Duration: 1 hour 30 minutes **Date: 01/02/2026**

Level: 1st Year Medicine
Exam: Physics – Biophysics

Important!!: For each question, select only one correct answer.

Q 01: A glucose solution contains 9 g dissolved in 250 ml of water. The molar mass of glucose is 180 $g \cdot mol^{-1}$. What are the molarity and the mass concentration of the solution?

A. $C = 0{,}2\ mol \cdot l^{-1}$; $C_{mass} = 36$ g/l
B. $C = 0{,}05\ mol \cdot l^{-1}$; $C_{mass} = 39\ g/l$
C. $C = 2\ mol \cdot l^{-1}$; $C_{mass} = 3.6\ g/l$
D. $C = 0{,}2\ mol \cdot l^{-1}$; $C_{mass} = 0.0\ 36\ g/l$
E. $C = 0{,}9\ mol \cdot l^{-1}$; $C_{mass} = 0.39\ g/l$

Q 02 : In blood plasma, consider only Na^+ and Ca^{2+} ions. Data :
$[Na+] = 0.14\ mol.l^-$ $[Ca^{2+}]$=0.002 $mol.l^-$ ionic mobility $u_{Na^+} = 5.2 \times 10^{-8}$, $u_{Ca^{+2}} = 5.0 \times 10^{-8}\ m^2/V.s$ Charge of an ion : $e = 1.6 \times 10^{-19}\ C$, Avogadro's number : $N_A = 6.02 \times 10^{23}\ mol^{-1}$

Estimate the ratio of ionic conductivities of Na^+ and Ca^{2+}, $\frac{\sigma_{Na^+}}{\sigma_{Ca^{+2}}}$ in an electrolyte solution.

A. 10
B. 184
C. 50
D. 10
E. 36

Q03 : A mass x of glycerol ($C_3H_8O_3, M = 92\ g \cdot mol^{-1}$) is dissolved in 2.5 kg of solvent. This solution produces the same freezing ΔT_f point depression as 2.5 g of sucrose ($C_{12}H_{22}O_{11}, M = 342\ g \cdot mol^{-1}$) dissolved in 125 g of the same solvent. What is the va lue of x?

A. 0.15 g
B. 2.5 g
C. 7.3 g
D. 13.5 g
E. 25 g

Q 04 : Hemoglobin (M≈64,500 g/mol) diffuses through a semi-permeable membrane according to Fick's law. Diffusion coefficient: $D = 2 \times 10^{-11}\ m^2/s$; Membrane thickness: $\Delta x = 5\ \mu m$; Surface area: $S = 1\ cm^2$; Concentrations: blood side $C_1 = 2 \times 10^{-3}\ mol/l$, tissue side $C_2 = 0.5 \times 10^{-3}\ mol/l$. What amount of hemoglobin (in mol) crosses the membrane in time 30 minutes?

A. 1.08×10^{-6} mol
B. 1.08×10^{-3} mol
C. 3.6×10^{-7} mol
D. 6×10^{-12} mol
E. 10^{-12} mol

Q 05 : The electrical conductivity σ\sigmaσ of an electrolyte solution is given, in its general form, by:

$$\sigma = \sum C_i\,|Z_i|u_i\,F$$

For a binary electrolyte, this expression becomes:

$$\sigma = C.F.\propto (|z^+|u^+ + |z^-|.u^-)$$

If the ionic charge $|Z_i|$, the ionic mobility u_i and Faraday's constant F are all kept constant, which change in the remaining parameter leads to an increase in the electrical conductivity σ?

A. An increase in the ionic mobility
B. An increase in the degree of dissociation of the electrolyte
C. An increase in the molar concentration of the electrolyte
D. An increase in the ionic valence
E. Dilution of the solution

Q 06 :Fick's first law describes the diffusive flux of a substance across a membrane or medium: $J = -D\frac{dC}{dx}$.Which of the following statements is correct?

