Ministero dell'Istruzione, dell'Università e della Ricerca

# 01AA80001

## ADMISSION TEST FOR THE DEGREE COURSE IN MEDICINE AND SURGERY

**Academic Year 2018/2019**

Cambridge Assessment Admissions Testing


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**1** Alpha, Beta and Gamma are the three political parties in the Parliament.

There are 360 seats in the Parliament. Before last week's General Election, each party held 120 seats.

In last week's election:

There was no change in 216 seats.

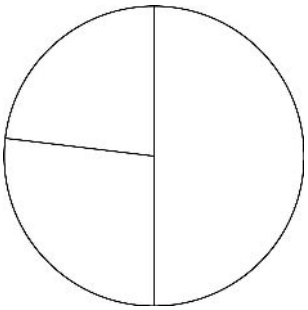
Alpha gained 15 seats from Beta and 23 seats from Gamma.

Beta gained 31 seats from Alpha and 41 seats from Gamma.

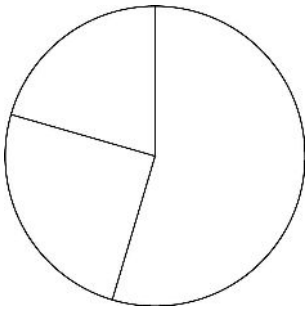
Gamma gained 24 seats from Alpha and 10 seats from Beta.

Which pie chart, suitably labelled, shows the current state of the parties in the Parliament?

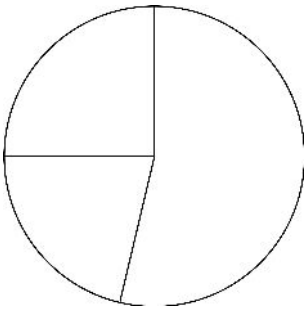
**A**



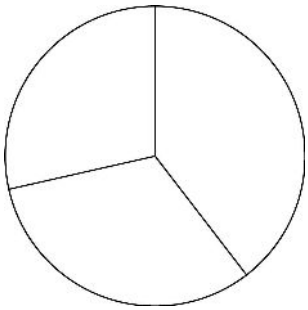
**B**



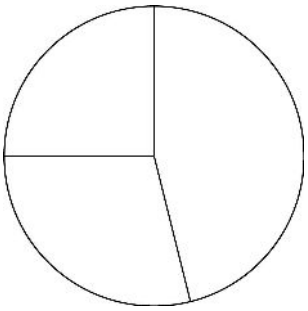
**C**



**D**



**E**

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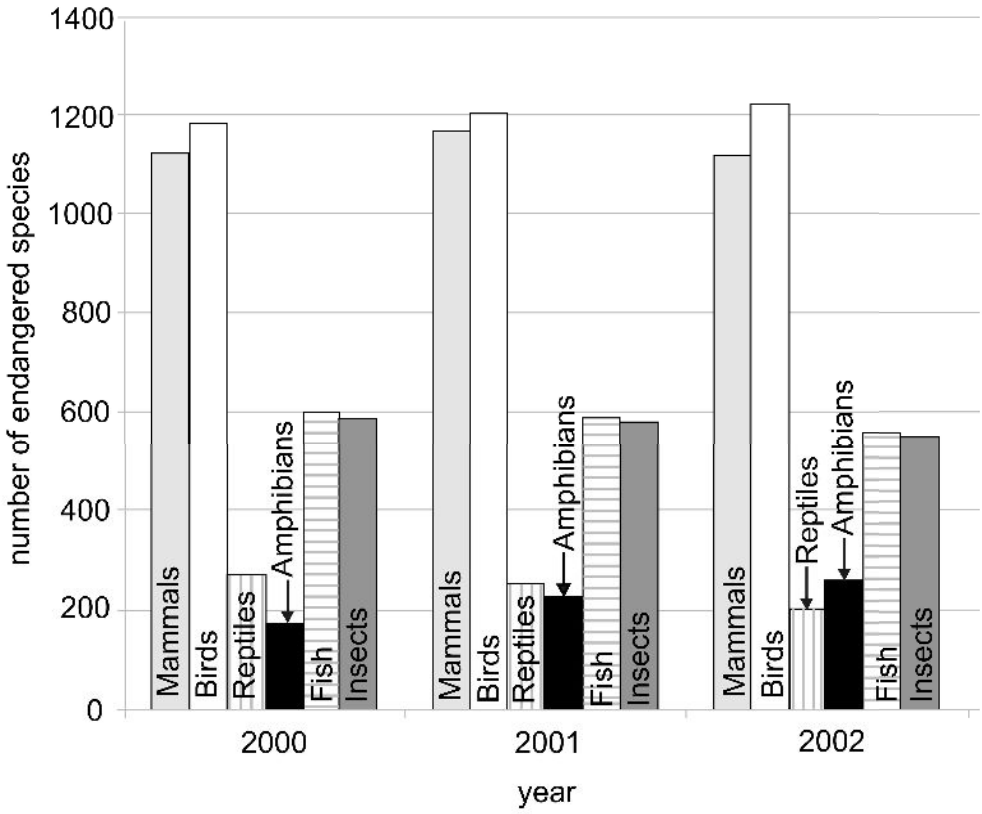
**2** The bar chart below shows the number of endangered species between 2000 and 2002 per animal class.




