General

The last United Nations Climate Change Conference was referred to as "COP26". What is COP an abbreviation of?

- Conference of Parties
- Concerns of People
- Climate on Precipice
- Congress of Preservation

What is the probability that 2 friends have their birthdays on the same day?

- 1/360
- $1/365^2$
- 1/365
- $1-(364/365)^2$

An axiom is

- A neuronal cell type
- a statement or proposition that summarises a principle
- a statement or proposition that can be proved to be true
- a statement or proposition which is regarded as being self-evidently true.

A family has three children. What is the probability that they have exactly one daughter?

- 1/8
- 3/8
- 1/4
- 3/4

The maximum value of the function $f(x) = 1 - e^x$ in the range $-\infty \leq x \leq \infty$

- ∞
- 2
- 1
- 0

You and your pet pigeon drive 24km due east and then 32km due north to a clearing in a forest. You release the pigeon so that it can fly home. If the pigeon flies at an approximate speed of 40km/h, and you average 50km/h on the drive home, who gets home first?

- You arrive first, by about 30 minutes
- You arrive first, by about 12 minutes
- Both you and the pigeon arrive at the same time
- You arrive last

For a normal distribution, if the mean is doubled, how does the area under the curve change?

- Doubles
- Halves
- Need standard deviation to estimate area
- Remains same

If only two nucleotides A and G occur in a 4-base pair DNA sequence, how many such sequences are possible?

- 4
- 8
- 16
- 32

Many of the world's deserts occur in two bands centred at around 30°N and 30°S latitude. This can be explained by

- Patterns of continental drift
- Patterns of atmospheric circulation above and below the equator
- Global climate changes that have occurred
- Latitudinal variation in soil types

A hypothesis is a statement that is:

- A best guess about a particular process
- Provable using experiments
- Testable using experiments
- Can neither be proved or disproved

Bacterial cell membrane is composed of an almost equal amount of protein and lipids. Assuming a bacterial cell as a sphere of diameter 2 micrometer, approximately how many lipids molecules will be there in that bacterial cell membrane. Assume, the surface area per lipid headgroup is 0.2 nm^2

- $3 \cdot 10^7$
- $3 \cdot 10^6$
- $3 \cdot 10^5$
- $3 \cdot 10^4$

Identify the odd one out

- Nipah
- Covid-19
- Small Pox

Rabies

If a healthy individual has a probability of 0.5 to contract COVID when s/he comes in contact with 1 COVID-positive individual, then what is the probability that the healthy individual has contracted COVID after coming in contact with 4 COVID-positive individuals?

2

1

0.0625

0.9375

A mammalian cell typically has 1.2 meters (when completely outstretched) of double stranded DNA. The total time to duplicate the DNA is 5 hours. How many origins of replication are there if the rate of duplication is 16μmeters/min?

2500

25

250

500

Imagine that you are looking at one cancer cell under the microscope, and trying to estimate the probability that it will die due to a chemotherapy regime. You know that 95% of cells treated with the chemotherapy turn on the P53 gene and that these cells have 80% chance of dying. The remaining 5% do not turn on P53 and have only 10% chance of dying. What is the probability that the cell you're looking at will die?

76.5%

66.5%

86.5%

69.75%

Physics

Heat and water loss in animals is proportional to the ratio of their surface area to volume. Imagine a spherical cow. When the radius of the cow doubles, its surface area-to-volume ratio:

Reduces by 3/r

Remains unchanged.

Becomes half.

Doubles

Electromagnetic radiation that is emitted from a nucleus is in the form of:

Cherenkov radiation

Gamma rays

Ultraviolet light

Microwaves

A particle of mass m and initial velocity V is faced with a damping force proportional to the square of its velocity and equal to a v^2. In how much time will the particle come to a stop?

2m/aV

2 ma/V

2 mV/a

Never stop

Electrons can be scattered from the surface of a metal to form a diffraction pattern. This shows that:

Electrons can behave like waves

Electrons have charge

Electrons can behave like waves and particles

Electrons can behave like particles

How are chemical elements greater than atomic mass of iron are thought to be formed?

