CATÓLICA
FACULDADE DE MEDICINA
LISBOA

UNIVERSIDADE
CATÓLICA
PORTUGUESA

Integrated Masters in Medicine

Model Exam | Special Admissions

According to the terms of Article 4, paragraph 1., subparagraph b), of the Regulations for Access and Admission to the Integrated Masters in Medicine of the Católica Medical School

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Academic Year: 2025/2026

Exam: Mathematics

Date: 16/06/2025

Duration: 90 minutes

Compensation time: 30 minutes

Instructions:

- The exam is based on 20 questions, 10 multiple-choice and 10 essay questions.
- Each multiple-choice question is marked out of 0.5 values and each essay question is marked out of 1.5 values.
- Only a blue or black pen may be used.
- The use of a broker is not allowed.
- All questions must be answered on the exam sheet.
- The use of a scientific calculator is allowed.

1. A box contains 5 red, 7 green, and 8 blue balls. Two balls are drawn at random without replacement. Assume that each ball has an equal probability of being drawn. The probability both balls are green is:

a) ☐ 0,18 b) ☐ 0,23 c) ☐ 0,25 d) ☐ 0,11

2. A component fails 3% of the time under stress and 1% without stress. The probability that a component is under stress is 0.2. Calculate the overall probability of failure.

3. If P(A) = 0,6, P(B) = 0,5, and P(A ∩ B) = 0,3 then P(A ∪ B) is:

a) ☐ 0,8 b) ☐ 0,9 c) ☐ 0,7 d) ☐ 0,6

4. Calculate the expected value and variance of the random variable X with the following distribution:

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$X = x_i$	0	1	2	3
$P(X = x_i)$	0,2	0,4	0,3	0,1

5. The value of K in the distribution below is:

$X = x_i$	0	1	2	3
$P(X = x_i)$	K/2	0,4	0,3	0,1

a) ☐ 0 , 1 b) ☐ 0,2 c) ☐ 0,4 d) ☐ 0,3

6. A geometric sequence has first term $u_1 = 2$ and ratio r = 3. Calculate the sum of the first 6 terms.

7. A line ***t*** has slope m = -3. A perpendicular line to ***t*** will have slope:

a) ☐ 1/3 b) ☐ -1/3 c) ☐ 3 d) ☐ -3

8. Show that $(2n - 3)^2 + (2n - 1)(2n + 1) + (2n + 3)^2 = 12n^2 + 17$, where $n \in \mathbb{Z}$.

9. Consider points A(1,2) and B(5,2). D coordinates to creates a right triangle ABD are:

a) ☐ (2,4) b) ☐ (1,2) c) ☐ (0,3) d) ☐ (5,0)

10. A function ***f(x) = 5x²-20x+1*** is given. Find vertex coordinates and determine whether it is a maximum or minimum.

11. One of the solutions of the equation ***x² + 6x + 13 = 0*** is:

a) ☐ -3+2i b) ☐ 3-2i c) ☐ - 2+3i d) ☐ 2-3i

12. Consider the function ***f(x) = x³ + ln(x)***, x > 0. Compute f ''(2).

13. For the function ***h(ϑ) = 3 + 2cos(ϑ),*** the value of θ when h = 4 is:

a) ☐ π/3 b) ☐ π/2 c) ☐ π/4 d) ☐ π/6

14. The function ***g(x) = (3x + 5)/(x - 2)*** is given. Find the vertical and horizontal asymptotes.

15. The complex number $z = 6e^{(\frac{i\pi}{3})}$ into algebraic form is:

a) ☐ $3\sqrt{3}$+3i b) ☐ 6 c) ☐ 3+3$\sqrt{3}$ i d) ☐ 3+3i

16. Let **p(x) = 5x² + ln(3x)**, x > 0. Determine the x- inflection point.

17. The sum of the first 12 terms of the arithmetic sequence $u_n = 7n - 2$ is:

a) ☐ 432 b) ☐ 522 c) ☐ 500 d) ☐ 498

18. Find the exact value of θ > 0 (in radians) such that $3 + 4\sin(\vartheta) = 5$ and then calculate 2cos(θ).

19. The function $f(x) = \ln(3x) + 4e^{7x}$ is given. The first derivative of function *f* at x = 1 is:

a) ☐ $3+28e^7$ b) ☐ $1+28e^7$ c) ☐ $2+26e^7$ d) ☐ $1+26e^7$

20. Write the complex number Z = 4 + 4i in polar form.

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1. Option **d)**

2. P(F|S) = 0,03 P(F|NS) = 0,01 P(S) = 0,2

Applying the Law of Total Probabilities,

$$P(F) = P(F|S) * P(S) + P(F|NS) * P(NS)$$

$$P(F) = 0{,}03 * 0{,}2 + 0{,}01 * 0{,}8 = 0{,}014$$

3. Option **a)**

4. E[X] = 0*0,2+1*0,4+2*0,3+3*0,1 = 1,3

Var(X) = $E[X^2] - E[X]^2$

$E[X^2] = 0^2*0{,}2+1^2*0{,}4+2^2*0{,}3+3^2*0{,}1 = 2{,}5$

$Var(X) = 2{,}5 - 1{,}3^2 = 0{,}81$

5. Option **c)**

6. $S_n = \frac{u_{1(r^n-1)}}{(r-1)}$

$u_1 = 2$ r = 3

$S_6 = \frac{2(3^6-1)}{(3-1)} = 2 * \frac{728}{2} = 728$

7. Option **a)**

8. $(2n-3)^2 + (2n-1)(2n+1) + (2n+3)^2 = 4n^2 - 12n + 9 + 4n^2 - 1 + 4n^2 + 12n + 9 = 12n^2 + 17$

9. Option **d)**

10. vertex coordinates = (-b/2a; f(-b/2a))

x_{vertex} = 20/10 = 2

y_{vertex} = 5*4-20*2+1 = -19

vertex coordinates : (2, -19).

It is a minimum.

11. Option **a)**

12. $f'(x) = 3x^2 + \frac{1}{x}$ $f''(x) = 6x - \frac{1}{x^2}$ $f''(2) = 6 * 2 - \frac{1}{4} = 11{,}75$

13. Option **a)**

14. $\frac{3x-5}{x-2} = 3 + \frac{11}{x-2}$

Function g(x) has a vertical asymptote, x = 2 and a horizontal asymptote, y = 3.

15. Option **c)**

16. $p'(x) = 10x + \frac{1}{x}$ $\quad p''(x) = 10 - \frac{1}{x^2}$ $\quad 10 - \frac{1}{x^2} = 0$

$10x^2 - 1 = 0 \wedge x \neq 0 \Leftrightarrow x = \pm\sqrt{\frac{1}{10}}$.

x-inflection point is $\sqrt{\frac{1}{10}}$, because x > 0.

17. Option **b)**

18. $3 + 4sen(\theta) = 5 \Leftrightarrow sen(\theta) = \frac{2}{4} = \frac{1}{2}$ $\quad \frac{1}{4} + cos^2(\theta) = 1 \Leftrightarrow \cos(\theta) = \pm\frac{\sqrt{3}}{2}$

$$2\cos(\theta) = 2\frac{\sqrt{3}}{2} = \sqrt{3}$$

19. Option **b)**

20. $\rho = \sqrt{4^2 + 4^2} = \sqrt{32} = 4\sqrt{2}$

$tg(\theta) = \frac{4}{4} = 1$ $\quad \theta = \frac{\pi}{4}$ (because θ is an angle of 1st quadrant)

$$z = 4\sqrt{2}e^{(\frac{\pi}{4}i)}$$

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Academic Year: 2025/2026

Exam: Biology

Date: 18/06/2025 (Wednesday) at 10:00 am

Duration: 90 minutes

Compensation time: 30 minutes

Instructions:

- The exam is evaluated from 0 to 200 points.
- The exam is based on 30 questions, 25 multiple-choice and 5 essay questions.
- Each multiple-choice question is marked out of 5.0 points and each essay question is marked out of 15.0 points.
- Only a blue or black pen may be used.
- The use of a broker is not allowed.
- All questions must be answered on the exam sheet.