Which one of the following pieces of information can be inferred from the bar chart above?

**A** The number of species of insects that were endangered was almost equal to the number of species of fish that were endangered over the three-year period.

**B** The number of endangered species of mammals remained constant over the three-year period.

**C** The number of endangered species of reptiles increased over the three-year period while that of amphibians decreased.

**D** In 2001, there were exactly four times as many endangered species of birds as there were endangered species of reptiles.

**E** More species of bird became endangered over the three-year period than any other animal class.

**3** Competition between restaurants is fierce and restaurateurs are trying to gain recognition for the quality of their food. Research from Oxford University might just give them that edge over their competitors. More than a hundred people participated in a series of experiments to see if the taste of food was affected by the cutlery used to eat it. The study found that desserts tasted better when eaten using small spoons. Similarly yoghurt tasted creamier when eaten with a black spoon. Cheese cut with a heavy knife tasted more expensive than cheese cut with a lighter knife.

Which one of the following is a conclusion that can be drawn from the above passage?

**A** People choose restaurants only because of the quality of the food.

**B** Restaurants should think carefully about what cutlery they use.

**C** Restaurants should pay less attention to food presentation.

**D** Customers pay attention to the cutlery they are using.

**E** Variety of cutlery is more important than quality of food.

**4** It's better for your children's health to give them a video game to play than to let them watch television. Researchers at Queensland University examined the effects of video gaming and watching television on children between the ages of two and five. They found that the children burned more calories when they were gaming than when they were watching television; higher blood pressure was associated with watching television, but not with video gaming. The scientists believe that the difference comes from two distinct kinds of screen time: passive screen time, where you are simply viewing programmes or films, and active screen time, where you are engaging both your mind and your body.

Which one of the following is the main conclusion of the above argument?

**A** Playing video games helps to reduce children's blood pressure.

**B** Watching television does not stimulate children’s minds.

**C** Video gaming engages both the mind and the body.

**D** Video gaming is better for children’s health than watching television.

**E** Children burn more calories when they play video games than when they watch television.

**5** In a family, each of the six children has one packet of crisps on each weekday (Monday to Friday) for their packed lunch. The triplets have Cheese flavoured crisps, the twins have Paprika flavoured crisps, and the oldest child always has Chilli flavoured crisps. The exact number of packets of crisps needed are purchased at the same time for the four-week period.

The table below shows the price of single packets of crisps and multipacks of crisps of the same flavour. A multipack is a discounted collection of a number of single packets of one flavour.

| *packet type* | *price* |
|---|---|
| single packet | £0.50 |
| multipack of 6 | £2.50 |
| multipack of 12 | £4.50 |
| multipack of 24 | £8.50 |
| multipack of 36 | £12.50 |

What is the most money that can be saved for the four weeks by purchasing the appropriate combination of multipacks and single packs of the different flavours rather than all single packs?

**A** £43.50

**B** £23.50

**C** £8.00

**D** £18.00

**E** £16.50

**6** Sperm whales have the largest brains on the planet, although both humans and dolphins have larger brains relative to their body size. But why should relative brain size be important? If one thinks of a brain as a computer, there is no obvious reason why it must be sized in proportion to the body it lives in. Why for example should a whale need an especially large brain, when a hummingbird – which has complex tasks to perform – manages with a tiny one?

Which one of the following is a conclusion that is supported by the above passage?

**A** Brain size and the ability to perform complex tasks are not necessarily related.

**B** Hummingbirds and whales have equally complex tasks to perform, despite huge difference in brain size.

**C** Dolphins are more intelligent than whales.

**D** There is no important difference between a brain and a computer.

**E** Whales need larger brains than either dolphins or humans because of their enormous size.

**7** Food manufacturers should reduce sugar levels in processed foods. This is because there are too many overweight and obese people. Since people are unable or unwilling to make sensible decisions for themselves, manufacturers must take responsibility for rectifying a problem to which they contribute.

Which one of the following illustrates the principle used in the above argument?

**A** Cigarette packets should have plain packaging and display government health warnings.

**B** In order to reduce sugar intake, foods with high sugar content should be taxed more heavily.

**C** Power tools should have clear instructions in order to reduce the number of accidents caused by incorrect use.

**D** Labelling on food should be improved so that consumers are clear about the level of sugar in a product.

**E** To reduce the number of deaths caused by excessive speed, car manufacturers should incorporate speed limiters in vehicles.

**8** Action has to be taken now to stop the spread of bovine tuberculosis (TB). Experts agree that reducing the number of badgers in the most heavily infected areas will help to break the cycle of infection between badgers and cattle and begin to reduce TB in both species. Although badgers can be vaccinated, there is no vaccine available to protect our cattle, and best estimates suggest it will be ten years before one is available. The only way to stop bovine TB spreading is to kill badgers.

