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GAMSAT

Graduate Australian Medical School Admissions Test

Sample Questions

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Contents

Published 2005, reprinted 2008 by the
Australian Council for Educational Research

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Introduction

The *GAMSAT Sample Questions* (second edition) contains examples of the kind of materials and qu can expect to find in the *Graduate Australian Medical School Admissions Test* (GAMSAT). Advice on how prepare for the test, as well as information on registration procedures, testing date and test centres are provi the *GAMSAT Information Booklet*, available from the website below:

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The questions are grouped to reflect the three Sections of GAMSAT:

Section I	Reasoning in Humanities and Social Sciences
Section II	Written Communication
Section III	Reasoning in Biological and Physical Sciences

Sections I and III of the booklet contain approximately half as many questions as the corresponding Sections of the real GAMSAT. By working through these questions you will become familiar with the various types of material presented, and gain experience in the technique of arriving at the answers.

To help you appreciate the kinds of reasoning involved in GAMSAT, solutions to some of the questions are presented on pages 42–46, and pages 47–52. For each question analysed, the solution presents an interpretation of the question and a line of reasoning which leads to the correct answer. However, you should realise that the suggested solutions are designed to be merely illustrative and that more than one way to a solution may exist for many questions. Indeed, in the test itself candidates will undoubtedly use a variety of interpretation and reasoning skills in responding to the questions.

Answers for all questions in Sections I and III are given on page 53.

Section II of the booklet contains samples of writing tasks similar to those which will appear in the real GAMSAT. This section gives you an opportunity to practise writing a finished piece of work in a limited time. Obviously no solutions can be given, but notes on the assessment of Written Communication in GAMSAT are provided on page 46.

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Section I

Reasoning in Humanities and Social Sciences

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Questions 1 – 4

This passage is taken from Darwin's ***On the Origin of Species****.*

PASSAGE

Several writers have misapprehended or objected to the term Natural Selection. Some have even imagined that natural selection induces variability, whereas it implies only the preservation of such variations as arise and are beneficial to the being under its conditions of life. No one objects to agriculturalists speaking of the potent effects of man's selection; and in this case the individual differences given by nature, which man for some object selects, must of necessity first occur. Others have objected that the term selection implies conscious choice in the animals which become modified; and it has even been urged that, as plants have no volition, natural selection is not applicable to them! In the literal sense of the word, no doubt, natural selection is a false term; but who ever objected to chemists speaking of the elective affinities of the various elements? — and yet an acid cannot strictly be said to elect the base with which it in preference combines. It has been said that I speak of natural selection as an active power or Deity; but who objects to an author speaking of the attraction of gravity as ruling the movements of the planets? Everyone knows what is meant and is implied by such metaphorical expressions; and they are almost necessary for brevity.

1 In this passage Darwin claims that he is accused of

A personifying nature.
B denying the role of God in nature.
C overestimating his own importance.
D exaggerating the consequences of natural selection.

2 From line 6 onwards the author is most concerned to

A introduce the use of metaphor in scientific writing.
B explain how species influence their own evolution.
C defend terminology which he used in earlier writing.
D demonstrate that selection is applicable to all species.

3 In responding to the objection that 'as plants have no volition, natural selection is not applicable to them' (lines 8–9), Darwin begins with

A a denial.
B a concession.
C an extrapolation.
D an amendment.

4 Darwin presents metaphor as a way of

A putting a general idea in specific terms.
B putting a specific idea in general terms.
C expressing a complex notion concisely.
D expressing the fine points of a concept precisely.

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Questions 5 – 10

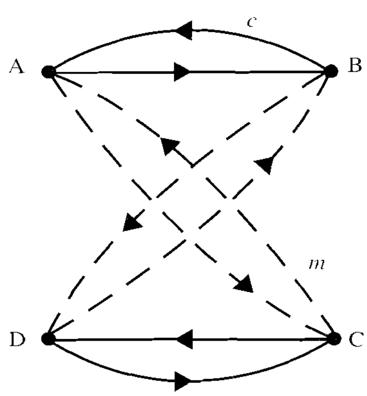
The diagrams below present the patterns of clan membership for two kinship groups of Pacific Islanders, the Kariera and the Tarau. The diagrams show the requirements for marriage between clans and the way the clan membership of fathers determines the clan membership of children.

In the diagrams, the broken lines (*m*) indicate allowed marriage relationships where any man from the clan at the origin of the arrow may marry a woman of the clan to which the arrow points. The solid lines (*c*) indicate allowed filiation relationships, where every child of a father from the clan at the origin of the arrow becomes a member of the clan to which the arrow points.

A man of clan X must marry a woman of clan *m*(X).

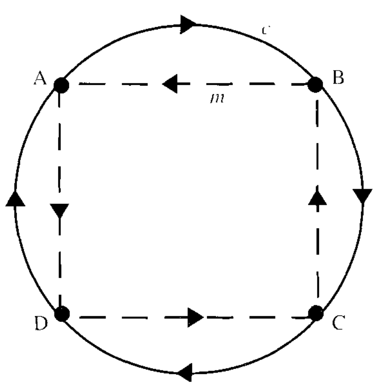
The children of a man of clan X will be of clan *c*(X).

Figure 1. *The Kariera System (four clans: A, B, C, D)*



X	A	B	C	D
MARRIAGE: *m* (*X*)	C	D	A	B
FILIATION: *c* (*X*)	B	A	D	C

Figure 2. *The Tarau System (four clans: A, B, C, D)*



X	A	B	C	D

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5 In both systems, individuals belong to the clan of

A one parent.
B their aunts.
C their uncles.
D their siblings.

6 In the Tarau system, marriage

A and the clan of children are reciprocal.
B and the clan of children are sequential.
C is reciprocal and the clan of children is sequential.
D is sequential and the clan of children is reciprocal.

7 In both systems

A mothers belong to a different clan to their siblings.
B mothers belong to the same clan as their children.
C children belong to a different clan to their father.
D children belong to the same clan as their father.

8 In the Kariera system, the clan of c (A) is

A A.
B B.
C C.
D D.

9 In the Tarau system, sons marry women from the same clan as their

A father.
B mother.
C grandfather.
D grandmother.

10 In the Kariera system, an individual belongs to the clan of their

A grandmother.
B grandfather.
C uncle.
D aunt.

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Unit 3

Questions 11 – 13

Song for a Birth or a Death

Last night I saw the savage world
And heard the blood beat up the stair;
The fox's bark, the owl's shrewd pounce,
The crying creatures — all were there,
And men in bed with love and fear.

The slit moon only emphasised
How blood must flow and teeth must grip.
What does the calm light understand,
The light which draws the tide and ship
And drags the owl upon its prey
And human creatures lip to lip?

Last night I watched how pleasure must
Leap from disaster with its will:
The fox's fear, the watch-dog's lust
Know that all matings mean a kill:
And human creatures kissed in trust
Feel the blood throb to death until

The seed is struck, the pleasure's done,
The birds are thronging in the air;
The moon gives way to widespread sun.
Yes but the pain still crouches where
The young fox and the child are trapped
And cries of love are cries of fear.

Elizabeth Jennings

11 The opening lines of the poem suggest an atmosphere that is

A tense.
B immoral.
C ominous.
D uncertain.

12 The speaker suggests the animal and human worlds

A are predatory by nature.
B differ in their treatment of their young.
C are superficially tranquil with menacing undercurrents.
D are governed by impulses that are unique to each world.

13 'The pleasure's done' (line 18) suggests

A a state of ecstasy.
B a joyless aftermath.
C potency and fertility.
D a hedonistic attitude to life.

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Questions 14 – 17

For each of questions 14–16, select the proverb from **A** – **D** which is closest in meaning to the given proverb.

14 Let all live as they would die.

A The good die young.
B A person can die but once.
C A good life makes a good death.
D Fear of death is worse than death itself.

15 Death keeps no calendar.

A The evening crowns the day.
B Nothing is certain but death and taxes.
C Death devours lambs as well as sheep.
D We must live by the living, not by the dead.

16 Vows made in storms are forgotten in calms.

A After a storm comes a calm.
B In a calm sea, every person is a pilot.
C The post of honour is the post of danger.
D While the thunder lasted, two bad people were friends.

17 What aspect of greatness is considered by the following four proverbs?

A great tree attracts the wind.
They sit not sure that sit too high.
The highest tree has the greatest fall.
Little fishes slip through nets, but great fishes are taken.

A the dangers inherent in being great
B the stress resulting from trying to be great
C the obstructions that impede the path to greatness
D the difficulties faced by those who set themselves unattainable goals

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Unit 5

Questions 18 – 26

The will of the people practically means the will of the most numerous or the most active part of the people; the majority, or those who succeed in making themselves accepted as the majority; the people, consequently, may desire to oppress a part of their number; and precautions are as much needed against this as against any other abuse of power. The limitation, therefore, of the power of government over individuals loses none of its importance when the holders of power are regularly accountable to the community, that is, to the strongest party therein. This view of things, recommending itself equally to the intelligence of thinkers and to the inclination of those important classes in European society to whose real or supposed interests democracy is adverse, has had no difficulty in establishing itself; and in political speculations 'the tyranny of the majority' is now generally included among the evils against which society requires to be on its guard.

Like other tyrannies, the tyranny of the majority was at first, and is still vulgarly, held in dread, chiefly as operating through the acts of the public authorities. But reflecting persons perceived that when society is itself the tyrant — society collectively, over the separate individuals who compose it — its means of tyrannising are not restricted to the acts which it may do by the hands of its political functionaries. Society can and does execute its own mandates: and if it issues wrong mandates instead of right, or any mandates at all in things with which it ought not to meddle, it practises a social tyranny more formidable than many kinds of political oppression, since, though not usually upheld by such extreme penalties, it leaves fewer means of escape, penetrating much more deeply into the details of life, and enslaving the soul itself. Protection, therefore, against the tyranny of the magistrate is not enough: there needs protection also against the tyranny of the prevailing opinion and feeling; against the tendency of society to impose, by other means than civil penalties, its own ideas and practices as rules of conduct on those who dissent from them; to fetter the development, and, if possible, prevent the formation, of any individuality not in harmony with its ways, and compel all characters to fashion themselves upon a model of its own. There is a limit to the legitimate interference of collective opinion with individual independence: and to find that limit, and maintain it against encroachment, is as indispensable to a good condition of human affairs, as protection against political despotism.

John Stuart Mill, 1859.

18 The passage as a whole suggests that Mill wants to draw his contemporaries' attention to the

A dangers of limiting the political power of the majority.
B importance of defining the limits of society's power over the individual.
C need to enact legislation safeguarding society's authority over the individual.
D need to liberate the legal system from the interests of the traditional ruling class.

19 In the first paragraph Mill argues that the election of government by the majority is

A no guarantee against tyranny.
B the best safeguard against tyranny.
C the only means of combating the interests of the aristocracy.
D accepted as the best political arrangement by all intelligent thinkers.

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20 'The limitation … of the power of government over individuals loses none of its importa[illegible]lders of power are regularly accountable to the community.' (lines 5–7)

Which one of the following would best illustrate this assertion?

A a dictator's seizure and maintenance of power as a result of civil war
B evidence of widespread corruption amongst government officials in a democratic state
C persecution of a minority group under a government repeatedly elected by democratic process
D the difficulty of mounting free and fair elections in a state which has recently thrown off dictatorship

21 In using the word 'inclination' in line 8, Mill imputes to the 'important classes in European society' a degree of

A altruism.
B stupidity.
C intelligence.
D self-interest.

22 At which one of the following is Mill's attack directed in the second paragraph?

A the rule of law
B government by the majority
C the imposition of social conformity
D extreme penalties for minor offences

23 According to Mill, social tyranny may be more onerous than political oppression because it

A more pervasively imposes its strictures upon the individual.
B is unconstrained by the authority of any governing body.
C deflects democracy from its aim of serving the people.
D is exercised by the majority upon the individual.

24 In lines 18–19 ('if it issues … not to meddle') Mill implies that society should

A not interfere in some areas of life.
B never interfere with an individual's liberty.
C be prepared to intervene when right is clearly on its side.
D guide and influence behaviour, rather than issue mandates.

25 Which one of the following phenomena would Mill be likely to find objectionable?

A legislation to prevent the persecution of minority groups by the majority
B the movement to privatise instrumentalities and utilities formerly owned by the state
C legislation to ensure that members of the judiciary are drawn from diverse sections of society
D the establishment of equal opportunity boards to monitor the opinions expressed by tertiary academics

26 This passage appears to be a prelude to a discussion of

A the history of democracy.
B the nature of political tyranny.
C limits that might be placed on the exercise of the collective will.
D the influence of exceptional individuals in forming collective opinion.

