



AUSTRALIAN * SCIENCE
INNOVATIONS

2023 AUSTRALIAN SCIENCE
OLYMPIAD EXAM



**Australian
Science
Olympiads**

BIOLOGY

TO BE COMPLETED BY THE STUDENT. USE CAPITAL LETTERS.

First Name: **Last Name:**.....

Date of Birth:/...../.....

Male Female Unspecified Year 10 Year 11 Other:

Name of School: **State:**

Examiners Use Only:									

BIOLOGY

Time Allowed

Reading Time: 10 minutes

Examination Time: 120 minutes

INSTRUCTIONS

- *Attempt all questions in ALL sections of this paper.*
- **Permitted materials: non-programmable, non-graphical calculator, pens, pencils, erasers and a ruler.**
- **Answer all questions on the MULTIPLE CHOICE ANSWER SHEET PROVIDED. Use a pencil.**
- **Marks will not be deducted for incorrect answers.**

Integrity of Competition

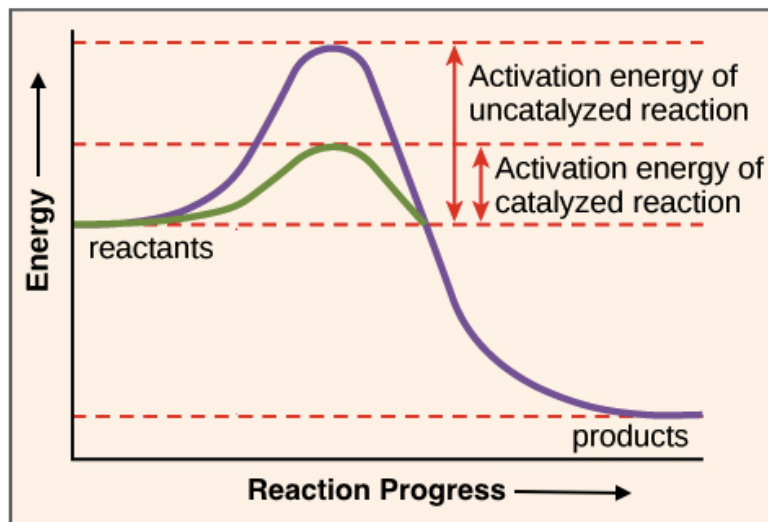
If there is evidence of collusion or other academic dishonesty, students will be disqualified. Markers' decisions are final.

- **1 mark for each question**
- **Total marks for the paper 60 marks**

1. Which of the following is viewed as scientific fact without any exceptions?
 - a. Law
 - b. Theory
 - c. Hypothesis
 - d. Observation

2. Which of the following summarises an accepted hypothesis tested by many scientists?
 - a. Rule
 - b. Theory
 - c. Observation
 - d. Conclusion

3. Enzymes aid in the completion of chemical reactions on a cellular level.



Given the information in the graph which of the following is **TRUE** about enzymes?

- a. Enzymes lower the activation energy of a chemical reaction
- b. Enzymes raise the activation energy of a chemical reaction
- c. Enzymes leave the activation energy of a chemical reaction unchanged

- d. Enzymes decrease the rate of a chemical reaction

Questions 4 and 5 relate to the following information.

Chymosin, known also as rennin, is a proteolytic enzyme related to pepsin that is synthesised by chief cells in the stomach of some animals. Its role in digestion is to curdle or coagulate milk in the stomach, a process of considerable importance in the very young animal. If milk were not coagulated, it would rapidly flow through the stomach and miss the opportunity for initial digestion of its proteins. Students investigated rennin activity. They bubbled different volumes of carbon dioxide (CO₂) gas into milk samples. Each sample was 50 mL and was kept at a constant temperature. The students then added rennin to each milk sample and recorded the time taken for the milk to curdle.

<i>Volume of CO₂</i> <i>(number of bubbles)</i>	<i>Time taken for rennin to curdle milk samples (seconds)</i>				
	<i>Trial 1</i>	<i>Trial 2</i>	<i>Trial 3</i>	<i>Trial 4</i>	<i>Average</i>
100	253	257	250	260	255
150	238	232	241	229	235
200	216	214	219	211	215
250	208	202	212	198	205
300	210	200	199	311	203

4. In the investigation what is the dependent variable?
- Rennin
 - Carbon dioxide
 - The time taken for rennin to curdle milk samples (seconds)
 - The volume of CO₂ (number of bubbles)
5. What can the students conclude from the results of their rennin investigation?
- Rennin does not curdle milk.
 - The results are too varied to make any conclusion.
 - The volume of carbon dioxide bubbled through the milk samples increases the time taken to curdle the milk.
 - The volume of carbon dioxide bubbled through the milk samples decreases the time taken to curdle the milk.

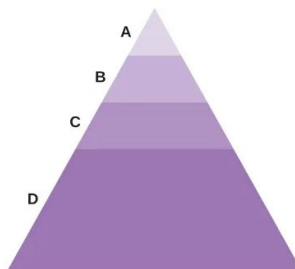
6. Imagine an elaborate termite mound with tunnels and passageways throughout where termites live in a large community. Now imagine that an elephant scratched itself against the mound and it collapsed.



In which of these two scenarios, before or after the elephant scratched, was the termite community in a state of higher entropy?

- The termite community is in the state of lower entropy after the elephant disrupted the mound because of the increased disorder, and energy must be spent to bring the system to higher entropy.
- The termite community is in the state of higher entropy after the elephant disrupted the mound because of the increased disorder, and energy must be spent to bring the system to lower entropy.
- The termite community is in the state of higher entropy before the elephant disrupted the mound because of the reduced disorder, and energy is given out of the system after the collapse of the mound.
- The termite community is in the state of lower entropy before the elephant disrupted the mound because of the higher degree of randomness, and energy is given out of the system after the collapse of the mound.

7. The figure depicts energy exchange through trophic levels.

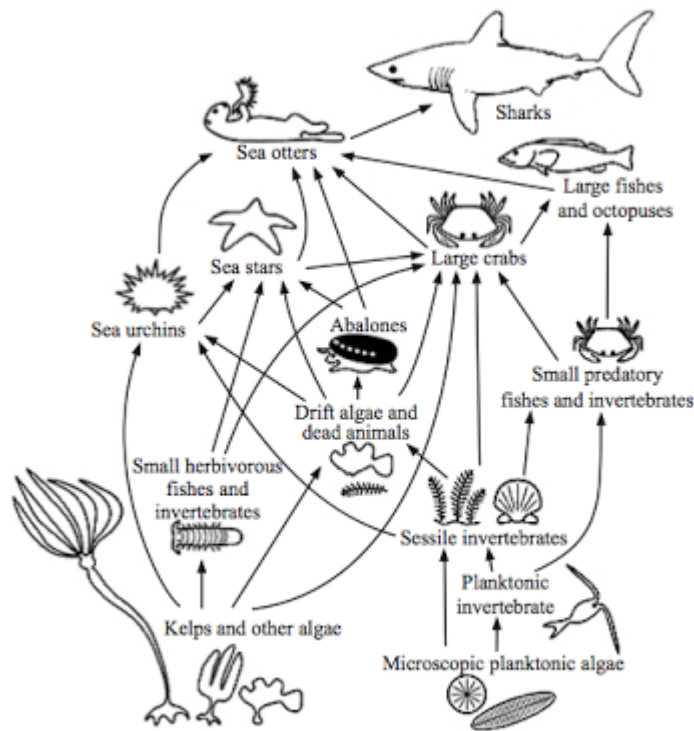


Which trophic level represents the primary producers?