Which one of the following, if true, most strengthens the above argument?

**A** Five annual vaccinations are necessary to protect a badger fully against bovine TB.

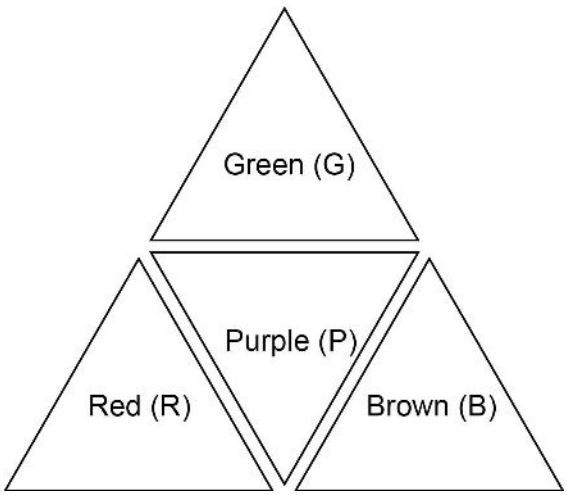
**B** Less than ten per cent of the dairy cows destroyed each year are destroyed because of bovine TB.

**C** In a trial, killing ten thousand badgers reduced the TB rate in cattle by only fifteen per cent.

**D** Shooting large numbers of badgers is more expensive than vaccinating them.

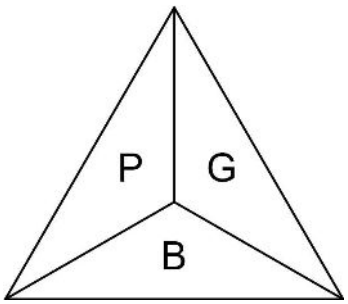
**E** When efforts are made to remove badgers, many are injured rather than killed outright.

**9** A regular tetrahedron is made by fastening together four triangles made from card coloured on one side only, as shown in the diagram below.

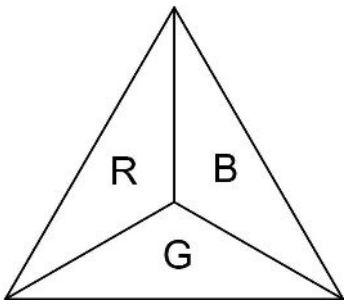



Which one of the following is NOT a possible view of this tetrahedron when looked at from above?

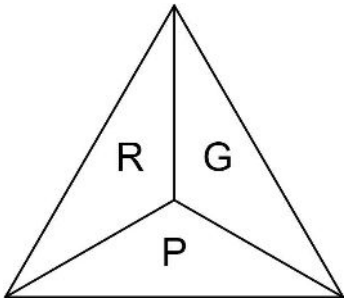
**A**



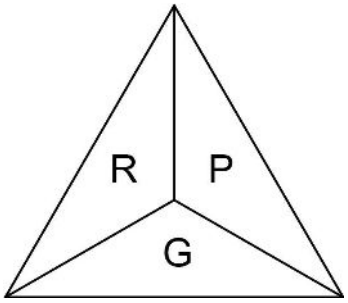

**B**



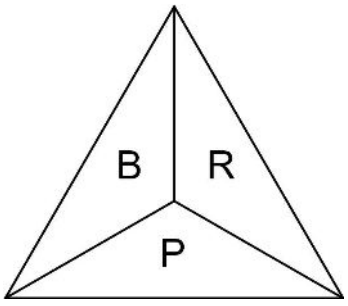

**C**




**D**




**E**



**10** You want to buy a house in your local area with three bedrooms and a garage. However, you only want to spend €150,000. Houses in your local area with three bedrooms and a garage never sell for less than €200,000. You will have to spend more to get the house you want.

Which one of the following most closely matches the logical structure of the above argument?

**A** You want a well-paid job with lots of holiday and the chance to retire early. Such jobs do not exist, so you need to adjust your expectations.

**B** You want to study mathematics but you don't like numerical reasoning. Mathematics is essentially numerical reasoning, so you should choose a different subject.

**C** You want a large powerful car that is fuel efficient. Large powerful cars are never fuel efficient, so you will have to spend more on fuel if you want a large powerful car.

**D** You want to buy the painting at the auction. Lots of other people want to buy it, so you have to be prepared to bid a lot of money to be successful.

**E** You want either the green jacket or the blue jacket. The green jacket looks good and the blue jacket is a bargain, so there are advantages in buying either one.

**11** One of the populations with the highest life expectancy is Iceland. The people there are very healthy, as indicated by the low incidence of diabetes, obesity, heart disease and diet related cancers. Their diet is rich in good quality local fish, and meat and dairy products from grass fed animals. The fish and meat is all caught, produced and processed on a small scale. If we want to live long and healthy lives we should adopt the Icelanders' diet.

Which one of the following is the best statement of the flaw in the above argument?