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Unit 6

Questions 27 – 35

The following passage is the opening of a novel by Patrick White.

BUT old Mrs Goodman did die at last.

Theodora went into the room where the coffin lay. She moved one hairbrush three inches to the left, and smoothed the antimacassar on the little Empire prie-dieu that her mother had brought from Europe. She did all this with some surprise, as if divorced from her own hands, as if they were related to the objects beneath them only in the way that two flies, blowing and blundering in space, are related to a china and mahogany world. It was all very surprising, the accomplished as opposed to the contemplated fact. It had altered the silence of the house. It had altered the room. This was no longer the bedroom of her mother. It was a waiting room, which housed the shiny box that contained a waxwork.

Theodora had told them to close the box before the arrival of Fanny and Frank, who were not expected till the afternoon. So the box was closed, even at the expense of what Fanny would say. She would talk about Last Glimpses, and cry. She had not lived with Mrs Goodman in her latter years. From her own house she wrote and spoke of Dear Mother, making her an idea, just as people will talk of Democracy or Religion, at a moral distance. But Theodora was the spinster. She had lived with her mother, and helped her into her clothes. She came when the voice called.

At moments she still heard this in the relinquished room. Her own name split stiff and hollow out of the dusty horn of an old phonograph, into the breathless house. So that her mouth trembled, and her hand, rigid as protesting wood, on the coffin's yellow lid.

From the church across the bay a sound of bells groped through a coppery afternoon, snoozed in the smooth leaves of the Moreton Bay fig, and touched the cheek. The blood began again to flow. I am free now, said Theodora Goodman. She had said this many times since the moment she had suspected her mother's silence and realised that old Mrs Goodman had died in her sleep. If she left the prospect of freedom unexplored, it was less from a sense of remorse than from not knowing what to do. It was a state she had never learned to enjoy. Anything more concrete she would have wrapped in paper and laid in a drawer, knowing at the back of her mind it was hers, it was there, something to possess for life. But now freedom, the antithesis of stuff or glass, possessed Theodora Goodman to the detriment of grief. She could not mourn like Fanny, who would cry for the dead until she had appeased the world and exhausted what she understood to be sorrow. Fanny understood most things. The emotions were either black or white. For Theodora, who was less certain, the white of love was sometimes smudged by hate. So she could not mourn. Her feelings were knotted tight.

27 The opening line of the novel suggests that

- **A** Mrs Goodman's death came as a surprise.
- **B** Mrs Goodman's death was not unexpected.
- **C** death seemed a constant threat to Mrs Goodman.
- **D** it seemed as though Mrs Goodman would never die.

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28 Theodora's reactions when she entered the room where the coffin lay (paragraph two) se

A calm and collected.
B shocked and bereft.
C anxious and perturbed.
D detached and disoriented.

29 In the second paragraph Theodora sees her hands (line 5) as

A tentative and uncertain.
B strangely clumsy and alien.
C insistently irritating and intrusive.
D anxious and potentially hysterical.

30 Theodora is surprised after her mother's death because

A she had not prepared herself for such a situation.
B she did not want to believe it had happened.
C everything seemed to have changed.
D nothing seemed to have changed.

31 We are given the impression in the passage that Fanny's talk about 'Last Glimpses' (line 13) is

A superficial and sentimental.
B proper and respectful.
C tender and emotional.
D delicate and refined.

32 Fanny's response to her mother seems

A warm and grateful.
B blundering but genuine.
C hypocritically dismissive.
D distant and conventional.

33 In contrast with Fanny, Theodora's feelings seem

A a hysterically suppressed reaction to what has happened.
B a genuine response to the experience she has had.
C compassionate and sympathetic.
D insincere and superficial.

34 Theodora's response to 'the prospect of freedom' (line 26) is

A submerged and deferred.
B confused and ambiguous.
C passionate and elated.
D frank and direct.

35 The attitude of the writer to Theodora is

A shifting and ambivalent.
B critical and judgmental.
C unsympathetic and detached.
D sympathetic and understanding.

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Section II

Written Communication

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Task A

Consider the following comments and develop a piece of writing in response to one or more of them.

Your writing will be judged on the quality of your response to the theme; how well you organise and present y point of view, and how effectively you express yourself.

You will not be judged on the views or attitudes you express.

* * * * * * *

If poverty is the mother of crime, stupidity is its father.

Jean de La Bruyére

The faults of the burglar are the qualities of the financier.

George Bernard Shaw

Speaking generally, punishment hardens and numbs, it produces concentration, it sharpens the consciousness of alienation, it strengths the power of resistance.

Nietzsche

The reformative effect of punishment is a belief that dies hard, chiefly, I think, because it is so satisfying to our sadistic impulses.

Bertrand Russell

The faculties for getting into jail seem to be ample. We want more organisations for keeping people out.

Charles Dudley Warner

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Task B

Consider the following comments and develop a piece of writing in response to one or more of them.

Your writing will be judged on the quality of your response to the theme; how well you organise and present your point of view, and how effectively you express yourself.

You will not be judged on the views or attitudes you express.

* * * * * * *

Anybody who is any good is different from anybody else.

Felix Frankfurter

People are always talking about originality, but what does this mean? As soon as we are born, the world begins to work on us, and this goes on to the end.

Goethe

They will say you are on the wrong road, if it is your own.

Antonio Porchia

Conformity is the jailer of freedom and the enemy of youth.

John F. Kennedy

We are half ruined by conformity, but we should be wholly ruined without it.

Charles Dudley Warner

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Section III

Reasoning in Biological
and Physical Sciences

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Questions 1 – 6

Peak arterial blood pressure is generated when the ventricles of the heart contract, forcing blood into the arterial system. This peak blood pressure is called systolic pressure. The base arterial blood pressure (i.e. the minimum between the peaks) is known as diastolic pressure.

Figure 1 shows the typical (mean) effect on the systolic and diastolic blood pressure of changing from a 'normal' diet (containing moderate levels of fruits and vegetables, and dairy products that are not fat-reduced) for:

I people with *high normal* blood pressure, who are changed to a diet containing a relatively high proportion of fruits and vegetables;

II people with *high normal* blood pressure, who are changed to a diet containing a relatively high proportion of fruits and vegetables, and fat-reduced dairy products; and

III people with *moderately raised* blood pressure (i.e. *mild hypertensives*), who are changed to a diet containing a relatively high proportion of fruits and vegetables, and fat-reduced dairy products.

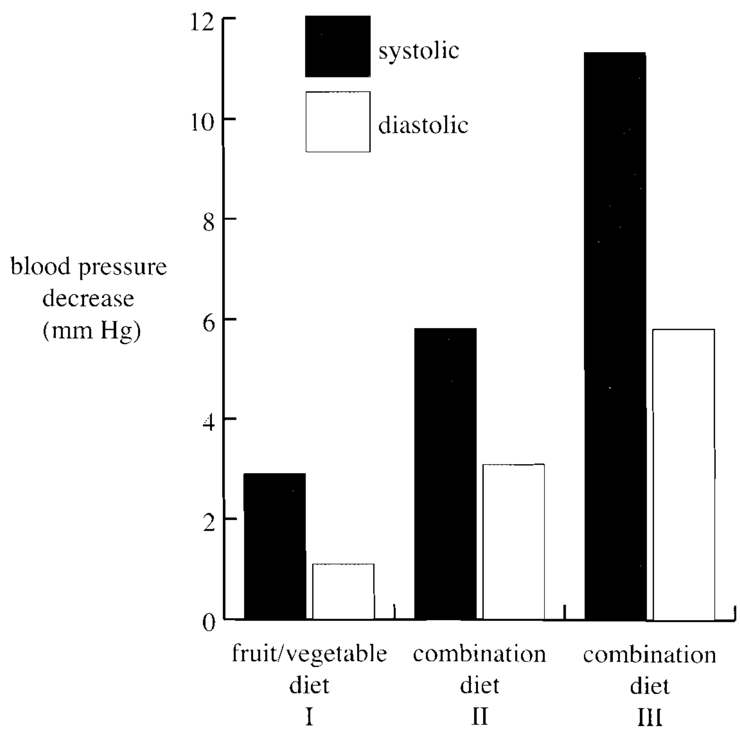

Figure 1

G. Taubes, 'Study says low-fat diet can lower blood pressure', *Science*, Vol. 276, 18 April 1997.

Suppose that *before* the dietary change the mean blood pressures (systolic/diastolic) of the three groups were:

I 130/80

II 130/80

III 150/95

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1 Which one of the following is likely to be the best estimate of the systolic pressure of a [illegible] person on a combination diet?

- **A** 125 mm Hg
- **B** 130 mm Hg
- **C** 135 mm Hg
- **D** 140 mm Hg

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2 Of the following, systolic blood pressure is likely to increase most for

- **A** mild hypertensive people on a normal diet changed to a combination diet.
- **B** mild hypertensive people on a combination diet changed to a normal diet.
- **C** people with high normal blood pressure on a normal diet changed to a combination diet.
- **D** people with high normal blood pressure on a combination diet changed to a normal diet.

3 Which one of the following is likely to be the best estimate of the diastolic pressure of a mild hypertensive person on a fruit and vegetable diet?

- **A** 88 mm Hg
- **B** 92 mm Hg
- **C** 96 mm Hg
- **D** 100 mm Hg

4 Of the following, diastolic blood pressure is likely to increase most for a typical

- **A** mild hypertensive person on a combination diet changed to a fruit and vegetable diet.
- **B** mild hypertensive person on a fruit and vegetable diet changed to a combination diet.
- **C** person with high normal blood pressure on a combination diet changed to a fruit and vegetable diet.
- **D** person with high normal blood pressure on a fruit and vegetable diet changed to a combination diet.

Questions 5 and 6 refer to the following additional information:

Blood pressure is commonly measured by placing an inflatable cuff around the arm above the elbow, inflating the cuff to a pressure that occludes arterial blood flow (i.e. closes the arteries) and then gradually decreasing the pressure. As the pressure applied by the cuff declines, a stethoscope applied to the arm is used to monitor arterial sounds. Initially no sound is heard. As the pressure applied declines, however, a pulse becomes audible. The pressure at which the pulse is first audible is the systolic pressure. With further decline in cuff pressure, the pulse sound becomes less pronounced and eventually disappears. The pressure when the pulse is first inaudible again is the diastolic pressure.

5 The pulse sound disappears mainly because the

- **A** force of ventricular contraction declines as cuff pressure declines.
- **B** diastolic pressure declines below a certain level.
- **C** systolic pressure equals diastolic pressure.
- **D** arterial occlusion ceases altogether.

6 Suppose the cuff pressure was 140 mm Hg for a typical mild hypertensive person on a normal diet.

The pulse sound would

- **A** be heard throughout most of the cardiac cycle.
- **B** be heard once, briefly, during each cardiac cycle.
- **C** not be heard because the cuff pressure is too high.
- **D** not be heard because the cuff pressure is too low.

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Questions 7 – 9

Figure 1 shows a side view (not to scale) of a quarter-circle 'slide-slot' that is held in a fixed position on a horizontal table. The radius of curvature of the curved surface (RST) is 8 cm.

A solid ball of radius 1 cm and mass 50 g is held at rest, touching the slide-slot at point R. The ball is released and allowed to slide down the surface RST under the influence of gravity, and without rolling. Point S is half-way along the surface between points R and T.

Assume the ball slides in a vertical plane, there are no frictional forces present, and that the gravitational acceleration (**g**) of a free-falling object is 10 m s^{-2}.