- A
- B
- C
- D

Questions 8 and 9 relate to the following information.

8. What energy role do the kelps and other algae have in this marine food web?



[Source: <http://cbc.amnh.org/crisis/foodweb.html>]

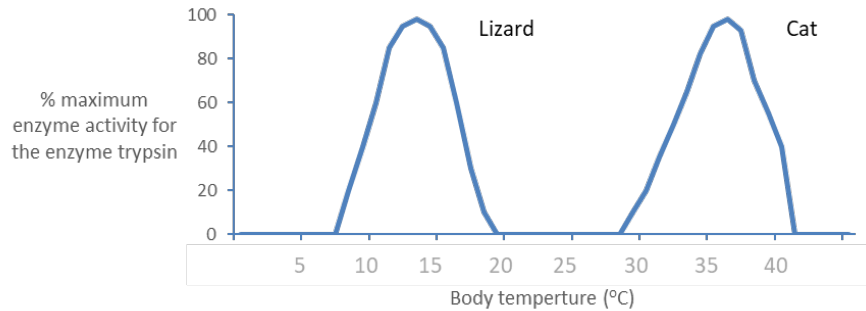
- a. Producer
- b. Consumer
- c. Composer
- d. Decomposer

9. In this marine food web, which organism is a secondary consumer?

- a. Microscopic planktonic algae
- b. Sessile invertebrates
- c. Sea otters
- d. Large fishes and octopuses

10. Antibiotics and vaccines are both used to fight germs but they work in different ways. How are antibiotics different from vaccines?
- Antibiotics alter immune systems; vaccines kill off microorganisms.
 - Antibiotics kill off microorganisms; vaccines alter immune systems.
 - Antibiotics are live vaccines.
 - Antibiotics are inactivated vaccines.
11. What species is the closest living relative to humans?
- Baboons
 - Chimpanzees
 - Orangutan
 - Gibbons
12. What is an ecosystem?
- The populations of all species within a geographical area.
 - All of the environments and all of the communities on the planet.
 - The populations of all species and all abiotic factors within a geographical area.
 - All of the individual organisms belonging to the same species within a geographical area.
13. Australian Spinifex Hopping-mice are small active seed eaters well adapted to desert life. Their food seeds have a high energy content but contain very little water. It would be reasonable to expect the following adaptive mechanism in the mice to help maintain water balance:
- An increased number of sweat glands in the skin.
 - A large volume of urine with a low concentration of dissolved salts.
 - Faeces in the form of dry hard pellets.
 - A small volume of urine with a low concentration of dissolved salts.

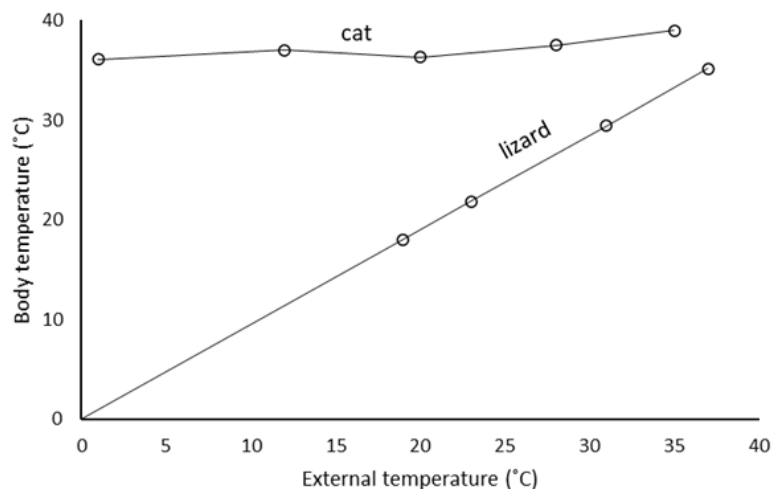
14. The graph below shows enzyme activity for the enzyme trypsin in lizards and cats.



From the information in the graph, which of the following statements is **INCORRECT**?

- At 43 °C the enzyme trypsin is inactive.
- The lizard has a normal body temperature range greater than that of the cat.
- The maximum activity for trypsin in lizard is at a temperature of approximately 13 °C.
- The most efficient temperature for enzyme activity in the cat is approximately 36 °C.

15. The relationship between the external temperature and the body temperature of the lizard or the cat, depicted in the below graph, is best represented by with of the following statements?



- The lizard is an ectotherm. Its body temperature remains constant as the external temperature changes.
- The lizard is an endotherm; therefore, its body temperature increases as the external temperature increases.
- The cat is an ectotherm; therefore, its body temperature increases as the external temperature increases.
- The lizard is an ectotherm; therefore, its body temperature increases as the external temperature increases.

16. Professor Chen buys laboratory supplies in bulk. On one occasion she purchased 5 red pens at \$1.29 each, 4 green pencils, 2 erasers, 3 blue pens at \$1.49 each, 6 green pens at \$1.79 each, 9 black pens at \$0.99 each and 2 workbooks at \$2.35 each. What was the average cost of a pen? (Correct to 2 decimal places)
- \$0.99
 - \$1.29
 - \$1.33
 - \$1.39
17. The main difference between active and passive transport is that:
- active transport occurs in animals and passive transport occurs in plants.
 - active transport is diffusion whereas passive transport is osmosis.
 - active transport requires the input of energy and passive transport relies on physical processes that require no added energy input.
 - active transport involves the blood and circulation, and passive transport occurs in cells.

Questions 18 to 20 relate to the following information.

A group of university students collect the following data as part of a controlled experiment.

Table 1. Number of vertebrate species observed in a 2-hour window.

Sample Number	Habitat 1	Habitat 2	Habitat 3
1	3	1	4
2	3	1	3
3	3	8	7
4	2	10	3
5	4	13	6

18. Based upon this data, which of the following statements is **TRUE**?
- A greater average number of species were observed in habitat 3 as compared to habitat 2.
 - The observation of nocturnal insects may have skewed the results in habitat 2.
 - The students observed a maximum of four distinct species on habitat 1.
 - The difference between sample 1 and sample 5 for habitat 2 could be due to random error.

