cork weight = 4mg. Using the force equation created initially. $F_t = F_b - mg = 4mg - mg = 3mg$	D
2.	Definition of Pascal's principle	A
3.	A 1 m^3 volume cube under water displaces $1m^3$ of water. This weight of water = pVg = 1000(1)(10) = 10000 N which is equivalent to the buoyant force. The apparent weight in water is $m_{app}g$ = 18300(10) = 183000 N. This apparent weight is lessened by the buoyant force pulling up with 10000 N of force. So outside of the water, this upwards force would not exist and the actual weight would be 193000 N which equal 19300 kg of mass.	D
4.	Using fluid continuity. $A_1v_1 = A_2v_2$ $\pi R^2 v_1 = \pi(2R)^2 v_2$ $v_1 = 4\ v_2$	E
5.	This is based on two principles. 1 – Bernoulli's principle says that when speed increases pressure drops. Second, continuity says more area means less speed based on $A_1v_1 = A_2v_2$ So the smallest area would have the largest speed and therefore most pressure drop.	B
6.	Since A and B have the same mass and density, they have the same volume. C has the same volume as A and B since it's the same shape as B. So all three objects have the same volume. When submerged, they will all displace the same amount of water and therefore all have the same buoyant force acting on them. *Note: if the objects were floating instead of submerged than the heavier ones would have larger buoyant forces.*	E
7.	Pascals principle of equal pressure transfer in a fluid allows for hydraulic lifts to function.	A
8.	Pascals principle says $P_1 = P_2$ $F_1/A_1 = F_2/A_2$ $F_2 = F_1A_2 / A_1 = 500(40)/(2)$	C
9.	Buoyant force is equal to weight of displaced fluid. Since the density is constant and the volume displaced is always the same, the buoyant force stays constant	B
10.	The wood is floating and is only partially submerged. It does not displace a weight of water related to its entire volume. The iron however is totally submerged and does displace a weight of water equal to its entire volume. Since the iron displaces more water, it has a larger buoyant force acting on it.	B
11.	For floating objects, the weight of the displaced fluid equals the weight of the object. For a more dense fluid, less of that fluid needs to be displaced to create a fluid weight equal to the weight of the object. Since the salt water is more dense, it will not need as much displaced.	B
12.	Definition of specific gravity. s.g = ρ_x / ρ_{H20}	A
13.	Same as question #5, but moving to more area → less speed → more pressure	B
14.	Flow continuity. $A_1v_1 = A_2v_2$ $\pi(0.02)^2(1) = \pi(0.01)^2 v_2$	D
15.	Buoyant force is based on how much weight of water is displaced. Since all three are completely submerged they all displace the same amount of water so have equal buoyant forces.	C

16. For floating objects, the buoyant force equals the weight of the objects. Since each object has the same weight, they must have the same buoyant force to counteract that weight and make them float. *IF the equal mass objects sunk, then the one with the smaller density would have a larger volume and displace more water so have a larger buoyant force. But that is not the case here.* D

17. P = F / A $1 \times 10^5 = F / (22*5)$ E

18. P = F / A = ma / A = kg (m/s^2) / m^2 = kg / (m•s^2) D

19. Three forces act on the block, F_t down, mg down and F_b up. $F_{net} = 0$ $F_b - F_t - mg = 0$ D

$F_b - 3 - 5 = 0$ $F_b = 8$ N – weight of displaced water = $\rho_{h20} V_{disp}\, g$

$8 = (1000)\ V\ (10) \rightarrow V = 0.0008\ m^3$

20. For floating objects $mg = F_b$ $\rho_{obj}V_{obj}\, g = \rho_{h20} V_{disp}\, g$ E

$\rho_{obj}\ (V)g = 1000\ (0.6V)\ g$ $\rho_{obj} = 600$

In oil the same is true $\rho_{obj}V_{obj}\, g = \rho_{oil} V_{disp}\, g$ (600)Vg = (800) x%V g x% = 0.75

21. Same as question 4 A

22. Based on continuity, less area means more speed and based on Bernoulli, more speed means less pressure. B

23. The weight of the mass is 4N. The scale reading apparent weight is 3N so there must be a 1N buoyant force acting to produce this result. B

24. Since the pressure in a fluid is only dependent on the depth, they all have the same fluid pressure at the base. Since all of the bases have the same area and the same liquid pressure there, the force of the liquid given by P=F/A would be the same for all containers. *Note: IF instead this question asked for the pressure of the container on the floor below it, the container with more total mass in it would create a greater pressure, but that is not the case here.* E

25. As the fluid flows into the smaller area constriction, its speed increases and therefore the pressure drops. Since the pressure in the constriction is less than that outside at the water surface, fluid is forced up into the lower tube. A

26. The buoyant force would be the difference between the two scale readings … (.09kg)(10 m/s^2) = 0.9 N of buoyant force. This equals the weight of displaced water. $F_b = \rho_{h20} V_{disp}\, g$ E
0.9 = 1000 (V) (10) … gives the volume of the displaced water = 0.00009 which is the same as the volume of the object since its fully submerged.