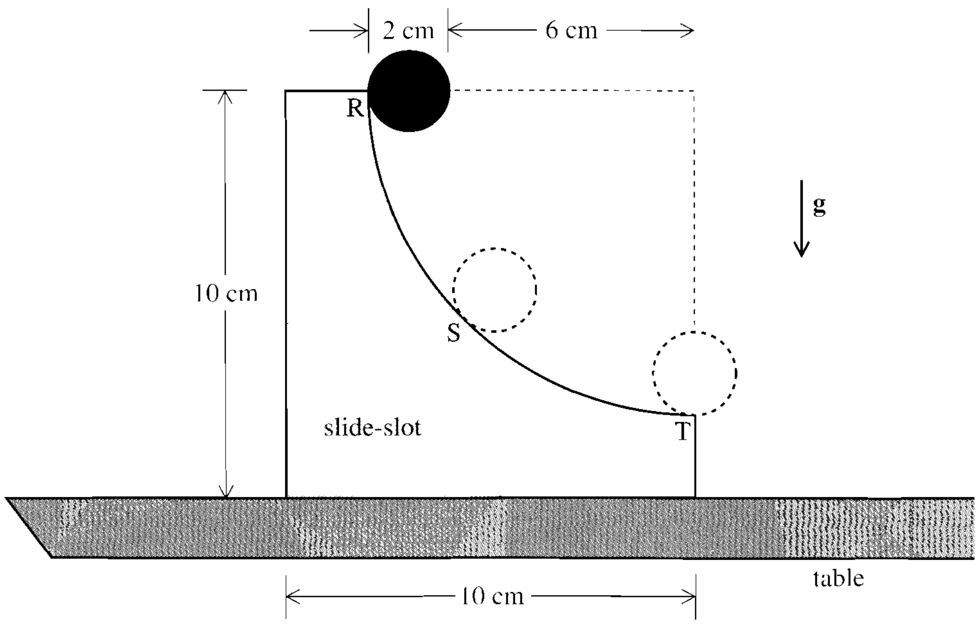

Figure 1

7 As the ball slides down the curved surface from point R to point T, the total mechanical energy (sum of kinetic and gravitational potential energies) of the ball

A decreases only.
B increases only.
C remains constant.
D first increases, reaching a maximum value at point S, and then decreases.

8 The decrease in gravitational potential energy of the ball, as it slides from point R to point T, is closest to

A 5.0×10^{-2} J.
B 4.0×10^{-2} J.
C 3.5×10^{-2} J.
D 3.0×10^{-2} J.

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9 The ball is allowed once more to slide down the slide-slot, starting at rest from point R. me the slide-slot is unconstrained horizontally so that it is free to slide on the table. While sliding ays in contact with the slide-slot. The mass of the slide-slot is 500 g.

Once again, assume the ball slides in a vertical plane, there are no frictional forces present, a gravitational acceleration (**g**) of a free-falling object is 10 m s^{-2}.

As the ball slides down the curved surface, from point R to point T, the total mechanical energy (sum kinetic and gravitational potential energies) of the ball

A decreases only.
B increases only.
C remains constant.
D first increases, reaching a maximum value at point S, and then decreases.

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Unit 3

Questions 10 and 11

If a nonvolatile and unreactive solute is added to a solvent, the vapour pressure above the resulting solution is less than the vapour pressure above the pure solvent at the same temperature. This is called Raoult's Law and can be expressed as

$P_{\text{solution}} = x_{\text{solvent}} \times P_{\text{solvent}}$ where

P_{solution} = vapour pressure of solution
x_{solvent} = mole fraction of solvent
P_{solvent} = vapour pressure of solvent

10 A consequence of Raoult's Law would be that the

A solute is less soluble than would otherwise be expected.
B solute is more soluble than would otherwise be expected.
C boiling point of the solution is lower than that of the pure solvent.
D boiling point of the solution is higher than that of the pure solvent.

11 A negative deviation from Raoult's Law is said to occur if the vapour pressure above a solution is less than the predicted value.

A negative deviation would be expected to occur if

A the solvent vapour is not an ideal gas.
B a solvent molecule has a greater mass than a solute molecule.
C a solvent molecule has a smaller mass than a solute molecule.
D the solute molecules are strongly attracted to the solvent molecules.

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Questions 12 – 16

Young sockeye salmon of equal size were made to swim against a current so that their speed through the water increased from 0 cm/s to a *top sustainable speed* (*tss*) of 78 cm/s. At the *tss*, fish swim as fast as possible without going into oxygen debt (i.e., without using significant anaerobic respiration).

To swim faster than the *tss*, or if for some other reason there is insufficient oxygen to enable aerobic metabolism to supply energy needs, the salmon need to use anaerobic respiration. Anaerobic processes can only be used significantly for brief periods.

Figure 1(a) shows how the (average) oxygen uptake of the fish varied with speed at a water temperature of 15 °C. At point M the fish were swimming at *tss*.

Figure 1(b), which is associated with Figure 1(a), indicates the rate of oxygen uptake at various water temperatures for the fish at rest (line 1) and swimming at various speeds (lines 2, 3 and 4) up to the *tss* (line 5).

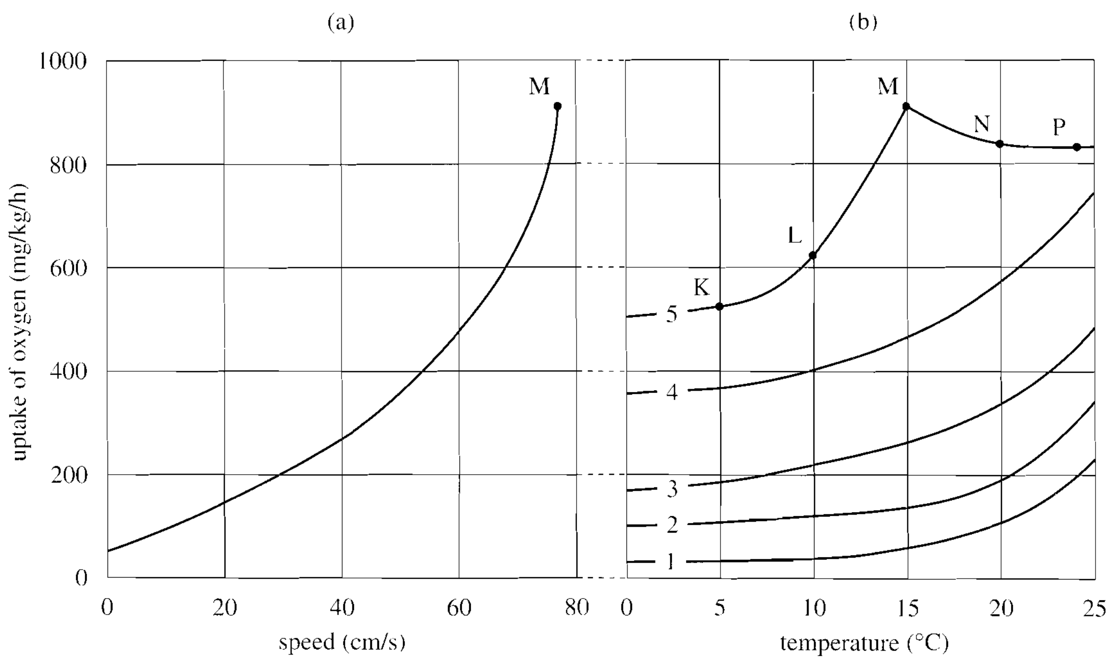

Figure 1

Adapted from 'The Swimming Energetics of Salmon', J.R. Brett. Copyright © 1965 by Scientific American, Inc. All rights reserved.

In relation to Figure 1(b), note that:

(1) the concentration of oxygen molecules in water decreases as water temperature rises;

(2) oxygen uptake increases with temperature because, as the temperature rises, a fish's general metabolic rate increases and, in addition, the fish puts more effort into flushing water past its gills to get diminishing oxygen from the water; and

(3) for each point on one of the five lines the speed of the fish is the same (e.g. 0 cm/s for line 1, 78 cm/s for line 5).

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12 For Figure 1(a), oxygen uptake increased with speed because

A water temperature changed.
B the fish used anaerobic respiration.
C the metabolic rate of the fish changed.
D gas exchange occurred at organs other than the gills.

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13 According to Figure 1(a), which one of the following is the best estimate of how many milligrams of oxygen is taken up in five minutes by a 100 g salmon swimming at 60 cm/s?

A 1
B 4
C 100
D 400

14 Which one of the following is the best estimate of the speed corresponding to line 3 in Figure 1(b)?

A 30 cm/s
B 40 cm/s
C 50 cm/s
D It is not possible tell which of **A**, **B** or **C** is best.

15 Which one of the following best helps to explain why, for line 3, oxygen uptake at 20 °C is greater than at 10 °C?

Compared with the case at 10 °C, at 20 °C

A The fish swims faster.
B Anaerobic respiration is greater.
C More energy is needed to achieve the *tss*.
D More energy is used for activities other than swimming.

16 $Q_{10} = \dfrac{\text{metabolic rate at X °C}}{\text{metabolic rate at (X − 10) °C}}$.

For line 5 of Figure 1(b), Q_{10} is greatest when X is the temperature corresponding to

A L.
B M.
C N.
D P.

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Questions 17 – 21

Organic acids that have a hydroxy group and a carboxylic acid group attached to two adjacent carbon atoms are often called by their colloquial name *ß-hydroxyacids*. This is because the hydroxy group is on the second carbon atom from the acid group. An example is mevalonic acid, $HOCH_2$-CH_2-COH(CH3)-CH_2-COOH, which is a precursor to the production of cholesterol in the body.

One method of producing ß-hydroxyacids in the laboratory is to react an aldehyde or ketone with an α–bromo ester (the bromine is attached to the same carbon atom as the carboxylate group) and metallic zinc in ether. Subsequent hydrolysis produces the ß-hydroxyacid. Figure 1 shows the steps in this reaction.

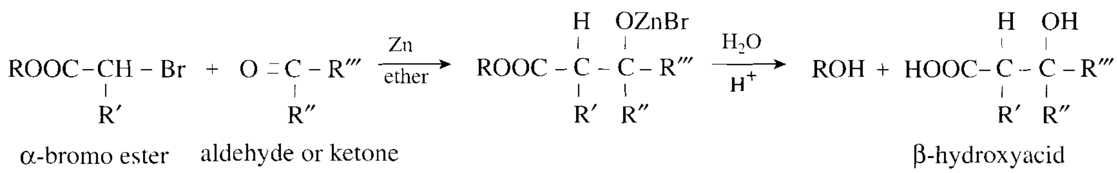

Figure 1

Note that

- the bromo-compound must be an α-bromo alkyl or aryl ester, **not** an α-bromocarboxylic acid.
- R′, R″ and R‴ can each be any of H, an alkyl or an aryl group.

17 Blood contains low levels of ß-hydroxybutyric acid (its more formal IUPAC name is 3-hydroxybutanoic acid).

Which of the following alkyl groups could be part of their respective reactants in the preparation of this ß-hydroxyacid by the reaction sequence described in Figure 1?

A R = R′ = R″ = R‴ = H
B R = CH_3 and R′ = R″ = R‴ = H
C R = R″ = CH_3 and R′ = R‴ = H
D R′ = R‴ = CH_3 and R = R″ = H

18 The reaction sequence described in Figure 1 would produce 3-hydroxypropanoic acid if

A R = R′ = R″ = R‴ = H.
B R = CH_3 and R′ = R″ = R‴ = H.
C R = R″ = CH_3 and R′ = R‴ = H.
D R′ = R‴ = CH_3 and R = R″ = H.

19 Which one of the following could be produced by the reaction sequence described in Figure 1?

A 4-hydroxybutanoic acid
B 3-hydroxy-3-methylpentanoic acid
C 4-hydroxy-3-methylpentanoic acid
D 4-hydroxy-4-methylhexanoic acid

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20 In order to prepare the compound 3-hydroxy-4-ethylhexanoic acid by the reaction [illegible] ibed in Figure 1, the two reactants needed are

- **A** methyl bromoacetate and 2-ethyl butantal.
- **B** methyl bromoacetate and 2-hexanone.
- **C** ethyl bromoacetate and 3-methyl butanal.
- **D** ethyl bromoacetate and 3-hexanone.

21 Under the conditions of the reaction sequence described in Figure 1, the reaction between acetone and propyl bromoacetate would produce

- **A** 2-ethyl-3-hydroxypropanoic acid.
- **B** 2,2-dimethyl-3-hydroxybutanoic acid.
- **C** 2,3-dimethyl-3-hydroxypropanoic acid.
- **D** 3-methyl-3-hydroxybutanoic acid.

Unit 6

Question 22

Figure 1 depicts an observer viewing the images of four coloured beads that are formed (focused) on two vertical screens by a thin converging lens. The beads are held at two different heights — one height above the principal axis of the lens, the other height below it — by vertical needles that are pinned into the corners of a rectangular board. The rectangular board is aligned so that its centre is directly below the principal axis of the lens and its longest sides are parallel to this axis. The lens is held vertically between the board and the two screens. The screens rest on the table at different distances from the lens.

