

Instruction for answers sheet reading

A,B,C,D,E The green letter indicates the correct answer

Section 1: Mathematics

Question #1

1000 is the product of three numbers suitably chosen among 2, 4, 16, 25, 125.
What is the sum of the three numbers?

A 131

B 45

C 21

D 133

E 143

I omit the answer

Question #2

What is the square root of one-fourth of 2^{14} ?

A 2^6

B $\frac{2^7}{4}$

C 2^8

D 2^9

E 2^7

I omit the answer

Question #3

On a series of 20 shots in the basket, Bob had a 55% success rate. After 5 more shots, the rate dropped to 52%. How many of the last 5 shots were successful?

A 2

B 0

- C 1
- D 3
- E 4
- I omit the answer

Question #4

Let a, b, c, d be real numbers such that $a \leq b$ and $c \leq d$. Which of the following inequalities is certainly true?

- A $ac^2 \leq bc^2$
- B $a - c \leq b - d$
- C $a + d \leq c + b$
- D $ac \leq bd$
- E $ac^2 \leq bd^2$
- I omit the answer

Question #5

When the polynomial $4x^2 + 3x - 1$ is divided by $x - 3$, the remainder is

- A 44
- B $\frac{44}{x - 3}$
- C 0
- D 15
- E $4x + 15$
- I omit the answer

Question #6

In the real number field the solution set for the inequality

$$x^3 - 3x^2 > 3 - x$$

is

- A $(3, +\infty)$
- B $(-1, 1) \cup (3, +\infty)$
- C $(-\infty, -1) \cup (1, 3)$
- D $(-\infty, 3)$
- E $(-\infty, +\infty)$
- I omit the answer

Question #7

Considering the following numbers

$$a = \sqrt{5} \quad ; \quad b = 2.5 \quad ; \quad c = \log_{10} 400$$

we have

A $a < b < c$

B $a < c < b$

C $b < c < a$

D $c < b < a$

E $b < a < c$

I omit the answer

Question #8

The equation in the real variable x

$$10^x = x^3 - x$$

has

A exactly two solutions

B exactly one solution

C no solution

D exactly three solutions

E exactly four solutions

I omit the answer

Question #9

The domain of the following function

$$y = f(x) = \sqrt{x(x+3)(x-2)}$$

is the set

A $-3 \leq x \leq 0$ or $x \geq 2$

B $x \geq 0$

C $-3 \leq x \leq 2$

D $x \leq 0$ or $x \geq 2$

E $-\infty < x < +\infty$

I omit the answer

Question #10

You have two cubes of side L made by the same homogeneous material. Inside the first cube, a

cubic hole of side $L/3$ has been cut, while the second cube has no holes inside. What is the ratio of the weight of the first cube to that of the second cube?

- A 26/27
- B 2/3
- C 8/9
- D 19/27
- E The ratio depends on the side L
- I omit the answer

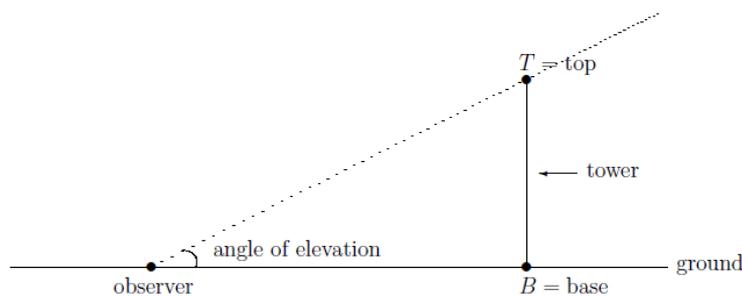
Question #11

In the Cartesian coordinate plane let r be the line of equation $y = -3x + 7$. Then the straight line symmetric to r with respect to the line $y = 4$ has equation

- A $y = 3x + 1$
- B $y = 3x - 7$
- C $y = \frac{1}{3}x + 1$
- D $y = \frac{1}{3}x - 7$
- E $y = 3x - 1$
- I omit the answer

Question #12

As shown in the figure below, the angle formed by a horizontal line (the "ground") and the line of sight to an object above the horizontal line is called the *angle of elevation*.



