

Question 1 (plant physiology)

The main function of the xylem is the transportation of dissolved minerals and water within plants, the phloem is responsible for the food transportation. The thickness growth in plants is issued by the cambium, not the xylem.

Correct answer - C

Question 2 (cell biology)

The golgi bodies are mainly processing and packaging proteins from the ER (endoplasmic reticulum) for further transportation. Lysosomes break down waste and foreign substances within cells. Ribosomes are enzymes that synthesize proteins by translating mRNA (messenger RNA) into amino acid chains. The nucleus stores the DNA and thus carries the genetic information to transmit hereditary characteristics from one generation to the next.

Correct answer - B

Question 3 (human physiology)

Red blood cells are responsible for carrying oxygen. Lymphocytes are part of our immune system and help us fight infections and diseases. Haemoglobin transports oxygen from the lungs and carbon dioxide from the tissues back to the lungs. The main function of platelets is helping with blood clotting.

Correct answer - C

Question 4 (ecology)

The third trophic level of an environmental number pyramid are secondary consumers, which eat primary consumers and thus are carnivores or omnivores.

Correct answer - D

Question 5 (human physiology)

The thyroid produces hormones such as thyroxine (T4) and triiodothyronine (T3). The pituitary makes hormones that regulate body functions, f.e. growth hormones (GH) or follicle-stimulating hormones (FSH). The adrenal gland mainly produces cortisol and adrenaline. In this task, the only gland producing digestive enzymes is the pancreas, the hormones are f.e. amylase, trypsin and lipase.

Correct answer - C

Question 6 (evolution)

Similarities within a group of animals are mostly derived from a common ancestor.

Correct answer - C

Question 7 (human physiology)

Red blood cells do not contain a nucleus. Because of that, blood transportation is optimised due to a higher percentage of hemoglobin within the cells. The remaining blood cells contain a nucleus.

Correct answer - C

Question 8 (human physiology)

The cochlea's role is converting sound waves to electric signals that our brain can interpret. The tympanic membrane separates our outer ear from the middle ear. The eustachian tube is a passageway which connects the middle ear to the throat and nose. Only the semicircular canals helps maintain equilibrium by sensing rotational and angular movements of the head.

Correct answer - B

Question 9 (pathology)

A goitre is a lump or swelling at the front of the neck caused by a swollen thyroid, which can affect both genders. Malaria is a disease caused by a parasite. A chronic kidney disease in unknown etiology can be caused by genetic factors, but not necessarily. Colour blindness is a hereditary disease affecting mainly men because it's coded on the X-chromosome.

Correct answer - C

Question 10 (plant physiology)

Having sunken stomata indicates that a plant is located at a hot and dry site. Sunken stomata decrease water loss due to less transpiration.

Correct answer - C

Question 11 (plant physiology)

Plant growth substances regulate plant growth and development. For example, ethylene and auxins can regulate fruit drop, gibberellins can trigger fruit development without fertilization and flowering outside the season. Plant hormones do not have toxic effects on pests.

Correct answer - D

Question 12 (human physiology)

Motor nerves carry impulses from the central nervous system to muscles and glands. Sensory neurons carry impulses from sensory organs to the central nervous system. Interneurons link sensory and motor neurons.

Correct answer - C

Question 13 (human physiology)

Heart muscles are involuntary, striated muscles. Skeletal muscles are striated and voluntary, smooth muscles are involuntary and unstriated muscles.

Correct answer - B

Question 14 (human physiology)

Neutrophils make up about 55-70% of all white blood cells, lymphocytes about 20-40%, eosinophils 1-6% and basophils less than 1%.

Correct answer - C

Question 15 (ecology)

Endemic animals are animals that are found only in one geographic area. The red faced malkoha is found only in Sri Lanka. Elephants and Spotted deers are obviously not endemic to Sri Lanka, the Asian koel lives in wide parts of Asia and Australia.