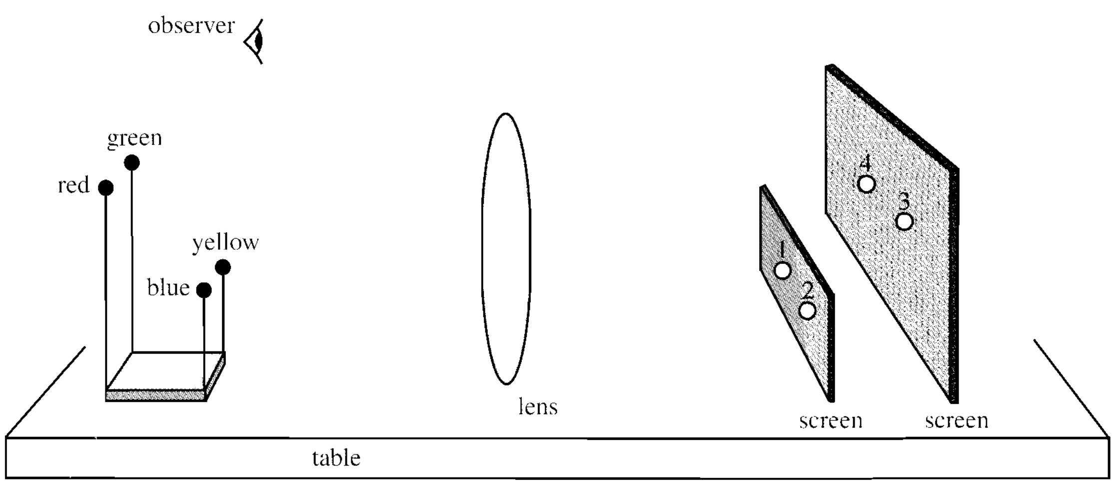

Figure 1

22 The images of the green, yellow, blue and red beads, in this order, are

- **A** 4 1 2 3.
- **B** 1 4 3 2.
- **C** 3 2 1 4.
- **D** 2 3 4 1.

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Questions 23 – 26

As flatfish (*Pleuronectiformes*) develop, they lose their bilateral symmetry. One of their eyes migrates across the top of the head, so that both eyes end up adjacent on the same side of the head. As a result, the adult fish is able to lie flat on its side on the sea floor with both eyes facing up. In some species of flatfish the right eye migrates to the left side of the head (they are left-eyed); in other species the left eye migrates to the right side of the head (they are right-eyed).

In one species of flatfish, the starry flounder (*Platichthys stellatus*), different populations have different proportions of left-eyed and right-eyed individuals. Off the west coast of the USA the population is evenly divided between left-eyed and right-eyed individuals. However, in the north Pacific, midway between the USA and Japan, 70% of the population is left-eyed and in Japanese waters all the starry flounder are left-eyed.

Consider the following hypotheses (I – III) about the starry flounder. The hypotheses assume that a single gene locus determines the final location of the eyes on the head.

I The Japanese fish are homozygous for a dominant left-eyed allele (LL), whereas west coast fish are homozygous for a neutral allele ($\ell\ell$) and have an equal chance of developing into either left- or right-eyed individuals.

II The Japanese fish are homozygous for the left-eyed allele (LL), whereas in the west coast fish both left-eyed (L) and right-eyed (R) alleles occur in equal proportions. Heterozygous individuals (LR) have an equal chance of developing into either the left- or right-eyed form.

III There are three alleles of the controlling gene: the left-eyed allele (L) is dominant to both the right-eyed allele (ℓ) and the neutral allele (ℓ'). Further, the right-eyed allele is dominant to the neutral allele. Fish that are homozygous neutral ($\ell'\ell'$) have an equal chance of developing into right- or left-eyed individuals.

23 From hypothesis I it can be concluded that the offspring (F_1) of a cross between a Japanese starry flounder and a right-eyed west coast starry flounder

A would include both left-eyed and right-eyed flounder.
B would be right-eyed flounder only.
C would be left-eyed flounder only.
D cannot be specifically predicted.

24 According to hypothesis III, many crosses between $\ell\ell'$ and $L\ell'$ individuals would result in offspring (F_1) in proportions closest to

A 85% left-eyed : 15% right-eyed.
B 75% left-eyed : 25% right-eyed.
C 60% left-eyed : 40% right-eyed.
D 50% left-eyed : 50% right-eyed.

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25 Consider hypothesis II.

Assume equal frequencies of left- and right-eyed alleles in the west coast population an ... no impediment to the occurrence of any possible genotype. From hypothesis II it can be conc... offspring (F1) of many crosses between Japanese starry flounder and randomly selected west co... would be

A three left-eyed flounder for every one right-eyed flounder.
B seven left-eyed flounder for every one right-eyed flounder.
C equal proportions of left- and right-eyed flounder.
D none of the above.

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26 When a left-eyed mid-Pacific female and a right-eyed west coast male were crossed and the offspring were all kept in standard laboratory conditions on the west coast of the USA, 50% of the thousands of offspring were right-eyed and 50% were left-eyed.

Of the following this result completely rules out

A hypothesis I.
B hypothesis II.
C hypothesis III.
D none of the hypotheses.

Unit 8

Question 27

27 In the following three circuits, all of the cells and globes are identical, and the internal resistances of the cells are negligible.

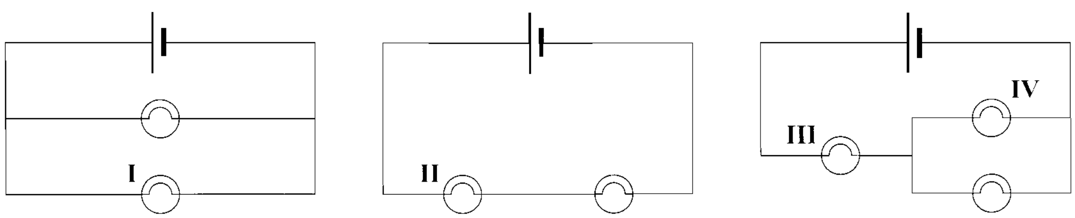

Figure 2

Which one of the four globes I, II, III or IV would be the brightest?

A I
B II
C III
D IV

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Questions 28 – 30

The rate of a reaction is the rate of the disappearance of a reactant or appearance of a product. It can be expressed as a function of concentrations of its reactants. However, the rate is not always proportional to the concentration of all reactants.

If the rate is proportional to the change in concentration of only one reactant (X), the rate law is

$$\text{rate} = k\,[\text{X}]$$

where k is a rate constant for the reaction. The change in concentration of X with time is given by

$$\ln \frac{[\text{X}]_0}{[\text{X}]_t} = kt$$

where $[\text{X}]_t$ is the concentration of X at some time t and $[\text{X}]_0$ is the concentration at the beginning of the reaction. A reaction that follows such a rate law is called a *first-order* reaction.

The rate of a *second-order* reaction is proportional to the product of the concentration of two reactants or the square of the concentration of one. For two reactants X and Y, the rate law can be any one of

$$\text{rate} = k\,[\text{X}]\,[\text{Y}] \quad \text{or} \quad \text{rate} = k\,[\text{X}]^2 \quad \text{or} \quad \text{rate} = k\,[\text{Y}]^2\,.$$

28 The conversion of sucrose to fructose and glucose in acidic solution can be represented by the following equation.

$$\text{sucrose (aq)} \ + \ H_2O\,(\ell) \xrightarrow{H^-} \text{fructose (aq)} \ + \ \text{glucose (aq)}$$

The rate law for the reaction is

$$\text{rate} = k\,[\text{H}\ ]\,[\text{sucrose}].$$

Let the rate of the reaction at pH 3 be r. If all the variables are kept constant except that the pH is changed to 2, then the rate of reaction will be

A $3r$.

B $10r$.

C $r/3$.

D $r/10$.

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29 The following data were collected for the reaction $R + S \longrightarrow T$.

Experiment	Initial [R] (M)	Initial [S] (M)	Initial rate (M/s)
1	0.100	0.100	3.2×10^{1}
2	0.100	0.200	3.2×10^{-1}
3	0.200	0.100	6.4×10^{-1}

What is the rate law for the reaction?

A rate = k [R]

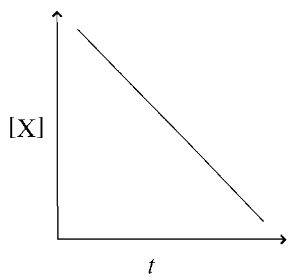
B rate = k [2R]

C rate = k $[R]^2$

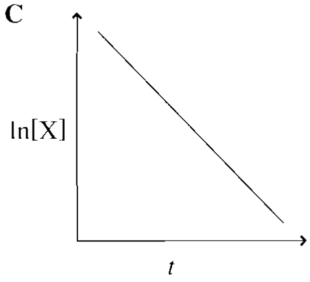
D rate = k [R] [S]

30 Which one of the following graphs represents a first-order reaction for reactant X?

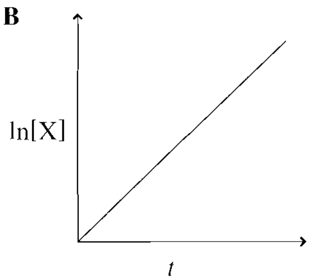
A



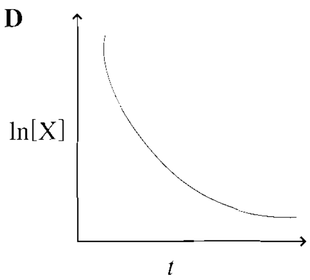
C



B



D



Unit 10

Question 31

31 Whenever cells are isotonic (isosmotic) with the extracellular fluid that surrounds them, the cytoplasmic and extracellular fluids have the same concentration of

A mineral ions.

B sodium ions.

C amino acids.

D water.

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Questions 32 – 35

The male Australian brush turkey (*Alectura lathami*) assembles an incubation mound consisting of litter, which is typically one metre high by five metres in diameter. As the litter decomposes, mostly due to the action of fungi, the temperature in the mound rises, stabilising around 33°C at a distance of 60 centimetres below the top of the mound. This is where the eggs are located. At mound temperatures below the stable incubation temperature, the rate of heat production in the mound is faster than the rate of heat loss from the surface of the mound, but the reverse is true above the incubating temperature.

In a typical mound, the fungi and other microorganisms utilise oxygen at the rate of 20 litres per hour, many times the rate of consumption by the eggs. As a consequence, the air in the spaces around the eggs contains 17% O_2 and 4% CO_2, which presents a problem for effective gas exchange and the maintenance of appropriate CO_2 and O_2 levels in the embryo. (In normal air, the O_2 level is 21% and the CO_2 level is 0.03%.)

The brush turkey eggshell is, relative to eggs of comparable size, half as thick as would be expected. Within the egg, the embryo is immersed in fluid, and gases reach it by diffusion across the chorioallantoic membranes.

After construction, the female digs trenches in the mound, into which she can lay eggs. In a single season, a brush turkey can lay 50 eggs. Unlike most birds, once the eggs are laid, brush turkeys do not care for their young.

The brush turkey embryo, like that of other birds, has an egg tooth, which can be used to break the shell. However, it primarily uses its large feet to break free. Brush turkeys emerge from their eggs in a highly developed state and dig through the litter to the surface. Having primary feathers, the birds are able to fly in the first day or two post-hatching.

Figure 1 indicates metabolic rate (joules per second) and oxygen consumption (mL per hour) of embryos within the eggs of two mound-building birds (brush turkey and mallee fowl), who do not provide parental care, and of a typical galliform bird. (Galliform birds care for their young.) The curves cover the period until the bird emerges from the egg.