In the core of stars

In the core of earth

By neutron star merger

During the big bang

A solid cylindrical glass rod has length 20.0 ± 0.1 cm and diameter 5.00 ± 0.01 mm. What is the percentage uncertainty in the calculated volume of this rod?

0.1%

0.2%

0.7%

0.9%

The returning motion of the boomerang is primarily driven by

Aerodynamic forces acting on the two arms of the boomerang
Due to central forces acting on the boomerang
A combination of aerodynamic forces on the two arms and gyroscopic precession
Adverse winds that blow back the boomerang towards the thrower

If the ionisation energy of a hydrogen atom is E. When the electron in a hydrogen atom jumps from the first excited state to the ground state, the energy emitted is:

E
< E
> E
0

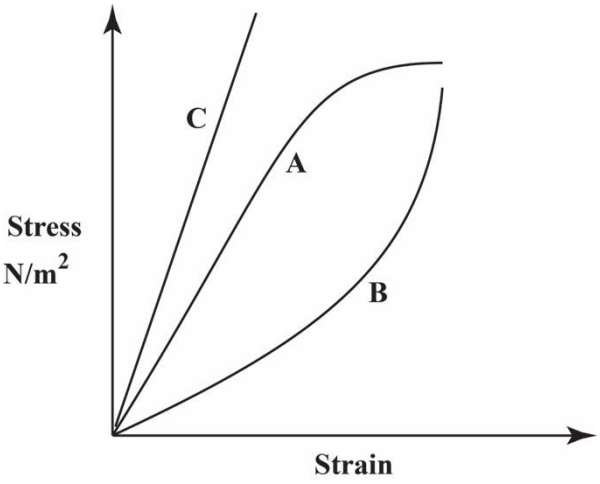
What happens to the protons in a given sample when an external magnetic field is applied?

All protons align with the field
All protons align opposite to the field
All protons assume a random orientation
Some protons align with the field and some align opposite to it

100 photons, one after the other, are sent to a photon detector that has a quantum efficiency of 0.1. How many times will the detector detect photons?

exactly 10 times
an average of 10 times with a root-mean-square deviation of 3
an average of 10 times with a root-mean-square deviation of 1
an average of 10 times with a root-mean-square deviation of 0.1

Our skin is easy to pinch, but very hard to pull apart. Based on this property, which of these curves most likely represents the mechanical properties of skin?

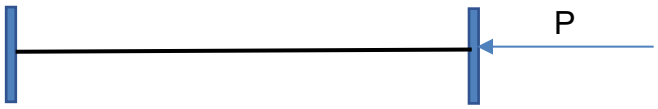


A
B
C
B and C

If the energy and momentum of a ball are E and P, respectively, its velocity will scale as:

E/P
P/E √
(E/P)
√(P/E)

Both ends of an actin fibre of length L are pinned to two parallel surfaces, as shown below. The elasticity modulus is E, and the moment of inertia is I. A load P is applied as shown. What is the maximum load that this fiber can withstand without buckling?



$\frac{\pi E^2 I}{L^2}$
$\frac{\pi^2 E I}{L}$
$\frac{\pi^2 E I}{L^2}$
$\frac{\pi^2 E I^2}{L^2}$

(answer is c)

A particle is performing Brownian motion with a diffusion constant D, and has a half-life of τ. The root mean square distance it will be displaced from its starting position before decaying will scale as:

- $\sqrt{D\tau}$
- $D\tau$
- $\sqrt{D/\tau}$
- D/τ

The first 4 harmonics produced by an organ pipe open at both ends are 50Hz, 100Hz, 150Hz and 200Hz. Which of the harmonics will remain once one end of the pipe is closed?