Suppose that observing the top T of a vertical tower BT , an observer has measured the elevation angles of 30° and 60° respectively from the positions P and Q on the ground. We know that the distance between point P and base B of the tower is equal to p meters and that point Q is q meters closer to B than point P . Then the ratio q/p is

- A 2/3
- B 1/2
- C 1/3
- D 3/4
- E dependent on the height of the tower
- I omit the answer

Question #13

In the Cartesian coordinate plane Oxy , the equation of the circle centered at $(3, 5)$ and passing through the point $(-1, 2)$ is

A $x^2 + y^2 - 6x - 10y + 9 = 0$

B $x^2 + y^2 + 6x + 10y + 9 = 0$

C $x^2 + y^2 + 6x + 10y - 19 = 0$

D $x^2 + y^2 - 6x - 10y - 19 = 0$

E $x^2 + y^2 - 6x - 10y + 29 = 0$

I omit the answer

Question #14

If the claim "*All students in my class speak at least three different languages*" is false, then it is certainly true that in my class

A there is a student who speaks no more than two different languages

B there is a student who speaks at least three different languages

C there is a student who speaks two different languages

D all students speak more than three different languages

E all students speak no more than two different languages

I omit the answer

Question #15

Liam and Tom are friends. Nevertheless, Liam always lies, while Tom always tells the truth. Which sentence did both Liam and Tom say?

A I am telling the truth

B You are telling the truth

C We are both telling the truth

D I always lie

E Today it is raining

I omit the answer

Question #16

Ann, Bob, Edith, Sam and Tom are friends. You ask Ann, Edith and Tom about their birthdays. Tom says that he was born in the same month as Edith but 9 days after her, and that his friends' birthdays are on March 20, April 23, April 24 and May 24. Ann and Edith say that they celebrate their birthdays on the same day of the week. So Ann's birthday is

A April 24

B March 20

- C** March 27
- D** April 23
- E** May 24
- I omit the answer

Question #17

The following table shows the distribution of the wrong answers in a test with 10 questions given to a class of 25 students:

wrong answer	0	1	2	3	4	5	7
numbers of students	2	7	6	3	4	2	1

What is the mean number of wrong answers per student?

- A** 2.44
- B** 61
- C** 0.88
- D** 3.5
- E** 4
- I omit the answer

Question #18

Grouped data on the systolic blood pressure (in mmHg) of 160 female students (*F*) and 150 male students (*M*) are given in the following table:

Pressure	≤ 115	> 115 and ≤ 120	> 120 and ≤ 129	> 129
% di <i>F</i>	12.5%	25%	50%	12.5%
% di <i>M</i>	10%	26%	52%	12%

It follows that

- A** the male students with systolic blood pressure at most equal to 115 mmHg are 75% of the female students with systolic blood pressure at most equal to 115 mmHg
- B** at most 60% of male students has systolic blood pressure greater than 120 mmHg
- C** half of the male students have systolic blood pressure greater than 120 mmHg
- D** the percentage of female students with systolic blood pressure greater than 120 mmHg is larger than the percentage of male students with systolic blood pressure greater than 120 mmHg
- E** more than 80 female students and more than 78 male students have systolic blood pressure equal to 129 mmHg

I omit the answer

Question #19

Four boys (M) and eight girls (F) signed up for a dance class. If the pairs of dancers are chosen at random, then the statistical frequencies of the couples FF (two girls), FM (one girl and one boy) and MM (two boys) are:

A $\frac{14}{33}$ for FF ; $\frac{16}{33}$ for FM ; $\frac{1}{11}$ for MM

B $\frac{2}{11}$ for FF ; $\frac{8}{11}$ for FM ; $\frac{1}{11}$ for MM

C $\frac{1}{3}$ for each of FF, FM, MM

D $\frac{1}{4}$ for FF ; $\frac{1}{2}$ for FM ; $\frac{1}{4}$ for MM

E $\frac{2}{12}$ for FF ; $\frac{9}{12}$ for FM ; $\frac{1}{12}$ for MM

I omit the answer

Question #20

A strange (but regular) dice has 1 dot on three faces, 2 dots on two faces and 3 dots on one face. If you roll the dice twice, what is the probability of getting two odd numbers?