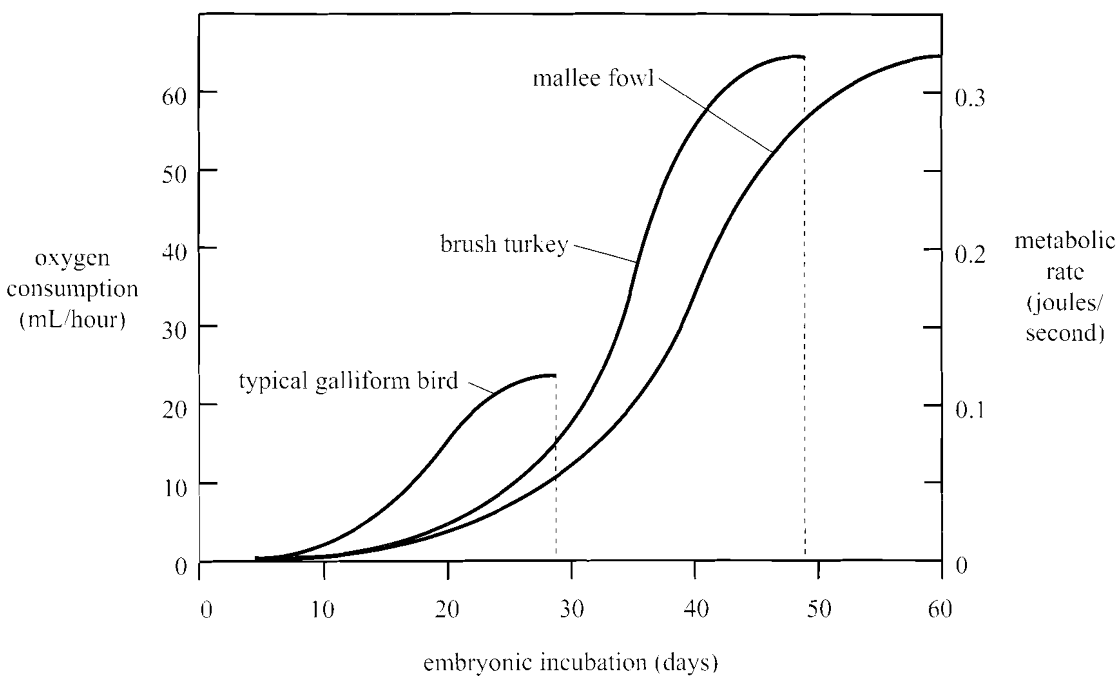

Figure 1

Adapted from '*The Brush Turkey*', Roger S. Seymour. Copyright © 1991 by Scientific American, Inc. All rights reserved.

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32 According to Figure 1, of the following, the greatest total amount of oxygen consump

- **A** occurs in the mallee fowl between day 50 and day 60.
- **B** occurs in the brush turkey between day 15 and day 35.
- **C** occurs in the galliform bird between day 1 and day 28.
- **D** cannot be determined from the data provided.

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33 According to Figure 1, of the following, the estimate that is closest to the total amount of energy produced by the mallee fowl during its 60 day incubation is

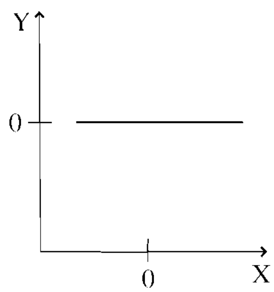
- **A** 50 kilojoules.
- **B** 200 kilojoules.
- **C** 700 kilojoules.
- **D** 2000 kilojoules.

34 Which one of the following features present in the brush turkey embryo or egg is **least** likely to specifically suit the bird to its unusual incubation environment or parenting approach?

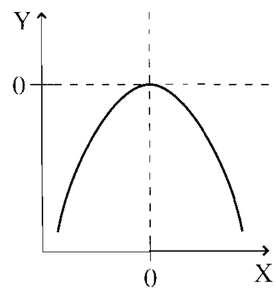
- **A** egg tooth
- **B** thin eggshell
- **C** large feet suitable for digging
- **D** relatively large yolk supply compared to other birds

35 In which one of the following graphs could the Y axis most suitably be labelled *heat produced in the mound minus heat lost from the mound* and the X axis most suitably be labelled *mound temperature at location of egg minus stable incubation temperature at location of egg*?

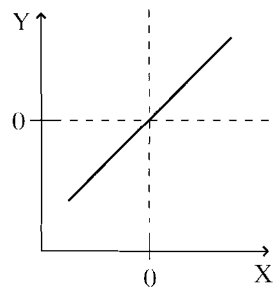
A



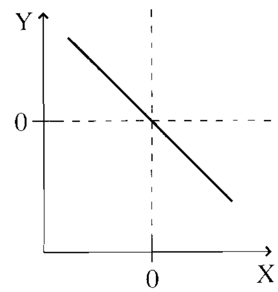
C



B



D



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Questions 36 – 38

When an acid/base indicator is added to a solution, its colour will depend on the pH of that solution. This is due to the fact that indicators can exist in either the protonated (acid) form or the deprotonated (base) form. For example, the indicator with the general formula HIn will ionise according to the equation:

$$\underset{\text{acid form}}{\mathrm{HIn(aq)}} \rightleftharpoons \mathrm{H^{+}(aq)} + \underset{\text{base form}}{\mathrm{In^{-}(aq)}}$$

To be a good indicator, the two forms, HIn and In^-, must have very different colours. The equilibrium constant for the ionisation reaction (K_a) can be expressed as

$$K_a = \frac{[\mathrm{H^+}][\mathrm{In^-}]}{[\mathrm{HIn}]}.$$

As $pK_a = -\log_{10} K_a$ and $pH = -\log_{10} [H^+]$, then the negative logarithm of this expression will be

$$pK_a = pH - \log_{10}\frac{[\mathrm{In^-}]}{[\mathrm{HIn}]} \quad \text{or} \quad pK_a = pH + \log_{10}\frac{[\mathrm{HIn}]}{[\mathrm{In^-}]}$$

Table 1 lists some of the commonly used acid/base indicators, their pK_a values and the colours of their acid and base forms.

Table 1

Indicator	**pK_a value**	**Colour of acid form**	**Colour of base form**
Bromothymol blue	6.8	yellow	blue
α-Naphtholphthalein	8.0	yellow	blue
Neutral red	7.4	red	yellow
Thymol blue	2.0 8.8	red yellow	yellow blue
Thymolphthalein	10.0	colourless	blue

Note: Thymol blue is a diprotic indicator, i.e. the base form after the first deprotonation becomes the acid form for the second deprotonation.

Both forms of the indicator are always present in a solution. However, if the ratio of one form to the other is greater than 10 to 1, then the colour observed will be just that of the predominant form.

If $10 > \frac{[\mathrm{In^-}]}{[\mathrm{HIn}]} > 0.1$, then the colour observed will be a mixture of the colours of the two forms, i.e. a mixture of red and yellow will appear orange while a mixture of blue and yellow will appear green.

Notes: (1) All of the solutions mentioned in the questions below are themselves colourless, i.e. the only colours present are due to the indicators.
(2) The pH of the solution is not affected significantly by the addition of an indicator.

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36 Samples of a colourless solution of unknown pH were placed in each of three test tubes. W… halein is added to the first test tube, it is colourless while when α-naphtholphthalein is added t… is blue.

If thymol blue was added to the third test tube, the colour would appear to be closest to

A yellow. **C** orange.
B blue. **D** green.

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37 The range of pH values over which any of the indicators will completely change from the colour of their acid form to the colour of their base form is expected to be

A 0.1 . **C** 2.0 .
B 1.0 . **D** 10.0 .

38 Equal numbers of moles of bromothymol blue and neutral red are added to a solution that has a pH of 7.1. The concentrations of the protonated and deprotonated forms of each of the two indicators can be represented as follows:

m is the concentration of the protonated form of bromothymol blue;
n is the concentration of the deprotonated form of bromothymol blue;
r is the concentration of the protonated form of neutral red; and
s is the concentration of the deprotonated form of neutral red.

Which of the following shows the relationship of these concentrations?

A $m = n = r = s$ **C** $m \neq n \neq r \neq s$
B $m > n$ and $r > s$ **D** $m = s < n = r$

Unit 13

Question 39

An electromagnetic wave travels from medium 1 to medium 2. Let the refractive indexes, frequencies and wavelengths of the electromagnetic wave in the two media be denoted as follows:

	refractive index	frequency	wavelength
medium 1	n_1	f_1	λ_1
medium 2	n_2	f_2	λ_2

39 If $n_1 > n_2$, then

A $f_1 < f_2$ and $\lambda_1 > \lambda_2$. **C** $f_1 = f_2$ and $\lambda_1 < \lambda_2$.

B $f_1 = f_2$ and $\lambda_1 > \lambda_2$. **D** $f_1 > f_2$ and $\lambda_1 = \lambda_2$.

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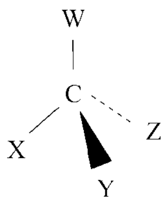
Questions 40 and 41

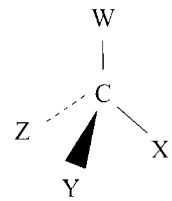
When a carbon atom is covalently bonded to *four different* atoms or groups of atoms, it is possible for it to form two structures that are non-superimposable mirror images. Such structures are called *stereoisomers*. One method of representing three-dimensional images on a plane is as follows:



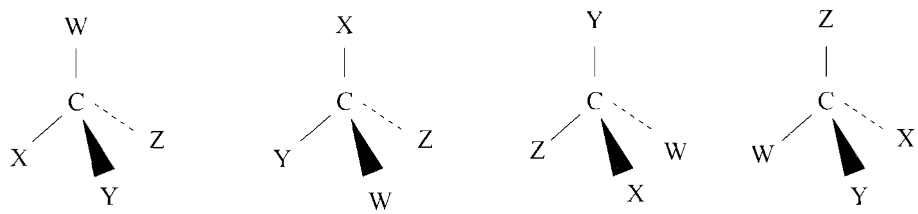
Structure (i)

W and X are in the plane,
Y is in front of the plane and
Z is behind the plane

Structure (i) and structure (ii) are mirror images and cannot be superimposed onto each other.



Structure (ii)



Structure I   Structure II   Structure III   Structure IV

Figure 1

40 The structure in Figure 1 that **cannot** be superimposed onto any of the others is

A structure I.
B structure II.
C structure III.
D structure IV.

41 Consider the two organic compounds 2-butanol and 2,2-dichlorobutane.

Stereoisomers are possible for

A both 2-butanol and 2,2-dichlorobutane.
B 2-butanol but not for 2,2-dichlorobutane.
C 2,2-dichlorobutane but not for 2-butanol.
D neither 2-butanol nor 2,2-dichlorobutane.

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Questions 42 – 43

Three thermodynamic quantities that are associated with a chemical or physical change are the change in free energy (ΔG), the change in enthalpy (ΔH), and the change in entropy (ΔS). The relationship between the three quantities is given by the equation

$$\Delta G = \Delta H - T\,\Delta S \qquad (T = \text{temperature in kelvin})$$

42 When a sample of the polymer poly(ethene) is heated in an oven, it quickly shrinks to less than half of its initial size.

From the reaction that occurs when the poly(ethene) is heated, it can be deduced that

A $\Delta H > 0$ and $\Delta S > 0$.

B $\Delta H > 0$ and $\Delta S < 0$.

C $\Delta H < 0$ and $\Delta S > 0$.

D $\Delta H < 0$ and $\Delta S < 0$.

43 When potassium nitrate (KNO_3) crystals are dissolved in water, a drop in temperature is observed.

From this observation, predict the signs of ΔS and ΔH when potassium nitrate is crystallised from an aqueous solution.

A ΔS is positive and ΔH is positive

B ΔS is positive and ΔH is negative

C ΔS is negative and ΔH is positive

D ΔS is negative and ΔH is negative

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Questions 44 – 47

Figure 1 shows schematically the forces acting on the spine of a man when he bends his back to a horizontal, stationary position. The spine is approximated as a lever of length L, which is pivoted at one end. The combined weight of the man's head, arms and torso, W, is 420 N, and the weight acts on the spine (lever) at a distance $0.6L$ from the pivot point, as indicated in the figure.

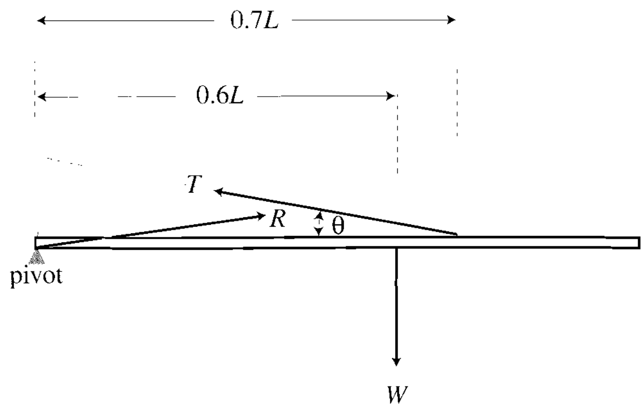

Figure 1

Let T denote the magnitude of the resultant force exerted by the muscles of the back on the spine so as to keep the spine (lever) horizontal. This force acts on the lever $0.7L$ from the pivot point in a direction inclined at angle to the spine (lever), as indicated in the figure. R denotes the magnitude of the resultant force exerted by the pivot on the spine, and this force counterbalances the combined effects of T and W.

Notes:

(1) The spine (lever) is in equilibrium when the resultant external force and the resultant external torque acting on it are each equal to zero.

(2) A torque produced by a force on the spine (lever) is equal to the magnitude of the force multiplied by the perpendicular distance from the pivot to the imaginary line along which the force acts. For example, the torque produced by the weight W in Figure 1, about the indicated pivot, is equal to $0.6L \times W$.

