Formula One

IJSO MCQ mock test

Solutions

Question Number	Option			
1	A	B	C	~~D~~
2	A	~~B~~	C	D
3	~~A~~	B	C	D
4	A	B	C	~~D~~
5	~~A~~	B	C	D
6	A	~~B~~	C	D
7	A	~~B~~	C	D
8	A	B	C	~~D~~
9	A	~~B~~	C	D
10	A	B	~~C~~	D
11	A	~~B~~	C	D
12	A	B	C	~~D~~
13	A	B	C	~~D~~
14	~~A~~	B	C	D
15	A	B	C	~~D~~

Question Number	Option			
16	A	B	C	~~D~~
17	A	~~B~~	C	D
18	A	B	~~C~~	D
19	A	~~B~~	C	D
20	A	B	C	~~D~~
21	A	B	C	~~D~~
22	A	B	C	~~D~~
23	~~A~~	B	C	D
24	A	~~B~~	C	D
25	~~A~~	B	C	D
26	A	B	C	~~D~~
27	A	~~B~~	C	D
28	A	B	C	~~D~~
29	A	B	~~C~~	D
30	A	B	C	~~D~~

Question 01 – Braking Distance

The car's usual speed is $v = \frac{d}{t} = \frac{13.5}{0.15} = 90\ m/s$

While processing the situation, the driver moves $d_1 = v \cdot t_{reaction} = 18m$

After that, by writing Galilei's equation, we get $v^2 = 12gd_2$, from which we have $d_2 = \frac{v^2}{12g} = 68.88m$

The total distance is $D = d_1 + d_2 = 86.88m$

So, the correct answer is option **D**.

Question 02 – Oscillating Car

The effective mass supported by each spring is $m = \frac{M}{4} = 200\text{kg}$

The angular frequency is $\omega = \sqrt{\frac{k}{m}} = 24.5\ \text{s}^{-1}$

$\omega = \frac{2\pi}{T}$, we have $T = \frac{2\pi}{\omega}$

The frequency is $f = \frac{1}{T} = \frac{\omega}{2\pi} = 3.90\text{Hz}$

So, the correct answer is option **B.**

Question 03 – Spark Plug

$$C = \frac{\epsilon_0 A}{d} = \frac{8.85 \cdot 10^{-12} \times 1 \cdot 10^{-6}}{0.5 \cdot 10^{-3}} = 1.77 \cdot 10^{-14}\ F$$

$$Q = CV \rightarrow V = \frac{Q}{C}$$

$$\frac{Q}{CE} = (1 - e^{-\frac{t}{RC}})$$

$$\frac{300}{500} = (1 - e^{-\frac{t}{RC}})$$

$$e^{-\frac{t}{RC}} = 0.4$$

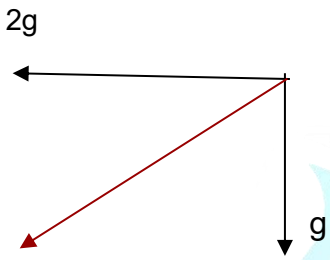
$$\frac{t}{RC} = -\ln 0.4 = 0.9163$$

$$t = 0.9163\ RC = 0.9163 \times 1.77 \cdot 10^{-14} \times 1000 = 1.622 \cdot 10^{-11}\ s$$

So, the correct answer is option **A.**

Question 04 – Forces acting on blood

The blood will feel a downward acceleration of g due to gravity, and a backwards acceleration of 2g, due to the acceleration of the vehicle.



The angle the total force (in red), makes with the vertical, obeys:

$$tg\theta = \frac{2g}{g} = 2 \rightarrow \theta = arctan(2) = 63.4°$$

And, relative to the driver, it points to the back.