1. The Buçaco National Forest (BNF) constitutes a heritage of incalculable value. The forest is organized into several landscape units, including Vale dos Fetos and Mata Climácica. The latter is a plant formation, made up of autochthonous plants[1], which preserves the typical characteristics of the primitive forest that existed in this region before human occupation.

Vale dos Fetos, an enclosed valley that develops along a fault, is one of the darkest and coolest areas of BNF, where one can find a great diversity of mosses. Mosses are non-vascular plants, with the gametophyte generation more developed than the sporophyte generation and with biflagellate antherozoids (male gametes).

In sunny and dry places, there is an abundance of plants with fleshy leaves belonging to the Sedum genus. These succulent plants open their stomata only at night and, through the action of the PEP (phosphoenolpyruvate) carboxylase enzyme present in the cytosol, the absorbed carbon dioxide is stored in the vacuoles, in the form of malic acid ($C_4H_6O_5$). During the day, stored malic acid is transported to chloroplasts, where it is decarboxylated.

In the forest, close to small streams with clear, flowing water, lives the Lusitanian salamander, *Chioglossa lusitanica*, from the Salamandridae family, a species endemic to the northwest of the Iberian Peninsula (Portugal and Spain). Adult individuals of this species feed on small insects, arachnids, and molluscs, and have a capacity that is uncommon in amphibians: they release their tail when threatened (autotomy), regenerating it later. The Lusitanian salamander, which is distinguished from other salamander species by having a narrow and elongated body, can reach 15 cm in length as an adult, of which two thirds corresponds to the tail, and has essentially cutaneous respiration, as it does not have functional lungs.

Note: [1] Autochthonous – native species, that is, natural to a given ecosystem or a given region.

1.1. The processes that occur in the life cycle of mosses lead to the formation of

(A) gametes, through meiosis, the life cycle being haplodiplontic.

(B) unicellular gametophytes, with postzygotic meiosis.

(C) diploid sporophytes, from genetically different spores.

(D) haploid spores, which mark the beginning of the gametophyte generation.

1.2. The processes that occur during the night period in plants of the genus Sedum lead

(A) the downward movement of water in the xilemic vessels.

(B) the increase in osmotic pressure in the vacuoles.

(C) the temporal separation of CO_2 absorption and perspiration.

(D) the entry of CO_2 into cells by mediated transport.

1.3. Order the expressions identified by the letters A to E, in order to reconstruct the correct sequence of events that allow the absorption of CO_2 and its subsequent use in the production of organic matter, in plants of the Sedum genus.

A. Opening of the stomata.

B. K^+ entry into stomatal cells against the concentration gradient.

C. Occurrence of anabolic processes due to the action of PEP carboxylase.

D. Carbon incorporation during the Calvin cycle.

E. Transport of malic acid to chloroplasts.

1.4. Although it evolved from ancestors with functional lungs, the Lusitanian salamander does not have functional lungs. This characteristic highlight that

(A) from a Darwinian perspective, lung atrophy resulted from the occurrence of a mutation.

(B) from a Lamarckian perspective, the variability of their ancestors ensured metabolism with cutaneous hematosis.

(C) the increase in the area/volume ratio favored the survival of salamanders in an environment with high humidity.

(D) the increased thickness of the integument allowed the salamanders to survive during periods of high dryness.

1.5. Complete the following text, selecting the appropriate option for each space.
Write each letter on the answer sheet, followed by the number that corresponds to the selected option.

According to the criteria of the modified Whittaker classification system, Lusitanian salamanders have __a)__ . These amphibians, as adults, have circulation __b)__ and a heart with __c)__. Digestion of the prey they capture occurs __d)__.

a)	**b)**
1. absorption heterotrophism **2.** prokaryotic cell structure **3.** high tissue differentiation	**1.** simple **2.** full double **3.** incomplete double
c)	**d)**
1. two ventricles and one atrium **2.** two atria and one ventricle **3.** two atria and two ventricles	**1.** in a complete digestive tract **2.** in a gastrovascular cavity **3.** in an incomplete digestive tract

1.6. The Lusitanian salamander uses two different cell division mechanisms, one to reproduce and the other to regenerate its tail.

Associate with the division mechanisms, presented in Column I, the events described in Column II that correspond to them. Each number must be associated with only one letter, and all numbers must be used.

Column I	**Column II**
(a) Only in mitosis **(b)** Only in meiosis **(c)** In mitosis and meiosis	**(1)** There is replication of genetic information before nuclear division begins. **(2)** There is pairing of homologous chromosomes and exchange of segments with each other. **(3)** There is maintenance of ploidy and a reduction in the amount of DNA by half, compared to the mother cells in G2. **(4)** The centromeres divide, and the chromatids separate to opposite poles of the cell. **(5)** Haploid cells are formed from the division of diploid cells. **(6)** The nuclear membrane reorganizes around chromosomes made up of two chromatids. **(7)** Genetically identical daughter cells are formed.

2. The diagram shows the structure of insulin.

From the diagram, what can be concluded about the structure of insulin?

(A) It is composed of two polypeptide chains stabilized by disulfide bonds.

(B) It is a simple protein composed of one continuous polypeptide chain.

(C) It is a fibrous protein.

(D) Its molecules do not display quaternary structure.

3. Malaria is a disease caused by protozoa introduced into human blood through the bite of the female *Anopheles gambiae* mosquito. The female, when feeding on blood, acquires an abundant nutritional supplement with ten essential amino acids, which provides her with a higher reproductive rate.
Mosquitoes control the coagulation system during their meals by having anticoagulant substances in their saliva. One of these substances – anopheline – is a peptide molecule that inhibits the thrombin enzyme. This enzyme converts fibrinogen, a soluble plasma protein, into fibrin, an insoluble protein, forming clots that impede blood circulation.
The mosquito detects odors through the axonal endings of the olfactory neurons of the antennae, which, on their surface, have receptors to which odorant molecules bind.
Precisely manipulating the behavior of mosquitoes through their olfactory faculties is a strategy that can help save many lives.

3.1. The parasite introduced into the bloodstream by the *Anopheles gambiae* mosquito, being a protozoan, is a

(A) unicellular prokaryotic.

(B) multicellular prokaryotic.

(C) eukaryotic unicellular.

(D) eukaryotic multicellular.

3.2. The nutritional supplement obtained from the diet of female *Anopheles gambiae* mosquitoes allows the synthesis of

(A) carbohydrates in anabolic pathways.

(B) protides in anabolic pathways.

(C) carbohydrates in catabolic pathways.

(D) protides in catabolic pathways.

3.3. The mosquito's olfactory neurons send signals to a

(A) nervous center through motor neurons.

(B) effector organ through sensory neurons.

(C) effector organ through motor neurons.

(D) nervous center through sensory neurons.

3.4. Explain how anopheline can be the basis for the development of a new drug intended for the prevention and treatment of cardiovascular diseases.

4. The table shows the mRNA codons for three amino acids.

Valine	Threonine	Proline
GUU	ACU	CCU
GCC	ACC	CCC
GCA	ACA	CGA
GCG	ACG	CCG

Which substitution mutation of a base triplet on a DNA strand will lead to the same polypeptide being formed at translation?

