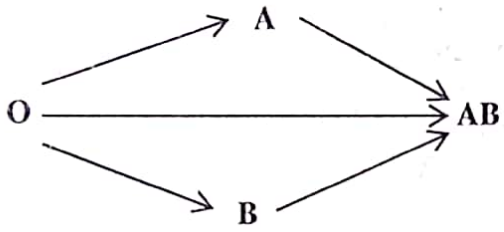
1. **B:** Rhesus factor, as well as ABO blood group of the **donor** and **recipient** are important for making blood transfusions. The donor should be healthy, with no infectious diseases and also have a good packed cell volume (PCV). The table below summarizes compatibility in blood transfusion considering the ABO system (RBC = Red blood cell).

Blood group	Antigen on RBC	Antibody in Plasma	Can donate to	Can receive from
A	A	Anti-B	A and AB	A and O
B	B	Anti-A	B and AB	B and O
AB	A, B	None	AB	All blood group
O	None	Anti-A, Anti-B	All blood groups	O

The above table may be illustrated in the form below, bearing in mind that both O and AB can donate to themselves.



Thus blood **group O** is said to be the "**universal donor**" while blood **group AB** is said to be the **"universal recipient"**. Also, note that the plasma lacks the corresponding antibody to the antigen on the RBC (for instance, a group A individual lacks anti-A antibodies, but rather has anti-B antibodies) . This is nature's way of preventing agglutination of blood.

2. **D:** The ***electromagnetic theory*** states that "A moving charged body behaves like a magnet and can interact with both electric and magnetic fields through which it passes" the other options contain uncharged particles.

3. There are 2 forms of force viz:
   - **Contact force**
   - **Non-contact force**

   Non-contact forces act without a physical contract between the source of exertion and the recipient of the force. They act by way of **fields**. Examples are Gravitational, Magnetic, Electrical etc.

A

4. **B.**

5. **B:** The umbilical cord connects the embryo to the mother and transports oxygen and nutrients via blood to the embryo. The placenta is the region where the umbilical cord makes functional contact with the uterine wall. The amnion is one of the membranes covering the embryo or foetus.

6. **B:** The atom is made up of "**PEN**"
   P = Proton
   E = Electron
   N = Neutron

7. **A:** The fundamental quantities are: Mass (kg), Length (m), Time (s), Quantity of charge (C), Temperature (K), Amount of substance (mol) and Luminous Intensity (Candela).

8. Find the submerged volume of the cube in water using: **Vol = Area × Height**
   $= (20 \times 20 \times 15)\text{cm}^3 = 6000\text{m}^3$
   This volume is the volume of water displaced when the cube is submerged in water.

NB: density of water is constant; if not given, it is $= 1g/cm^3$

Now, finding the actual volume of the cube when it is not submerged:

Volume, $V = 20 \times 20 \times 20 = 8000cm^3$

The question requires that we find the **density** of the cube. (density = mass/volume)

The mass or weight of the water displaced is the same as that of the cube (The **Law of Floatation** states that "a floating object displaces its own weight of the liquid in which it floats". Also, the Weight of liquid displaced (upthrust) = Weight of object). Therefore, we find the mass of the water since we know both its density and volume.

mass = density × vol $= 1 \times 6000 = 6000g$

Therefore, density of the cube = mass/vol of cube $= \frac{mass}{vol\ of\ cube} = \frac{6000}{8000} = 0.75g/cm^3 = 0.75g/cm^3$

C

Or by **short-cut**, since mass is the **same** for both, let's make <u>mass constant</u> for both, such that:

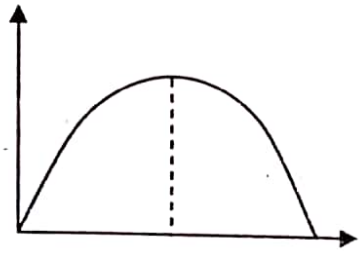
mass = density × volume = Constant

∴ Density of H_2O × Vol. of H_2O = Density of cube × Vol of cube

$1 \times 6000 = \rho$ of cube $\times 8000$

$\therefore \quad \rho \text{ of cube} = \frac{6000}{8000} = 0.75g/cm^3$

9. **Projectile motion** is when a body/object is thrown **obliquely** into the air side that it observes two paths as shown below



C

10. The **alkanes** (C_nH_{2n+2}) do not decolorize bromine water. However, the **alkenes** (C_nH_{2n}) and the **alkynes** (C_nH_{2n-2}) do!