So, the correct answer is option **D.**

Question 05 – ERS System

$$C = \frac{\epsilon_0 \, \epsilon_r \, A}{d} = \frac{8.85 \cdot 10^{-12} \times 5.0 \times 0.20}{1 \cdot 10^{-3}} = 8.85 \cdot 10^{-9} \, F$$

$$E = \frac{1}{2} CV^2 = \frac{1}{2} \times 8.85 \cdot 10^{-9} \times (500)^2 = 1.1 \cdot 10^{-3} \, J$$

So, the correct answer is option **A.**

Question 06 – Rear-view Mirror

f = -0.3 m, u = + 5m

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-0.3} + \frac{1}{5} = -\frac{47}{15}$$

$$v = -\frac{15}{47}\ m$$

Since v is negative, the image is virtual. Since, v is smaller than u, the image is diminished. Since the image is formed behind the mirror, the object is upright.

So, the correct answer is option **B**.

Question 07 – Acceleration

According to conservation of momentum, initial momentum = final momentum

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2)\, v_f$$

$$v_f = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} = \frac{870 \times 100 + 950 \times 83.33}{870 + 950} = 91.30 \text{ m/s}$$

$$a = \frac{\Delta v}{\Delta t} = \frac{100 - 91.30}{50 \cdot 10^{-3}} = 174 \text{ ms}^{-2} = \frac{174}{9.80} \text{ g} = 17.76 \text{ g} \approx 17.8 \text{ g}$$

So, the correct answer is **B**.

Question 08 – Accident

Let's analyze each option

I. The blood analysis shows two kinds of antibodies, which corresponds to blood group O. Since blood group O is a universal donor and not the universal recipient, statement I is wrong.

II. The total number of phalanges in the human body is 56 (14 per hand and 14 per foot). He broke 2, so that leaves him with 54 unbroken phalanges (56 – 2). The total number of ribs in the human body is 24. He broke 3, so that leaves him with 21 unbroken ribs (24 – 3). Therefore, statement II is correct.

III. Clotting factors are involved in hemostasis, not homeostasis. Therefore, statement III is wrong.

IV. The patient feels the tap normally but lacks the knee-jerk reflex. This indicates damage to the motor (efferent) pathway, not ascending (sensory) nerves. Therefore, statement IV is wrong.

V. An increased heart rate after trauma is caused by sympathetic activation, including hormones from the adrenal medulla such as norepinephrine. Therefore, statement V is correct.

So, the correct answer is option **D**.

Question 09 – Heat Absorbed

$$V_m = \frac{RT}{P} = \frac{0.0821 \times 300}{1} = 24.63 \text{ L}$$

$$\text{moles} = \frac{V}{V_m} = \frac{400 \text{ L}}{24.63} = 16.24 \text{ mol s}^{-1}$$

$$\text{Heat} = \text{moles} \times C_P \times \Delta T$$

$$16.24 \times (0.80 \times 29 + 0.20 \times 30) \times (310 - 300) = 4742 \text{ J}$$

So, the correct answer is option **B.**

Question 10 – Hungaroring Track Part 1

Let's analyze each option

A. Number of drivers = electrons, not nucleons. Mass number is protons + neutrons, unrelated here. Therefore, statement A is wrong.

B. Losing 1 electron → cation. Potassium ion (K^+) has 19 protons, 18 electrons. But we started with 20 drivers (20 e^-). Losing 1 gives 19 electrons → looks more like K atom, not K^+. This analogy doesn't fit well. Therefore, statement B is wrong.

C. Inner orbits = lower energy states in the Bohr model. Therefore, statement C is true.

D. Losing 2 electrons = cation (Ca^{2+}), not anion. Therefore, statement D is wrong.

So, the most suitable option is **C**.

Question 11 – Hungaroring Track Part 2

Let's analyze each statement

A. Use the right-hand rule. Clockwise current (positive charges) → field goes into the page (down). But drivers are negative charges, so the effective current is opposite (counterclockwise). That would give an upward field, not downward. Therefore, statement A is incorrect.

B. When the magnet falls, the downward flux increases. Therefore, according to Lenz's law, the induced current will try to oppose that. This induced current will make the electrons go faster. Therefore, statement B is correct.

C. No—drivers are negative charges. Their clockwise motion corresponds to a counterclockwise conventional current. Therefore, statement C is incorrect.