(A) GCT to GGA

(B) CGT to CTA

(C) CAA to CGA

(D) TGA to TCA

5. What is a function of the lymphatic system?

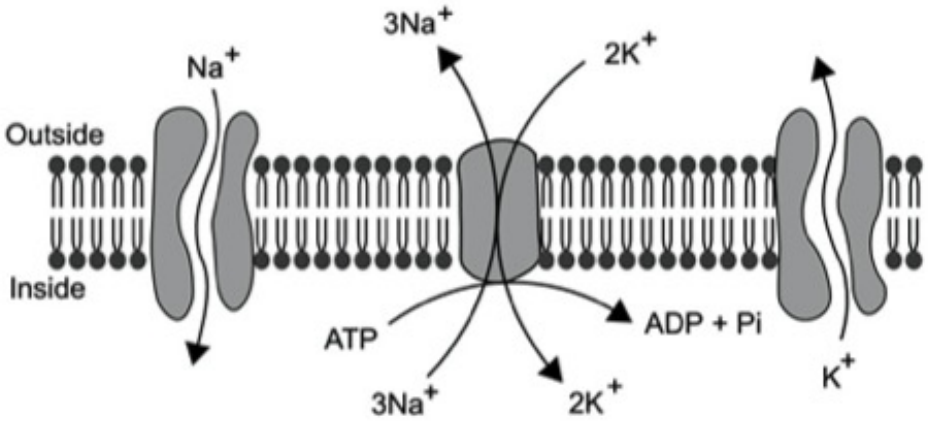
(A) absorption of glucose

(B) blood clotting

(C) circulation of body fluids

(D) temperature regulation

6. The diagram shows the movement of ions that can occur across the membrane of a neuron.



From the diagram, what can be deduced about the movement of sodium ions?

(A) They are actively pumped out and some re-enter by simple diffusion.

(B) They are actively pumped out and some re-enter by facilitated diffusion.

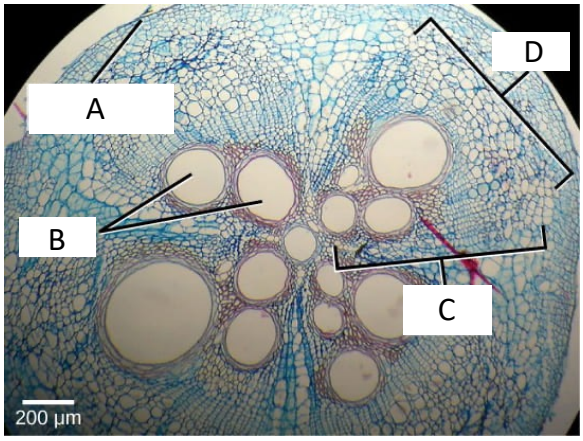
(C) They diffuse out of the cell along with potassium ions.

(D) There is a net movement of sodium ions into the cell.

7. The diagram shows a cross-section through a leaf.

7.1. Make the legend of the figure.

7.2. Explain the function of the tissues represented by the letters B and D.



8. The diagram shows the circulatory system of a fish.

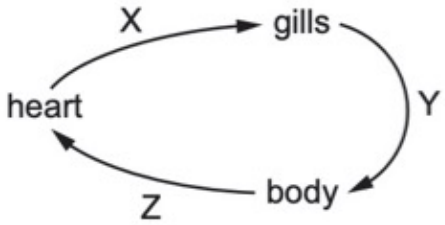
Where in the circulatory system is the oxygen concentration lowest?

(A) Y and Z

(B) X and Y

(C) Y only

(D) X only



9. Which cell is a component of the innate immune system?

(A) Phagocyte

(B) T lymphocyte

(C) B lymphocyte

(D) B memory cell

10. The horse, *Equus ferus*, and the donkey, *Equus asinus*, are able to interbreed. The offspring they produce is called a mule.

Which statement is correct?

(A) The horse and the donkey are the same species; the mule is infertile.

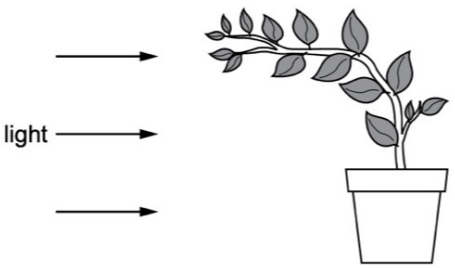
(B) The horse and the donkey are the same genus; the mule is fertile.

(C) The horse and the donkey are the same genus; the mule is infertile.

(D) The horse and the donkey are the same species; the mule is fertile.

11. The diagram shows a plant.

Which characteristic of living organisms is shown by the plant in the diagram?



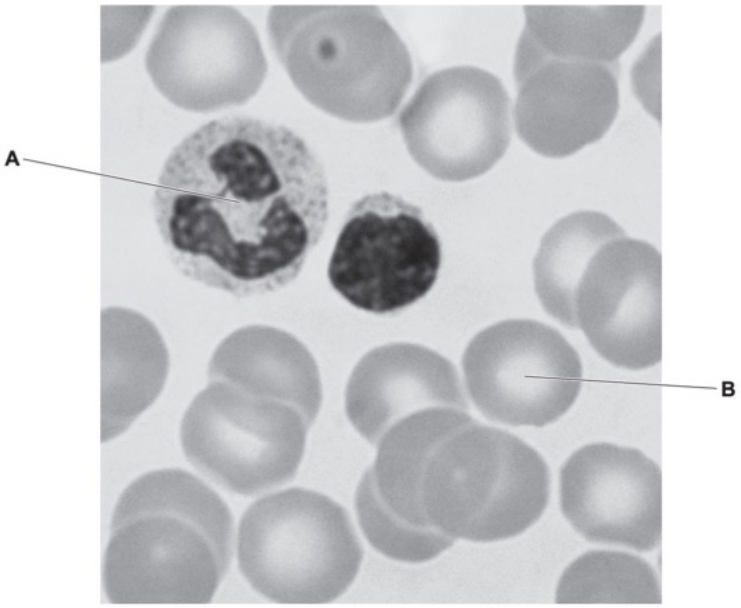
(A) excretion

(B) reproduction

(C) respiration

(D) sensitivity

12. The figure is a photomicrograph of a sample of human blood.



12.1. Identify and describe the functions of the cells labelled A and B in the figure.

12.2. Describe how platelets in the blood prevent disease.

12.3. Blood plasma transports many substances including excretory products and hormones. Identify the names of two excretory products in humans:

(A) Amino acids

(B) Cellulose

(C) Carbon dioxide

(D) Glucose

(E) Lipase

(F) Oxygen

(G) Urea

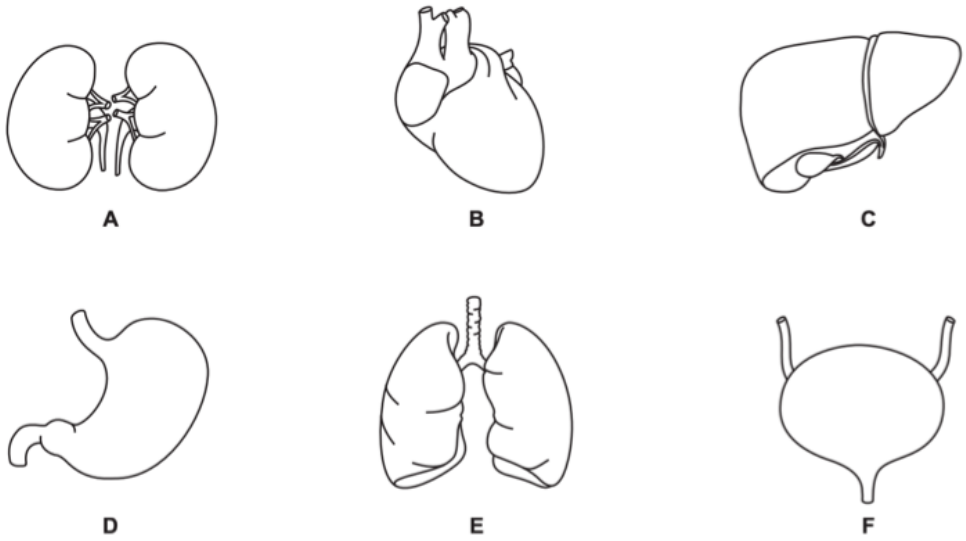
13. Lichens are formed from two different organisms living together. Organism X and organism Y are found in most lichens. The table shows some of the characteristics of organism X and organism Y.

