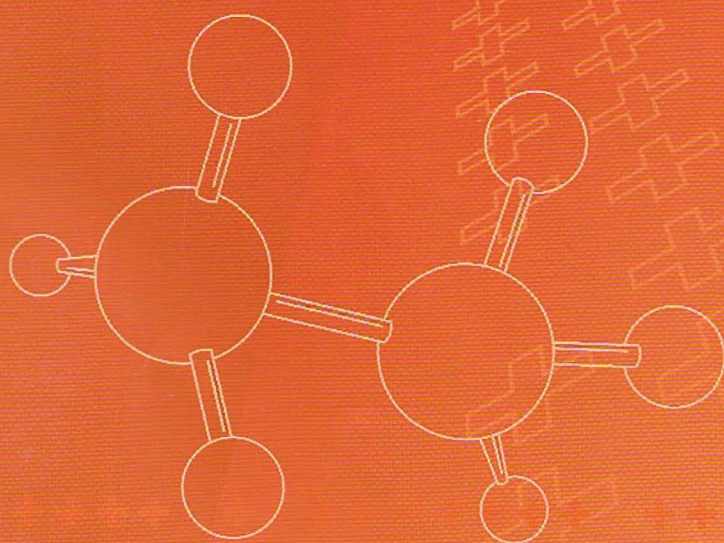


GAMSAT

**Graduate Australian
Medical School Admissions Test**



Practice Questions

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1 Introduction

GAMSAT Practice Questions contains examples of the kind of materials and questions you can expect in the *Graduate Australian Medical School Admissions Test* (GAMSAT). Advice on how you can prepare for the test, as well as information on registration procedures, testing date and test centres are provided in the *GAMSAT Information Booklet*, available from the website below:

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Items contained in *GAMSAT Practice 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 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 techniques of arriving at the answers.

To help you appreciate the kinds of reasoning involved in GAMSAT, solutions to all of the questions are presented on pages 51–57, and pages 59–66. 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 67.

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 for GAMSAT are provided on page 58.

2 Reasoning in Humanities and Social Sciences

UNIT 1

Questions 1 – 5

Sandpiper

The roaring alongside he takes for granted,
and that every so often the world is bound to shake.
He runs, he runs to the south, finical, awkward,
in a state of controlled panic, a student of Blake.

The beach hisses like fat. On his left, a sheet
of interrupting water comes and goes
and glazes over his dark and brittle feet.
He runs, he runs straight through it, watching his toes.

5

—Watching, rather, the spaces of sand between them,
where (no detail too small) the Atlantic drains
rapidly backwards and downwards. As he runs,
he stares at the dragging grains.

10

The world is a mist. And then the world is
minute and vast and clear. The tide
is higher or lower. He couldn't tell you which.
His beak is focussed; he is preoccupied.

15

looking for something, something, something.
Poor bird, he is obsessed!
The millions of grains are black, white, tan, and grey,
mixed with quartz grains, rose and amethyst.

20

Elizabeth Bishop

- 1 According to the poem, the sandpiper regards the sea as
- A a threat.
 - B untroubling.
 - C distracting.
 - D the source of life.

- 2 To the speaker, the sandpiper first appears
- A a symbolic figure connecting land and sea.
 - B distracted and disturbed by the surroundings.
 - C at the interface between real and mythical worlds.
 - D disconcertingly unaware of the larger surroundings.
- 3 The impression that the sandpiper is 'in a state of controlled panic' (line 4) is reinforced through
- A the regular rhyme of the second and fourth lines of each stanza.
 - B images of the sea's magnitude such as 'The roaring alongside' and 'a sheet of interrupting water'.
 - C repetition of words and phrases such as 'He runs, he runs' and 'something, something, something'.
 - D the effect of uncertainty conveyed in lines 8 and 9:
 'watching his toes.
 —Watching, rather...'
- 4 In the allusion to the poet Blake in line 4 and the description of the sandpiper's reaction to the surrounding world, the poem seems to be suggesting
- A that the poetic spirit is an engulfing power.
 - B an association between creative intensity and obsessiveness.
 - C the capacity of the great artist to be uniquely inspired by nature.
 - D that great genius becomes petty and crazy in a lesser incarnation.
- 5 Which one of the following comments about Elizabeth Bishop's poetry best characterises the particular quality of 'Sandpiper'?
- 'Sandpiper' features
- A 'shifts of physical scale'.
 - B 'the engulfing power of the world'.
 - C 'the dignified frailty of a human observer'.
 - D 'long perspectives of time which dwarf the merely human'.

UNIT 2

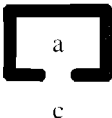


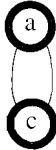
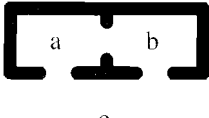
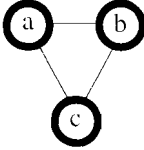
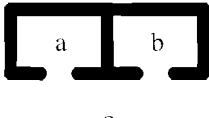
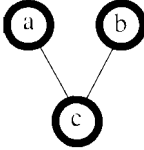
Questions 6 – 11

Architecture can be considered to be a method for controlling the way in which people within a society move through space. This control is not exercised at random, but responds to social needs, and to this extent is consistent and logical within any given society.