D. No—like charges repel, not attract. They would push away from each other, not toward the center. Therefore, statement D is incorrect.

So, the correct answer is option **B**.

Question 12 – Tire Pressure

Total pressure at $20°C = 21.0 + 14.7 = 35.7$ psi

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$V_1 = V_2$, $P_1 = 35.7$, $T_1 = 20 + 273$, $T_2 = 100 + 273$

$$P_2 = \frac{35.7 \times 373}{293} = 45.4 \text{ psi}$$

Gauge pressure $= 45.4 - 14.7 = 30.7$ psi

So, the correct answer is option **C**.

Question 13 – Hydrazoic Acid

$$PV = nRT \rightarrow n = \frac{PV}{RT}$$

$$n = \frac{2 \times 50}{0.0821 \times 300} = 4.060 \text{ mol}$$

The efficiency is only 80%. Therefore, $\frac{4.060}{0.80} = 5.075$ mol of N_2 needs to be produced.

$$2NaN_3 \rightarrow 3N_2$$

Therefore, 5.075 moles of N_2 mean $5.075 \times \frac{2}{3} = 3.383$ mol of NaN_3

$$\text{Mass} = \text{moles} \times M = 3.383 \times (22.99 + 3 \times 14.01) = 220.0 \text{ g}$$

So, the correct answer is option **D**.

Question 14 – ERS Battery

The energy recovered can be calculated by

$\Delta E = Q\Delta V$

Where Q is the total charge involved and ΔV is the average cell potential

$$Q = \frac{\Delta E}{\Delta V} = \frac{200 \times 10^3\ J}{3.7\ V} = 54054\ C$$

The moles of electrons will be

$Q = nF$

Where F (96500 C/mol) is Faraday's constant (the charge in one mole of electrons)

$$n = \frac{Q}{F} = \frac{54054\ C}{96500\ (C/mol)} = 0.56\ mol\ e^-$$

So, the correct answer is option **A.**

Question 15 – Catalytic Converter Part 1

From Hess's law we can conclude that $\Delta H_0 = \Delta H_1 + \Delta H_2 + \Delta H_3$. Therefore, statements A and C are false. Statement B is false because catalytic converters do not need to be replaced often because all the holes that bind a gas in the process set the gas free later, so all free sites on the catalytic converter are generally regenerated. Statement D is true because it captures the idea that the catalyzed multistep route has lower effective activation barriers (hence faster/easier oxidation).

So, the correct answer is option **D**.

Question 16 – Catalytic Converter Part 2

$$\text{C mass burning rate} = 0.1 \text{ kg/min} \times 0.85 = 0.085 \text{ kg/min} = 85 \text{ g/min}$$

$$\text{C moles burning rate} = \frac{85 \text{ g/min}}{12.01} = 7.077 \text{ mol/min}$$

$$\text{rate of } CO_2 \text{ formed initially} = 7.077 \times 0.4 = 2.831 \text{ mol/min}$$

$$\text{rate of CO formed initially} = 7.077 \times 0.6 = 4.246 \text{ mol/min}$$

$$\text{rate of CO turning into } CO_2 = 6 - 2.831 = 3.169 \text{ mol/min}$$

$$\text{Catalytic efficiency} = \frac{3.169 \text{ mol/min}}{4.246 \text{ mol/min}} \times 100\% = 74.6\%$$

So, the correct answer is **D**.

Question 17 – Lactic Acid Production

$$\mathrm{pH} = \mathrm{pK_a} + \log\frac{[\mathrm{A^-}]}{[\mathrm{HA}]} = 3.9 + \log 10 = 4.9$$

So, the correct answer is option **B**.