Correct answer - B

16. (Electron structures)

The same electron structure as the chloride ion means having the same number of electrons as it. Because the ion is a monovalent anion, the number of electrons in it is $N = Z(\text{Cl}) + 1 = 18$

(A) The Ca^{2+} ion has $Z - 2 = 20 - 2 = 18$ electrons - correct.

(B) The chlorine atom has $Z = 17$ electrons.

(C) The Na^+ ion has $Z - 1 = 11 - 1 = 10$ electrons.

(D) The potassium atom has $Z = 19$ electrons.

17. (Periodic table)

Elements in Group III are generally trivalent (having the electron structure ns^2np^1).

Trivalent elements form oxides with the general formula X_2O_3

Correct answer - (D)

18. (Periodic table)

Elements in the same group are characterized by the same valence (and the same outer shell structure), but an increasing number of electron shells. So the number of electrons in the outermost energy level (the valence shell) remains constant when moving down in a group.

Correct answer - (B)

19. (Reactivity)

The reactivity of sodium is given by the fact that it easily gets oxidized ($\text{Na} \rightarrow \text{Na}^+ + e^-$).

The oxidation means losing one electron, so the energy necessary is the primary ionization energy.

Sodium is very reactive because that ionization energy is low.

The reactivity of sodium also comes from the fact that, to reach a stable octet, sodium only has to lose one electron (it has only one outermost electron).

Its relatively low atomic mass correlates with a low nuclear charge, so a weaker attraction is felt by the electron that needs to be removed to form Na^+ ions.

In conclusion, all the reasons presented contribute to the high reactivity of sodium, so:

Correct answer - (D)

20. (Bonding)

Ionic bonds require an anion and a cation. Typically cations are formed by metals, while anions are formed by nonmetals. The only compound in the given list that contains a metal is magnesium fluoride. The others are covalent compounds, created by covalent bonding between nonmetals.

Correct answer - (B)

21. (Bonding)

(A) - HBr is a polar molecular which has a dipole moment.

(B) - CH_4 has slightly polar bonds, but symmetric tetrahedral structure, so the dipole moments (which were anyway very small) cancel out.

(C) - H_2 only has a homonuclear bond (a covalent bond between two identical atoms) which has no dipole moment (neither of the hydrogen atoms is more electronegative than the other).

(D) - CO_2 has polar $\text{C}=\text{O}$ bonds, but a linear structure so the dipole moments of the bonds cancel out.

Correct answer - (A)

22. (Mixtures)

Milk is an emulsion (small fatty particles are dispersed in an aqueous medium). The fact that fat molecules are not found in between the water molecules means milk is not a homogenous mixture (even though it appears like this on a macroscopic scale), rather a heterogeneous one.

Correct answer - (D)

23. (Reactivity)

For metal A to be able to reduce metal B (found in an aqueous solution in the form of a salt), we need to have the relationship $A > B$ between the reactivity of the two metals (also, A needs to have a smaller reducing potential than B).

(A) Zn is more reactive than Cu, so it does displace it from its salt.

(B) Fe is more reactive than Ag, so it does displace it from its salt.

(C) Cu is not more reactive than Al, so it can not displace it from its salt.

(D) Mg is more reactive than Al, so it does displace it from its salt.

Correct answer - (C)

24. (Solubility)

(A) When a solid is placed in a solvent, it starts dissolving. Because of this, around the solid particle, a concentrated region is formed, in which the solid can hardly dissolve. The solute then spreads in the solvent because of Brownian motion. Stirring the solution makes this process go faster and helps the dissolution process.

(B) Pulverizing the solid, means dividing it into more and smaller particles, which dissolve faster and more evenly spread across the volume of the solvent.

(C) Heating the solution increases Brownian motion and the possibility of diffusing the solute between solvent molecules, making the dissolution process easier.

(D) Increasing the pressure increases the solubility of gases, but in the case of solids, it does not affect solubility.