**A** There may be other reasons for the Icelanders' health and longevity.

**B** People may not like being told what they should eat.

**C** The Icelandic diet may be prohibitively expensive elsewhere.

**D** There may be insufficient space in many countries to raise grass fed animals.

**E** Vegetarians may not be able to live on an Icelandic diet.

**12** Recent research in the USA has found that areas with more dentists per person have much lower rates of obesity than neighbouring areas of similar population size. Clearly, public health authorities concerned with obesity rates should focus more resources on the provision of dental care. Dentists are a neglected asset in the struggle against the serious health problems associated with obesity.

Which one of the following is the best statement of the flaw in the above argument?

**A** It assumes dental care in the USA is somewhat similar to that found elsewhere.

**B** It assumes that obesity rates should be a priority concern for public health authorities.

**C** It ignores factors that might prevent public health authorities from spending more on obesity and related conditions.

**D** It ignores the fact that help and advice concerning obesity can be delivered in a variety of ways.

**E** It assumes that a higher number of dentists causes lower obesity rates.

**13** David normally takes 45 minutes to walk at a steady speed in a straight line from his house, past his friend Barry's house and then past a shop to reach his college.

Today, however, he stopped at Barry's house on the way and had to wait 3 minutes for him to be ready to leave. They stopped at the shop to buy their lunch, which took another 3 minutes.

It normally takes David 20 minutes to walk from his home directly to the shop and Barry normally takes 32 minutes to walk directly from his home to the college and they both walk at the same steady speed.

How long does it take them to walk from Barry's house to the shop?

**A** 7 minutes

**B** 1 minute

**C** 13 minutes

**D** 4 minutes

**E** 10 minutes

**14** The table below shows how to choose an appropriate glue for different materials you may want to bond together. For example, to bond cork and rubber you can use either rubber contact glue or epoxy glue.

| | *balsa wood* | *plywood* | *acrylic* | *card* | *fabric* | *polystyrene* | *metal* | *cork* | *glass* | *rubber* |
|---|---|---|---|---|---|---|---|---|---|---|
| *rubber* | G | G | I | F I | G | H | F I | G I | G I | F G |
| *glass* | I | I | F I | F I | G | D H | F I | G I | G I | |
| *cork* | G I | G I | F I | F I | G | D H | G I | D G J | | |
| *metal* | I | I | F I | F I | G | D H | F I | | | |
| *polystyrene* | D | D | D H | D | D H | D H | | | | |
| *fabric* | G H | G H | G | G | D H | | | | | |
| *card* | C D | C D | D F I | C D | | | | | | |
| *acrylic* | F I | F I | B | | | | | | | |
| *plywood* | D E | D E | | | | | | | | |
| *balsa wood* | C D | | | | | | | | | |

Key
B – acrylic cement
C – balsa cement
D – PVA glue
E – synthetic resin glue
F – cyanoacrylate (superglue)
G – rubber contact glue
H – latex glue
I – epoxy glue
J – polyester resin

Which one of the following statements is supported by the information in the table?

**A** Acrylic can be bonded to polystyrene using cyanoacrylate.

**B** Synthetic resin glue can only be used to glue wood materials together.

**C** Balsa cement can only be used to glue balsa wood to another material.

**D** The only materials that are suitable for bonding together with three different types of glue are cork with cork.

**E** Polystyrene and card can only be bonded with rubber contact glue.

**15** Mr and Mrs Massa's rectangular lawn measures 10 metres by 6 metres. They pay Giovanni to cut the grass and trim the edges. Giovanni charges a fixed rate per square metre of grass to be cut and another fixed rate per metre of edge to be trimmed. For Mr and Mrs Massa's lawn, this results in a charge of $12 to cut the grass and $8 to trim the edges.

Now, Mr and Mrs Costa next door want Giovanni to do the same for them. Their lawn is also rectangular and measures 15 metres by 9 metres.

If he charges them at the same rate as the Massas, how much will Giovanni charge Mr and Mrs Costa, in total, for cutting their grass and trimming their edges?

**A** $35

**B** $30

**C** $45

**D** $39

**E** $36

**16** A leaking undersea oil well in the USA caused massive damage to wildlife and was extremely expensive to clear up. Worst of all, it destroyed the livelihoods of poor people living in the area. Despite this, in the developed world we still don't take seriously the risks of deepwater drilling. Until we can be satisfied that regulation is effective and that oil companies are operating safely, deepwater drilling should be banned.

Which one of the following, if true, most weakens the above argument?

**A** The risks of deepwater drilling were known prior to the accident in the USA.

**B** Oil companies involved in the accident in the USA paid money to compensate the victims.

**C** A ban on deepwater drilling would cause oil prices to rise, which would affect poor people most.

**D** Oil companies will operate more safely in future than they did before the accident in the USA.

**E** Alternatives to fossil fuels may eventually be able to meet our energy needs.

**17** A 300g packet of Scottish oatcakes has the following information on the side of the packet:

| *typical values* | *per 100g* | *per oatcake* |
|---|---|---|
| energy | 462 kcal | 60 kcal |
| protein | 10.78g | 1.4g |
| carbohydrate – total | 56.0g | 7.27g |
| carbohydrate – sugars | 2.31g | 0.3g |
| fat – total | 20.79g | 2.7g |
| fat – saturates | 5.4g | 0.7g |
| fibre | 6.9g | 0.9g |

How many oatcakes are there in the packet?