- 50Hz and 150Hz only
- 100Hz and 200Hz only
- 150Hz and 200Hz only
- None

Chemistry

What is the molarity of water if its density is 1000kg/m^3 (Molar mass of water is 18 g/mol)

55.55 moles
45.46 moles
60.0 moles
40.56 moles

The roasting of cocoa beans or the baking of bread, gives us the flavours and aromas that we savour in these foods. It also produces melanoidins that give the brown colour associated with roasting or baking. Which chemical reaction is responsible for this delicious outcome?

Diels-Alder reaction
Wittig's reaction
Maillard reaction
Perkin's reaction

The rate of reaction for a second order reaction can be

dependent on concentration of one reactant
dependent on concentration of two reactants
independent of product concentration
all of the above

When large globular proteins are homogeneously mixed with short polymer chains, which of the following statements is true?

Depletion interaction will keep the mixture homogeneous
the smaller polymers will keep the larger proteins separated to maximize the protein entropy
the smaller polymers will bind to the larger proteins
the smaller polymers can push the larger proteins together to maximize their own entropy

What does K_{cat}/K_m signify?

Specificity of enzyme for different substrates
Rate of product formation
Rate of substrate consumption
Maximum rate of reaction

Which one of the following statements is wrong?

Cellulose is a polysaccharide
Uracil is a pyrimidine
Serine is a sulphur containing amino acid

Sucrose is a disaccharide

Silicates, Silicone and silica all share the follow:

A linear chair structure

Si-O bonds

Si-Si bonds

Catalysis for hydrogenation

Choose the most appropriate option from below for the spectroscopic evidence of hydrogen bond formation. D—H……A where D and A are the hydrogen bond donor and acceptor respectively. H is the hydrogen atom.

Red-shift in the D—H vibrational frequency and de-shielding of H in D—H is observed in IR and NMR spectrum respectively.

Blue-shift in the D—H vibrational frequency and de-shielding of H in D—H is observed in IR and NMR spectrum respectively.

Blue-shift in the D—H vibrational frequency and shielding of H in D—H is observed in IR and NMR spectrum respectively.

Red-shift in the D—H vibrational frequency and shielding of H in D—H is observed in IR and NMR spectrum respectively.

You have added a drop of high concentration sugar solution in a bowl of water at room temperature. A few minutes later, which of the following statements is true?

Sugar solution has high viscosity. Hence, the rate of change of concentration of the sugar solution will be zero.

The rate of change of concentration of the sugar solution at a point in space is proportional to the second derivative of concentration with time

The molar flux of sugar molecules is proportional to the concentration gradient

The temperature gradient will be proportional to the second derivative concentration with time

What chemical would you add to D_2O to produce ND_3

TiN

NO_2

Li_3N

$NaNO_2$

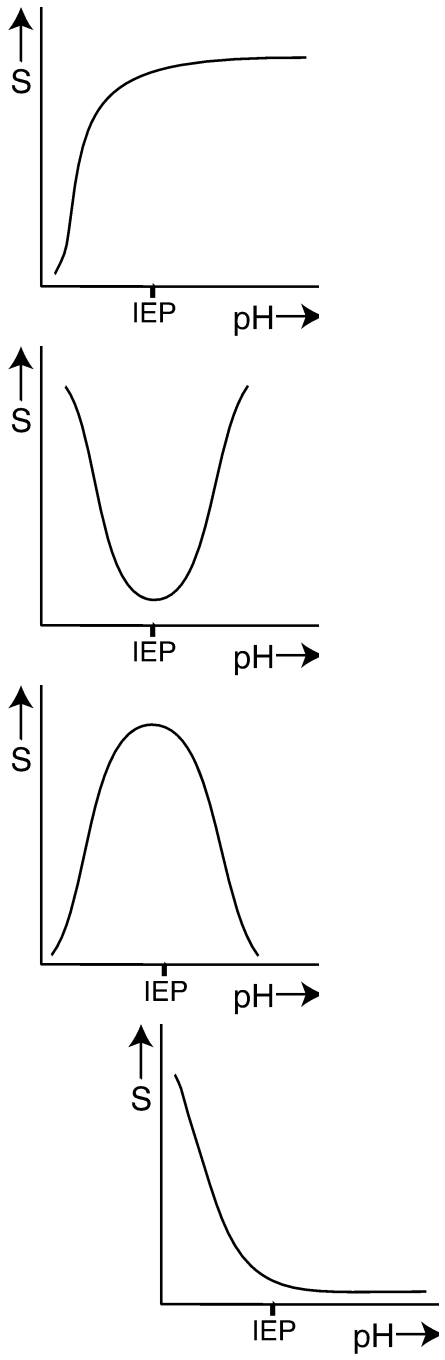
Identify the statement about haemoglobin that is not correct