(3) If $\alpha = \sin\theta$ and $\beta = \cos\theta$ then the vertical and horizontal components of T are αT and βT, respectively.

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44 By equating appropriate torques about the pivot in Figure 1, it is found that the magni[illegible]ewton) is equal to

A $\frac{360}{\beta}$. **C** $\frac{360}{\alpha}$.

B $\frac{490}{\beta}$. **D** $\frac{490}{\alpha}$.

45 By resolving vertical and horizontal components of appropriate forces in Figure 1, it is found that the magnitude of R (in Newton) is equal to

A $\sqrt{\beta^2T^2 + (420 - \alpha T)^2}$. **C** $(420 - T)$.

B $\sqrt{\beta^2T^2 - (420 - \alpha T)^2}$. **D** $(\alpha + \beta)\,T$.

Questions 46 and 47 refer to the following additional information:

Suppose the man, with his spine in the bent position as depicted in Figure 1, now picks up a box weighing 280 N. Assume that the weight of the box acts at the free end of the (spine) lever.

46 In order for the man to maintain his spine in a horizontal position, the magnitude of T must now be equal to

A $\frac{640}{\beta}$ N. **C** $\frac{640}{\alpha}$ N.

B $\frac{760}{\beta}$ N. **D** $\frac{760}{\alpha}$ N.

47 The man understands that he can reduce the chance of back damage whilst lifting the box, if he flexes his knees and keeps his spine vertical.

If the man lifts the 280 N box in this way, keeping the centre of gravity of the box almost directly above his spine's pivot, R will then be closest to

A 140 N. **C** 700 N.
B 280 N. **D** 1120 N.

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Questions 48 – 50

In the bread mould *Neurospora crassa*, synthesis of the vital amino acid arginine is achieved utilising the metabolic pathways represented in Figure 1. In the figure, the names of certain enzymes (E_1, E_2, E_3 and E_4) are indicated; and arg-1, arg-2, . . . , arg-12, shown in association with specific reactions in the pathway, represent mutations of different genes, each of which stops the functioning of the corresponding enzyme.

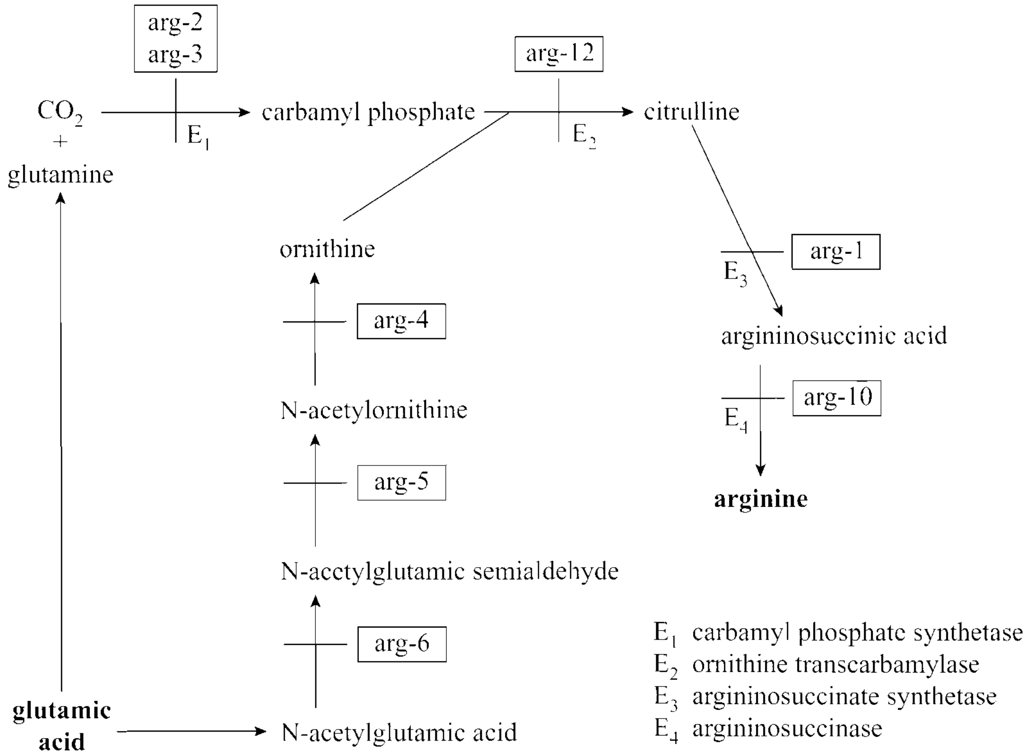

Figure 1

Adapted from *Outline Studies in Biology: Biochemical Genetics* by R.A. Woods 1973. By permission of Chapman and Hall.

In a study, colonies of mutant *Neurospora* strains, each having a mutation of a different one of the genes controlling arginine synthesis, were produced by UV irradiation.

Various *Neurospora* arginine pathway mutants were incubated on culture plates containing a *minimal nutrient medium* that, of the arginine pathway metabolites, only supplied glutamic acid. None of the mutants is able to grow on the minimal medium. In some instances, the minimal nutrient medium was supplemented with one of the substances from the arginine pathway.

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48 Which of the enzymes in the metabolic pathway depicted in Figure 1 is ornithine trans

The one affected by

A arg-2.
B arg-4.
C arg-5.
D arg-12.

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49 Which one of the following does **not** match an arginine mutant with its growth response (+ or −) on plates supplemented with the substance indicated (either ornithine or citrulline)?

	mutant	**growth on medium with named supplement** **ornithine**	**citrulline**
A	arg-2	+	+
B	arg-6	+	+
C	arg-10	−	−
D	arg-12	−	+

50 A *Neurospora* mutant designated arg-x occurs. It will grow on the minimal medium if it is supplemented with citrulline alone but not if it is supplemented with carbamyl phosphate alone.

Of the following, the enzyme affected by mutant arg-x could be one corresponding to

A arg-1 but not one corresponding to any other mutation.
B arg-12 but not one corresponding to any other mutation.
C either arg-2 or arg-3.
D either arg-6 or arg-12.

Unit 18

Question 51

Some molecules are amphiprotic – they can both donate and accept hydronium ions. Consider the amphiprotic molecule ZH, where in reaction **I**, it is acting as an acid while in reaction **II**, it is acting as a base.

Reaction **I** $ZH(aq) + H_2O(l) \longrightarrow H_3O^+(aq) + Z^-(aq)$

Reaction **II** $ZH(aq) + H_2O(l) \longrightarrow ZH_2^+(aq) + OH^-(aq)$

The equilibrium constant for reaction **I** is called an acidity constant K_a while that for reaction **II** is called a basicity constant K_b.

51 The stronger a base, the

A smaller is its pK_b value and the larger is the pK_a value of its conjugate acid.
B larger is its pK_b value and the smaller is the pK_a value of its conjugate acid.
C smaller is both its pK_b value and the pK_a value of its conjugate acid.
D larger is both its pK_b value and the pK_a value of its conjugate acid.

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Question 52

The normal human ear is sensitive to sound in the frequency range 20 Hz to 20 kHz. At 1000 Hz it is able to detect sound intensities from about 10^{-12} W m^{-2} to about 1 W m^{-2}.

A logarithmic scale is often used when measuring sound intensity:

for any sound intensity, I, the *sound intensity level*, Lp, measured in *decibels* (dB), is given by

$$Lp = 10 \log \left(\frac{I}{10^{-12}} \right).$$

On this scale $Lp = 0$ dB at the *threshold of hearing*, that is, when $I = 10^{-12}$ W m^{-2}.

Note that since log 2 = 0.30, changing the sound intensity by a factor of 2 changes the sound intensity level by 3 dB.

Some points on this scale are shown in Table 1. At sound intensities above 1 W m^{-2} pain is felt rather than sound being heard and damage to the ear may occur.

Table 1 Some Sound Intensity Levels for Normal Human Hearing

Sound intensity level (dB at 1000 Hz)	
160	burst eardrum
120	threshold of pain
100	maximum output from large orchestra
80	loud radio
60	normal conversation
40	quiet radio
20	whisper
0	threshold of hearing

52 The change in sound intensity level from normal conversation to the threshold of pain corresponds to an increase in sound intensity by a factor of

A 2 .

B 60 .

C 10^{6} .

D 10^{60} .

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Unit 20

Questions 53 – 55

Ethanol is removed from the body by reaction with the enzyme *alcohol dehydrogenase* (ADH). In fact, ADH will react with any alcohol that has a hydrogen atom on the carbon to which the alcohol group is attached. The effect of the enzyme is to remove this hydrogen and the hydrogen atom of the alcohol (OH) group. ADH, like all enzymes, is very specific and will not catalyse any other reaction. However, the product of the ADH reaction with an alcohol may undergo further reaction with other enzymes.

53 The reaction of an alcohol with ADH is an example of

A oxidation.
B reduction.
C dehydration.
D hydrogenation.

54 The reaction of 2-butanol with ADH would produce

A 2-butanal.
B methylethylketone (butanone).
C diethylketone (3-pentanone).
D 2-butanoic acid.

55 Which one of the following statements about reactions of ADH with alcohols is **not** correct?

A The product formed by the reaction of a primary alcohol with ADH is an aldehyde.
B The product formed by the reaction of a secondary alcohol with ADH is a ketone.
C The product formed by the reaction of a tertiary alcohol with ADH can be either an aldehyde or a ketone.
D A tertiary alcohol does not react with ADH.

Unit 21

Question 56

Pure water undergoes self-ionisation according to the equation

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq).$$

The equilibrium constant for the reaction as written is 1.0×10^{-14} at 25 °C and 1.0×10^{-13} at 60 °C.

56 At 60 °C, pure water has a pH value that is

A less than 7.0 but the water is still neutral.
B less than 7.0 and therefore the water is acidic.
C equal to 7.0 and therefore the water is neutral.
D greater than 7.0 and therefore the water is basic.

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Notes on assessment and solutions to some Sample Questions

Reasoning in Humanities and Social Sciences

Unit 1

The questions about this short passage from Charles Darwin's *On the Origin of Species* require candidates to follow Darwin's reasoning as he outlines challenges to his own view before countering them.

Question 1 **A**

In this question candidates need to construe 'It has been said that I speak of natural selection as an active power or Deity' as a personification of nature. Rather than claiming that he is accused of denying a role to God in nature, he claims that he is accused of treating natural selection as a Deity, the opposite of **B**. **C** is a misreading of the passage, as Darwin's claims are modest and focused on the concept itself, and not about his own role. **C** misreads both the content and the tone of the passage. **D** is wrong because the passage itself is about the concept of natural selection rather than an explication of its effects.

Question 2 **C**

This question requires candidates to recognise the logic and direction of Darwin's argument. The second part of the passage focuses on justifying the use of the term 'natural selection' against the challenges that have been made to its legitimacy. **A** is wrong because the use of metaphor is only brought in towards the end of the passage and is not the focal point of this section. **B** and **D** are wrong because Darwin is not concerned at this point to explain how natural selection works in practice, but with defending his choice of the term in the first place.

Question 3 **B**

In this question candidates need to recognise the way in which Darwin appears to qualify his position by distinguishing between a 'literal' and, by implication, a non-literal use of a word. **A** is wrong because rather than denying that he attributes volition to plants, Darwin is merely conceding that there is literally no choice or selection involved. **C** is wrong because he is not extrapolating a conclusion but rather explaining that he is using terms metaphorically. **D** is wrong because he is clarifying, not altering, his position.

Question 4 **C**

To be able to answer this candidates need first to be able to identify the metaphor and then recognise how it is being used. The last word in the passage, 'brevity', cues the candidate to the notion of 'concisely' in **C**. Both **A** and **B** miss Darwin's point about the usefulness of the metaphorical expression. This usefulness lies in the capacity of metaphors to illuminate and render something complex more accessible and comprehensible. **D** is wrong because it is not the explanation of the 'fine points' of a concept that is at issue but rather making comprehensible what is difficult to explain.

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Unit 2

This unit tests the understanding of a pair of figures and tables showing the required pattern of marriage and membership of children for two groups of Pacific Islanders. The answers to some questions are to be deduced from the introductory text and the answers to other questions can be deduced from either the figures or the tables.

Question 5 **D**

In both systems no distinctions are made between siblings, and all children are in a different clan to both parents. As aunts and uncles are siblings of parents, and hence in the same clan as one or other parent, aunts and uncles are also in different clans to the children of their siblings. Hence **D** is the only correct answer.