**A** 23

**B** 24

**C** 18

**D** 29

**E** 21

**18** A train is travelling at 30 mph towards a terminus which is 120 miles away.

At the same time, a pigeon starts flying from the terminus towards the train. When it meets the train, it turns and flies back towards the terminus and, when it arrives there, it turns and flies back towards the train again. The pigeon flies at an average speed of 40 mph.

The pigeon continues to do this until the train reaches the terminus.

Assuming that no time was lost in each turnaround, how far (to the nearest 10 miles) does the pigeon fly altogether?

**A** 160 miles

**B** 180 miles

**C** 240 miles

**D** 140 miles

**E** 120 miles

**19** A puzzle is made up of these three pieces. The pieces can be flipped and rotated, but they cannot overlap.

Which one of the following shapes CANNOT be made using these three pieces?

**A**

**B**

**C**

**D**

**E**

**20** ‘Internet addiction’ is about to be classified as a recognised psychiatric disorder. Internet addiction is characterised by a number of signs: excessive use of the internet; anger or depression if access is lost; isolation from friends and family; and, most significantly, poor educational achievement. This should make us cautious about incorporating computer-based learning into all aspects of education. Educationalists should consider the long-term problems associated with extensive internet use as well as its immediate attractions.

Which one of the following is an assumption of the above argument?

**A** All computer-based learning includes internet use.

**B** Students are unable to regulate their internet use.

**C** It is a bad idea to incorporate computer-based learning into education.

**D** Classifiying internet addiction as a recognised psychiatric disorder will help lead to a cure.

**E** Excessive internet use is the only cause of poor educational achievement.

**21** The *Almagest* is the common title of a mathematical and astronomical treatise written by

**A** Claudius Ptolemy.

**B** Pythagoras.

**C** Johannes Kepler.

**D** Nicolaus Copernicus.

**E** Aristotle.

**22** Which of these pairs of nation and national newspaper name is wrong?

**A** France – Le Monde

**B** Denmark – De Telegraaf

**C** United Kingdom – The Times

**D** Germany – Süddeutsche Zeitung

**E** Slovakia – Nový Čas

**23** Which of the following can be a result of exercise in a healthy human?

1. a decrease in muscle pH
2. an increase in blood pH
3. more blood flows to certain organs

**A** 1 and 2 only

**B** 1 and 3 only

**C** 1, 2 and 3

**D** 3 only

**E** 2 and 3 only

**24** The enzyme HIV-1 protease is produced by the HIV virus.

The enzyme is formed from two identical chains of 99 amino acids. In each chain, amino acids 25, 26 and 27 in the sequence form part of the active site.

Which levels of structure control the shape of the active site of the HIV protease?

**A** primary, secondary and tertiary only

**B** primary, secondary, tertiary and quaternary

**C** primary and quaternary only

**D** secondary and tertiary only

**E** quaternary only

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**25** Which of the following could explain why the phenotype of a healthy female child may show differences from her healthy biological brother (apart from the gender)?

1. independent assortment after the formation of the female zygote
2. crossing over between a chromosome from the sperm and a chromosome from the egg
3. random alignment of homologous chromosomes at the equator of the cell during metaphase I

**A** 1 and 2 only

**B** 1 only

**C** 2 only

**D** 2 and 3 only

**E** 3 only

**26** A eukaryotic cell undergoes division. At one point it has pairs of chromosomes being separated by spindle fibres and moving towards the poles of the cell.

What stage of division is this?

**A** anaphase in Meiosis I

**B** anaphase in Mitosis

**C** metaphase in Mitosis

**D** metaphase in Meiosis II

**E** telophase in Meiosis I

**27** The genes P, Q, R and S occur on the same chromosome. The COV (crossover values) for the pairs of genes are:

P and Q 35%

P and R 5%

R and Q 40%

Q and S 10%

R and S 30%

Which one of the following sequences of letters represents a correct order of genes on the chromosome?

**A** PQRS

**B** RSQP

**C** PRSQ

**D** RPSQ

**E** PQSR

**28** Which one of the following statements is correct when the pressure in the ventricles of a healthy human heart is at its highest?

**A** The semi-lunar valves will be closed.

**B** The atria of the heart will be filling.

**C** A wave of electrical activity will be reaching the atrioventricular node.

**D** The heart will be in atrial systole.

**E** The atrioventricular valves will be open.

**29** Reverse transcriptase is mainly found in retroviruses such as HIV. Four nucleotides are needed for the reaction catalysed by this enzyme.