X	Y
made of strands called hyphae	single-celled
hyphae have cell walls and many nuclei	cell contains a nucleus and chloroplasts

Which kingdoms do X and Y belong to?

	X	Y
(A)	fungus	prokaryote
(B)	fungus	protoctist
(C)	protoctist	fungus
(D)	protoctist	plant

14. The following figure is a diagram showing some of the organs in the human body.



The table below lists the names of several organs shown in the diagram, along with their identifying letters and functions. Match and replace the numbers in the table with the correct information to complete it accurately.

Name of the organ	Letter in the Figure	Function
1	**2**	excretes carbon dioxide from the body
Heart	**3**	**4**
5	F	stores urine
6	**7**	excretes urea, excess water and ions

15. Which parents could produce offspring with blood group O?

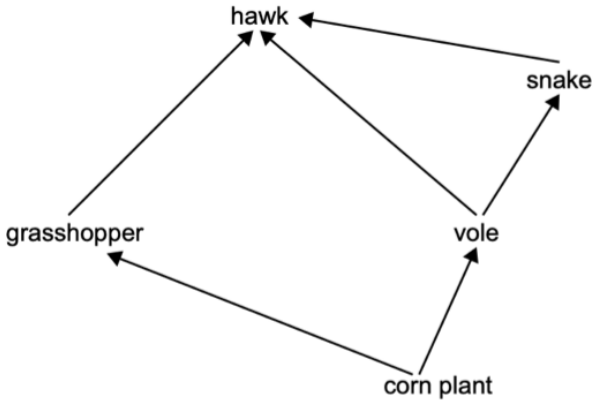
(A) heterozygous father with blood group A and heterozygous mother with blood group B.

(B) heterozygous father with blood group A and homozygous mother with blood group B.

(C) homozygous father with blood group A and heterozygous mother with blood group B.

(D) homozygous father with blood group A and homozygous mother with blood group O.

16. Figure shows a simple food web.



16.1. Based on the food web shown in the figure, it is correct to identify the following: ____ as a producer, ____ as an herbivore, and ____ as a secondary consumer.

(A) corn plant / vole / hawk

(B) corn plant / grasshopper / snake

(C) corn plant / snake / hawk

(D) corn plant / vole / grasshopper

16.2. The organism that feeds at more than one trophic level is the

(A) snake.

(B) hawk.

(C) vole.

(D) grasshopper.

16.3. In a complex food web, the removal of a keystone species is most likely to result in:

(A) A slight increase in biodiversity due to reduced predation pressure

(B) Minimal impact, as most species are functionally redundant

(C) A trophic cascade that significantly alters the structure and biodiversity of the ecosystem

(D) A temporary decrease in biomass, followed by quick ecological compensation

17. What is a correct statement about antibiotics?

(A) Bacteria may become resistant to antibiotics as a result of artificial selection.

(B) Bacteria may become resistant to antibiotics as a result of natural selection.

(C) Viruses may become resistant to antibiotics as a result of artificial selection.

(D) Viruses may become resistant to antibiotics as a result of natural selection.

END

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Academic Year: 2025/2026

Exam: Biology

Date: 18/06/2025 (Wednesday) at 10:00 am

Duration: 90 minutes

Compensation time: 30 minutes

ANSWERS

Question	Correct Option
1.1	D
1.2	B
1.3	B, A, C, E, D
1.4	C
1.5	a) – 3; b) – 3; c) – 2; d) – 1
1.6	(a) – (3), (7); (b) – (2), (5), (6); (c) – (1), (4)
2	A
3.1	C
3.2	B
3.3	D
4	A
5	C
6	B
8	D
9	A
10	C
11	D
12.3	C, G

Question	Correct Option
13	B
14	1 - lungs; 2 - E 3 - B; 4 - pumps blood 5 - (urinary) bladder 6 - kidney; 7 - A
15	B
16.1	A
16.2	B
16.3	C
17	D

3.4. *Answer topics:*

- Reference to thrombin inhibition by anopheline;
- Reference to non-formation of fibrin/clots;
- Relationship between minimizing the formation (or non-formation) of clots and the prevention/treatment of cardiovascular diseases.

7.1. A – Epidermis (dermal tissue); B – Xylem; C – Vascular bundle; D – Phloem

7.2. Xylem (letter B) transports water and minerals through vessel elements and tracheids, which are dead at maturity and have a primary and secondary cell wall. Xylem transports and stores water and water-soluble nutrients in vascular plants.
Phloem (letter D) transports sugars and other items. Phloem is responsible for transporting sugars, proteins, and other organic molecules in plants

12.1. A is a white blood cell, produces antibodies / phagocytosis (described)
B is a red blood cell, transports oxygen

12.2. Platelets help prevent disease by playing a crucial role in the body's defense against blood loss and infection through the process of blood clotting (also called coagulation). Here's how they work:
- Injury Response: When a blood vessel is injured, platelets quickly gather at the site of the damage.
- Clot Formation: They stick to the broken vessel wall and to each other, forming a temporary platelet plug.
- Release of Chemicals: Platelets release substances that activate clotting factors in the blood, leading to the formation of a fibrin mesh that strengthens the clot.

- Barrier Against Pathogens: This clot seals the wound, preventing excessive bleeding and also blocking the entry of pathogens (like bacteria and viruses), reducing the risk of infection.

In summary, platelets help prevent disease by stopping blood loss and creating a barrier to infection at injury sites.

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Academic Year: 2025/2026

Exam: Chemistry

Date: 20/06/2025 (Friday) at 10:00 am

Duration: 90 minutes

Compensation time: 30 minutes

Instructions:

- The exam is evaluated from 0 to 200 points.
- The exam is based on 20 questions, 15 multiple-choice and 5 essay questions.
- Each multiple-choice question is marked out of 10.0 points and each essay question is also marked out of 10.0 points.
- Only a blue or black pen may be used.
- The use of a broker is not allowed.
- All questions must be answered on the exam sheet.
- To solve the exam, you must consult the periodic table, the form and the table of constants found on the last 2 pages.
- The use of a scientific calculator is allowed.

Group I

(15 multiple-choice questions)

1. The table shows the approximate melting and boiling temperatures of two thermometric substances at normal pressure.

Thermometric substance	Melting temperature / °C	Boiling temperature / °C
Water	0	100
Ethanol	-114	78

An advantage of using ethanol as a thermometric substance, compared to water, is that it allows the measurement of temperatures (at normal pressure)

(A) between -114°C and 0°C.

(B) below -114°C.

(C) between 78°C and 100°C.

(D) above 100°C.

2. Which statement about the noble gases is correct?

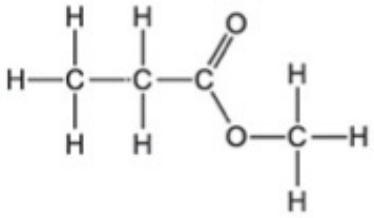
(A) Noble gases are diatomic molecules.

(B) Noble gases are reactive gases.

(C) Noble gases have full outer electron shells.

(D) The noble gases are found on the left-hand side of the Periodic Table.

3. The structure of ester W is shown.



Which row gives the names of ester W and the carboxylic acid and alcohol from which it is made?

	Name of ester W	Carboxylic acid	Alcohol
(A)	propyl methanoate	propanoic acid	methanol
(B)	propyl methanoate	methanoic acid	propanol
(C)	methyl propanoate	propanoic acid	methanol
(D)	methyl propanoate	methanoic acid	propanol

4. The presence of ethanol, CH_3CH_2OH (M = 46.08 g mol^{-1}), in a person can be determined using a breathalyzer. In the breathalyzer, the ethanol present in exhaled air reacts with dioxygen, O_2, present in the air, being converted into ethanoic acid, CH_3COOH. This reaction can be translated as:

$$CH_3CH_2OH\ (g) + O_2\ (g) \longrightarrow CH_3COOH\ (g) + H_2O\ (g)$$

4.1. Consider that air contains 21% by volume of O_2 and assume that the molar volume of a gas at the temperature and pressure at which the reaction occurs is 24.0 dm^3 mol^{-1}. Which of the following expressions allows you to calculate, in dm^3, the volume of air required for the complete reaction of 0.0275 g of CH_3CH_2OH?