Correct answer - (D)

25. (Stoichiometry)

On the products side of the equation, there are 6 nitrogen atoms in copper nitrate and 2 nitrogen atoms in nitrogen monoxide, 8N in total. To balance the number of nitrogen atoms, we add the coefficient 8 to nitric acid.

On the reactants side of the reaction, there are now 8 hydrogen atoms. All of these are found in water after the reaction. Because every water molecule has 2 hydrogen atoms, the coefficient of water is 4.

Correct answer - (C)

26. (Redox reactions)

In hydrogen sulfide, the oxidation state of sulfur is -2. In Br_2 , the oxidation state of bromine is 0. In the products, the oxidation state of sulfur in sulfuric acid is +6, while that of bromine in hydrobromic acid is -1.

Thus, in the reactions, the oxidation state of sulfur increases and that of bromine decreases. The oxidizing agent gets reduced (and it oxidizes the other substance). Getting reduced means gaining electrons and having a decrease in the oxidation state. In this reaction, this is the case of bromine, so the oxidizing agent is bromine.

Correct answer - (B)

27. (Thermodynamics)

Pressure remains constant = isobaric transformation.

In the case of an isobaric transformation, we can use Charles's law, $\frac{V}{T} = \text{constant}$.

We can write $\frac{V_1}{T_1} = \frac{V_2}{T_2}$, so $V_2 = V_1 \frac{T_2}{T_1}$

Using $T_1 = 25+273=298\text{K}$ and $T_2 = 100+273=373\text{K}$ and $V_1 = 300\text{ml}$, we get $V_2 = 376\text{mL}$

Correct answer - (C)

28. (Analytical chemistry)

In general, all nitrates are soluble. In fact, the most used silver salt is silver nitrate.

Silver halides (in the case of this question, bromide and chloride) are white precipitates, turning more yellowish when the halide is heavier (AgCl - white, AgI - yellowish white).

Silver carbonate is a white precipitate.

Correct answer - (B)

29. (Energy)

In the given energy profile, the reactants are represented by A, the products by C, and the transition state by B.

The activation energy is the energy required to start the reaction - that is, the energy necessary to form the transition state (the state in which the energy is maximum).

From the energy profile given, the activation energy is the energy of the transition state minus that of the reactants, so B-A.

Correct answer - (D)

30. (Electrochemistry)

The current is constant, so the amount of copper being oxidized/reduced per unit of time is constant, so the graph is linear.

All the negative ions gather at the copper anode (positive electrode). These are HO^- and SO_4^{2-} .

The species that could be oxidized (oxidation takes place at the anode) are Cu or the two anions. Because of the higher oxidation potential, Cu is the one being oxidized. Copper is turned into ions and dissolved in the solutions, so the mass of the anode decreases.

We could have concluded that the anions are not being oxidized from the fact that that would have resulted in a constant mass of the anode, and this variant does not exist.

Correct answer - (C)

Question 31

This is a problem in statics, so we should use the equality of the torques.

$$m_p \times g \times x = (m_q + m_r) \times g \times 3x$$

And on the other rod

$$m_q \times g \times y = m_r \times g \times 2y$$

Which simplify to

$$m_p = 3(m_q + m_r)$$

$$m_q = 2m_r$$

And with the info that $m_p = 9\text{kg}$ by substituting

$$m_p = 3\left(m_q + \frac{m_q}{2}\right), \quad 9\text{kg} = \frac{9m_q}{2}, \quad m_q = 2\text{kg}$$

CORRECT ANSWER - B

Question 32

As a common trick in circuit problems, we'll simplify by substituting parallel and series resistors

Both the top and the bottom of the "square" add up to 5Ω , which totals to 2.5Ω for the square. Then adding the 1.5 resistor to the square gives us the total resistance of 4Ω .

Using Ohm's law we get $I = \frac{V}{R}$, $I = 4V \div 4\Omega = 1A$.