A group of molecules may inhibit this enzyme. These molecules are structurally similar to the nucleotides but slightly altered so that bonds normally formed in the reaction cannot be made.

Which of the following statements may be correct?

1. The four inhibitor molecules will resemble adenine, thymine, guanine and cytosine.
2. The inhibitor molecules can prevent the formation of phosphodiester bonds.
3. The inhibitor molecules can result in a reduction in the number of new virus particles produced.

**A** 1 and 3 only

**B** 1, 2 and 3

**C** 3 only

**D** 1 and 2 only

**E** 2 and 3 only

**30** A section of unmutated double-stranded DNA contains 100 nucleotides and 38% of these nucleotides contain thymine.

Which one of the following correctly identifies the number of hydrogen (H) bonds and phosphodiester bonds present in this section of DNA?

**A** 138 H bonds present and 98 phosphodiester bonds present

**B** 224 H bonds present and 98 phosphodiester bonds present

**C** 112 H bonds present and 99 phosphodiester bonds present

**D** 138 H bonds present and 99 phosphodiester bonds present

**E** 112 H bonds present and 98 phosphodiester bonds present

**31** A condition caused by the dominant allele of a gene on the X chromosome is passed down through a family. Individual Z inherits the condition.

For this family, which of the following statements must be correct, assuming no spontaneous mutations have occurred?

1. If Z is a boy, then he must have inherited the dominant allele from his father.
2. If Z is a boy, then one of his mother's parents must have also had the condition.
3. If Z is a girl, then both of her parents must have had the allele.
4. If Z is a boy, and has children, then all of his daughters will have the condition.

**A** 2 and 4 only

**B** 1 and 3 only

**C** 1, 3 and 4 only

**D** 1 and 4 only

**E** 2 and 3 only

**32** Squamous epithelium, ciliated epithelium and cartilage are tissues found in healthy humans.

Which one of the following structures is made up of at least TWO of these tissues?

**A** alveoli

**B** oviduct

**C** Bowman's capsule

**D** trachea

**E** capillaries

**33** Mutations in the CFTR gene cause cystic fibrosis (CF). The non-mutated allele of the gene can be obtained and then introduced into the lung cells of a person with CF using liposomes as a vector. This treatment gives only short-term relief from the symptoms of CF.

Which of the following statements would be a correct explanation of this treatment?

1. Genes are unstable and break down over time in the cell.
2. Lung cells are constantly being replaced and new cells will have the faulty allele.
3. The non-mutated allele is recessive.

**A** 1 and 2 only

**B** 1 only

**C** 2 only

**D** 1 and 3 only

**E** 2 and 3 only

**34** Which of the following structures make a solution that can raise the pH in the digestive system of a healthy human?

1. gall bladder
2. pancreas
3. stomach

**A** 2 and 3 only

**B** 1 and 2 only

**C** 1 only

**D** 2 only

**E** 3 only

**35** An organism, in bright sunlight, has the following features:

- Consists of some cells with organelles which contain grana.
- All cells contain molecules of ATP, ADP and NAD.
- Some cells release carbon dioxide by diffusion all the time.

Which one of the following statements about the organism is correct?

**A** It is made up of cells which all contain mitochondria and chloroplasts.

**B** It is photosynthetic but has some cells which only respire.

**C** It is an anaerobic organism which only releases carbon dioxide.

**D** It is eukaryotic and all cells carry out photosynthesis.

**E** It is prokaryotic and only carries out respiration.

**36** Which of the following contain peptide bonds?

1. ribosomes in human liver cells
2. antibodies in human plasma
3. cilia on human bronchial cells
4. cholesterol in the membrane of human kidney cells

**A** 2, 3 and 4 only

**B** 1 and 3 only

**C** 1 and 4 only

**D** 2 and 4 only

**E** 1, 2 and 3 only

**37** B lymphocytes are involved in the human immune response to a bacterial infection.

Which of the following processes would TYPICALLY be carried out by these lymphocytes in response to the infection?

1. cell division by mitosis
2. transcription producing mRNA
3. engulfing and digesting bacteria

**A** 1 and 2 only

**B** 3 only

**C** 1 and 3 only

**D** 1 only

**E** 2 and 3 only

**38** A Petri dish contains populations of two different species of bacteria (V and W). Both are growing and reproducing at the same rate, using the same resources. The conditions are then changed and the rate of growth and reproduction of the population of species V increases.

Which of the following, acting independently, could cause this increase in growth and reproduction rate?

1. a decrease in temperature
2. a change in pH
3. the addition of an antibiotic

**A** 1, 2 and 3

**B** 2 and 3 only

**C** 2 only

**D** 1 and 2 only

**E** 1 and 3 only

**39** Part of a polypeptide sequence consists of four amino acids -1-2-3-4-.

The tRNA anticodons for each amino acid are:

| *amino acid* | *anticodon* |
|---|---|
| 1 | GCA |
| 2 | ACA |
| 3 | UUG |
| 4 | GGU |

Which one of the following is the correct sequence, in a 3′ to 5′ direction, for the bases on the template strand of the DNA?