A.If the concentration gradient $\frac{dC}{dx}$>0, then the flux $J > 0$.
B. Diffusion always occurs from a region of low concentration to a region of high concentration.
C. The diffusive flux is proportional to the concentration gradient and directed from the high-concentration region to the low-concentration region.
D. The flux depends on time.
E. The flux is independent of the diffusion coefficient D.

Q 07 :A capacitor in a series RC circuit (R, C) is charged by a voltage source VsThe initial capacitor voltage is $V_c(0) = 0$.Which of the following statements correctly describes the capacitor voltage$V_c(t)$ at time t?

A. $V_c(t) = Vs(1 - e^{-t}/_{RC})$
B. $V_c(t) = Vse^{-t}/_{RC}$
C. $Q(t) = C.E(1 - e^{\frac{-t}{\tau}})$
D. $V_c(t) = Vs(1 - e^{RC}/_{-t})$
E. $I(t) = \frac{Vs.e^{-t}/_{\tau}}{R}$

Q 08 :We dissolve 24 g of acetic acid $CH3COOH$, molar $mass\ M = 60\ g/mol$, in 1 $liter$ of water. The degree of dissociation is $\alpha = 0.1$.What is the osmolarity of the solution?

A. 0.36 osmol/l
B. 0.40 osmol/l
C. 0.44 osmol/l
D. 0.24 osmol/l
E. 0.60 osmol/l

Q 09 :A glucose infusion is administered through a semi-permeable membrane with:
Thickness: $e = 1\ mm$
Surface area: $S\ =\ 0{,}01\ m^2$, Concentration gradient: $\Delta C = C_{plasma} - C_{perfuse'} = 0{,}1\ mol.m^{-3}$
Diffusion coefficient: $D = 2 \times 10^{-9}\ m^2.s^{-1}$According to Fick's first law, what is the total diffusive flux of glucose through the membrane (mol/s)?

A. 2×10^{-12}
B. 2×10^{-6}
C. 2×10^{-10}
D. 2×10^{-9}
E. 2×10^{-8}

Q10: A cell has three ion channels in parallel: sodium (Na^+), potassium (K^+), and leak (L). The measured currents are: $I_{Na} = 1\ \mu A$, $I_K = 2\ \mu A$ The total measured current is $I_{tot} = 5\ \mu A$?
What is the leak current I_L?

A. 1 μA
B. 2 μA
C. 3 μA
D. 4 μA
E. 5 μA

Q 11 : A neuron has three ion channels: sodium Na^+, potassium K^+, and leak L. Their resistances are: $R_{Na} = 50\Omega$, $R_K = 100\Omega$, $R_L = 200\Omega$ .The sodium and potassium channels are in parallel, and this combination is in series with the leak channel.The membrane voltage is $Vm = 60\ mV$.
What is the current through the leak channel I_L?

A. 0.03 mA
B. 257.0 mA
C. 2.57 mA
D. 25.7 mA
E. 0.257 mA

Q 12 : A pacemaker is modeled by a series RC circuit. The parameters are:
Resistance: $= 1\ k\Omega$, Capacitance: $C = 10\ \mu F$, voltage source : $V = 100\ mV$: Initial capacitor voltage : $V_C(0) = 0$ .Time constant: $\tau = 10\ ms$
After 10 ms, what are the current $I(t)$, and charge Q?

A. $0.633\ \mu C$; $0.037\ mA$
B. $10\ \mu C$; $0.063\ mA$
C. 100 μC ; 0.1 mA
D. $1000\ \mu C$; $0.5\ mA$
E. $0.1\ \mu C$; $1\ mA$

Q 13 : A perfusion solution is an aqueous solution containing: NaCl at a concentration of 0,14 $mol.l^{-1}$, KCl at a concentration of 0,01 $mol \cdot l^{-1}$.Assume that both salts are completely dissociated.What is the total osmolarity of this solution?