Walls serve to create socially meaningful spaces, and at the same time act as barriers to deny access to them. Portals/doorways, on the other hand, are controllable breaches within barriers that can deny or facilitate access to social spaces. Analysis of buildings in terms of access and denial, of barriers and breaches, has the potential to provide information on how societies order their built environment to achieve their social aims.

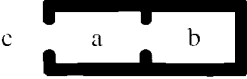

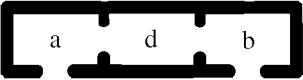
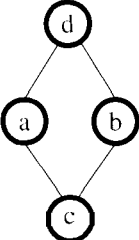
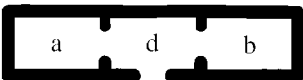
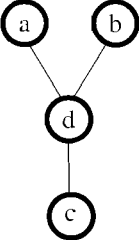
The following diagram suggests a model for such an analysis. On the left is a series of spatial systems (i.e. buildings) shown in plan, each composed of one or more spatial units (i.e. rooms: a, b and d). Each spatial unit is defined by walls (solid lines) and doorways (gaps between lines). On the right-hand side is shown a series of so-called 'Gamma Maps',* which represent movement into and through the units of a spatial system. The area outside each spatial system is considered, for purposes of the argument, to be a homogeneous space, c.

* The term 'gamma' is arbitrary.

SPATIAL SYSTEMS	GAMMA MAPS
	
	
	
	

SPATIAL SYSTEMS

GAMMA MAPS

Relations between three associated spaces are described in the following terms:

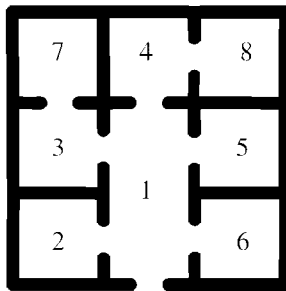
- *symmetrical* if [a is to b] as [b is to a] with respect to c;
- *asymmetrical* if [a is not to b] as [b is to a] with respect to c;
- *distributed* if there are two or more routes from a to b (any of which may pass through c); and
- *nondistributed* if any route from a to b must pass through some other space.

6 Which one of the following assumptions underlies the formulation of Gamma Maps?

- A All portals provide unqualified access to a spatial unit.
- B Some spatial units have more social meaning than others.
- C Issues of access and denial are solved only to a limited extent by architecture.
- D The functions of spatial units are determined by their symmetry and distributedness.

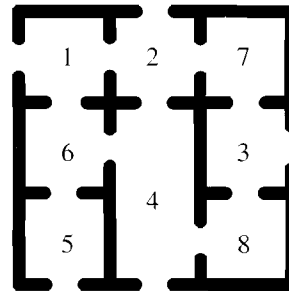
Questions 7 and 8 refer to the four building plans shown below. Each question presents a social situation. You are asked to match the plans (or rooms within each plan) to the specific situation.

I



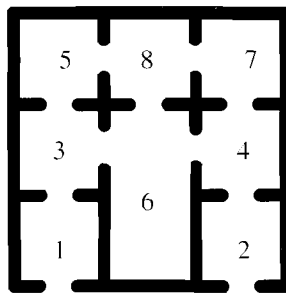
9

III



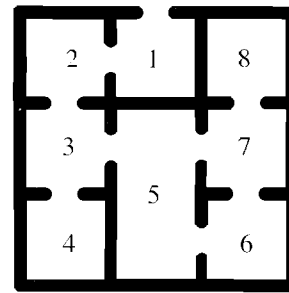
9

II



9

IV



9

- 7 The wife is matriarch of the household, in a society where power and privilege are inversely proportional to accessibility.

Which one of the following rooms is most likely to be the wife's bedroom?

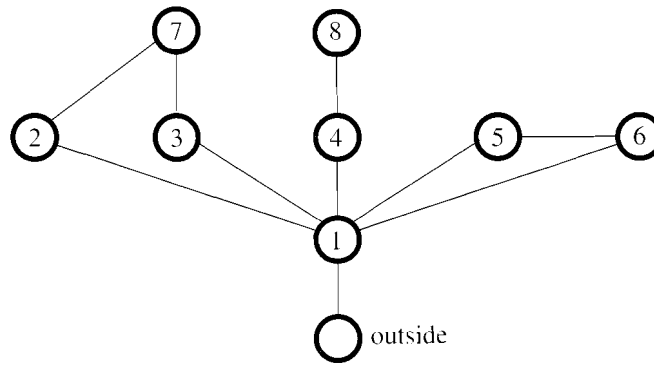
- A IV.6
- B III.5
- C II.1
- D I.1

- 8 At the local hospital, patients are first registered, then screened into casualty and emergency cases. The casualties are examined, given a prescription and sent on their way; the more seriously ill casualties are directed to a large room to await specialist treatment. The emergency patients are given intensive treatment before being prepared for speedy removal by ambulance to the central hospital. Doctors must at all times be accessible to both casualties and emergency patients.