(A) $V = \frac{21\times0.0275\times24.0}{100\times46.08}\ dm^3$

(B)) $V = \frac{100\times0.0275\times24.0}{21\times46.08}\ dm^3$

(C) $V = \frac{21\times0.0275}{100\times46.08\times24.0}\ dm^3$

(D) $V = \frac{100\times0.0275}{21\times46.08\times24.0}\ dm^3$

4.2. The first practical device for detecting alcohol in the human body was known as the "balloon test". The presence of CH_3CH_2OH in exhaled air was detected by a change in color, due to the reaction translated into

$$2\ Cr_2O_7^{2-} + 16\ H^+ + 3\ CH_3CH_2OH \longrightarrow 4\ Cr^{3+} + 3\ CH_3COOH + 11\ H_2O$$

(orange) *(green)*

In the presence of CH_3CH_2OH, the _____ color is observed, with $Cr_2O_7^{2-}$ being the _____ species.

(A) orange... oxidant

(B) orange ... reducing

(C) green ... reducing

(D) green... oxidizing

5. The ion $^{23}_{11}Na^+$ contains:

(A) 11 protons, 11 electrons, and 23 neutrons

(B) 11 protons, 10 electrons, and 12 neutrons

(C) 23 protons, 10 electrons, and 11 neutrons

(D) 23 protons, 11 electrons, and 10 neutrons

6. The equation for the manufacture of ammonia in the Haber process is shown.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which row describes the effect of the stated change on the reaction rate and the yield of ammonia?

	Change	Effect on reaction rate	Effect on yield of ammonia
(A)	decrease pressure	increases	decreases
(B)	decrease temperature	decreases	increases
(C)	increase pressure	increases	decreases
(D)	increase temperature	increases	increases

7. Lumps of calcium carbonate react with dilute hydrochloric acid as shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Which change in conditions decreases the rate of the reaction?

(A) Increasing the concentration of the acid.

(B) Increasing the volume of the acid.

(C) Increasing the temperature.

(D Increasing the size of the lumps of calcium carbonate.

8. In the synthesis of acetylsalicylic acid, salicylic acid, $C_7H_6O_3$ (M = 138.13 g mol^{-1}), reacts with acetic anhydride, $C_4H_6O_3$ (M = 102.10 g mol^{-1} e ρ = 1.08 g cm^{-3}), giving rise to acetylsalicylic acid, $C_9H_8O_4$ (M = 180.17 g mol^{-1}), and acetic acid, $C_2H_4O_2$ (M = 60.05 g mol^{-1}). This reaction is catalyzed by sulfuric acid.

In a laboratory, 40.0 g of $C_7H_6O_3$ were added to excess acetic anhydride and 45.0 g of $C_9H_8O_4$ were obtained. The yield of the reaction can be calculated as follows:

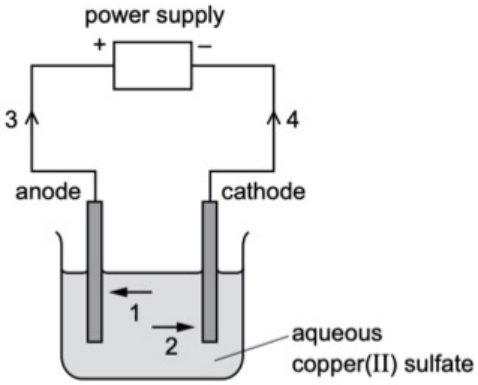
(A) $\eta = \frac{45 \times 138.13}{180.17 \times 40} \times 100\ \%$

(B) $\eta = \frac{40 \times 180.17}{138.13 \times 45} \times 100\ \%$

(C) $\eta = \frac{180.17}{40 \times 138.13} \times 100\ \%$

(D) $\eta = \frac{138.13}{180.17 \times 45} \times 100\ \%$

9. The diagram shows a circuit used to electrolyse aqueous copper(II) sulfate.



Which arrows indicate the movement of the copper ions in the electrolyte and of the electrons in the external circuit?

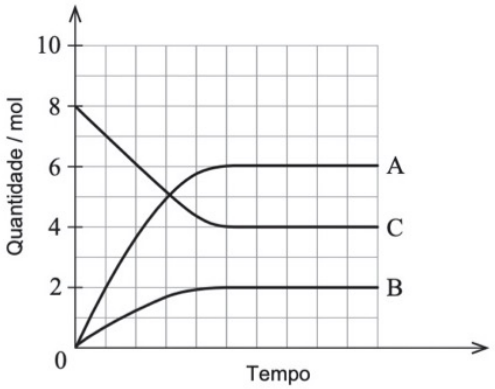
	Copper ions	Electrons
(A)	1	3
(B)	1	4
(C)	2	3
(D)	2	4

10. Consider a closed gaseous system in which species A, B and C are involved in a chemical reaction and x, y and z correspond to their stoichiometric coefficients.

This reaction can be translated as:

$$z\ C\ (g) \rightleftharpoons x\ A\ (g) + y\ B\ (g)$$

The figure shows the graph that reflects the evolution, over time, of the quantity of each of the species, A, B and C, until the equilibrium state is reached, at temperature T.



10.1. According to the figure, the stoichiometric coefficients x, y and z are, respectively,

(A) 3, 1 and 2

(B) 3, 2 and 1

(C) 2, 1 and 3

(D) 2, 3 and 1

10.2. To study the effect of using a catalyst on the reaction, the same amount of species C was introduced into two identical reactors, under the same pressure and temperature conditions. The catalyst was also added to one of the reactors. Consider that the temperature, T, remained constant in both reactors. In the reactor to which the catalyst was added, it increased the

(A) reaction extent.

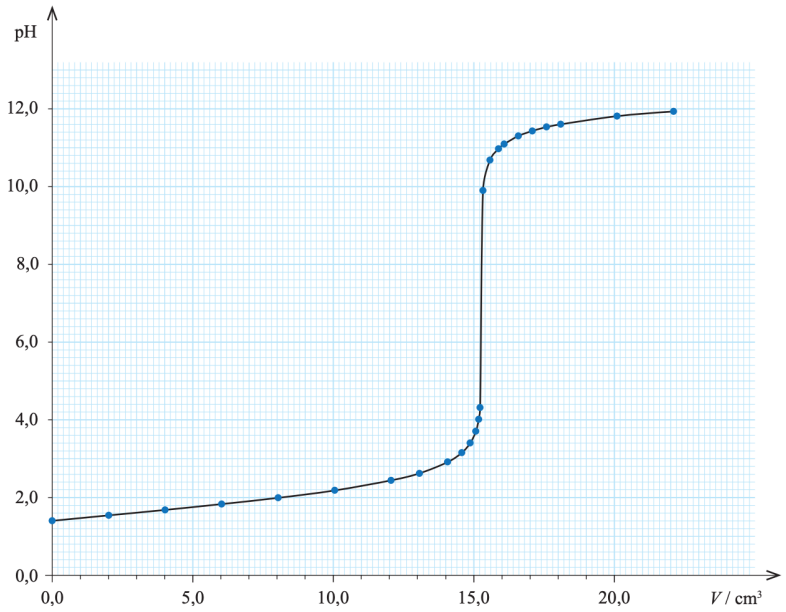
(B) equilibrium constant, Kc, at temperature T.

(C) percentage of A and B in the equilibrium reaction mixture.

(D) reaction rate.