**A** GCAACATTGGGT

**B** CGTTGTAAGCCA

**C** CGUUGUAAGCCA

**D** GCAACAUUCCCU

**E** ATGGTGCCTTTC

**40** Which of the following statements about a neurone in a healthy human is/are correct?

1. Transport across its cell membrane can occur by exocytosis.
2. It contains the gene that codes for insulin.
3. It contains circular DNA.

**A** 1, 2 and 3

**B** 1 and 3 only

**C** 1 and 2 only

**D** 2 and 3 only

**E** 1 only

**41** Compounds of chlorine include:

$Cl_2O$ KCl KClO $KClO_3$ $KClO_4$ $Cl_2O_7$

Which one of the following options correctly lists the oxidation states of chlorine that are shown in these compounds?

**A** –1, +1, +5 and +7 only

**B** –1, 0 and +1 only

**C** –1 only

**D** –1, 0, +1, +5 and +7 only

**E** –1, +1, +3, +5 and +7 only

**42** Which one of the following substances has the highest solubility in the specified liquid at a temperature of 298 K and 1 atm pressure?

**A** sodium chloride in liquid cyclohexane

**B** bromine in liquid hexane

**C** hydrogen in liquid water

**D** potassium bromide in liquid tetrachloromethane

**E** silicon dioxide in liquid water


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**43** What is the molecular formula of the compound shown below?

**A** $C_6H_{10}$

**B** $C_6H_{12}$

**C** $C_6H_8$

**D** $C_6H_6$

**E** $C_6H_{14}$

**44** Which of the following species have the same number and arrangement of electrons in their lowest energy states?

$_{19}K^+$ $_{11}Na^+$ $_{8}O^-$ $_{8}O^{2-}$ $_{16}S^-$

**A** $_{8}O^-$ and $_{8}O^{2-}$

**B** $_{19}K^+$ and $_{16}S^-$

**C** $_{11}Na^+$ and $_{8}O^{2-}$

**D** $_{19}K^+$ and $_{11}Na^+$

**E** $_{8}O^-$ and $_{16}S^-$

**45** Five atoms are shown below. The letters are NOT chemical symbols.

Which one of the following atoms has the highest first ionisation energy?

**A** $^{23}_{11}Z$

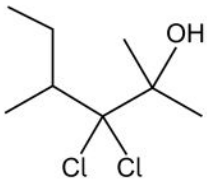
**B** $^{20}_{10}W$

**C** $^{21}_{9}X$

**D** $^{22}_{11}Y$

**E** $^{19}_{9}V$

**46** What is the correct IUPAC name of this compound?




**A** 3,3-dichloro-2,4-dimethylhexan-2-ol

**B** 3,3-chloro-2-ethyl-4-methylpentan-4-ol

**C** 3,3-dichloro-4-ethyl-2-methylpentan-2-ol

**D** 3,3-chloro-4-ethyl-2-methylpentan-2-ol

**E** 4,4-dichloro-3,5-dimethylhexan-5-ol

**47** Which row correctly shows the shape of each molecule and whether the molecule is polar (i.e. has a permanent dipole moment) or non-polar?

[Atomic numbers: H = 1; B = 5; C = 6; N = 7; O = 8; F = 9; P = 15; Cl = 17]

| | *molecule* | *shape* | *polar or non-polar* |
|---|---|---|---|
| 1 | $BF_3$ | trigonal planar | polar |
| 2 | $CH_2Cl_2$ | tetrahedral | non-polar |
| 3 | $CO_2$ | linear | polar |
| 4 | $NH_3$ | trigonal planar | polar |
| 5 | $PCl_5$ | trigonal bipyramidal | non-polar |

**A** row 3

**B** row 1

**C** row 4

**D** row 2

**E** row 5

**48** Consider a fixed volume and amount of an ideal gas at 10 °C.

What temperature would it have to be changed to in order for the pressure to be doubled?

**A** 5 °C

**B** 20 °C

**C** 566 °C

**D** 293 °C

**E** 278 °C

**49** Consider this ionic equation in aqueous solution:

$$CH_3O^- + H_2O \rightarrow CH_3OH + OH^-$$

Which statement about this reaction is correct?

**A** Water is acting as a Brønsted–Lowry base.

**B** The $CH_3O^-$ ion is a Lewis acid.

**C** The final mixture of solutions would have a pH below 7.

**D** $CH_3OH$ is the conjugate acid of $CH_3O^-$.

**E** The hydroxide ion is the conjugate acid of the water.

**50** A sealed container contains 1.00 mol of hydrogen gas, which behaves as an ideal gas.

Which of the following changes increase(s) the total kinetic energy of the hydrogen gas molecules initially within the container?

1. Changing the amount of hydrogen from 1.0 mol to 1.2 mol whilst keeping the pressure and volume constant.
2. Changing the pressure from 1.0 atm to 1.2 atm whilst keeping the volume and number of moles constant.
3. Changing the volume from 1.0 L to 1.2 L whilst keeping the pressure and number of moles constant.