A $4/9$

B $2/3$

C $1/4$

D $1/9$

E $3/5$

I omit the answer

Section 2: Text comprehension and critical reasoning

Question #1

One of the rules of sales is that an advertisement only has to catch the attention of a possible customer. It does not have to actually say anything about a product itself in order to increase sales. Getting people to simply remember a product is more important for advertising than getting them to know anything about the product.

Which of the following is an assumption on which this argument depends?

A Potential customers will remember a product even if they do not know much about it

B Telling the truth about products would decrease sales

C It is not difficult to catch a possible customer's attention

- D Advertisers lie more often than they tell the truth
- E People who advertise products know very little about them
- I omit the answer

Question #2

Twentieth-century cities are experiencing a period of radical transformation shown by the large building projects that are redesigning entire parts of cities, from high-speed railways to expressways. Throughout the world, cities are looking to the future, skylines all look the same, and speed and movement are the key words.

Which of the following statements best describes the main concept expressed in the argument presented above?

- A In the twentieth century, cities across the world are undergoing a great change aimed at making travel quicker
- B The key words for the public transport of the future are innovation and speed
- C Cities across the world have similar configurations because they are designed using the same concept of growth
- D The change to twentieth-century cities is determined by their function and not their configuration
- E The change to cities, in the twentieth century, is linked to the population moving from the countryside to urban centres
- I omit the answer

Question #3

3D printing shops are springing up here and there in capital cities across the world, even though demand for objects is still limited at the moment. In the future, each district of each city will have its own "local factory" to meet its residents' specific needs.

Which of the following statements is an assumption of the argument presented above?

- A In the future, demand for 3D printed objects will increase
- B The fact that 3D printing shops are becoming widespread in capital cities does not let us draw any conclusions about peripheral places
- C "Local factories" will supplant the 3D printing shops
- D All the needs of future residents will be met by 3D printing
- E In the future, the quality of 3D printed objects will be excellent
- I omit the answer

Question #4

In the face of a crisis that has led to the closure of some eleven European refineries in the last five years, ENI has decided to convert the Porto Marghera plant: an investment of 100 million euros, compared with the 600 needed to build a new plant. This is the first case in the world of the green conversion of a traditional refinery.

Which of the following statements best describes the main concept expressed in the argument presented above?

- A** ENI has decided to invest in restructuring one of its plants to prevent its possible closure
 - B** ENI has decided to invest in restructuring one of its plants to save 400 million euros
 - C** Green conversion is the main thrust of European ecological policies
 - D** Other market operators will also convert their facilities to become green
 - E** Porto Marghera is the trail-blazing project of ENI's new ecological policy
- I omit the answer

Question #5

Despite being universal, gossiping at work is seen as unprofessional and can compromise career progression chances, damage the reputation of individuals or groups or the organisation itself and lead to lower productivity or the departure of the best employees.

Which of the following statements, if true, would greatly strengthen the argument presented above?

- A** The Minister for Employment has declared that firms that supported the "internal and external privacy management" project last year, implementing policies aimed at controlling gossip, recorded higher productivity than companies that showed no interest in the project
 - B** The annual employee productivity assessment by management is a legal obligation that not all small and medium-sized companies fulfil
 - C** Some international firms devote two or three training days on evaluating and countering gossip at work, based on the findings of company surveys of organisational well-being
 - D** Checking that there are no conflicts of interest among the management of public companies is a legal obligation that is fulfilled every three years at ministerial level
 - E** The "employee of the year" award is a way for firms to acknowledge the work carried out by the employee and usually involves giving the winner a financial reward
- I omit the answer

Question #6

In the last decade, investment in research and development in Italy increased modestly, reaching 1.25% of Gross Domestic Product in 2018. But this level is way below that of technologically advanced countries, confirming the current trend towards specialisation in hand-crafted rather than high-tech products.