The students have learnt the following formulae as part of their course work:

$$\text{sum of squared differences} = \sum_{i=1}^n (x_i - \bar{x})^2$$

$$\text{range} = \text{maximum observation} - \text{minimum observation}$$

They propose the following calculation for a species diversity index for a given habitat:

$$\text{diversity index} = \frac{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2}}{\text{range}}$$

19. Given the sum of squared differences for habitat 1 and habitat 3 are 2 and 13.2 respectively, the diversity index for these two habitats are (respectively):

- a. 1.10 ; 3.30
- b. 0.71 ; 0.91
- c. 0.90 ; 0.78
- d. 1.32 ; 3.45

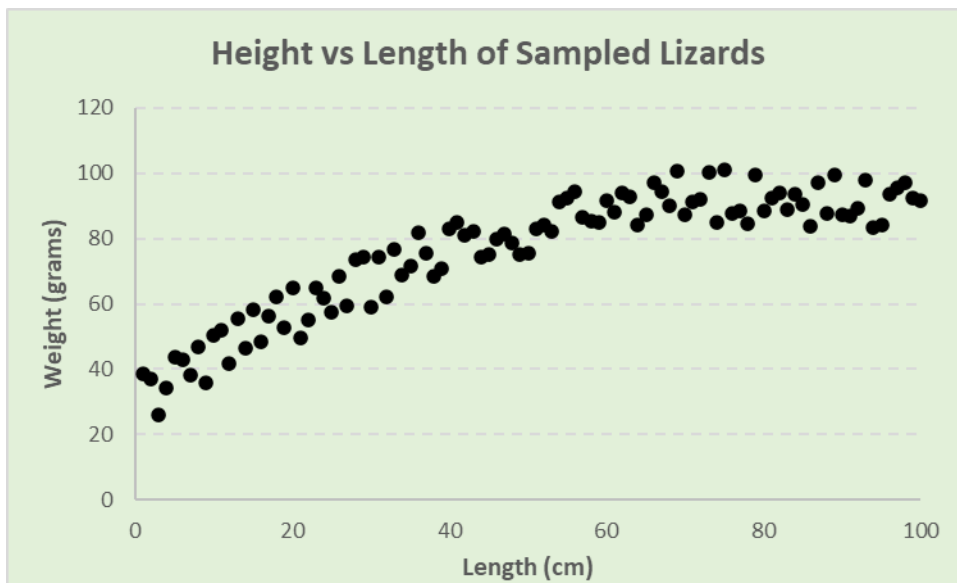
20. Using the information above which of the following statements is **FALSE**?

- a. Assuming the numerator of the diversity index remains constant, increasing the maximum observation for a given habitat will increase the corresponding diversity index.
- b. Areas of higher species diversity are typically the focus of conservation efforts.
- c. Habitat 2 shows greater variability in the number of species observed as compared to habitat 1.
- d. The diversity index proposed by the students is a measure of variability.

21. In a population of 1000 chihuahuas, the recessive allele for white fur has a frequency of 0.20. Assuming that the allele frequencies of the population do not change and there is random mating and no natural selection, what is the expected number of chihuahuas that have white fur?

- a. 640
- b. 320
- c. 40
- d. 0, as the allele is recessive

22. A researcher samples the weight and length of lizards from a local population and plots their results on the chart below. Each point on the chart represents a single lizard measured.

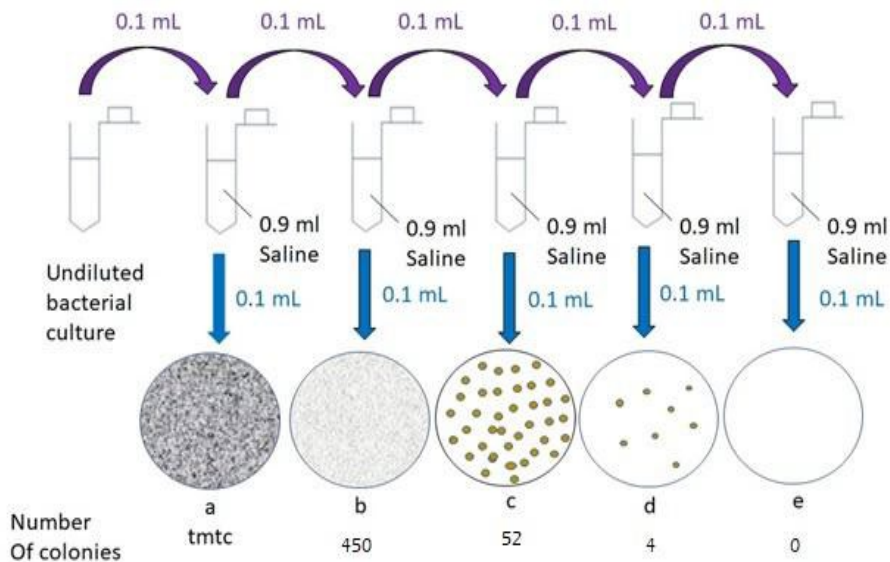


Which of the following statements best describes the researcher's observations?

- a. There is no observed relationship between lizard weight and lizard length.
- b. There is an observed linear relationship between lizard weight and lizard length.
- c. There is an observed non-linear relationship between lizard weight and lizard length.
- d. For any two lizards, the longer lizard will always weigh more than the shorter lizard.

Questions 23 to 26 relate to the following information.

Bacterial count of a liquid culture can be determined using serial dilutions of the culture and plating the dilutions on agar plates. The colonies are then counted (see image) and the dilution factor leading to the counted plates is used to calculate the number of colony forming units per millilitre (CFU/mL) in the original culture. Before performing the calculation, it is important to determine which plate to use to do the counts. When there are too many colonies on the plates it becomes difficult to count individual colonies accurately (note that tmtc means too many too count). When there are few colonies on the plate, the number of colonies becomes not statistically significant. Using the figure below answer the following Bacterial count questions.



23. If you were to repeat the plating of dilution e (from the image) many times, some plates will show colonies.

- a. True
- b. False

24. Looking at the tubes used to prepare the dilutions, what is the dilution factor of the last tube that is plated on e.

- a. 0.01
- b. 0.001
- c. 0.0001
- d. 0.00001

25. Which plate (a – d) should you use to perform the counts?

- a. a
- b. b
- c. c
- d. d

26. Using the plate determined in (c), what is the bacterial count in CFU/mL?

- a. 520
- b. 5,200
- c. 52,000
- d. 520,000

27. You have obtained a pond water sample and wish to determine the concentration of bacteria which are gram-negative and lactose-fermenting. After making two 1/100 dilutions, you plate 0.1 mL of the second dilution onto two plates of MacConkey Agar (only gram-negative bacteria are expected to grow on MacConkey agar of these colonies, the red ones are lactose-fermenters). After appropriate incubation, you find that one plate contains 140 red colonies and 45 white colonies, and the other plate contains 160 red colonies and 35 white colonies. What was the concentration of gram-negative, lactose-fermenting CFU per mL of the pond water sample?

