2021A22 (BUOYANCY)

Level 1: To find the minimum buoyant force needed, we need to find the gravitational force that we know is acting on the boat. Remember, these two forces need to have at least equal magnitude to ensure the boat floats instead of sinks. The gravitational force would be the mass of what's floating on water (the boat's mass plus the blade's mass) multiplied by the gravitational constant.

$$Gravitational\ Force = (Mass_{boat} + Mass_{blade}) * Gravitational\ Constant$$

$$Gravitational\ Force = (90{,}000{,}000kg + 8{,}200kg) * 9.8\ {}^{m}/_{s^2}$$

$$Gravitational\ Force = 882.98\ meganewtons = 882{,}980{,}000\ N$$

Therefore, the buoyant force must also be equal to 882.98 meganewtons for the ship to float.

Level 2: To solve this problem, we can look back at our equation for the buoyant force:

$$Buoyant\ Force = Density\ of\ Fluid\ \times 9.8\ {}^{m}/_{s^2} \times Displaced\ Volume\ of\ Fluid$$

We are given the density of water as 1,000 ${}^{kg}/_{m^3}$, so we need to solve for the volume of the displaced fluid. We can do this using the dimensions given! The volume of the displaced fluid is the volume of the cargo ship underwater.

$$Volume_{cargo\ ship\ underwater} = length * width * depth\ into\ water$$

$$Volume_{cargo\ ship\ underwater} = 400\ m * 60\ m * 20\ m = 480{,}000\ m^3$$

$$Buoyant\ Force = 1{,}000\ {}^{kg}/_{m^3} \times 9.8\ {}^{m}/_{s^2} \times 480{,}000\ m^3 = 4.7\ giganewtons = 4{,}700{,}000{,}000\ N$$

Source: https://theconversation.com/suez-canal-blockage-how-cargo-ships-like-ever-given-became-so-huge-and-why-theyre-causing-problems-158090