Which of the following statements can be deduced from the argument presented above?

- A** None of the statements can be deduced from the text
- B** Higher investment in high-tech would lead to higher investment in research and development
- C** The specialisation in the production of hand-crafted products characterises "Made in Italy" as a technologically advanced sector
- D** There is a directly proportional relationship between investment in research and development and specialisation in hand-crafted products

E Advanced countries do not have hand-crafted production worthy of note

I omit the answer

Question #7

In the 21st-century economy, characterised by speed, interconnection and intangibility, individuals with their skills, ideas and interpersonal relationships are the true strategic assets to invest in. Companies should focus their attention on the human resources working in the organisation, as they represent their distinctive capital that sets them apart and guarantees their success over their competitors.

Which of the following statements best summarises the conclusion of the argument presented above?

A For a company to succeed, it is important that it develops and invests in its human capital

B To increase speed and interconnection, Italian companies need to devote a substantial part of their income to personnel training and management

C The characteristics of speed, interconnection and intangibility of the economy 2.0 have changed how modern companies and their organisation are conceived

D Companies need to know the strategic assets in which to invest to develop the skills, ideas and relations of the individuals working in it

E Human resources are the distinctive capital that makes the difference and determines company investment plans

I omit the answer

Question #8

Eight people -- four drivers: Edward, Rachel, Michael, and Alice; and four passengers: Charles, Sarah, John, and Harry -- are being assigned to four cars, numbered 1 to 4.

Each person is assigned to exactly one car, and exactly two people are assigned to each car. Assignments of people to cars must conform to the following conditions:

- Exactly one driver is assigned to each car.
- Edward and Alice are assigned to consecutively numbered cars, with Edward assigned to the lower-numbered car.
- Edward is assigned to the same car as Charles.
- Rachel is not assigned to the same car as Sarah.

If Charles is assigned to car 2 and Sarah is assigned to car 4, which one of the following must be true?

A Rachel is assigned to car 1

B Edward is assigned to car 1

C Michael is assigned to car 3

D John is assigned to car 1

E Harry is assigned to car 3

I omit the answer

Question #9

Premature babies that are regularly massaged are more active than premature babies that are not massaged. For the same daily milk intake, babies that are massaged gain more weight than babies that are not massaged. This appears strange because usually more active babies require more calories to gain weight.

Which of the following statements, if true, would explain the apparent inconsistency described in the argument presented above?

- A** Increased activity means that premature babies' intestines mature faster, so that they digest and absorb more nutrients
- B** Increased activity leads to increased hunger, especially if the quantity of food given remains the same
- C** The massages increase the baby's curiosity about the environment and the curiosity increases the activity level
- D** Massages do not increase babies' speed of growth unless they are born prematurely
- E** Premature babies need a daily intake of nutrients that is significantly greater than that needed by full-term babies
- I omit the answer

Question #10

Vampire bats fly over a much larger area than other similar-sized bats. The reason for this is that the animals they feed on are not very common in the forests where they live and this scarcity of prey forces them to fly further to find food.

Which of the following statements, if true, would greatly strengthen the argument presented above?

- A** Vampire bats fly over a much larger area only if they are in regions where there is not much food for them; this is not true if they are in regions where such food is plentiful
- B** Vampire bats fly over an area eight times larger than the area over which similar-sized bats fly
- C** After babies are born, vampire bats must look for food more often to feed themselves and their offspring
- D** Vampire bats sometimes fly over a small area for many weeks
- E** For similar living conditions, vampire bats eat less than other bat species
- I omit the answer

Section 3: Chemistry and physics

Question #1

Which periodic table group contains elements in three states of matter at standard ambient pressure and temperature?