- a. 1.4×10^7 CFU/mL
- b. 1.5×10^7 CFU/mL
- c. $d.6 \times 10^7$ CFU/mL
- d. 3.0×10^7 CFU/mL

28. There is a large population of Silverback Gorillas, Curie and Gaus both sample 5 members of the population and measure their mass. Curie's sample has an average mass of 173.2kg but Gauss' has an average mass of 145.6kg. They are concerned as to why the two samples have such different average masses.

What is the most sensible conclusion to make about why they have different masses?

- a. One of them doesn't know how to weigh the Silverbacks properly.
- b. This is just the nature of random sampling; they have no indication about the actual mean mass unless they weigh every single Silverback.
- c. The samples they have taken are too small, the actual mean mass likely lies somewhere in between their sample masses.
- d. The samples they have taken are too small, the actual mean mass is probably very different to both of their sample's means.

29. Gram-staining is a process used to differentiate between two types of bacteria (gram-positive and gram-negative), based on their cell wall composition. Gram-positive bacteria generally have a single outer membrane surrounded by a thick layer of peptidoglycan. Gram-negative bacteria generally possess a thin layer of peptidoglycan located between two outer membranes.

The process works as outlined below.

1. Heat-fixed cells are stained with crystal violet stain, which colours the cells purple.
2. Iodine solution is added, which forms a complex with the crystal violet stain and traps it within the cell.
3. Cells are washed with ethanol solution. Ethanol is known to be able to dissolve an outer lipid membrane, which releases the crystal violet stain.
4. A pink-coloured counterstain is added.

Which of the following is correct?

- a. Gram-positive - pink, Gram-negative - purple
- b. Gram-positive - purple, Gram-negative – pink
- c. Gram positive - purple, Gram-negative - clear
- d. Gram positive - clear, Gram negative - purple

30. How many polypeptides, each composed of 30 amino acids, can be made from the 20 common amino acids?

- a. 20^{30}
- b. 30^{20}
- c. 10^{20}
- d. 600

Questions 30 and 31 relate to the following information.

Chi-squared tests are useful statistical tests for testing whether a hypothesis is true for categorical data. We can use them to conduct tests of independence, which can be useful for various ecological applications. The rule for calculating a Chi-squared tests is as below:

$$\chi^2 = \sum \frac{(E_i - O_i)^2}{E_i}$$

That is given a collection of categories for any category (*i*) we use the value the hypothesis predicts (E) and the observed value (O) in said category (*i*). Consider the example below, where the hypothesis states that a rodent's eye colour should not influence whether it lives for longer than 1 year. It is known that on average 0.67 Rodents live past 1 year and 0.44 are born with red eyes (This data has not been collected and has been made for the sake of this question).

Expected data (E)			
	Red	Not Red	Total
Lives longer than a year	290	380	670
Does not live longer than a year	150	180	330
Total	440	560	1000

Observed data (O)			
	Red	Not Red	Total
Lives longer than a year	303	367	670
Does not live longer than a year	137	193	330
Total	440	560	1000

Using the formula above the Chi-squared (χ^2) value for this test, to two decimal places, can be calculated as **3.09**.

31. Below is a table for converting Chi-squared (χ^2) values to the probability that the hypothesis is true.

Probability	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
χ^2	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63

To reject our hypothesis, that the two categories are independent of each other, the probability that the hypothesis is true must be <0.05 .

Is this the case? True or False?

- a. True
- b. False

32. If some other data was observed, and from that data a probability of 0.029 was determined, what would be the most reasonable conclusion to make about the relationship between rodents having red eyes and living longer than 1 year?

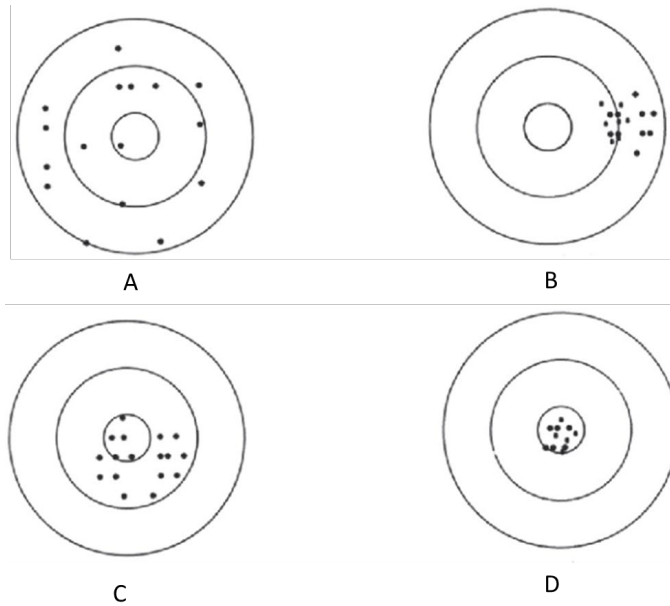
- a. If a rodent lives longer than 1 year it probably has red eyes.
- b. If a rodent lives longer than 1 year it probably does not have red eyes.
- c. The eye colour of a rodent has an effect on how long it will live.
- d. If a rodent lives longer than 1 year its eye colour will change.

33. In research, bias occurs when error is introduced by selecting or encouraging one outcome or answer over others. Bias can occur at any phase of research, including study design or data collection, as well as in the process of data analysis and publication.

Which type of bias may occur because researchers do not obtain complete information about a population?

- a. Measurement bias.
- b. Sampling bias.
- c. Response bias.
- d. No bias.

34. Bias impacts the validity and reliability of findings, leading to misinterpretation of data.



Which of the images above (A – D) is representative of research methods that do not hit the heart of the research aim, but repeated attempts get almost the same (but wrong) results?

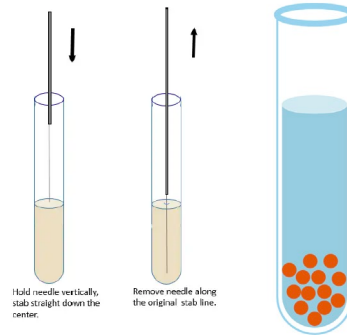
- a. A
- b. B
- c. C
- d. D

35. The Hume highway goes between Sydney and Melbourne. The fact that animals like Squirrel Gliders have habitats that it cuts through and that they cannot cross it safely has been of great concern, especially since following land-clearing in Victoria much of the ideal tree-hollow habitat for squirrel gliders is along the highway. To combat this, rope bridges have been constructed periodically over the Hume so that Squirrel Gliders can safely cross over the Hume.