Question 18 – 7075 Aluminum

Out of the compounds given, Aluminum, Zinc, and Magnesium react with HCl. However, copper doesn't because Cu is less reactive than H.

$$\text{Al moles} = \frac{10 \times 0.90}{26.98} = 0.33358 \text{ mol}$$

$$2\,\text{Al} + 6\,\text{HCl} \rightarrow 2\,\text{AlCl}_3 + 3\,\text{H}_2$$

$$\text{H}_2 \text{ moles formed} = 1.5 \times 0.33358 \text{ mol} = 0.50037 \text{ mol}$$

$$\text{Zn moles} = \frac{10 \times 0.06}{65.38} = 0.00918 \text{ mol}$$

$$\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$$

$$\text{H}_2 \text{ moles formed} = 0.00918 \text{ mol}$$

$$\text{Mg moles} = \frac{10 \times 0.025}{24.31} = 0.01028 \text{ mol}$$

$$\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$$

$$\text{H}_2 \text{ moles formed} = 0.01028 \text{ mol}$$

$$\text{Total H}_2 \text{ moles formed} = 0.50037 + 0.00918 + 0.01028 = 0.51983 \text{ mol}$$

So, the correct answer is option **C**.

**When solving problems like this, be mindful about which compounds react with which. Some students tend to solve problems like this if Cu reacts with HCl.

Question 19 – Reaction Rates

$v = k[F]^0 = k$ (zero order reaction)

Here [F] denotes the concentration of fuel

$$v = \frac{[F]}{\Delta t} = Ae^{-\frac{E_a}{RT}}$$

Dividing the results obtained in experiment 1 and 2

$$\frac{[F]_1}{[F]_2} \times \frac{\Delta t_2}{\Delta t_1} = e^{-\frac{E_a}{R}(\frac{1}{T_1}-\frac{1}{T_2})}$$

$$\frac{0.50}{0.75} \times \frac{8}{10} = e^{-\frac{E_a}{R}(\frac{1}{800}-\frac{1}{900})}$$

$$\frac{8}{15} = e^{\frac{-E_a}{7200R}} \rightarrow e^{\frac{-E_a}{R}} = (\frac{8}{15})^{7200}$$

Dividing the results obtained in experiment 1 and 3

$$\frac{[F]_3}{[F]_1} \times \frac{\Delta t_1}{\Delta t_3} = e^{-\frac{E_a}{R}(\frac{1}{T_3}-\frac{1}{T_1})} \rightarrow \frac{[F]_3}{[F]_1} = \frac{6}{10} \times (\frac{8}{15})^{7200\times(\frac{1}{950}-\frac{1}{800})}$$

$$\frac{[F_3]}{[F_1]} = 1{,}466 \rightarrow n_3 = 0.50 \times 1.466\, moles = 0.73\, moles$$

So, the correct answer is option **B**.

Question 20 – Equilibrium

Considering the reaction for 1s,

CO intake = 1 L

H_2O intake = 2L

If x moles of CO and H_2O react,

Final CO moles = 1 - x

Final H_2O moles = 2 - x

Final CO_2 moles = x

Final H_2 moles = x

$$K = \frac{[H_2]\,[CO_2]}{[CO]\,[H_2O]} = \frac{x^2}{(1-x)^2} = 1.60$$

$$\frac{x}{1-x} = \sqrt{1.60} = 1.265$$

$$x = 0.5585\ L/s$$

So, the correct answer is option **D**.

Question 21 – Hydrogen Combustion

Power $= 1000 \times 745.7 = 745700$ W

Energy needed in 1 min $= 745700 \times 60 = 4.474 \cdot 10^7$ J

Energy from burning hydrogen $= \frac{4.474 \cdot 10^7}{0.8} = 5.593 \cdot 10^7$ J

Moles of $H_2O = \frac{5.593 \cdot 10^7}{286 \times 1000} = 195.6$ mol

$2\,H_2 + O_2 \rightarrow 2H_2O$

Therefore, H_2 moles $= H_2O$ moles $= 195.6$ mol

H_2 mass $= 2 \times 1.01 \times 195.6 = 395.0$ g

So, the correct answer is option **D**.