- A** Halogens

- B** Noble gases
- C** Alkaline earth metals
- D** Alkali metals
- E** Carbon group
- I omit the answer

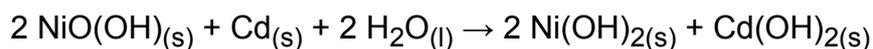
Question #2

Which of the following organic compounds is a primary alcohol?

- A** $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- B** $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- C** CH_3OCH_3
- D** CH_3COCH_3
- E** $\text{CH}_3\text{CH}_2\text{CHO}$
- I omit the answer

Question #3

The balanced electromotive reaction of a nickel-cadmium battery is

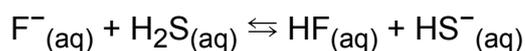


During discharge, the cadmium electrode

- A** is oxidized and loses mass
- B** is reduced
- C** gains electrons
- D** gains mass
- E** is oxidized and gains mass
- I omit the answer

Question #4

Given the equilibrium reaction



which of the following represents the Brønsted-Lowry bases for this reaction?

- A** $\text{F}^-_{(\text{aq})}$ and $\text{HS}^-_{(\text{aq})}$
- B** $\text{F}^-_{(\text{aq})}$ and $\text{H}_2\text{S}_{(\text{aq})}$

- C** $\text{HF}_{(\text{aq})}$ and $\text{HS}^{-}_{(\text{aq})}$
- D** $\text{HF}_{(\text{aq})}$ and $\text{H}_2\text{S}_{(\text{aq})}$
- E** none of the answers shown is correct
- I omit the answer

Question #5

If 20.0 mL of 1.0 M HBr are diluted to a total volume of 60.0 mL, what is the molar concentration of the HBr in the resulting solution?

- A** About 0.33 M
- B** 0.25 M
- C** 1.0 M
- D** 0.50 M
- E** About 0.66 M
- I omit the answer

Question #6

A 50 W lightbulb is plugged into a standard 100 V outlet. Assume that the electrical energy is provided as in the case of a direct-current circuit. What is the resistance of the bulb filament?

- A** 200 Ω
- B** 100 Ω
- C** 400 Ω
- D** 20 Ω
- E** 2 Ω
- I omit the answer

Question #7

An ideal fluid flows from left to right at a steady rate through a tube segment. The cross-sectional areas of the tube are $A_1 = 100 \text{ cm}^2$ on the left side and $A_2 = 50 \text{ cm}^2$ on the right side. The fluid speed is $v_1 = 20 \text{ cm/s}$ on the left side. What is the fluid speed v_2 on the right side?

- A** 40 cm/s
- B** 5 cm/s
- C** 80 cm/s
- D** 320 cm/s
- E** 10 cm/s
- I omit the answer

Question #8

A block is placed at rest on a plane inclined at an angle α to the horizontal. The coefficient of static friction between block and plane is $\mu_s = 1$. Determine the maximum angle of incline to keep the block from sliding.

A 45°

B 60°

C 15°

D 30°

E 1°

I omit the answer

Question #9

A transverse circular wave propagates on a plane surface without energy dissipation. If the wave amplitude is 2 cm at a distance of 10 cm from its centre, what is the wave amplitude at a distance of 40 cm from its centre?

A 1 cm

B 0.5 cm

C 2 cm

D 0.25 cm

E It cannot be answered without knowing the wave frequency

I omit the answer

Question #10

An ideal gas is confined into a cylinder with a movable piston and is in equilibrium at 20 °C and 1 atm. Then the temperature is raised to 40 °C while we keep the pressure of the gas constant. Which of the following statements is correct?

A The initial gas volume expands by about 7%

B The initial gas volume does not change

C The initial gas volume expands by 50%

D The initial gas volume doubles

E The gas undergoes an expansion or a compression, depending on the number of moles

I omit the answer

Section 4: Biology

Question #1

Mendel's laws define the behaviour

A of all hereditary characteristics

- B** only of certain morphological characteristics
- C** only of certain striking but not essential characteristics
- D** of punctiform mutations and their incidence
- E** only of characteristics that do not affect survival
- I omit the answer

Question #2

Phagocytosis means

- A** the process whereby a cell incorporates solid particles inside it
- B** the initial phase of digestion
- C** the process of grinding foods in the digestive system
- D** nutrition with plants
- E** nutrition with live prey
- I omit the answer

Question #3

Which of the following combinations would you expect to find in a person's blood after a rich meal?