CORRECT ANSWER - D

Question 33

It's clear that it is intended for us to get the acceleration, the distance, the force, and then the work.

$$a = \frac{v}{t}, a = 20 \frac{m}{s} \div 200s = 0.1 \frac{m}{s^2}$$

$$F = ma, F = 1000kg * 0.1 \frac{m}{s^2} = 100N$$

$$s = \frac{vt}{2}, s = 2000m$$

$$A = F \times s, A = 200kJ$$

CORRECT ANSWER - D

Question 34

We can just look at the mass that's in the air

$$F_{string} - mg = 0$$

We are given on the picture that the weight (mg) is $4N$

Therefore the tension is also 4N

CORRECT ANSWER - A

Question 35

Using Boyle's law (or ideal gas law)

$$P_1 V_1 = P_2 V_2$$

Initial air column length: $L_1 = 33cm$

The pressure on the air from the Hg must be equal to the pressure on the Hg from the air, therefore:

Initial pressure: 86 cm Hg (= atmospheric + 10 additional)

Final pressure after flipping: 66 cm Hg (= atmospheric - 10)

Volume is proportional to length, therefore

$$L_2 = \frac{P_1}{P_2} L_1, \quad L_2 = \frac{86}{88} * 33 = 43cm$$

CORRECT ANSWER - D

Question 36

Same as in Question 32, substitute resistors till we get the equivalent Resistor (R_{eq}).

The top line equates to: $R + R/2 + (2R)/2 + R/2 + R = 4R$

And parallel with the bottom gives: $1/R_{eq} = 1/4R + 1/R$, $R_{eq} = 0.8\Omega$

******Or we could've just looked at the picture, realised its a parallel link with one branch being R, therefore the whole being $<1R$ saw the given answers and realised that only one is under $1R$

This is a neat trick which I suggest you should use as much as possible, it saves valuable time :)

CORRECT ANSWER - D

Question 37

The simplest solution is just noticing that because there is no friction there will be no slowing down, therefore the only valid answer is the one that has no negative sloped lines - C

CORRECT ANSWER - C

Question 38

This is just simple geometry if we use that the angle of incidence is equal to the angle of refraction. ($\theta_r = \theta_i$)

There are many ways that we could do the angle chasing that give the formula:

$$\beta = 90^\circ - 26^\circ = 64^\circ$$

CORRECT ANSWER - D

Question 39

Using Pascal's law: The pressure on the liquid from the confined air equals the pressure on the same level on the right side of the U tube. Then using hydrostatic pressure and accounting for the atmosphere:

$$P = P_{atm} + \rho gh$$

CORRECT ANSWER - C

Question 40

We are given $mg = 15N$, $m = 1.5kg$ and $mg - F_U = 12N$

Using Archimedes' principle we get $F_U = \rho Vg$

And by substituting we get: $\rho Vg = 15N - 12N$, $V = 3N/(\rho g)$

$$V = 3 * 10^{-4} m^3, \quad \rho_o = \frac{m}{V} = 5000 \frac{kg}{m^3}$$

CORRECT ANSWER - B

Question 41

We could calculate the forces and add them and do a lot of work, but instead just look at the resulting forces in the y-axis: the gravitational force 5N downwards and the resulting force of the Ws upwards. The ball is stationary therefore $F_r = 5N$

CORRECT ANSWER - D

****Questions 42,43,45,46 are in math!**

Question 42

The two equations are similar. So, we can write

$$y^2 = 4x = y^2 = (2x)^2 = 4x^2$$

$$4x = 4x^2$$

Hence, $x = 0$ or $x = 1$.