**A** 3 only

**B** 2 and 3 only

**C** 1, 2 and 3

**D** 1 and 2 only

**E** 1 only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**51** When nitrogen and hydrogen are mixed under suitable conditions of temperature and pressure, and in the presence of a catalyst, an equilibrium state is attained:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H \text{ is negative}$$

Which of the following statements explain(s) why, when the pressure on a mixture of nitrogen and hydrogen is increased while the temperature remains constant, the time taken to attain equilibrium is decreased?

1. The molecules have a higher collision frequency.
2. The yield of ammonia ($NH_3(g)$) decreases.
3. A greater proportion of molecules in the mixture have energy greater than the activation energy.

**A** 2 only

**B** 3 only

**C** 1 and 3 only

**D** 1, 2 and 3

**E** 1 only

**52** Which of the following statements, if any, are correct for the properties of Group I elements?

1. They form hydrides where the hydrogen has an oxidation state of –1.
2. They can reduce iodine to iodide.
3. Their outer electrons are delocalised when in the liquid state.

**A** 1, 2 and 3

**B** 1 and 2 only

**C** 1 and 3 only

**D** none of them

**E** 2 and 3 only


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**53** The equation below has two roots.

$$\frac{x+4}{x+1} = x$$

What is the sum of the two roots?

**A** 2

**B** $-2$

**C** 4

**D** $-4$

**E** 0

**54** A pentagon has one line of symmetry. All five sides are 6 cm, and the interior angles, in anticlockwise order, are 60°, 150°, 90°, 90° and 150°.

What is the area of this pentagon?

**A** $3(5+\sqrt{3})\ \text{cm}^2$

**B** $9(2+\sqrt{3})\ \text{cm}^2$

**C** $3(4+\sqrt{3})\ \text{cm}^2$

**D** $3(12+\sqrt{3})\ \text{cm}^2$

**E** $9(4+\sqrt{3})\ \text{cm}^2$


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**55** An electric train is travelling on a straight, horizontal track. A constant resultant force (greater than zero) acts on the train in the direction of the train's motion.

What happens to the magnitude of the acceleration and to the magnitude of the velocity of the train while this force is acting?

**A** The acceleration increases and the velocity remains constant.

**B** The acceleration remains constant and the velocity increases.

**C** The acceleration decreases and the velocity increases.

**D** The acceleration remains constant and the velocity remains constant.

**E** The acceleration increases and the velocity increases.

**56** Which one of the following is an equation of the line that passes through (4, 3) and is perpendicular to the line $y = 2x + 4$?

**A** $2x - y = 5$

**B** $2y + x = 11$

**C** $2y - x = 2$

**D** $2x + y = 11$

**E** $2y + x = 10$

**57** Three spherical particles have the following diameters: 1650 pm, 1.5 nm and 0.0036 μm.

What is their order of diameter (smallest first)?

**A** 0.0036 μm, 1.5 nm, 1650 pm

**B** 1.5 nm, 0.0036 μm, 1650 pm

**C** 1650 pm, 1.5 nm, 0.0036 μm

**D** 0.0036 μm, 1650 pm, 1.5 nm

**E** 1.5 nm, 1650 pm, 0.0036 μm

**58** A wire made of a metal of uniform resistivity $1.0 \times 10^{-6}\ \Omega\,\text{m}$ is 2.0 m long and has a diameter of $2.0 \times 10^{-3}$ m.

What is the electrical resistance of this length of the wire?

**A** $\dfrac{2.0 \times 10^{-3}}{\pi}\ \Omega$

**B** $5.0 \times 10^{-13}\,\pi\,\Omega$

**C** $\dfrac{1.0}{2\pi}\ \Omega$

**D** $2.0 \times 10^{-12}\,\pi\,\Omega$

**E** $\dfrac{2.0}{\pi}\ \Omega$

**59** The Earth's atmosphere contains oxygen and nitrogen. The mass of an oxygen molecule is greater than the mass of a nitrogen molecule. The temperature of air in a room on a particular day is 300 K.

Below are four statements about the motion of the two types of molecule in this room.

1. They have an equal mean square velocity $(\overline{v^2})$.
2. A nitrogen molecule has a greater mean square velocity $(\overline{v^2})$ than an oxygen molecule.
3. A nitrogen molecule has a greater mean kinetic energy than an oxygen molecule.
4. An oxygen molecule has a greater mean kinetic energy than a nitrogen molecule.

Which of the statements is/are correct?

**A** statement 1 only

**B** statement 1 and 3 only

**C** none of them

**D** statement 2 only

**E** statement 2 and 4 only

**60** Evaluate

$$(3 \times 10^3)^3 \times (2 \times 10^{-5})$$

**A** $5.4 \times 10^{-1}$

**B** $5.4 \times 10^2$

**C** $5.4 \times 10^1$

**D** $5.4 \times 10^5$

**E** $5.4 \times 10^4$