What is one of the benefits offered by these rope bridges?

- a. Allows gene flow to occur between populations on either side of the Hume, increasing genetic diversity.
- b. Decreases the habitat area that the Hume removes.
- c. Decreases the effect of competition between Squirrel Gliders.
- d. Reduces predation on the Squirrel Gliders.

36. Dr K is travelling in the Antarctic and collects a sample of unknown bacteria X that they want to characterise. They grow bacteria X on an agar plate containing horse blood and find that bacteria X can break down red blood cells (haemolysis). They then use a sterile needle to introduce bacteria X into a test tube of semisolid agar as shown in the figure to the left. Non-motile bacteria are not able to move independently through semisolid agar away from the initial stab line, whereas motile bacteria are. Dr K finds that bacteria X can grow throughout the bottom of the test tube but never at the top, as shown in the blue test tube to the right. From the given information alone, what would the most reasonable conclusion be?



Bacteria X are:

- Pathogenic, Motile, Aerobic
 - Pathogenic, Motile, Anaerobic
 - Pathogenic, Non-Motile, Aerobic
 - Non-pathogenic, Motile, Anaerobic
 - Non-pathogenic, Non-Motile, Aerobic
37. In DNA, Guanine is complementary to Cytosine and Adenine is complementary to Thymine. Guanine interacts with Cytosine with 3 hydrogen bonds, Adenine and Thymine do so with 2 hydrogen bonds. There are 5 (A to E) 1000 base pair segments of double stranded DNA. They are described below:

- A: 5% Guanine
B: 10% Guanine
C: 10% Cytosine
D: 5% Thymine
E: 20% Adenine

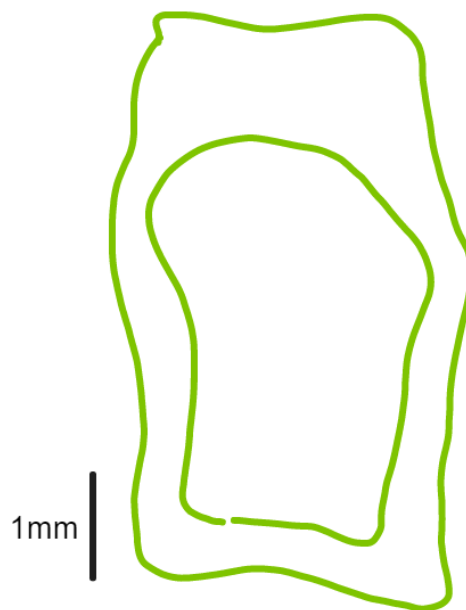
Which of the above would first separate into two different strands at the highest temperature?

- A
- B
- C
- D
- E

38. Why are plants green?

- a. Green has been evolutionarily favoured because herbivores tend to prefer eating green things less.
- b. Plants contain a green pigment (chlorophyll) to capture light for photosynthesis.
- c. Plants contain a compound, called chlorophyll, which is green because it captures green light.
- d. There has been evolutionary pressure for all plants to be the same colour so that herbivores struggle to differentiate between poisonous and non-poisonous species. This colour just so happens to be green.

39. Below is a sketch of a cell made to the same scale as it was viewed under the microscope. The microscope has a zoom of 1000x and a key for the length as it was viewed is provided in the sketch.



What is the closest estimate of the cells area?

- a. $16.5 \mu m^2$
- b. $40.0 mm^2$
- c. $10 mm^2$
- d. $15 mm^2$

Questions 40, 41, 42 and 43 relate to the following information.

Since European occupation of Australia, human activities have caused the dramatic decline and extinction of 90 Australian taxa, as recognised under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Rabbits were first introduced to mainland Australia when five domestic animals were brought to Sydney on the First Fleet. About 90 subsequent importations would be made, but none of these populations became invasive before 1859. Within the next 50 years, rabbits would spread to all corners of the country at a rate of 100km per year – the fastest colonisation rate for an introduced mammal ever recorded (Alves et al. 2022).

40. Which of the following is a **TRUE** statement about introduced species?

- a. Introduced species that become established in their new environment are able to do so because they are able to evolve quicker than introduced species that do not become established.
- b. If an introduced species becomes established, it will always become invasive.
- c. To be successful, introduced species must find a way to survive all of the same environmental and community factors that native species have to survive.
- d. Introduced species are usually better equipped to survive in an ecosystem than the native species are.

41. The prevalence of threats to Australian threatened taxa across broad taxonomic groups, vertebrate taxonomic groups and extinction risk categories is reported in the below table by Kearney et al. (2019). The colour of each cell is scaled to correspond with the percentage of the species group listed as being affected by each threat category.

	Total (1533)	Invertebrates (48)	Plants (1212)	Vertebrates (272)	Amphibians (29)	Birds (84)	Fish (34)	Mammals (74)	Reptiles (51)	Critically Endangered (178)	Endangered (646)	Vulnerable (709)
Invasive species	82%	79.2%	79.5%	94.1%	100%	95.2%	97.1%	97.3%	82.4%	80.9%	86.5%	78.1%
Ecosystem modifications	74.1%	79.2%	75.7%	66.5%	65.5%	72.6%	79.4%	62.2%	54.9%	64.6%	79.1%	71.9%
Agricultural activity	56.9%	72.9%	53.5%	69.9%	69%	82.1%	47.1%	73%	60.8%	51.1%	60.2%	55.4%
Human disturbance	38.4%	20.8%	40.3%	33.1%	51.7%	35.7%	38.2%	27%	23.5%	34.8%	43%	35%
Climate change	34.8%	45.8%	32.1%	44.9%	44.8%	56%	55.9%	37.8%	29.4%	43.3%	36.2%	31.3%
Transportation	30.3%	14.6%	34%	16.9%	41.4%	16.7%	2.9%	17.6%	11.8%	27.5%	34.4%	27.4%
Overexploitation	27.4%	50%	24.6%	36%	48.3%	40.5%	52.9%	28.4%	21.6%	25.8%	26.3%	28.8%
Urban development	22.2%	31.2%	21.4%	24.6%	24.1%	26.2%	29.4%	14.9%	33.3%	23.6%	22.6%	21.6%
Energy production	18.9%	10.4%	18.2%	23.5%	10.3%	20.2%	47.1%	16.2%	31.4%	19.7%	20.4%	17.2%
Pollution	17.8%	25%	16.2%	23.9%	44.8%	19%	61.8%	6.8%	19.6%	15.7%	21.8%	14.7%
Geological Events	1%		1.3%							0.6%	0.6%	1.6%

Invasive species is reported as the most common threat, listed as affecting 82% of threatened taxa in Australia.