Oxygen binds the porphyrin ligands of the haem groups

Oxygen binding is sensitive to pH

Carbon Monoxide is toxic as it binds haemoglobin with a higher affinity than oxygen
Oxygen binding to Haemoglobin is reversible.

Which of the following options show the appropriate solubility (S) curve of globular protein in polar solvent when plotted as a function of pH. IEP is the isoelectric point of the protein.



(answer b)

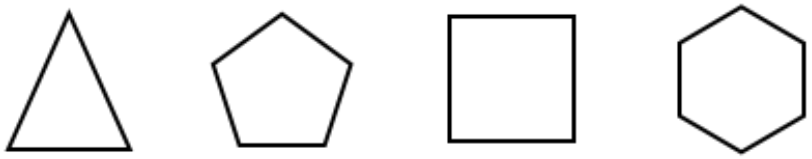
The data in the table in the table below is collected for an enzyme-catalyzed reaction.

[S] mM	V_0 (μmol.min^{-1})
8×10^{-6}	80
2×10^{-5}	140
8×10^{-5}	224
4×10^{-3}	277
2×10^{-2}	280
1×10^{-1}	279

The K_m for this enzyme is approximately:

8×10^{-6} mM
2.0×10^{-5} mM
8.0×10^{-5} mM
2×10^{-2} mM

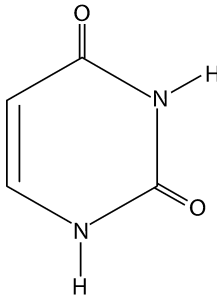
A series of alkanes is shown below. Which one has the lowest melting point

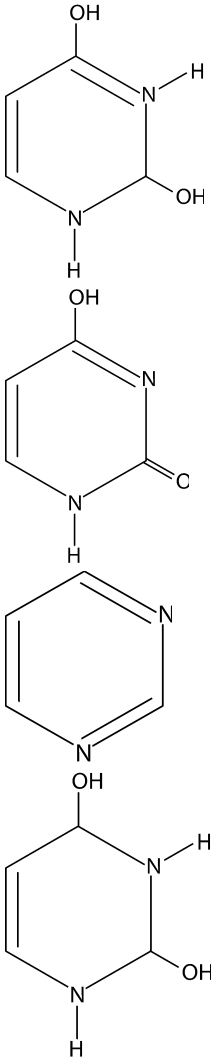


(1) (2) (3) (4)

2
3
1
4

Which of the following molecules is a tautomer of the structure shown?





Correct Answer

Biology

If a person has memory loss which part of the brain is most likely affected?

Amygdala
Spinal cord
Neocortex
Hippocampus

A mitochondrial mutation is detected in a man. This mutation is only lethal beyond the age of 70. He marries a woman who does not carry the mutation, and they then have children. What percentage of his grand-daughters would be carriers for this mutation

100%
0%
25%
33%

The nervous systems of invertebrates differ from the nervous systems of vertebrates in the following way:

Invertebrate neurons lack a myelin sheath around their axons.
Invertebrate neurons do not generate action potentials
Invertebrate neurons lack electrical synapses
All of the above

While culturing a eukaryotic cell line, you add radio-labelled methionine in the culture media. After addition, you are able to cleanly separate individual organelles at different times. In which organelle would you detect radioactivity first?

Rough Endoplasmic Reticulum
Lysosome
Mitochondria
Nucleus

Mature vertebrate erythrocytes always:

Lack a nucleus
Have a bi-concave shape
Use haemoglobin to carry oxygen
All of the above

Which of the following phyla are considered diploblastic (i.e. consisting of two germ layers)?

