Tech Yourself Fluid Concepts: How to Use Internet Resources

S. Viridi*, F. Haryanto, F. A. Purnama

Department of Physics, Institut Teknologi Bandung
Jalan Ganesha 10, Bandung 40132, Indonesia

*dudung@gmail.com | <https://dudung.github.io>

VERSION 20171031.9

It is interesting to find out that students still have difficulties in learning ideal fluids at the introductory level in the first year university courses, especially for hydrodynamics concept (Suarez *et al.* 2017), even there is already a lot of resources related to fluids topics for elementary physics (and of course beyond it) in the forms of not-so-easy-old-textbooks-to-read for hydrostatics (Loney 1992) and hydrodynamics (Chirgwin & Plumpton, 1967), today lecture note with a lot of figures and motivations (McDonough, 2009), formal lecturer video (YaleCourses, 2008), free online course videos (KhanAcademy, 2017), commercial courses teaching video with 5-day free trials (Friedl, 2017), lecture slides and homework (Bolster, 2013), concept map (Nave, 2017), and encyclopedia article (Faber, 2016).

One of the problems for students while searching in the web is impulsiveness, that they tend to find immediately an exact right answer instead of first collecting piece by piece information in constructing the one (Kuiper *et al.*, 2008). There is a lot of search engines can be used to search information in the web (Gil, 2017), and even we can search how to search (Gibbs, 2016). Resources in the previous paragraph, which are related to fluid concepts, have been found using the following search terms together: fluids, concepts, pdf, elementary physics, online course, etc.

In an Elementary Physics course the topics could be as starting search terms, e.g. density, volume, fluid flow rate, continuity equation, hydrostatic pressure, fluid pressure, Bernoulli's principle, Archimedes' principle, u pipe hydrostatics, surface tension, etc. Even Wikipedia is not suggested as primary source for information we can still use it as a start point, since its content is more comprehensive than results of a search engine.

Figure 1. Map concept of fluids in HyperPhysics (Nave, 2017).

Supposed that we would like to learn about something related to fluids but we do not know in which part it should be. Then we can first navigate to the work of

Nave in HyperPhysics (Nave, 2017) for the concept map as shown in Figure 1. Assumed from the map it was Archimedes principle. Then, we can search the term in the web.

Figure 2. Measuring weight of a mass: in air (left) and in fluid with density ρ_2 (right).

Example of a problem is given in Figure 2, where value of g , T_1 , ρ_1 , T_2 are known and value of ρ_2 is to find. Can we get the answer for such a particular problem in the web? With the keywords: apparent weight buoyancy fluid density, second result shows a video related to the problem at about time 7:53 (KeysToMaths1, 2013) as shown in Figure 3.

Figure 3. Measuring weight of a mass: in air (left) and in fluid with density ρ_2 (right) from (KeysToMaths1, 2013).

It seems what given in Figure 3 is not the exact right answer and students should you the information to get the demanded solution.

In the first weight measuring it can be written that

$$\begin{aligned}\sum F_y &= 0 \\ \Rightarrow T_1 - w &= 0 \\ T_1 &= w,\end{aligned}\quad (1)$$

and from the second

$$\begin{aligned}\sum F_y &= 0 \\ \Rightarrow T_2 - w + F_A &= 0 \\ F_A &= w - T_2.\end{aligned}\quad (2)$$

Relation among g , w , ρ , and V will give

$$w = mg = \rho_1 V g \quad (3)$$

and buoyant force

$$F_A = \rho_2 g V. \quad (4)$$

Substitute Equation (1) into Equation (2) will produce

$$F_A = T_1 - T_2. \quad (5)$$

Substitute Equation (4) into Equation (5) will lead to

$$\rho_2 g V = T_1 - T_2. \quad (6)$$

And finally, substitute Equation (3) to Equation (6) will give

$$\left(\frac{\rho_2}{\rho_1}\right) T_1 = T_1 - T_2 \quad (7)$$

$$\Rightarrow \rho_2 = \rho_1 \left(1 - \frac{T_2}{T_1}\right),$$

the relation that was asked.

Please notice that the symbols used in Figure 3 are f_{sm} (left), B , f_{sm} (right) while in this work (Figure 2) those are T_1 , F_A , and T_2 .

Is there any other possibility for resources in the web for the same problem? The answer is yes. Figure 4 shows the alternative one at time 4:46 (van Biezen, 2016).

Figure 4. Measuring weight of a mass: in air (left) and in fluid with density ρ_2 (right) from (van Biezen, 2016).

Again in this video different symbols are used e.g ρ_{OBJ} , ρ_{LIQ} , BF , T (left), and T (right) for ρ_1 , ρ_2 , F_A , T_1 , and T_2 . Comparison of the uses of symbols is given in Table 1.

Table 1. Meaning of symbols.

Physical property	Figure		
	2	3*	4**
Measured weight in air	T_1	f_{sm}	T
Measured weight in fluid	T_2	f_{sm}	T
Object density	ρ_1	-	ρ_{OBJ}
Fluid density	ρ_2	-	ρ_{LIQ}
Buoyant force	F_A	B	BF

*(KeysToMaths1, 2013), **(van Biezen, 2016)

You can find as many alternatives as you want, which depend only on the keywords fed to the search engine.

Figure 5. Comparison of formula: left (KeysToMaths1, 2013) and right (van Biezen, 2016).

We can see from Figure 5 that second resource (van Biezen, 2016) give nearer formulation to Equation (7) than the first one (KeysToMaths1, 2013). Previous work is, of course, more direct to the solution but still for slightly different problem (Viridi, 2016).

As summary we can say that using the web you, as student can learn as deep as you wish and earlier than

the class you are attending. Then you can ask the lecturer about materials that you do not understand.

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