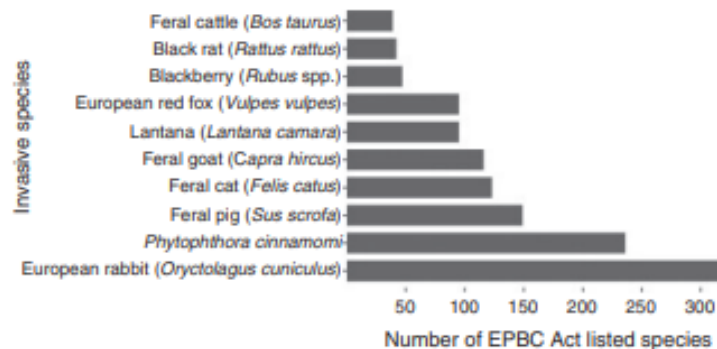
How many individuals does this represent?

- a. n = 11
- b. n = 82
- c. n = 1257
- d. n = 1533

42. Which taxa is most threatened by invasive species according to the data above?

- a. Plants
- b. Vertebrates
- c. Amphibians
- d. Fish

43. The European rabbit (*Oryctolagus cuniculus*) negatively impacts more threatened species in Australia than does any other invasive species. Over 300 threatened native species are at increased risk due to rabbits – more than from any other invasive species. The graph displays the 10 invasive species listed as impacting the greatest number of EPBC Act-listed threatened taxa.

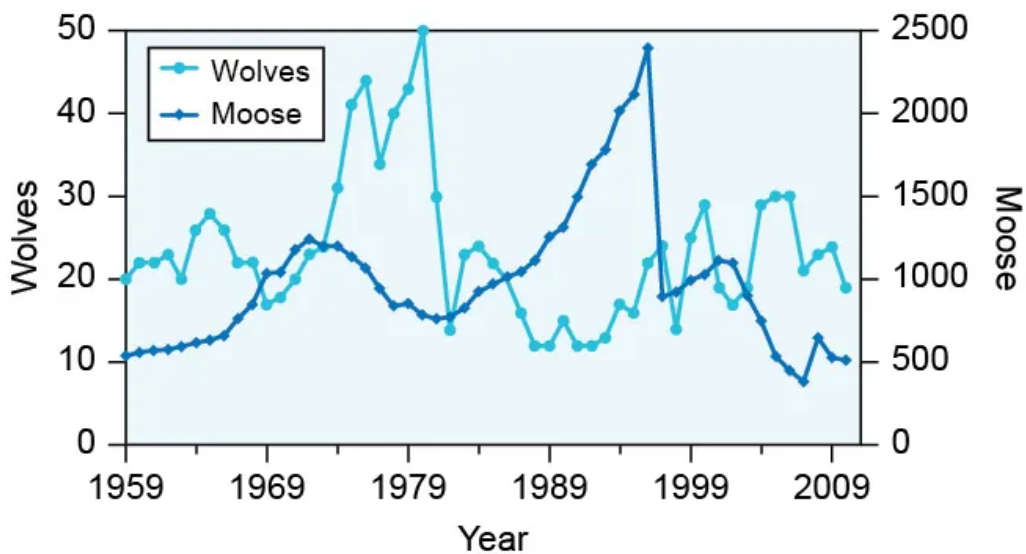


Using data from Kearney et al's study in Question 41 and according to the graph, what percentage of EPBC Act listed taxa are threatened by the European rabbit (*Oryctolagus cuniculus*)?

- a. 10%
- b. 21%
- c. 25%
- d. 100%

44. The graph shows the wolf and moose populations in Isle Royale, a remote wilderness island that is a protected national park in Michigan, USA. Wolves are the main predator of moose, but there are many other factors at play.

Around 1996, the moose population suddenly crashed.

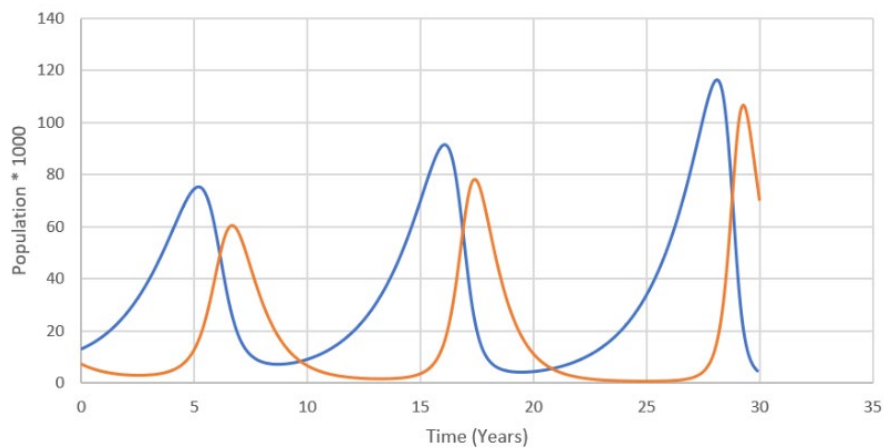


(credit: modification of work by John A. Vucetich/The Wolves and Moose of Isle Royale)

Which hypothesis best explains why the wolf population did not increase during this time?

- The moose population dropped due to a very severe winter.
- The moose population dropped due to over hunting by the wolves.
- The moose population dropped due to a disease slowly spreading through the population.
- The moose population dropped due to their habitat being destroyed by people.

45. Consider the below graph of population count for two different species, over a period of time where no significant external events are occurring.



What is a likely relationship between the two species?

- Both benefit each other (Mutualistic).
- The Orange species is benefited by the presence of the Blue species, the Blue species is not affected by the Orange (Commensalism).
- The Blue species is benefited by the presence of the Orange species, the Orange species is not affected by the Blue (Commensalism).
- The Blue species preys on the Orange species (Predator - Prey).
- The Orange species preys on the Blue species (Predator – Prey).

Questions 46, 47 and 48 relate to the following information.

It is well accepted that humans are not the only animal to have complex culture. Klump et al. (2021) documented the emergence of an evolving set of behaviours in response to human-generated resources, specifically rubbish bins, in Sulphur-crested cockatoos (*Cacatua galerita*). Residents of Sydney are caught in a battle of wits with Sulphur-crested cockatoos. The Cockatoos discovered that people's bins often contain food, with bread and fruit being favourites.