- A** High sugar and high insulin
- B** High sugar and low insulin
- C** Low sugar and no insulin
- D** No sugar and low insulin
- E** Low sugar and low insulin
- I omit the answer

Question #4

Afferent neural pathways are

- A** sensitive
- B** mixed
- C** only sympathetic
- D** motor
- E** motor and sympathetic
- I omit the answer

Question #5

The unit of measurement of the size of human cells is the

- A** micrometre

- B** millimetre
- C** nanometre
- D** dalton
- E** angstrom
- I omit the answer

Question #6

A fundamental difference between plants and animals lies in their capacity to

- A** fix CO₂
- B** adapt to appropriate environments
- C** resist disease
- D** reproduce
- E** breathe
- I omit the answer

Question #7

An allele is

- A** a variant form of a gene
- B** a somatic characteristic
- C** one of the mitotic chromatids
- D** the mutated form of a gene
- E** a hereditary characteristic
- I omit the answer

Question #8

How many cervical vertebrae do humans have?

- A** 7
- B** 3
- C** 12
- D** 8
- E** 5
- I omit the answer

Question #9

The two chromatids of a chromosome separate in

- A** anaphase

- B** prophase
- C** interphase
- D** metaphase
- E** telophase
- I omit the answer

Question #10

Which of the following cells does not have a nucleus?

- A** Escherichia coli
- B** Erythroblast
- C** Amoeba proteus
- D** Tripanosoma brucei
- E** Syncytium
- I omit the answer

Section 5: Technical and scientific knowledge

Question #1

All mammals

- A** feed their young with milk
- B** are large
- C** are placental
- D** are land animals
- E** are omnivorous
- I omit the answer

Question #2

Electrical capacitors are used to

- A** accumulate electrical charge
- B** store electric currents
- C** limit potentials
- D** increase potentials
- E** accumulate potential differences
- I omit the answer

Question #3

Diastolic and systolic blood pressure is expressed in

A mm Hg

B pascal

C atm

D mm air

E neutrons/m²

I omit the answer

Question #4

Lamarck's theory of evolution is based on

A the inheritance of acquired characteristics

B natural selection

C programmed evolution

D spontaneous generation

E recurring disasters

I omit the answer

Question #5

X-rays are

A electromagnetic waves

B very fast free electrons

C elastic waves with a lot of energy

D very penetrative nucleons

E a bundle of neutrons

I omit the answer

Question #6

Spallanzani and Pasteur demonstrated that the spontaneous generation of microorganisms is

A impossible

B possible, if induced

C rare, but possible

D frequent

E normal

I omit the answer

Question #7

A liquid poured into a system of communicating vessels

- A** reaches the same level in all receptacles (if these receptacles are not capillary)
- B** reaches a level proportional to the specific weight of the liquid in the various receptacles
- C** reaches the same level in all receptacles, with no exception
- D** reaches different heights in the various receptacles, according to their size
- E** none of the answers shown is correct
- I omit the answer

Question #8

In which of the following conditions is it not possible to propagate a virus in a laboratory?

- A** Propagation in growing medium full of amino acids and sugars
- B** Propagation in embryonated eggs
- C** Propagation in laboratory animals
- D** Propagation in cells cultivated "in vitro"
- E** Propagation in bacterial cultures
- I omit the answer

Question #9

All living beings are classified with two terms that indicate

- A** genus and species
- B** kingdom and genus
- C** kingdom and class
- D** order and species
- E** habitat and ecological niche
- I omit the answer

Question #10

Electrolysis of water is a process in which the passage of an electric current causes the decomposition of water into

- A** oxygen and hydrogen gas
- B** oxygen and carbon dioxide
- C** water and oxygen
- D** water and hydrogen
- E** oxygen and carbon

I omit the answer