11. The figure below shows the titration curve of 10.00 cm^3 of a sulfuric acid solution with a standard sodium hydroxide solution of concentration 5.00×10^{-2} mol dm^{-3}. The reaction that occurs can be translated as

$$H_2SO_4\,(aq) + 2\,NaOH\,(aq) \rightarrow Na_2SO_4\,(aq) + 2\,H_2O\,(l)$$



11.1. The concentration of the sulfuric acid solution can be calculated using the following expression::

(A) $[H_2SO_4] = \frac{5\times10^{-2}\times15.1}{10}$ mol dm^{-3}

(B) $[H_2SO_4] = \frac{5\times10^{-2}\times10}{2\times15.1}$ mol dm^{-3}

(C) $[H_2SO_4] = \frac{5\times10^{-2}\times15.1}{2\times10}$ mol dm^{-3}

(D) $[H_2SO_4] = \frac{5\times10^{-2}\times10}{15.1}$ mol dm^{-3}

11.2. Consider the following statements regarding the previous text and figure:

I. According to Arrhenius, the dissociation reaction of NaOH is: NaOH (aq) $\rightarrow$ Na^+ (aq) + OH^- (aq)
II. The conjugate pair of H_2SO_4 is SO_4^{2-}.
III. The basicity constant, K_b, of the dissociation of NaOH is given by por $K_b = \frac{[NaOH]}{[Na^+]\cdot[OH^-]}$.
IV. Methyl orange indicator (3.1 – 4.4 turning point) should be used in the titration.
V. The conjugate base of H_2SO_4 is strong.

The true statements are:

(A) I and II

(B) I and III

(C) III and IV

(D) II, IV and V

12. Which of the following electronic configurations could correspond to a carbon atom, $_6C$, in the ground-state?

(A) $1s^2\ 2s^1\ 2p_x^1\ 2p_y^1\ 2p_z^1$

(B) $1s^2\ 2s^2\ 2p_x^1\ 2p_y^0\ 2p_z^1$

(C) $1s^2\ 2s^1\ 2p_x^2$

(D) $1s^2\ 2s^1\ 2p_x^2\ 2p_y^1$

Group II

(5 essay questions)

13. Nitrogen oxides, which are mainly produced by combustion in automobile engines and thermal power plants, contribute to the formation of several chemical species that have an impact on the environment. Nitrogen oxides are formed by nitrogen and oxygen atoms.
In the atmosphere, nitrogen oxides can produce nitric acid, HNO_3, a strong acid, and nitrous acid, HNO_2, a weak acid, which contribute to the acidification of rainwater.
Consider two aqueous solutions, one of HNO_3, with pH 1.00, and the other of HNO_2, with pH 2.16, both with the same concentration and temperature.

13.1. Determine the acidity constant, K_a, of HNO_2 for the temperature considered.
Present all calculations performed.

13.2. Solutions of HNO_3 and HNO_2, of the same volume, were titrated with an aqueous solution of a strong base, NaOH, at a temperature of 25°C, until reaching the equivalence point.

13.2.1. The volume of NaOH used to titrate the HNO_2 solution is ____ to the volume of NaOH used to titrate the HNO_3 solution, and the pH at the equivalence point for the HNO_2 titration is ____ to 7.

Fill in the blanks with the words “equal”, “lower” or “higher”.

13.2.2. Indicate the type of titration and identify the titrant and the titree.

14. Phosphorus pentachloride, PCl_5, can decompose in the gas phase, yielding phosphorus trichloride, PCl_3, and chlorine, Cl_2. This reaction can be translated as:

$$PCl_5\ (g) \rightleftharpoons PCl_3\ (g) + Cl_2\ (g)$$

A variable volume reactor initially contains only 3.00 mol of PCl_5 (g) and 0.80 mol of PCl_3 (g). The system reaches equilibrium at temperature T. Consider that the volume of the reactor is 2.5 dm^3 and that 90% of the initial amount of PCl_5 (g) has not reacted.

14.1. Calculate the equilibrium constant, K_c, of the decomposition reaction considered, at temperature T.
Present all calculations carried out.

14.2. Consider that, with the system in equilibrium, the reactor volume decreases at temperature T. Predict, with reasons, how the amount of PCl_5 will vary.

END

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			atomic number atomic symbol name relative atomic mass								5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

Form

Temperature Conversion (from Celsius to Kelvin)	$T = \theta + 273{,}15$
Density	$\rho = \frac{m}{V}$
Solution Concentration	$c = \frac{n}{V}$
Chemical Quantity	$n = \frac{m}{M}$
Relationship between pH and H_3O^+ concentration	$pH = -\log[H_3O^+]$

Table of Constants

Avogadro's constant	$N_A = 6.02 \times 10^{23}\ mol^{-1}$

CATÓLICA FACULDADE DE MEDICINA LISBOA

UNIVERSIDADE CATÓLICA PORTUGUESA

Integrated Masters in Medicine

Model Exam | Special Admissions

According to the terms of Article 4, paragraph 1., subparagraph b), of the Regulations for Access and Admission to the Integrated Masters in Medicine of the Católica Medical School

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Academic Year: 2025/2026

Exam: Chemistry

Date: 20/06/2025 (Friday) at 10:00 am

Duration: 90 minutes

Compensation time: 30 minutes

ANSWERS

Group I

(15 multiple-choice questions)

Question	**1**	**2**	**3**	**4.1**	**4.2**	**5**	**6**	**7**	**8**	**9**
Correct Option	A	C	C	B	D	B	B	D	A	C

Question	**10.1**	**10.2**	**11.1**	**11.2**	**12**
Correct Option	A	D	C	A	B

Group II

(5 essay questions)

13.

13.1. *Resolution steps:*

- Calculate the concentration of the HNO_3 solution (1.000×10^{-1} mol dm^{-3})
- Calculate the concentration of HNO_2 at equilibrium (9.308×10^{-2} mol dm^{-3})
- Calculate the acidity constant, K_a, of HNO_2 (5.14×10^{-4})

13.2.1. equal ... greater

13.2.2. Acid-base titration; titrant is NaOH and the titrated is HNO_3 or HNO_2.

14.

14.1. *Resolution steps:*

- Calculate the amount of Cl_2 (g) in the equilibrium state (0.30 mol)
- Calculate the amount of PCl_3 (g) in the equilibrium state (1.10 mol)
- Calculate the equilibrium constant, Kc, of the decomposition reaction considered, at temperature T (4.9×10^2)

14.2. *Response elements:*

- decrease in volume, consequent increase in pressure and favoring the reaction that generates fewer molecules;

OR decrease in volume, consequent increase in concentrations of reactants and reaction products and increase in the reaction quotient;

- favoring the reverse reaction and increasing the amount of PCl_5.

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Integrated Masters in Medicine

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According to the terms of Article 4, paragraph 1., subparagraph b), of the Regulations for Access and Admission to the Integrated Masters in Medicine of the Católica Medical School

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Academic Year: 2025/2026

Exam: Physics

Date: 20/06/2025 (Friday) at 10:00 am

Duration: 90 minutes

Compensation time: 30 minutes

Instructions:

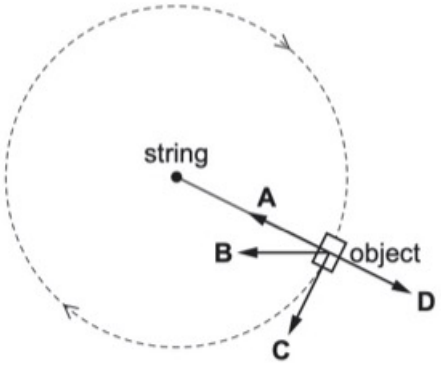
- The exam is evaluated from 0 to 200 points.
- The exam is based on 20 questions, 15 multiple-choice and 5 essay questions.
- Each multiple-choice question is marked out of 10.0 points and each essay question is also marked out of 10.0 points.
- Only a blue or black pen may be used.
- The use of a broker is not allowed.
- All questions must be answered on the exam sheet.
- To solve the exam, you must consult the form and the table of constants found on the last 2 pages.
- The use of a scientific calculator is allowed.