When $x = 0$, $y = 0$

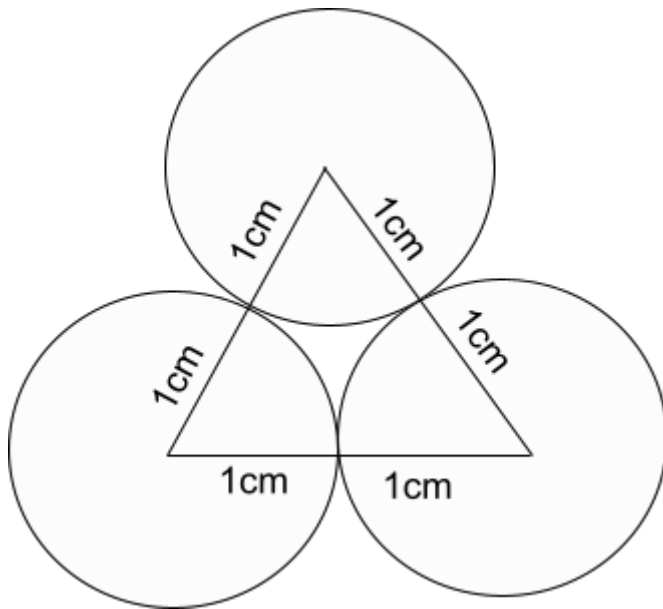
When $x = 1$, $y = 2$

$(0,0)$ and $(1,2)$ are the only possible solutions

Correct Answer :- D

Question 43

We should draw a little construction



The corners of the triangles are the centers of the circles. After drawing this triangle, it is quite obvious that we could subtract the area of the 3 sectors from the area of the triangle

$$\text{Area of the equilateral triangle} = \frac{1}{2} * \text{base} * \text{height}$$

$$\text{Base} = 2 \text{ cm. Height} = 2 \text{ cm} * \sin 60 = 2 \text{ cm} * 0.9 = 1.8 \text{ cm}$$

$$\text{Area} = \frac{1}{2} * 2 \text{ cm} * 1.8 \text{ cm} = 1.8 \text{ cm}^2$$

$$\text{Area of 1 sector} = \frac{60}{360} * \pi r^2 = \frac{1}{6} * 3 * 1^2 = 0.500 \text{ cm}^2$$

$$\text{Area of 3 sectors} = 0.500 \text{ cm}^2 * 3 = 1.500 \text{ cm}^2$$

$$\text{Area of the shaded portion} = 1.8 \text{ cm}^2 - 1.500 \text{ cm}^2 = 0.300 \text{ cm}^2$$

Correct Answer :- D

Question 45

Volume of a cube = a^3 , where a represents the side length

So, when the side length is tripled, the volume will be 27 times the original volume.

Correct Answer :- D

Question 46

If two lines are parallel, their gradient must be similar. The gradient of the graph $y=4x$ is 4. The gradient of the new line must also be equal to 4. The only option with an equation of line where the gradient is 4 is option C.

Correct Answer :- C

Question 44

We are given: $V_2 = \frac{V_1}{3}$, $P_2 = 9P_1$, $T_1 = 27^\circ\text{C} = 300\text{K}$

Using the ideal gas law we get:

$$T_2 = T_1 \times \frac{P_2 V_2}{P_1 V_1} = 300\text{K} \times 3 = 900\text{K} = 627^\circ\text{C}$$

CORRECT ANSWER - D

Question 47

Achimedes' principle : $F_b = \rho V g = m_{\text{liquid displaced}} g$

But since the block is floating it is also equal to its weight...

2 CORRECT ANSWERS!?

CORRECT ANSWER - A,B!?

Question 48

Just like Newton's prism - refraction.

CORRECT ANSWER - D

Question 49

$$P - P_0 = \rho h g, \quad \rho = \frac{P - P_0}{h g} = 40 \text{ kPa} \div 20 \frac{\text{m}^2}{\text{s}^2} = 2000 \frac{\text{kg}}{\text{m}^3}$$

CORRECT ANSWER - D

Question 50

Reducing the amount of air reduces its pressure (simple logic or ideal gas law), therefore the outside greater pressure crushes the can.

CORRECT ANSWER - B

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