Echinodermata
Chordata

Mollusca
Cnidaria

An altered form of a replicative DNA polymerase lacks 3'→ 5' exonuclease activity. This alteration would most likely result in which of the following?

A decrease in processivity
An increased mutation rate
An inability to replicate DNA
An inability to remove RNA primers

On an expedition to Mars, the newest rovers discover microbial life. Yay! On further probing, scientists discover that Martian microbes also use DNA, RNA, and proteins. Researchers changed one nucleotide in a Martian gene and found that the resultant mutant protein had changes in 3 adjacent amino acids. These observations are consistent with a Martian genetic code consisting of:

Non-overlapping 2 codons
Overlapping 2 base codons
Overlapping triplet codons
Overlapping 4 base codons

Species that live on mountain tops are more prone to extinction due to climatic warming. This is because:
They are all long-lived, and adapting to these changes in climate is not possible.
Mountain tops have small areas, and species cannot shift their distributions upwards.
Mountains are eroding over time and mountaintops are physically unstable.
Mountain tops have low oxygen and adapting to both increased temperature and low oxygen is not possible.

Acorn worms have been extensively studied as a way to understand the evolution of the chordates. Which of the following features is a distinct chordate affinity found in acorn worms.

presence of post-anal tail
radially symmetrical body plan
presence of pharyngeal gill slits
ventral hollow nerve cord

Over time, cracks and damage occur in concrete. One way to repair this is by introducing microbes into concrete during the building process. These would heal the concrete if cracks appear. Which type of microbial species have been found suitable in self-healing concrete.

Aspergillus sp.
Bacillus sp.
Methanococcus sp.
Dictyostelium sp.

Co-operation, including seemingly altruistic behaviours can be advantageous when there is Reciprocity. This theory of reciprocal altruism provides one explanation for cases of seemingly altruistic behaviour by various animals (for example, sharing of blood meal in vampire bats). Under which of the following conditions this theory cannot be used as an explanation of co-operative behaviour?

The animal is an invertebrate
The animal is distributed such that repeated encounter between conspecifics is very rare
The animal cannot recognize kins from non-kins
The animal can recognize non-kins, but cannot distinguish between close and distant distant genetic relatives

E. coli was engineered to express two different fluorescent proteins (GFP and RFP) under identical promoters. The strain is engineered such that the two proteins are expressed at a 1:1 ratio, giving the bacteria a 'yellow' colour. As the culture grows further over time, which of the following scenarios is most likely? Assuming that neither GFP nor RFP confers any kind of selection pressure.

GFP starts predominating over RFP, turning the cultures green
RFP starts predominating over GFP, turning the culture red
Individual bacterium in the culture starts expressing the two proteins distinctly, providing a mosaic pattern
Robust regulatory mechanisms for transcription and translation ensure the maintenance of 1:1 ratio, thus the culture will remain 'yellow'.

There are three genes *a*, *b*, and *c*. Percentage of crossing over between *a* and *b* is 20%, *b* and *c* is 28% and *a* and *c* is 8%. What is the order of arrangement of these three genes on the chromosome?

a, b, c
a, c, b
b, a, c
c, b, a

Many organisms use cilia to move inside fluids. Which of the following statements is true for ciliary motion?

The viscous friction coefficient for the motion of a cilium parallel to its axis is smaller than the viscous friction coefficient for the motion of a cilium perpendicular to its axis.

The viscous friction coefficient for the motion of a cilium parallel to its axis is equal to the viscous friction coefficient for the motion of a cilium perpendicular to its axis.
The viscous friction coefficient for the motion of a cilium parallel to its axis is larger than the viscous friction coefficient for the motion of a cilium perpendicular to its axis.
The viscous friction coefficient for the motion of a cilium parallel to its axis tends to infinity when compared with the viscous friction coefficient for the motion of a cilium perpendicular to its axis.