46. What type of behaviour causes cockatoos to search for food?

- a. Reasoning
- b. Instinct
- c. Classical Conditioning
- d. Social Learning

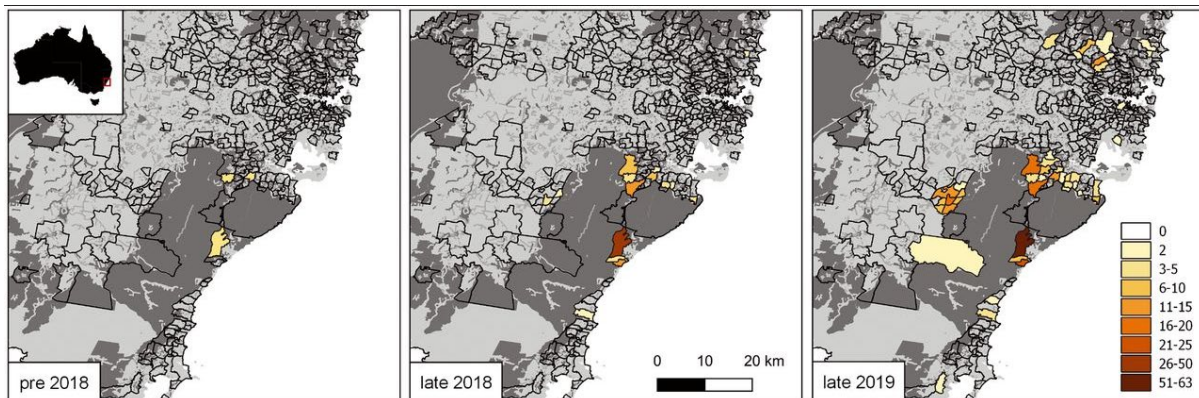
47. Residents have started protecting their bins from the cockatoos.



What type of learning is this?

- a. Reasoning
- b. Instinct
- c. Classical conditioning
- d. Social Learning

48. As fast as residents come up with new ways to stop the Sulphur-crested cockatoos from opening the bins, the birds are working out ways to defeat them. The image depicts the Spread of bin opening across the Sydney and Wollongong regions.



The trick was seen in only three suburbs of Sydney in 2018, but by 2019 it had spread to 44 suburbs. What type of learning is this?

- a. Reasoning
- b. Instinct
- c. Classical conditioning
- d. Social Learning

Questions 49 and 50 relate to the following information.

The Glycaemic Index (GI) is used as one dietary guide for consumers to help rank foods as a reference for nutritional benefit. The GI indicates how that product is predicted to affect human blood sugar levels soon after consumption. It provides a proximate measure of the available carbohydrate content delivered by the food. Foods with a relatively higher GI than others indicate that they are more rapidly absorbed and produce a comparatively larger rise in blood sugar levels. The Glycaemic index can be useful but has also been criticized for being perhaps too simplistic due to its focus only on individual food types. For example, when carbohydrate consumption is mixed with fatty or protein-based foods, blood sugar levels do not rise at the rate or to the extent that the carbohydrate content alone predicts.

In response to this information, you decide to investigate the predicted rise in blood sugar after the ingestion of two popular meals. To do this it is the Glycaemic Load (GL) that provides the best information. $GL = (GI \times \text{amount of Carbs per serve})/100$

49. Based on your predicted GL values, when comparing a beef burger with a vegetable burger, both served in the same type of bread bun, and both options weighing a total of 45g each, which of the following is **TRUE**?
- a. The beef burger meal has the higher GL.
 - b. The vegetable burger meal has the higher GL.
 - c. The vegetable burger would be the healthier choice.
 - d. Vegetables and rice would be a better choice.

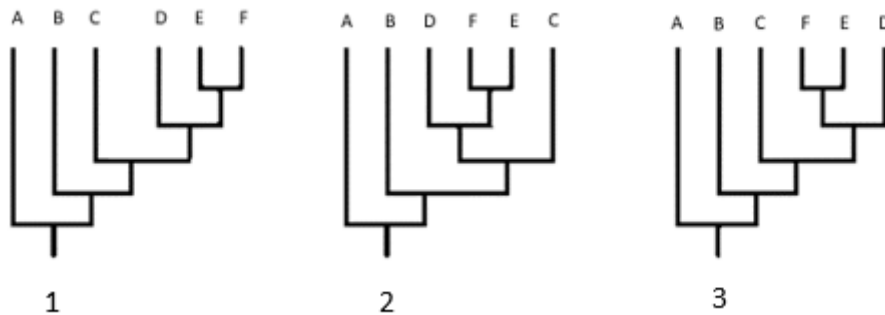
50. Various pasta meal options of penne pasta dressed with a drizzle of olive oil and oregano versus a meal of penne pasta dressed with meatballs and a tomato-based sauce were compared. Which of the following is **TRUE** when based on 35g per serve?

- a. Pasta on its own has the lower GL compared to the pasta and meatballs meal.
- b. Meatballs without pasta would be a healthier choice.
- c. Pasta and meatballs has a lower GL compared to the pasta and olive oil meal.
- d. Vegetables and rice would be a better choice.

Questions 51 and 52 relate to the following information.

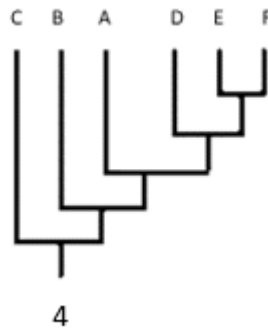
51. This evolutionary tree was built on the observed relationships among species that exhibit similar morphological traits.

The following depictions show 3 trees. Which tree is dissimilar?



- a. Tree 1 differs from the others.
- b. tree 2 differs from the others.
- c. tree 3 differs from the others.
- d. all of the trees differ from each other.
- e. None of the trees differ.

52. Genetic analysis of the species contained in the original tree shows a different configuration compared to that drawn based on morphology (see Tree 4).



Considering the two forms of evidence of morphological plus genetic analyses, the most likely conclusion would be that:

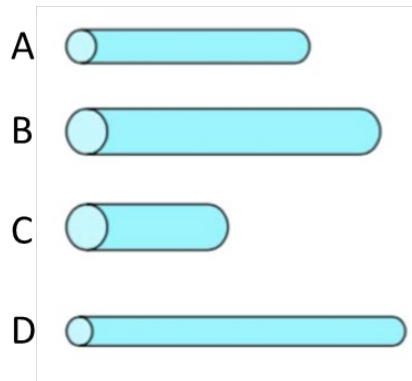
- convergent evolution of morphological traits occurred.
- the genetic analysis contained errors or DNA contamination.
- the sample species do not share ancestral lines.
- the contradiction means the sample species B and C are not really related.

Questions 53 and 54 relate to the following information.

Blood pressure is the force exerted by blood within blood vessels as a result of the pumping action of the heart. Cardiac output is the amount of blood leaving the heart with each contraction. Total peripheral resistance is the sum of the resistance of all the blood vessels in the systemic circulation. Resistance is related to the length, radius and number of blood vessels, as well as the viscosity of blood.

Blood pressure can be related to the product of the cardiac output and total peripheral resistance ($BP = CO \times TPR$).