Question 22 – Effects on the body

Let's analyze each option

A. is likely: blood pooling can impair venous and lymphatic return, causing tingling or discomfort.

B. is likely: reduced cerebral blood flow can cause syncope.

C. is likely: reduced retinal oxygenation can cause visual disturbances or "blackout."

D. is not likely: lung capacity does not increase due to deceleration forces, nor does cockpit air pressure rise enough to affect lung volumes. Lung capacity is determined by anatomy and respiratory mechanics, not transient G-forces.

So, the correct answer is option **D.**

Question 23 – Evolution

Industrial melanism is a classic example of natural selection, specifically directional selection, where environmental pollution causes dark-colored (melanic) forms of animals to become more common because they camouflage better against dark backgrounds, surviving predation while lighter forms die out.

So, the correct answer is option **A**.

Question 24 – Evolutionary Biology

Let's analyze each option

i) This corresponds to homologous evolution, where species share a common ancestor but evolve different traits. Therefore, this statement is correct.

ii) This is Lamarckian, not Darwinian evolution. In real populations, acquired traits are not genetically inherited, so this statement is incorrect.

iii) Mutations occur randomly, not with a goal in mind. Designing a streamlined body is intentional, so the statement is incorrect.

iv) This corresponds to convergent evolution, where unrelated species evolve similar traits in response to similar environmental pressures. This statement is correct.

So, the correct answer is option **B**.

Question 25 – Photoreceptors

Phytochromes are essential photoreceptors in the plant's photoreceptor system, primarily responsible for detecting and responding to far-red and red-light stimuli, and they play a critical role in regulating seed germination, SAS, photomorphogenesis, flowering, vernalization, etc.

So, the correct answer is option **A**.

Question 26 – Processing of Light

Let’s analyze each option

A. No strong evidence that red light alone causes macular degeneration. Therefore, option A is false.

B. Rods are the photoreceptors used for dim vision and have more acuity than cones. Therefore, option B is false.

C. The ventral tegmental area (VTA) is a crucial midbrain structure, central to the brain's reward system, not a part of the visual pathway. Therefore, option C is false.

D. The axons of the ganglion cells in the retina combine to form the optic nerve that carries information to the primary visual cortex. Option D is correct.

So, the correct answer is option **D**.

Question 27 – Dehydration

ADH, or Antidiuretic Hormone (also called vasopressin), is a crucial brain-produced hormone that regulates your body's water balance by telling the kidneys to reabsorb water, reducing urine output and controlling blood pressure.

So, the correct answer is option **B**.

Question 28 – Blocked Stomata

It is important to carefully consider the wording of the question; it says which of the following will NOT subsequently result from blocked stomata. Let's keep in mind that stomata function in gas transport, so blocking them will affect O_2 and CO_2 levels. Option A is factually correct; the light-independent reaction will not be stalled because it does not need CO_2 it only needs light and water. The light dependent reactions, however, require an input of CO_2, so ATP and NADH will build up but sugar will not be produced. Option B is also factually correct because photolysis rates will reduce if the Calvin cycle doesn't get enough CO_2 which leads to less NADP+ and less electrons too. Option C is factually correct because if there is a reduction in evaporative cooling, leaf temperature rises. Option D is incorrect because although in cases of severe photodamage, the immediate result is the suffocation of stomata, not the protection of leaves.

So, the correct answer is **D**.

Question 29 – Pooling of Blood

Veins have special valves that prevent backflow due to their low blood pressure. Arterioles and capillaries do not have valves. Lymphatic ducts have valves, but for lymph, not blood.

So, the correct answer is option **C**.

Question 30 – Tire Wear Particles

Contamination of soil and waterways with TWPs causes heavy metals to change the pH of the environment and negatively affect the health of plants and the ecosystem. Option A is incorrect; TWPs have heavy metals like zinc in them, they do not have a high nitrogen content and thus cannot lead to an algal bloom. Option B is incorrect; bioaugmentation is the process of introducing microorganisms into an environment to aid nutrient breakdown. TWPs are not and do not contain beneficial microorganisms. Option C is incorrect; fungi, plants, and insects cannot simply incorporate heavy metals into their exoskeletons.

So, the correct answer is option **D**.