Question 6 **B**

This question asks about the pattern of the Tarau system. It can be seen from the figure that the arrows of that system follow a clockwise or anti-clockwise sequence. An alphabetical sequence is also to be seen in the table. On the other hand the Kariera system shows pairs of arrows going backwards and forwards between certain points.

The Tarau system is appropriately described as a sequence involving all clans, whereas the Kariera system is appropriately described as a reciprocal relationship between pairs of clans.

The patterns of marriage and filiation are the same within each group, and hence **C** and **D** are incorrect.

Question 7 **C**

This question is based on the fact that in both systems all children are in different clans to their parents, and the same clan as their siblings. Mothers are in the same clan as their siblings, so **A** is incorrect. Mothers come from different clans to their children, so **B** is incorrect. Children are in different clans to their fathers, so **D** is incorrect. **C** is correct because children are in different clans to their father.

Question 8 **B**

This question is an interpretation of the symbols used in the Kariera table.

A child of a father in clan A — c(A) — is in clan B. c(A) is the father of B.

Question 9 **A**

This question involves deductions about family relationships in the Tarau system.

In that system a father A has children that are B, and fathers that are B marry women from A, so men in B marry women from the same clan as their fathers.

Question 10 **B**

This question involves deductions about family relationships in the Kariera system.

In the Kariera system, an individual of clan A has a father from clan B, and that father, as a child of clan B, had a father from clan A. Hence a child is in the same clan as their grandfather.

Unit 3

The questions about this apparently simple poem require the candidate to identify what is implied about the relationship between the animal and human worlds and the feelings of the speaker.

Question 11 **C**

In this question candidates must interpret the mood created by the first few lines of the poem. Each of the options given has negative connotations but the candidate must work out which best reflects the mood that is being conveyed. The words 'savage' and 'the blood beat up the stairs' suggest menace rather than uncertainty, and there are no moral overtones to the statements. The strong declarative statements and distinctive rhythm imply certainty rather than doubt, while 'tense' is not potent enough to capture the implications of violence.

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Question 12 **A**

Here candidates are asked to recognise the imperatives driving the inhabitants of both the human and animal worlds. In the animal world, 'blood must flow and teeth must grip'. The same moonlight that 'drags the owl upon its prey' also brings humans 'lip to lip'. The human kiss is accompanied by the 'blood throb to death'. Option **D** is wrong because the poem as a whole is about the similarities. not the differences, between the two worlds. **B** is wrong for the same reason but also because both the cub and the human infant are 'trapped'. **C** is wrong because this world is dark at all levels, not simply beneath the surface. There is no evidence of serenity of any kind.

Question 13 **B**

'The pleasure's done', coming as it does after a sexual coupling, suggests an act devoid of affection or mutual love. The words suggest satiation leading to depletion rather than potency, ecstasy or passion. Hedonism implies an abandonment to pleasure but the 'pleasure' in the poem is circumscribed by violence.

Unit 4

These questions are concerned with the interpretation of proverbs.

Candidates need to understand the ideas and attitudes expressed in the proverbs. The interpretation often involves construing metaphors and analogies.

Question 14 **C**

This question requires consideration of five proverbs which comment on death. The given proverb is: Let all live as they would die. This proverb implies that one should live as one would wish to die, and this is related to alternative **C** that a good life makes a good death.

Alternative **A** is about death and age, alternatives **B** and **D** are about the fear of death.

Question 15 **C**

This question requires a consideration of five proverbs which comment on death. The given proverb is: Death keeps no calendar. Selection of the correct answer in this question hinges on understanding that in devouring lambs, death is not following the expected chronological process of attacking only the old, and thus age (symbolised by the calendar) is irrelevant to death.

Question 16 **D**

This question requires a consideration of five proverbs which comment on the idea of danger. The given proverb is: Vows made in storms are forgotten in calms. Selection of the correct answer, **D**, hinges on understanding that the given proverb expresses a belief that feelings or commitments made at a time of danger (a storm) are only transitory and thus will vanish when the danger has passed (the calm). **D** is the only alternative that suggests commitments made during a time of danger are fragile.

Question 17 **A**

The four proverbs in this question are about the dangers inherent in being great, and they imply that greatness has negative consequences. Alternatives **B**, **C** and **D** are about the difficulties of achieving greatness.

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Unit 5

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The passage is drawn from John Stuart Mill's classic essay in political philosophy, *On Liberty*. The e… with the problem of protecting freedom of thought within a democracy and offers for modern readers a pe… on contemporary concerns about political correctness. The unit tests the ability of candidates to interpret ve… complex prose, to analyse an argument and to identify some of its implications.

Question 18 **B**

This question asks candidates to summarise the passage by identifying the focus or tendency of Mill's argument. The correct answer is a version of the end of the passage, in which Mill writes that it is essential to find the 'limit to the legitimate interference of collective opinion with individual independence' (lines 28–29).

Question 21 **D**

Candidates are asked in this question to define a relatively common word within a particular context. The difficulty lies in the complex syntax of the sentence under consideration. Mill implicitly contrasts the 'inclination' of the traditional ruling class with the 'intelligence' of thinkers, but the inference to be drawn is not that the former are stupid. Rather, while 'thinkers' are motivated by reason in wanting to restrict the tyranny of the majority, the 'important classes' are motivated by self-interest ('real or supposed interests').

Question 23 **A**

To answer this question candidates need first to have understood the distinction Mill draws between social tyranny and political oppression within the context of democratic government. In lines 19–22, it is argued that the particular danger of social tyranny, the pressure of public opinion, is that it 'penetrates … deeply into the details of life'. Although it is clearly true, as alternative **C** suggests, that social tyranny deflects democracy from its aim of serving the people, Mill's focus is on the kind of threat posed to individual liberty, rather than on a defence of the aims of institutionalised democracy.

Question 24 **A**

The passage draws careful distinctions between the kinds of power which a democracy legitimately exercises over its members, and those which illegitimately encroach on an individual's freedom. In this question candidates need to identify accurately the balance Mill recommends. The lines referred to in the question state that there are some areas of life in which society as a whole should not meddle; by implication there are some areas of life on which collective opinion can legitimately impose itself; thus alternative **B** is ruled out. This position is reinforced in the last sentence of the passage.

Question 25 **D**

This question demands an understanding of the concepts Mill discusses in the second paragraph of the passage, and the ability to apply the concepts by distinguishing a case which exemplifies tyranny over thought and feeling. Alternative **D**, in offering a case which affords the potential for suppressing opinions at odds with reigning ideologies, falls into the category of social oppression which Mill finds objectionable.

Unit 6

This passage is the opening of *The Aunt's Story*, a novel by Patrick White. It introduces Theodora, a spinster who has lived with her ageing mother, and her married sister, Fanny, who had not lived with them in latter years. The mother of the sisters has just died, and the passage records Theodora's and Fanny's reactions to her death. The unit involves interpretation of some moderately difficult language and some sophisticated nuances. Candidates have to understand the implied reactions of the characters, and recognise the implicit evaluations of the characters made by the writer.

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Question 30 **C**

The first sentence of the novel implies that the death of her mother had been long awaited by Theodora, but she is 'surprised by the accomplished as opposed to the contemplated fact'. The question asks about the nature and source of Theodora's surprise that is recorded in the second paragraph. It draws on the cues asked about in the preceding questions that suggest Theodora has been oppressed by the life with her mother, and that she has expected a kind of release with her mother's death.

The first alternative in this question is at odds with the implications of the opening statement of the passage that Theodora had been waiting for the death of her mother. The second alternative is at odds with the suggestions about the difficulty of living 'with Mrs Goodman in her latter years' and the feeling that Theodora 'could not mourn' offered at the end of the passage. It was not the event of her mother's death that surprised Theodora but the fact that 'everything seemed to have changed' in a way she had not expected.

Question 31 **A**

This question asks candidates to construe the phrase 'Last Glimpses' attributed to Fanny and the kind of feeling it betokens. The passage indicates that Fanny, unlike Theodora, did not take care of her mother in the last years of her life. She was concerned about 'Dear Mother' from a 'moral distance', and it is suggested in the passage that Fanny's reactions are superficial and sentimental rather than tender, respectful or refined.

Question 33 **B**

This question asks for a comparison of the writer's reactions to Fanny and Theodora. After a description of the sentimental and superficial view of her mother Fanny cultivates from a distance, the writer gives a sympathetic picture of Theodora's situation living with her mother.

Theodora's reactions to her mother's death seem rather impersonal and detached. It had been difficult to cope with her mother, and while Theodora does not celebrate her mother's death, she does not indulge in the sentimental effusions that Fanny does. The writer offers a sense that Theodora's reactions are 'a genuine response to the experience she has had' rather than a superficial, hysterical or hypocritically compassionate one.

Question 35 **D**

The final question asks for a global overview of the writer's reactions to Theodora in the passage as a whole. It requires a recognition that the writer is sympathetic to and understanding of Theodora's negative reactions to looking after her ageing mother, and that the writer recognises that such feelings were legitimate, and respects the tight knotted feelings that prevent her mourning her mother's death.

Written Communication

The Written Communication section of *GAMSAT* assesses writing ability with a special emphasis on the thoughts and ideas contained in candidates' written responses.

There are two separate pieces of writing (Task A and Task B) to be completed in one hour. Task A deals with current affairs issues and calls for expository and argumentative writing. Task B deals with more interpersonal issues and calls for personal and discursive writing.

Each test provides a theme and a number of topics relating to that theme. Candidates must write on one of the provided topics, but these are phrased generally and candidates may respond to the topic in a variety of ways. However, the piece of writing must address the topic set. If a response is only minimally or spuriously related to the topic it will be penalised.

Performances on the Written Communication section of *GAMSAT* are assessed against established criteria. Markers take into account both the quality of a candidate's thinking about a topic and the control of language demonstrated

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Reasoning in Biological and Physical Sciences

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Unit 1

This unit requires comprehension and application of text and graphical information related to biomedical information. Basic knowledge of the heart, cardiac cycle and pulse would be useful.

Question 1 **A**

According to the information provided, before being put on the combination diet, the high normal person would be expected to have a systolic pressure of 130 (130/80). The graph indicates that when such a person is changed to a combination diet (II), their systolic pressure would decrease by 6 mm Hg, so **A** is the best estimate.

Question 6 **B**

According to the information provided, a mild hypertensive on a normal diet would be expected to have a blood pressure of 150/95. With a cuff pressure of 140, the systolic pulse due to the heartbeat would be have a pressure strong enough to be heard once during each cycle.

Unit 2

This unit requires candidates to solve three problems dealing with a composite mechanical system. The unit tests candidates' ability to apply the principle of conservation of mechanical energy (for a conservative gravitational field) when one or more parts of the system are free to move as a result of the action of the gravitational force. Candidates are expected to be able to recall formulas for the potential energy of a body in the gravitational field and the kinetic energy of the body in motion. They are also expected to locate the centre of mass of a spherical object and to use this in calculation of changes of gravitational potential energy.

Question 9 **A**

In this case, the slide-slot is free to move as the ball slides down its curved surface from point R to point T. The slide-slot moves horizontally gaining kinetic energy while there is no change in its gravitational potential energy. The ball slides 'downwards' gaining kinetic energy and losing gravitational potential energy. The gravitational potential energy lost by the ball must equal the sum of the kinetic energies gained by the ball and the slide-slot. So the total mechanical energy of the ball is reduced (by an amount equal to the gain in kinetic energy of the slide-slot).

Unit 4

This unit requires inferences to be made on the basis of the text and graphical information provided that is related to a biological context. Quantitative reasoning is required in order to deal effectively with some items. A basic understanding of metabolism and respiration would be useful.

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Question 14 **B**

Figure 1(a) gives information for a water temperature of 15 °C. Line 3 on Figure 1(b) at 15 °C corresponds to an uptake of oxygen of about 250 mg/kg/h, which corresponds to a speed of about 40 cm/s on Figure 1(a).

Question 16 **B**

When X is the temperature corresponding to **M** (i.e. 15 °C), the uptake of oxygen is about 950 mg/kg/h. At a temperature 10 °C lower, the uptake of oxygen is about 550 mg/kg/h. Q_{10} is therefore about 1.7, which is higher than for the other options.

Unit 5

This unit requires candidates to comprehend and apply the information given concerning the production of β-hydroxyacids. It is assumed that candidates are aware of basic organic chemistry and the naming of simple organic compounds.