53. Which of the following blood vessels (a – d) is expected to have the highest total peripheral resistance (TPR)?



- a. A
- b. B
- c. C
- d. D

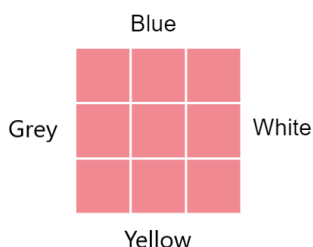
54. If the blood pressure is the same across each of the vessels, which is expected to have the highest flow?

- a. A
- b. B
- c. C
- d. D

55. Which of the following statements is **FALSE**?

- a. Distilled water (pH 7.0) has an equal concentration of H^+ and OH^- ions.
- b. Baking soda (pH 9.0) has a higher concentration of H^+ ions than black coffee (pH 5.0).
- c. Milk of magnesia (pH 10.0) has a higher concentration of OH^- ions than seawater (pH 8.0).
- d. A solution with a lower pH has a higher concentration of H^+ ions than a solution with a higher pH.
- e. A solution with a higher pH has a higher concentration of OH^- ions than a solution with a lower pH.

56. Consider the schematic of a rubix cube:

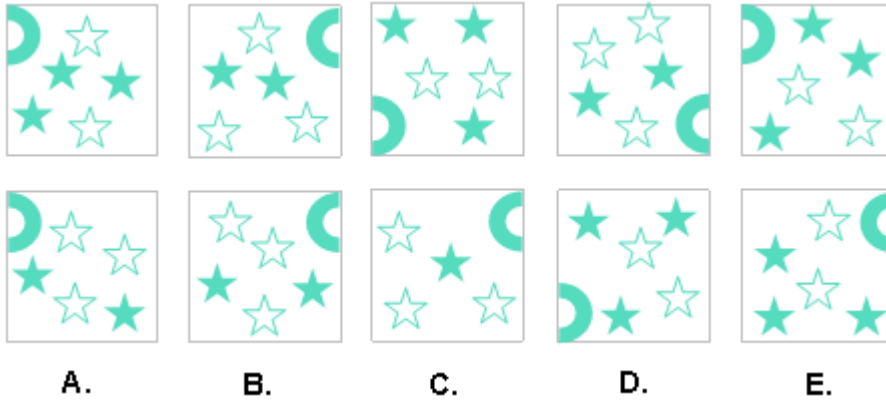


The side opposite the red one that cannot be seen is Green. The following manipulations are applied and are described from the perspective given in the schematic. First the Grey face is rotated 180°. Then the blue face is rotated 90° from left to right. Finally, the Red face is rotated 90° clock-wise.

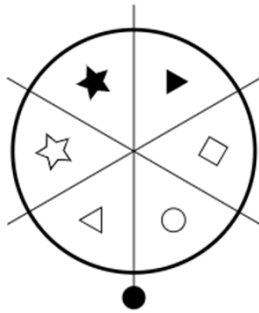
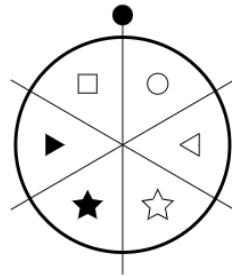
Which of the following (A – E) correctly displays the new state of the cube when viewed from the same perspective?



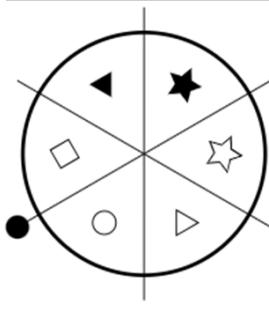
57. Which figure below is the odd one out?



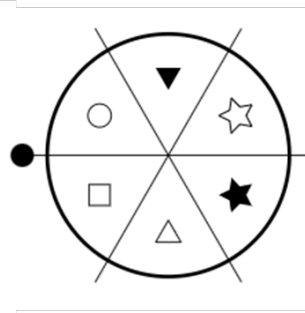
58. Which figure (A – D) is a rotation of the object?



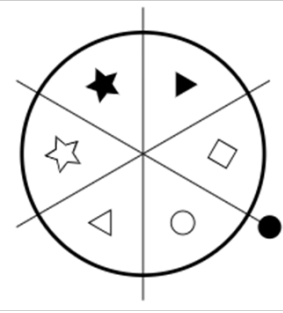
A



B

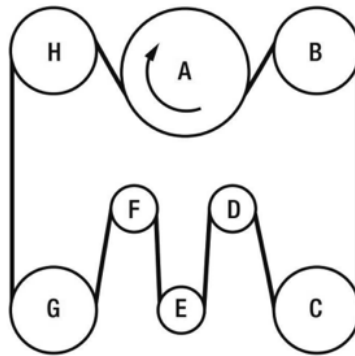


C



D

59. If wheel 'A' rotates clockwise, which of the other wheels will rotate anti-clockwise?



- a. A, F, D
- b. H, B, E, C, G
- c. H, B, F, D
- d. G, F, E, D, C

60. Koen has a number of oranges. When he arranges them in groups of four, he has one left. If he arranges them in groups of three, again he has one left over. If the oranges are set out in pairs, the result is the same: there is one left over. There are no more than 15 oranges altogether.

What is the exact number of oranges Koen has?

- a. 7
- b. 9
- c. 13
- d. 15

END OF EXAM

SOURCES

Question 3: Image sourced: <https://study.com/academy/practice>.

Question 4 and 5: Data sourced from https://www.boardofstudies.nsw.edu.au/hsc_exams/2014/pdf_doc/2014-hsc-biology.pdf.

Question 33:
Image adapted from: https://www.researchgate.net/figure/Graphical-presentation-of-possible-combinations-of-validity-and-reliability_fig1_291136833

Question 34: Image sourced from: <https://microbeonline.com/sulfide-indole-motility-sim-medium/>

Question 39-42:
Alves, J.M., Carneiro, M., Day, J.P., Welch, J.J., Duckworth, J.A., Cox, T.E., Letnic, M., Strive, T., Ferrand, N. and Jiggins, F.M., 2022. A single introduction of wild rabbits triggered the biological invasion of Australia. *Proceedings of the National Academy of Sciences*, 119(35), p.e2122734119.

Kearney, S.G., Carwardine, J., Reside, A.E., Fisher, D.O., Maron, M., Doherty, T.S., Legge, S., Silcock, J., Woinarski, J.C., Garnett, S.T. and Wintle, B.A., 2019. Corrigendum to: The threats to Australia's imperilled species and implications for a national conservation response. *Pacific Conservation Biology*, 25(3), pp.328-328.

Question 45:
Image sourced from: <https://www.123test.com/spatial-reasoning-test>

Questions 47 – 49:
Barbara C. Klump et al. Innovation and geographic spread of a complex foraging culture in an urban parrot. *Science* 373,456-460(2021). DOI:10.1126/science.abe7808

Questions 52 – 53:
Source of information: https://www.sharinginhealth.ca/biology/blood_pressure.html

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