Now using ρ = m/V for the object we have … $\frac{0.45}{0.00009} = \frac{45}{100} * \frac{10000}{9} = 500($

27. Use flow continuity. $A_1v_1 = A_2v_2$ C
since the area is the same at both locations the speed would also have to be the same.

28. Apply Bernoulli's equation. $P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$ D

$(9.5)(100000) + 0 + \frac{1}{2}(1000)(10)^2 = P_2 + (1000)(10)(15) + \frac{1}{2}(1000)(10)^2$

$P_2 = 800000\ N/m^2$

29. Both object are more dense than water and will sink in the pool. Since both have the same volume, they will displace the same amount of water and will have the same buoyant forces. C

30. Again both samples sink. Also, both samples have the same mass but different densities. For the same mass, a smaller density must have a larger volume, and the larger volume displaces more water making a larger buoyant force. So the smaller density with the larger volume has a larger buoyant force. B

31. V of this ball is $4/3\ \pi\ r^3 = 4/3\ \pi\ (0.4)^3 = 0.2681\ m^3$. For the ball to just sink, it is on the verge of floating, meaning the weight of the ball equals the buoyant force of the fully submerged ball. B
$mg = \rho_{fl} V_{disp}\, g$ $\quad$ $m (10) = 1400 (0.2681) (10)$ $\quad$ $m = 375$ kg

32. This object will float, so $m_{obj}g = F_b$ $\quad$ $\rho_{obj}V_{obj}\, g = \rho_{ocean} V_{disp}\, g$ A
$(0.95\text{x}10^3)(V)(10) = (1.1\text{x}10^3)(x\%\ V)(10)$
Gives x% = 0.86 but that is the amount submerged, so the visible about would be 1 – 0.86

33. Statement associated with Bernoulli's principle E

34. $s.g = \rho_{obj} / \rho_{h20}$ $\quad$ $0.82 = \rho_{obj} / 1000$ $\quad$ $\rho_{obj} = 820$ … then $\rho = m/V$ $\quad$ $820 = m / 1.3$ D

35. The apparent weight is the air weight – the upwards buoyant force. The buoyant force is given by $F_b = \rho_{fl} V_{disp}\, g = 1.25\text{x}10^3 (0.375) (10) = 4687.5$ N. D
The apparent weight is then (600)(10) – 4687.5 = 1312.5 N

36. Using fluid continuity. $A_1v_1 = A_2v_2$ $\quad$ $\pi(7R)^2v_1 = \pi(R)^2V$ $\quad$ $v_1 = V / 49$ A

37. The fluid flow is occurring in a situation similar to the diagram for question #27. B
Apply Bernoulli's equation. $P_1 + \rho g y_1 + ½\ \rho v_1^2 = P_2 + \rho g y_2 + ½\ \rho v_2^2$
$P + 0 + ½\ \rho v^2 = P_2 + \rho g y + ½\ \rho\ (2v)^2$
$P_2 = P + ½\ \rho v^2 – ½\ 4\rho v^2 – \rho g y$ $\quad$ $= P – 3/2\ \rho v^2 – \rho g y$

38. s.g is density / density and has no units E

39. Definition of Archimedes principle D

40. $P_{abs} = P_g + P_o = 2.026\text{x}10^5 + 1.01\text{x}10^5 = 3.03\text{x}10^5$ Pa D

41. Definition of buoyant force C

42. Using fluid continuity with W as river width. $A_1v_1 = A_2v_2$ $\quad$ $4(W)(12) = (8)(W)v_2$ $\quad$ $v_2 = 6$ m/s C

43. The relevant formula here is $P = Po + \rho gh$ B
Answer (a) is wrong, because at y1 on both arms, the pressure is just the atmospheric pressure. The pressure in the right arm at y3 is still just atmospheric, but on the left, it is atmospheric plus ρg(y1– y3). That rules out (a). The pressure at the bottom of the tube is everywhere the same (Pascal's principle), which rules out (c), and at the same time, tells us (b) is right. At y2, we can say P = Pbottom – ρ_{Hg}gy2 on both sides, so the pressure is equal. Answer (d) is wrong because at y3, the right arm is supporting only the atmosphere, while the left arm is supporting the atmosphere plus ρ_{H20} gh. Finally, (e) is silly because both arms at height y1 are at atmospheric pressure.

44. Apply Bernoulli's equation. $P_1 + \rho g y_1 \cancel{+ ½\ \rho v_1^2} = P_2 + \rho g y_2 + \cancel{½\ \rho v_2^2}$ A
$P_1 = P_2 + \rho g(y_2 – y_1)$

45. $P = F / A = 30 / \pi r^2$ … use 3 for π since its an estimate … $30 / (3*(.01)^2) = 100000$ Pa E

46. From a force standpoint, for the object to be completely submerged there would be three forces D
acting. F_b up, mg down and F_{push} down. $F_b = F_{push} + mg$ $F_{push} = F_b - mg$
$F_{push} = p_{h20} V_{disp} g - mg$
$= (1000)(2.5x10^{-2})(10) - (5)(10) = 200$ N

47. Using fluid continuity. $A_1v_1 = A_2v_2$ $\pi(D/2)^2v_1 = \pi(d/2)^2v_2$ solve for v_2 E