Group I

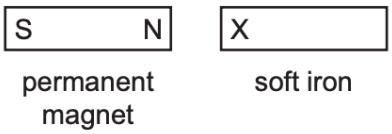
(15 multiple-choice questions)

1. An object on the end of a string moves in a clockwise circular path at constant speed. The diagram shows the object as viewed from above.

What is the direction of the resultant force on the object when it is in the position shown?



2. An unmagnetised piece of soft iron is placed close to a strong permanent magnet, as shown.



What is the induced polarity of end X of the soft iron and in which direction does the magnetic force act on the soft iron?

	polarity of end X	direction of force on the soft iron
(A)	N	to the left
(B)	N	to the right
(C)	S	to the left
(D)	S	to the right

3. Consider a system that expands, absorbs radiation, and heats up. Knowing that the work, heat, and radiation involved in this process are, respectively, 15 J, 35 J and 46 J, we can state that the internal energy variation of the system is:

(A) – 66 J

(B) 96 J

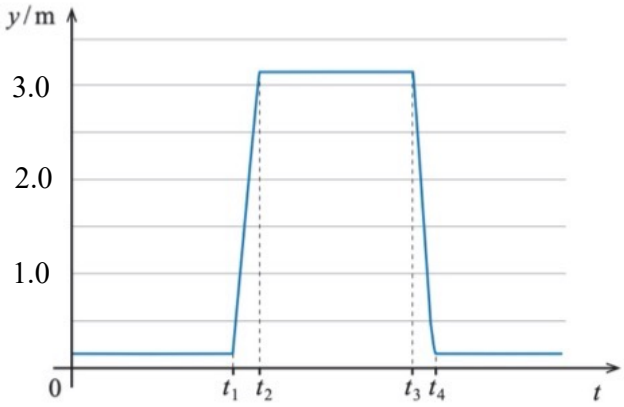
(C) 66 J

(D) – 96 J

4. In 2020, a space probe was sent to the planet Mars, as part of the Mars 2020 mission. This probe carried, for the first time in the history of space exploration, a small helicopter. Flying a helicopter on Mars was a challenge. Engineers knew that Mars' gravitational acceleration, approximately 1/3 of Earth's, would help with liftoff, but its thin atmosphere would make lift more difficult. Thus, the small helicopter, weighing 1.8 kg, was built with two 1.2 m diameter propellers, which rotate in opposite directions at 2400 revolutions per minute.

Using altimeter data, engineers confirmed the success of the first test flight, in which the helicopter only followed a vertical trajectory. The figure shows the graph of the helicopter's altitude, y, as a function of time, t.

Consider that the helicopter can be represented by its center of mass (material particle model).



The graph in the figure allows us to conclude that,

(A) between 0 and t_1, the helicopter moved away from the starting point.

(B) between t_1 and t_2, the movement of the helicopter was uniformly accelerated.

(C) between t_2 and t_3, the helicopter described a straight trajectory.

(D) between 0 and t_4, there was a reversal in the direction of the helicopter movement.

5. A student determines the density of an irregularly shaped stone. The stone is slowly lowered into a measuring cylinder partly filled with water.

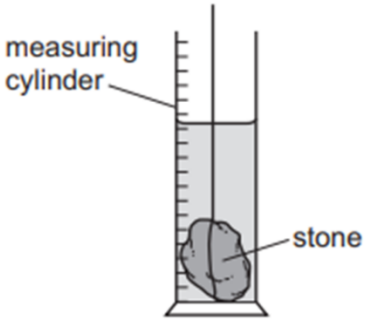
Which other apparatus does the student need to calculate the density of the irregularly shaped stone?

(A) Balance

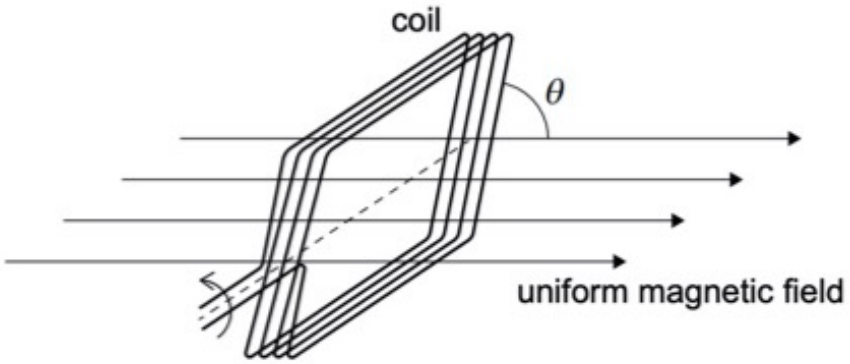
(B) Thermometer

(C) Metre rule

(D) Stop-watch



6. A rectangular conducting coil rotates at a constant angular velocity in a uniform magnetic field. The rotation axis of the coil is perpendicular to the field.



At one instant the plane of the coil is at an angle q to the direction of the field.
The magnitude of the emf induced in the coil is

(A) never zero.

(B) at a maximum when θ = 0° or 180°.

(C) at a maximum when θ = 45° or 225°.

(D) at a maximum when θ = 90° or 270°.

7. Which unit is a unit of weight?

(A) kilogram

(B) kilojoule

(C) kilometre

(D) kilonewton

8. A ball is thrown vertically upwards. Neglecting air resistance, it is possible to state that:

(A) At the beginning of the movement, when the ball is thrown, all the mechanical energy is in the form of potential energy, since the gravitational potential energy is maximum when the ball is at the launch point (considering that this is the reference point).

(B) At the highest point of the trajectory, where the speed of the ball is zero, all the mechanical energy is converted into kinetic energy.

(C) The gravitational potential energy increases as the ball rises, while the kinetic energy decreases.

(D) The total mechanical energy of the ball decreases along the path, since there is no air resistance to dissipate it.

9. A telecommunications technician is setting up a radio transmitter that emits electromagnetic waves with a frequency of 100 MHz. Knowing that the speed of electromagnetic waves in a vacuum is 3.0×10^{8} m s^{-1}, the wavelength of this electromagnetic wave is:

(A) 3 m

(B) 0.3 m

(C) 0.003 m

(D) 0.0003 m

10. Two runners take part in a race.

The graph shows how the speed of each runner changes with time

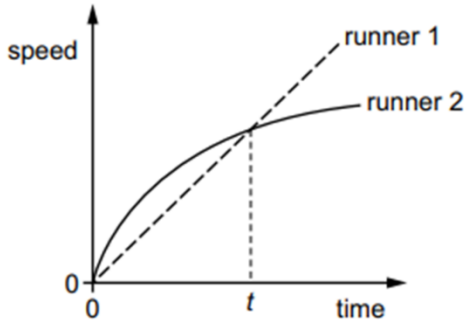
What does the graph show about the runners at time t?

(A) Both runners are moving at the same speed.

(B) Runner 1 has zero acceleration.

(C) Runner 1 runs ahead of runner 2.

(D) Runner 2 is slowing down



11. According to Newton's Third Law, when a bird flaps its wings to fly:

(A) The air pushes the bird upward with a force less than that exerted by the wings.

(B) The bird exerts no force on the air.

(C) The air exerts a force on the bird equal and opposite to that exerted by the wings.

(D) The force exerted by the air on the bird is greater than the force exerted by the wings on the air.

12. An acoustics technician is analyzing the propagation of sound in an industrial building. The technician emits a sound signal and notices that the echo returns after 1.5 seconds. Knowing that the speed of sound in air is 340 m s^{-1}, the distance between the technician and the wall where the sound reflected is:

(A) 51 m

(B) 255 m

(C) 510 m

(D) 25.5 m

13. Some whales emit a sound with a practically constant frequency, called a backbeat. Figure shows the recording of an electrical signal, obtained by a hydrophone, of part of a backbeat. The horizontal axis represents the time in ms.