Question 17 **C**

The first dot point indicates that the a-bromo-compound must be an ester, not an acid. Hence, R ≠ H. A comparison of the structure of 3-hydroxybutanoic acid HOOC-CH_2-CH(OH)-CH_3 and the general formula given in Figure 1 HOOC-CHR′-C(OH)R″-R‴ means that R′ = H and that of the two groups attached to the third C - R″ and R‴ - one must be H while the other is CH_3.

Question 19 **B**

The reaction in Figure 1 shows that the hydroxy group appears on the third C atom in the hydrocarbon chain. Under the IUPAC nomenclature system, this reaction can only produce 3-hydroxycarboxylic acids. The colloquial names took into account the fact that the first C atom in the chain – the C in the COOH group – could not have any group attached to it.

Question 20 **A**

The structure of 3-hydroxy-4-ethylhexanoic acid is HOOC-CH_2-CH(OH)-CH(CH_2-CH_3)-CH_2-CH_3. A comparison with the general formula means that R′ = H, R″ = H and R‴ = CH(CH_2-CH_3)-CH_2-CH_3. As R′ = H, the first reactant can be any bromoacetate ester (ROOC-CH_2Br). As R″ = H, the second reactant must be an aldehyde not a ketone; in fact, it is 2-ethylbutanal (CH_3-CH_2-CH(CH_2-CH_3)-CHO).

Question 21 **D**

In these reactants, R′ = H, and both R″ and R‴ = CH_3. Thus, the product is HOOC-CH_2-C(OH)(CH_3)-CH_3, which has the IUPAC name of 3-methyl-3-hydroxybutanoic acid.

Unit 6

This unit requires candidates to determine the relative positions of the images of four beads on two screens, as would be seen by an observer, when light rays from the beads pass through a thin converging lens. The problem is stated verbally with reference to an illustration. Candidates are expected to understand the geometrical properties involved in image formation by thin converging lenses.

Question 22 **D**

One strategy for solving the problem posed is to use geometric principles, in which imaginary rays are traced from the objects, through the lens, to the images of the objects formed on the screens. By extrapolating from the familiar case of two-dimensions to the case of three-dimensions, and by recognising that a converging lens causes lateral inversion between object and image (which can be easily verified by ray tracing in two-dimensions), candidates should be able to deduce that the observer would see the image of the green bead either at position 2 or position

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Unit 7

This unit requires candidates to apply basic rules related to genetic crosses to assess the value o
hypotheses.

Question 25 **A**

The Japanese flounder are LL. The west coast flounder have equal proportions of L and R so the cross is equivalent to LL × LR (note that LL × LL plus LL × RR is equivalent to LL × LR). The result is 1 LL: 1 LR. Since half the LR flounder are left-eyed, the answer is 3 left-eyed to 1 right-eyed.

Question 26 **D**

The following crosses would produce the result:

I $\ell\ell \times \ell\ell$

II LL × RR

III $L\ell \times \ell\ell$

Unit 8

This unit assesses candidates' knowledge of basic electrical circuit concepts. It requires candidates to apply Ohm's Law and the laws governing resistors in series and parallel to simple circuits.

Question 27 **A**

Let the cell in each circuit supply a voltage of V and let the resistance of each globe be R. The total resistance in the first circuit is $R/2$, the current flowing from the cell is $2V/R$ and so the current in each globe is V/R. The total resistance in the second circuit is $2R$, the current flowing from the cell is $V/2R$ and so the current in each globe is $V/2R$. The total resistance in the third circuit is $3R/2$ $(R+R/2)$, the current flowing from the cell is $2V/3R$ and so the current in globe **III** is $2V/3R$ while in globe **IV** it is $V/3R$. The globe through which the greatest current flows will be the brightest so the brightest globe is **I**.

Unit 11

This unit requires candidates to interpret verbal and graphical material. The context is that of general biology. A feature of the unit is the necessity to translate a verbal description into graphical form.

Question 34 **A**

The passage states that the egg tooth is a common device for escaping from the egg; however, the brush turkey primarily uses its large feet to break free. The other options are specific adaptations.

Question 35 **D**

If the temperature falls below the incubation temperature, heat production exceeds heat loss, so that temperature rises again (and vice versa).

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Unit 12

This unit requires candidates to apply Henderson's equation to indicators. Simple calculations relate pK_a values to the pH and colours of solutions and to the concentrations of the acid and base forms of the indicators.

Question 36 **D**

From the colours of the indicators in the first and second test tubes, the pH of the solution can be determined to be 9.0. As the thymolphthalein has a pK_a that is about the same as this pH value, there will be approximately equal concentrations of the acid and base forms. Therefore, the colour in the third test tube will be a mixture of the colours of the acid and base forms of thymolphthalein, i.e. the colour will be closest to green.

Question 37 **C**

As the range of the ratio [In]/[HIn] is from 10 to 0.1, the colour change will occur over the range from $\log_{10}10$, i.e. +1.0, to $\log_{10} 0.1$, i.e. –1.0, a range of 2.0.

Question 38 **D**

The ratio $[In^-]/[HIn]$ for the two indicators bromothymol blue and neutral red can be determined from the differences of the pH and the pK_a values. For bromothymol blue, this difference is positive (+ 0.3), so the ratio $[In^-]/[HIn]$ must be greater than 1, i.e. $n > m$. Similarly, a negative difference for neutral red means a ratio less than 1, so $r > s$. As the differences have the same magnitude (0.3) but opposite sign, the ratios must be reciprocals (2/1 and 1/2 respectively). This means that $m = s$ and $n = r$.

Unit 13

This unit deals with wave properties of an electromagnetic wave which crosses a boundary between two media. It assesses candidates' knowledge of basic principles and their ability to recall formulas that relate frequency, velocity and wavelength of an electromagnetic wave to the refractive index of a medium through which the wave passes.

Question 39 **C**

For the two media, the following equations hold:

$$v_1 = f\lambda_1 \qquad v_2 = f\lambda_2$$

and

$$n_1 = \frac{c}{v_1} \qquad n_2 = \frac{c}{v_2}$$

where c is the speed of the electromagnetic wave in a vacuum and v_1 and v_2 the speeds in the two media. The frequency of the electromagnetic wave is determined by its source and is unaffected by the medium through which it passes. From the above relations

$$\lambda_1 = \frac{n_2}{n_1}\lambda_2$$

Consequently, if $n_1 > n_2$, then $\lambda_1 < \lambda_2$, while $f_1 = f_2$.

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Unit 15

This unit requires candidates to understand the thermodynamic terms Gibbs free energy, enthalpy and e
to apply these to two chemical reactions.

Question 42 **A**

As the temperature is in Kelvin, T is always positive. For the shrinking reaction to occur spontaneously only above a certain temperature, the Gibbs free energy change (ΔG) must be negative only above that temperature. This can occur only if both ΔS and ΔH are positive. Alternatively, as heat is needed to cause the poly(ethene) to shrink, the reaction must be endothermic, i.e. ΔH is positive. The molecules of poly(ethene) will be more tangled and so less ordered when they contract and shrink, i.e. ΔS is also positive.

Question 43 **D**

As the dissolving of KNO_3 is endothermic, the crystallisation reaction must be exothermic, i.e. ΔH is negative. The ions in a crystal are much more ordered than the ions in a solution, i.e. ΔS is also negative.

Unit 16

This unit requires candidates to understand the meanings of forces and torques, to be able to resolve forces and to determine the magnitude of resultant forces.

Question 44 **C**

The torque downwards is the product of the man's upper body weight (420 N) and the distance from the spine's pivot ($0.6L$). This must be balanced by the product of the vertical component of the torque of the back muscles ($T\sin\theta$) and the distance from the spine's pivot ($0.7L$). Hence, $420 \times 0.6L = T\sin\theta \times 0.7L$.

Question 45 **A**

The magnitude of a vector can be determined from its components calculated along perpendicular directions, $R = \sqrt{R_{horizontal}^2 + R_{vertical}^2}$. The sum of all forces in each of these two directions must be zero as the spine's pivot point is in equilibrium. The only other horizontal force is a component of force T, $T\cos\theta$, which is acting in the opposite direction to R. Hence, $R_{horizontal} = -T\beta$. There are two other vertical forces, W acting downwards and $T\sin\theta$ acting upwards. Hence, $R_{vertical} + T\sin\theta - W = 0$ and so $R_{vertical} = 420 - T\alpha$. Thus, the magnitude of R is $\sqrt{T^2\beta^2 + (420 - T\alpha)^2}$.

Question 46 **D**

The torque downwards is due to both the man's upper body weight ($420 \times 0.6L$) and the weight of the box ($280 \times L$). This must be balanced (as in question 44) by the torque of the back muscles ($T\sin\theta \times 0.7L$). Hence, $420 \times 0.6L + 280 \times L = T\sin\theta \times 0.7L$.

Question 47 **C**

If the man keeps his spine vertical, then the weight of his upper body, 420 N, is directly over his spine's pivot. By making sure that the 280 N weight of the box is also almost directly over the spine's pivot as well when the box is lifted, the total force on the spine will be closest to the sum of these two forces.

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Unit 17

This unit requires candidates to make deductions related to a metabolic pathway presented in diagrammatic form. It assumes elementary knowledge about enzymes and metabolic pathways.

Question 50 **D**

The enzyme affected must be either E_2 (which is affected by arg-12), the enzyme involved in the conversion of glutamic acid to N-acetylglutamic acid, or an enzyme affected by arg-4, arg-5 or arg-6. Of the alternatives given, only option **D** presents a logical choice.

Unit 18

This unit requires candidates to understand how the position of an equilibrium affects the value of the equilibrium constant and the notation used to refer to these constants.

Question 51 **A**

As $pK = -\log_{10}K$, the higher the value of K, the lower the value of pK. Further, as there are competing equilibria, the smaller the basicity constant, the larger is the related conjugate acidity constant.

Unit 20

This unit requires candidates to comprehend and apply the information given concerning the reaction of alcohol dehydrogenase (ADH). It is assumed that candidates are aware of basic organic chemistry and the naming of simple organic compounds.

Question 53 **A**

The information states that hydrogen atoms are removed from the first carbon atom of the hydrogen chain and from the alcohol group. The oxidation number of combined hydrogen is generally +1 so the removal of hydrogen atoms is equivalent to oxidation.

Question 54 **B**

The removal of two hydrogen atoms from 2-butanol (CH_3-CH_2-CH(OH)-CH_3) will produce methylethylketone (CH_3-CH_2-CO-CH_3) which has the IUPAC name of butanone.

Question 55 **C**

Both primary and secondary alcohols have a hydrogen atom attached to the carbon atom to which is also attached the alcohol (-OH) group and so both can react with ADH. Primary alcohols will produce aldehydes while secondary alcohols will produce ketones. Tertiary alcohols do not have such a hydrogen atom and so cannot react with ADH. The statement that is **not** correct is **C**.

Unit 21

This unit requires candidates to understand the effect of temperature on the equilibrium constant involved with the self-ionisation of water and to interpret the definitions of an acid and a base.

Question 56 **A**

The self-ionisation of water will produce equal concentrations of H^+ and OH^- ions and so will always be neutral. At 60 °C, the concentrations will be 3.2×10^{-7} M and so the pH will be less than 7. In fact, as $[H^+] = [OH^-]$ and

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Answers to all Questions

Reasoning in Humanities and Social Sciences

1	**A**	13	**B**	25	**D**
2	**C**	14	**C**	26	**C**
3	**B**	15	**C**	27	**D**
4	**C**	16	**D**	28	**D**
5	**D**	17	**A**	29	**B**
6	**B**	18	**B**	30	**C**
7	**C**	19	**A**	31	**A**
8	**B**	20	**C**	32	**D**
9	**A**	21	**D**	33	**B**
10	**B**	22	**C**	34	**A**
11	**C**	23	**A**	35	**D**
12	**A**	24	**A**		

Reasoning in Biological and Physical Sciences

1	**A**	21	**D**	41	**B**
2	**B**	22	**D**	42	**A**
3	**B**	23	**C**	43	**D**
4	**A**	24	**C**	44	**C**
5	**D**	25	**A**	45	**A**
6	**B**	26	**D**	46	**D**
7	**C**	27	**A**	47	**C**
8	**C**	28	**B**	48	**D**
9	**A**	29	**A**	49	**A**
10	**D**	30	**C**	50	**D**
11	**D**	31	**D**	51	**A**
12	**C**	32	**A**	52	**C**
13	**B**	33	**C**	53	**A**
14	**B**	34	**A**	54	**B**
15	**D**	35	**D**	55	**C**
16	**B**	36	**D**	56	**A**
17	**C**	37	**C**		
18	**B**	38	**D**		
19	**B**	39	**C**		
20	**A**	40	**C**		

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