This is because alkenes and alkynes have **double** and **triple bonds** respectively and these serves as points for halogenation (i.e. addition of the halogens, e.g. Cl, Br, I), a reaction that causes decolourization of the characteristic brownish colour of bromine.

11. **D:** **Homeostasis** is defined as **"maintenance of a relatively constant internal environment** (or internal milieu)". These conditions of the internal environment include temperature, total body water, total body electrolytes, blood glucose etc.

12. Carbon electrodes (and platinum too) are inert. They do not influence the types of substances discharged at the cathode and anode.

<u>NB:</u> **In the electrolysis of brine (concentrated NaCl), using inert electrodes**

* **Hydrogen** is given off at the **cathode**
* **Chlorine** is given off at the **anode**
* The **resultant solution** is a concentrated solution of **sodium hydroxide (NaOH) a strong base.**

NB: In almost all cases of electrolysis of aqueous solutions of salts, hydrogen gas is given off at the cathode. The only notable exceptions are in

B

(i). The electrolysis of brine using mercury as the cathode, (here sodium is discharged as **sodium amalgam**) and,
(ii). In the electrolysis of molten salts of metals.

13. There are two widely accepted theories of evolution, these are:

(i) **The theory of use and disuse** which was propounded by **Jean Lamarck**. This theory postulates that body parts that are constantly used become enlarged and efficient while the ones that are not used become small and weak. Lamarck said that such acquired traits are transferred to offspring (he used the giraffe as illustration).

(ii) **The theory of natural selection** was propounded by **Charles Darwin**. It postulated that organisms that are well adapted to their environment (i.e. have the favourable variations) survive, while those that are not well adapted to their environment die off. This theory of natural selection has been also dubbed ***"survival of the fittest"***.
Darwin postulated that these favourable variations that enable a part of the population of organisms survive are passed on to the offspring. He identified *environmental pressure* as the driving force behind natural selection.

Louis Pasteur, a French biologist, discovered **Pasteurization** a process of preserving milk.
Robert Hooke, an English scientist, gave one of the earliest postulates of the **cell theory**, which states that "Living organisms are made up of one or more units called cells". Other cell theories were given by **Rudolf Virchow, Theodor Schwann** and **Matthias Schleiden**.

14. **B:** Aluminium materials such as aluminium oxide (Al_2O_3), has acidic and basic properties alike i.e. it is amphoteric. On reaction with acids, it exhibits basic properties, while on reaction with alkalis, it exhibits acidic properties.
Aluminium reacts with non-metals (e.g. sulphur, halogens, nitrogen, phosphorus, carbon) with the evolution of heat, as well as with iron (III) oxide.

15. **D:** **Renewable natural resources** have the potential to be replenished over time, if well maintained. Renewable natural resources include: **soil** (land), **the atmosphere, wind, water, forest** (wood), **wildlife, biomass**. The last three are living components.
Non-renewable natural resources tend to have a fixed or limited amount in nature e.g. **fossil fuels, minerals, crude oil, coal, natural gas, nuclear energy**, they are termed non-renewable resources as we cannot produce them by any known process or recover them when they are depleted. Non-renewable resources may be **conserved by using alternative energy sources** or by **recycling**, where appropriate.

16. This question is based on the general gas equation i.e.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad \text{.....(a)}$$

This law is a "fusion" of two laws viz, **Boyles' Law** and **Charles's Law**
NB: Charles' Law was based on the **Kelvin scales**, therefore the unit of temperature must be in **Kelvin**.
From the data (initial): $P_1 = 53mmHg$, $V_1 = 241cm^3$, $T_1 = 18^oC = 18 + 273K = 291K$ (NB: to convert from ^oC to K, add 273)
At S.T.P (final):
$P_2 = 760mmHg$ (1 atm or standard pressure), $V_2 = ?$, $T_2 = 273K$ (0^oC or standard temperature).
From equation (a) above

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1}$$

$$= \frac{53 \times 241 \times 273}{760 \times 291} = 15.77cm^3$$

B

17. **D:** Auxins are elaborated at the apices of roots and shoots.