A. 0,14 $Osm \cdot l^{-1}$
B. 0,15 $Osm \cdot l^{-1}$
C. 0,28 $Osm \cdot l^{-1}$
D. 0,30 $Osm \cdot l^{-1}$
E. 0,32 $Osm \cdot l^{-1}$

Q 14 : During phase 0 of a cardiac action potential, the sodium current I_{Na} is:

A. 0 mA (no sodium movement)
B. Negative (inward sodium current)
C. Positive (outward sodium current)
D. Equal to the potassium current , I_K
E. Maximal in magnitude but positive

Q15 : The freezing point depression ΔT_f of an non electrolyte solution is given by the classic formula:

A. $\Delta T_f = n.K_f \cdot m$
B. $\Delta T_f = K_f \cdot M$
C. $\Delta T_f = K_f \cdot m$
D. $\Delta T_f = K_f / m$
E. $\Delta T_f = m / K_f$

Q16 : A myocardial cell is modeled as a membrane capacitor $Cm = 1\,\mu F$ in series with the total resistance $Rtot$, which represents the ionic resistances in parallel: $R_{Na} = 50\Omega$, $R_K = 100\Omega$, $R_L = 200\Omega$. Which of the following values corresponds to the characteristic depolarization time τ of this cell?

A. 50.65 µs
B. 28.6 µs
C.100.6 µs
D. 200.6 µs
E. 1.65 µs

Q17: A myocardial cell behaves like an electric dipole when:

A. It is completely at rest
B. It is fully depolarized
C. It is partially depolarized
D. It is fully repolarized
E. It is in the refractory period

Q 18 : What is the correct sequence of cardiac electrical activation?

A. AV node ↦ SA node ↦ His bundle ↦ Purkinje fibers
B. Purkinje fibers ↦ SA node ↦ ventricles
C. SA node ↦ Purkinje fibers ↦ ventricles
D. His bundle ↦ SA node ↦ AV node
E. SA node ↦AV node ↦ His bundle ↦Purkinje fibers

Q 19 : The QRS complex on the ECG primarily corresponds to:

A. Atrial depolarization
B. Ventricular depolarization
C. Atrial repolarization
D. Ventricular repolarization
E.Ventricular contraction

Q 20 : In the Goldman (Goldman–Hodgkin–Katz) equation, the membrane potential

$$E_m = \frac{R.T}{F} ln\left(\frac{P_{K^+}[K^+]_{outside}}{P_{K^+}[K^+]_{inside}} + \frac{P_{Na^+}[Na^+]_{outside}}{P_{Na^+}[Na^+]_{inside}} + \frac{P_{Cl^-}[Cl^-]_{inside}}{P_{Cl^-}[Cl^-]_{outside}}\right)$$ depends on:

A. Only ionic concentrations
B. Only ionic charges
C. Only membrane capacitance
D. Ionic concentrations and ionic permeabilities
E. Only membrane resistance

Wishing you good luck

Les bords contiennent de petits carrés noirs pour la lecture automatique. Ne pas raturer !

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EMD 1 de Biophysique (Première Année de Médecine : 2025-2026)

Nom:

Prénom:

Salle/Place /

Matricule

Date de naissance : / /

Ce sujet contient 20 QCM

	A	B	C	D	E
1.	☒	☐	☐	☐	☐
2.	☐	☐	☐	☐	☒
3.	☐	☐	☐	☒	☐
4.	☒	☐	☐	☐	☐
5.	☐	☐	☒	☐	☐
6.	☐	☐	☒	☐	☐
7.	☒	☐	☐	☐	☐
8.	☐	☐	☒	☐	☐
9.	☐	☐	☐	☒	☐
10.	☐	☒	☐	☐	☐

	A	B	C	D	E
11.	☐	☐	☐	☐	☒
12.	☒	☐	☐	☐	☐
13.	☐	☐	☐	☒	☐
14.	☐	☒	☐	☐	☐
15.	☐	☐	☒	☐	☐
16.	☐	☒	☐	☐	☐
17.	☐	☐	☒	☐	☐
18.	☐	☐	☐	☐	☒
19.	☐	☒	☐	☐	☐
20.	☐	☐	☐	☒	☐

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