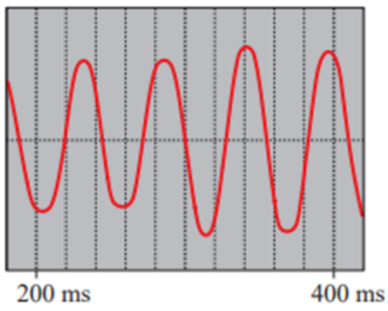
The frequency of this backbeat is contained in the interval

(A) [36, 39] Hz

(B) [8, 11] Hz

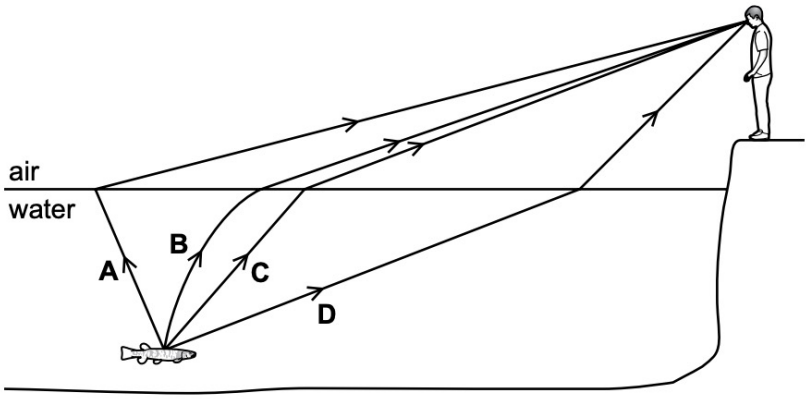
(C) [53, 56] Hz

(D) [17, 20] Hz



14. A boy sees a fish in a lake.

Which labelled path is taken by the light travelling from the fish to the boy's eye?



15. Which row about the change of energy in the energy store must be correct?

	Process	Energy store	Change of energy in store
(A)	water pumped up to a high-altitude dam	gravitational potential energy of water	increases
(B)	water pumped up to a high-altitude dam	kinetic energy of water	decreases
(C)	air passes through a wind turbine	gravitational potential energy of air	increases
(D)	air passes through a wind turbine	kinetic energy of air	increases

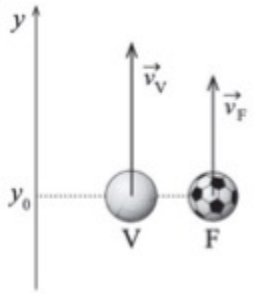
Group II

(5 essay questions)

16. A volleyball, V, and a soccer ball, F, were thrown vertically, from bottom to top, from the same position, y_0, with initial velocities of magnitudes 5.0 m s^{-1} and 4.0 m s^{-1}, respectively, according to the figure.

Admit that:

- y_0 is the reference level of gravitational potential energy;
- air resistance is negligible;
- balls can be represented by their center of mass (material particle model).



16.1. Determine, using energy considerations, the ratio between the maximum height reached by the volleyball ball, y_{max}, V, and the maximum height reached by the soccer ball, y_{max}, F.

16.2. Consider that the volleyball was thrown at time t = 0 s, and that the soccer ball was thrown 3 s later. Sketch a graph that represents the scalar component of the resultant force acting on the volleyball ball, $F_{R,V}$, as a function of time, t, from the instant the ball is thrown until the instant it reaches its maximum height.

17. In Antarctica, a 12 kg meteorite, at a temperature of 3100ºC, buries itself in a large block of ice with a speed of 10 km s^{-1}, in module. Admit that:

- the ice block is at a temperature of 0ºC;
- all the meteorite's kinetic energy is used to melt the block's ice;
- the mass thermal capacity of the material that makes up the meteorite is 830 J kg^{-1} K^{-1};
- the melting temperature of ice is 0ºC;
- the change in enthalpy (mass) of ice melting is 3.34×10^5 J kg^{-1}.

Determine the mass of ice that melts, considering that, in the end, the meteorite + ice block system is at 0ºC.

18. A roller coaster car with a mass of 500 kg starts from rest at the top of a slope, 20 m above sea level. Assume that there is no friction or air resistance and assume that the acceleration due to gravity is 9.8 m s^{-2}.

18.1. Calculate the gravitational potential energy of the car halfway down the slope.

18.2. Find the speed of the car halfway down the slope.

Show all solution steps.

END

Form

Temperature Conversion (from Celsius to Kelvin)	$T = \theta + 273{,}15$
Density	$\rho = \frac{m}{V}$
Energy (J) and Power (w)	$E = P \times t$
Energy gained or lost by a body due to its temperature variation	$E = mc\Delta T$
Temporal rate of energy transfer in the form of heat, by conduction	$\frac{Q}{\Delta t} = k\frac{A}{l}\Delta T$
Wave-length	$\lambda = \frac{v}{f}$
Equations of circular motion with linear speed of constant magnitude	$a_0 = \frac{v^2}{r}$ $v = \frac{2\pi r}{T}$ $\omega = \frac{2\pi}{T}$
Equations of rectilinear motion with constant acceleration	$x = a_0 + v_0 t + \frac{1}{2}at^2$ $v = v_0 + at$
Translational kinetic energy	$E_C = \frac{1}{2}mv^2$
Gravitational Potential Energy	$E_P = mgh$

Table of Constants

Speed of propagation of light in vacuum	$c = 3.00 \times 10^{8}\ \mathrm{m\ s^{-1}}$
Magnitude of the gravitational acceleration of a body near the Earth's surface	$g = 10\ \mathrm{m\ s^{-2}}$
Universal Gravitation Constant	$G = 6.67 \times 10^{-11}\ \mathrm{N\ m^{2}\ kg^{-2}}$
Avogadro's constant	$N_A = 6.02 \times 10^{23}\ mol^{-1}$

CATÓLICA FACULDADE DE MEDICINA LISBOA

UNIVERSIDADE CATÓLICA PORTUGUESA

Integrated Masters in Medicine

Model Exam | Special Admissions

According to the terms of Article 4, paragraph 1., subparagraph b), of the Regulations for Access and Admission to the Integrated Masters in Medicine of the Católica Medical School

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Academic Year: 2025/2026

Exam: Physics

Date: 20/06/2025 (Friday) at 10:00 am

Duration: 90 minutes

Compensation time: 30 minutes

ANSWERS

Group I

(15 multiple-choice questions)

Question	1	2	3	4	5	6	7	8	9	10
Correct Option	A	C	C	D	A	B	D	C	A	A

Question	11	12	13	14	15
Correct Option	C	B	D	C	A

Group II

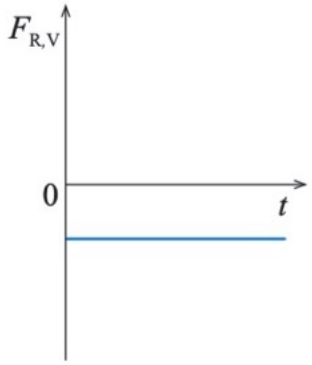
(5 essay questions)

16.

16.1. Determine the requested reason by going through the following steps:

- Calculates, considering $\Delta Ep = -\Delta Ec$, $y_{máx,\,V}$ (1.28 m)
- Calculates, considering $\Delta Ep = -\Delta Ec$, $y_{máx,\,F}$ (0.816 m)
- Calculates $\frac{y_{máx,V}}{y_{máx,F}}$ (1.6)

16.2.



17. Determine the requested value by going through the following steps:

- Calculates the energy transferred to the ice in the form of heat (3.1×10^7 J)
- Calculates the energy transferred to the ice from the kinetic energy of the meteorite (6.0×10^8 J)
- Calculates the mass of ice that melts (2×10^3 kg)

18.

18.1. $Ep = m \cdot g \cdot h = 500 \times 9.8 \times 10 = 49{,}000$ J

18.2. Calculate Emec = 98,000 J, then calculate the kinetic energy halfway (49,000 J) and calculate the speed using the kinetic energy. v = 14 m s^{-1}