18. 45g of the salt is contained in 1000g of water. How much of it is contained in 50g of the solution?

45g $\longrightarrow$ 1000g of water

x g $\longrightarrow$ 50g of water

$$x = \frac{45 \times 50}{1000} = 2.25g$$

A

19. The **pH values of 1 - 14**, correspond to a **hydrogen ion concentration of $10^{-1} - 10^{-14}$** e.g. a pH of 5 corresponds to a hydrogen ion concentration of 10^{-5} mol dm^{-3}.
For a pH of 2, the hydrogen ion concentration is 10^{-2} or 0.01.

A

20. **Hydra** is a coelenterate (cnidaria), an invertebrate.
Hydra has a sac-like body with a single opening (mouth) which is surrounded by tentacles that help to catch food and push it into the gut. Tentacles have many specialized stinging cells which stun the prey.
Hydra reproduces by both asexual and sexual means. **Asexual reproduction** is by **budding. Sexual reproduction** is by **fusion of the male and female gametes** (Hydra is an hermaphrodite i.e. it has both male and female sexual organs).
It feeds, moves and digests its food. It is an "animal" (heterotrophic nutrition) and cannot manufacture its food.

21. **A:** The prongs move about a rest point, in what is described as **oscillatory motion**. Oscillatory motion involves vibration about a fixed point, with a displacement, called "amplitude".

22. **B:** Chlorine bleaches by oxidation. Chlorine is also used in the manufacture of bleaching powder, $CaOCl_2$.

23. **B:** Streptococci are spherical bacteria arranged in chains. Staphylococci are spherical bacteria arranged in clusters. Bacilli are rod-shaped, while spirillae are cock-screw shaped. Cocci are isolated, single, spherical bacteria. Spirochaetes are spiral-shaped.

24. **Fungal crop disease** includes ***smut, rust, blight, root rot, downy mildew.***
Viral crop diseases are ***mosaic mottling, lesions, chlorosis, stunting and necrosis.***
Bacterial crop disease includes: ***bacterial blight, bacterial wilt, leaf spots, bacteria galls and soft rot.***
Groundnut rosette is caused by a **virus** and this virus is **spread by aphids.**
Blackpod disease is caused by a **fungus** that thrives under **wet or damp conditions**, e.g. as caused by rainfall.
Yam mosaic is caused by a **virus.**
Cassava blight is caused by a **fungus.**

B

25. **B:** Bile is produced from cholesterol in the liver. The kidney produces and concentrates urine, activates vitamin D, maintains the body's electrolytes, etc.

26. **A:** Blood group AB is otherwise known as ***"universal recipient"*** i.e. persons with blood group AB can receive blood from all other groups.

27. **B:** Starch (just like glycogen) is a polymer of glucose. **Starch** is the storage form of carbohydrates in **plants**, while **glycogen** is the storage form of carbohydrates in **animals.**
Fructose is a keto-monosaccharide. Lactose is milk sugar (a disaccharide). Maltose is a disaccharide which contains two glucose molecules.

28. **A:** The movement of the toy top observes rotational, oscillatory and translational motions, but not random motion. Random motion (Brownian motions is exhibited by gases, smoke, etc)

29. **C**

30. The resulting temperature is the final temperature, while the temperatures of the hot water and the cold water are the initial temperatures.
In **heat exchange** (as in the case of mixture of cold and warm water here), the hot body loses heat to the cold body, while the cold body gains heat. Also, the temperature of the hot body is usually larger than the final temperature, whereas, the temperature of the cold body is usually smaller than that the final temperature.

Hence, applying the **Consecration Law of Heat Exchange** which states:

Heat lost by hot body = Heat gained by cold body.

i.e. $mc(\theta_H - \theta_F) = mc(\theta_F - \theta_C)$

Where: θ_H = temp. of the hot water, θ_F = final temperature, θ_C = temp. of the cold water

Interpreting what we have in the question, now have:

$$mc(\theta_H - \theta_F) = 4mc(\theta_F - \theta_C)$$
$$(\theta_H - \theta_F) = 4(\theta_F - \theta_C)$$
$$\theta_H - 30 = 4(30 - 20)$$
$$\theta_H - 30 = 120 - 80$$
$$\theta_H - 30 = 40$$
$$\therefore \quad \theta_H = 40 + 30 = 70^\circ C$$

C