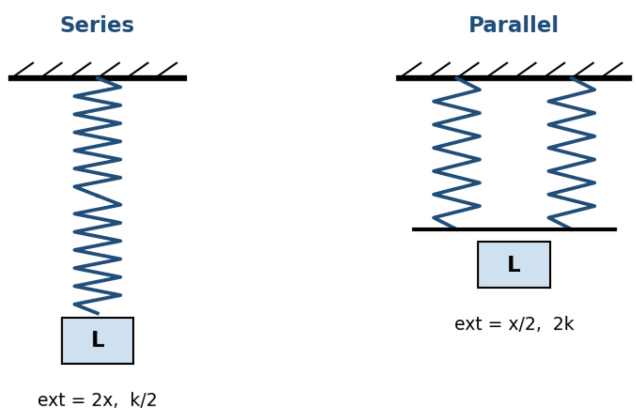
Chapter 6 — Mechanical Properties of Matter

Constructed Response Questions (with Answers)

Class 9 Physics (New Syllabus) — Board Level

Q 6.1. A spring of spring constant k gives extension x under load L (so x = L/k). For the two arrangements of identical springs, find (i) the total extension and (ii) the spring constant of the arrangement.

Ans: For one spring, L = kx, so x = L/k. Using Hooke's law for each spring:



Two identical springs arranged in series (left) and in parallel (right).

Arrangement	Total Extension	Spring constant of arrangement
Two springs joined end-to-end (in series), load L at the bottom	*2x*	*k / 2*
Two springs side by side (in parallel), sharing load L	*x / 2*	*2k*

Reasoning: In series, each spring carries the full load L, so each extends by x and the total extension is 2x; since L = k_{eq} × 2x, the arrangement constant is k/2 (springs in series are softer). In parallel, the load is shared, so each spring carries L/2 and extends by x/2; the common extension is x/2 and the arrangement constant is 2k (springs in parallel are stiffer).

Q 6.2. Springs are made of steel instead of iron. Why?

Ans: Steel is more elastic than iron. A more elastic material returns more accurately to its original shape and can bear a larger force within its elastic limit before being permanently deformed. Since a spring must stretch and compress repeatedly and return exactly to its original shape each time, steel is used instead of iron.

Q 6.3. Which of the following material is more elastic? (a) Iron or rubber (b) Air or water

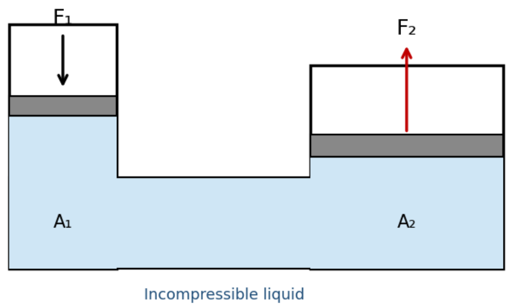
Ans: (a) Iron is more elastic than rubber. Elasticity means the ability to resist deformation and return exactly to the original shape, not the ability to stretch — iron regains its shape more precisely and resists deformation more strongly, so iron is more elastic. (b) Water is more elastic than air, because water is far less compressible and returns to its original volume when the applied pressure is removed.

Q 6.4. How does water pressure one metre below the surface of a swimming pool compare with the water pressure one metre below the surface of a very large and deep lake?

Ans: They are equal. Liquid pressure P = ρgh depends only on the depth h and the density ρ of the liquid, not on the total amount of water. Since both points are 1 m below the surface and the liquid is the same water, the pressure is the same in both cases.

Q 6.5. What will happen to the pressure in all parts of a confined liquid if pressure is increased in one part? Give a daily-life example.

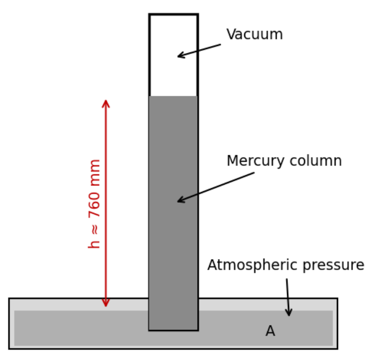
Ans: By Pascal's law, the increase in pressure is transmitted equally to all parts of the confined liquid without loss, so the pressure everywhere in the liquid rises by the same amount. A daily-life example is the hydraulic brake system (or the hydraulic car lift), where pressure applied at one piston is passed equally to the other pistons.



Pascal's law in a hydraulic system: pressure from A_1 is transmitted equally to A_2.

Q 6.6. If some air remains trapped within the top of the mercury column of the barometer (which is supposed to be vacuum), how will it affect the height of the mercury column?

Ans: The space above the mercury should be a vacuum so that only the atmospheric pressure supports the column. If air is trapped there, this air exerts its own pressure on top of the mercury and pushes it down. As a result, the mercury column falls, and the barometer reads a height lower than the true atmospheric pressure.



In a correct barometer the top is a vacuum; trapped air pushes the mercury column down.

Q 6.7. How is the long neck not a problem to a giraffe while raising its neck suddenly?

Ans: Because of the great height of the neck, the difference in blood pressure between the heart and the brain is large, since liquid pressure depends on height (P = ρgh). A sudden movement of such a long neck could cause a big change in the blood pressure reaching the brain. However, the giraffe's body has a special pressure-regulating system (a strong heart and valves in the neck veins) that keeps the blood pressure in the brain balanced, so the sudden raising of its long neck does not harm it.

Q 6.8. The end of the glass tube used in a simple barometer is not properly sealed and some leak is present. What will be its effect?

Ans: In a correct barometer the closed top is sealed with a vacuum above the mercury. If there is a leak, air enters this space and exerts pressure on the mercury from the top. This extra pressure pushes the mercury down, so the mercury column falls and the barometer gives a wrong (lower) reading; it can no longer measure the true atmospheric pressure.

Q 6.9. Comment on the statement: "Density is a property of a material, not the property of an object made of that material."

Ans: The statement is correct. Density = mass/volume is fixed for a given material and does not depend on the size or shape of the object. For example, a small nail and a large iron rod are different objects, but both are iron and have the same density (7800 kg m^{-3}). Increasing the amount of material increases mass and volume together, so density stays the same. Hence density is a property of the material, not of the particular object.

Q 6.10. How is the load of a large structure estimated by an engineer?

Ans: Engineers estimate it using density. Since density = mass/volume, the mass — and hence the weight or load — of a structure can be found from the volume of the building material and its known density (load = density × volume × g). This is why architects and engineers pay special attention to the density of building materials while designing roads, bridges and buildings and estimating the strength needed for foundations and pillars.