Which building best caters to these organisational requirements?

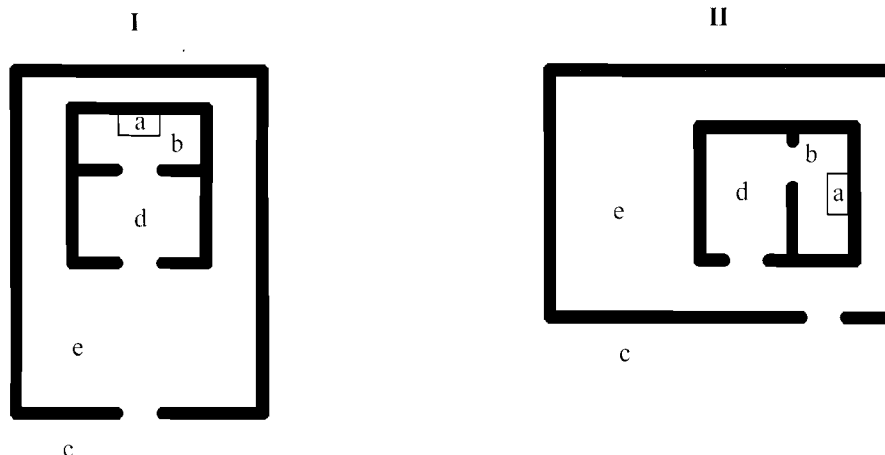
- A I
- B II
- C III
- D IV

Question 9 refers to this Gamma Map:

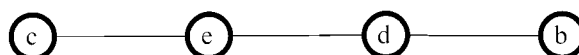


- 9 Which one of the following descriptions best fits the relationship of Rooms 8 and 1 to Room 4?
- A symmetrical and distributed
 - B symmetrical and nondistributed
 - C asymmetrical and distributed
 - D asymmetrical and nondistributed

Questions 10 and 11 refer to the following ground plans of two religious sanctuaries.



Both sanctuaries can be represented by the same Gamma Map, viz.



- 10 What distinguishing feature of each sanctuary is apparent in the plans but not in the Gamma Map?
- A number of portals
 - B size of each sanctuary
 - C relative sizes of portals
 - D relative positions of portals
- 11 Which of the following social situations is revealed by neither the plans nor the Gamma Map?
- A Only the high priest may enter the 'holy-of-holies'.
 - B To look directly upon the face of god is a grievous sin.
 - C The goddess looks out with benevolence over her people.
 - D There is a 'sacred distance' between people and their gods.

UNIT 3

Questions 12 – 14

The following definitions come from a book called The Devil's Dictionary, which looks cynically at the human condition.

- 12 Impartial, *adj.*** Unable to perceive any promise of personal advantage from espousing either side of a controversy or adopting either of two conflicting opinions.

The definition suggests that being impartial is a sign of

- A** indecision.
- B** lack of insight.
- C** lack of interest.
- D** lack of prejudice.

- 13 Marriage, *n.*** The state or condition of a community consisting of a master, a mistress and two slaves, making in all, two.

The definition suggests that in marriage

- A** we see a microcosm of society.
- B** the stronger partner dominates the weaker.
- C** each partner dominates and oppresses the other.
- D** men have licence to dominate and oppress women.

- 14 Obstinate, *adj.*** Inaccessible to the truth as it is manifest in the splendour and stress of our advocacy.

The definition implies that an obstinate person is one who

- A** is not persuaded by us.
- B** does not recognise the truth.
- C** listens to words rather than meanings.
- D** lacks insight into their own motivation.

UNIT 4

Questions 15 – 21

Pudovkin and Eisenstein were Russian film directors in the 1920s and 1930s. Below are extracts adapted from their comments on film and film editing.

COMMENTS BY PUDOVKIN

The foundation of film art is editing.

To show something as everyone sees it is to have accomplished nothing.

To the film director each shot of the finished film subserves the same purpose as the word to the poet.

Only by conscious artistic composition are the incidents and sequences pieced together from which emerges, step by step, the finished creation, the film. 5

The expression that the film is ‘shot’ is entirely false.

The film is not shot but built up from separate strips of celluloid that are its raw material.

Between the natural event and its appearance upon the screen there is a marked difference. It is exactly this difference that makes the film an art. Guided by the director, the camera assumes the task of removing every superfluity and directing the attention of the spectator in such a way that he sees only that which is significant and characteristic. 10

The film spectator is an ideal observer. And it is the director who makes him so.

Whereas the theatrical producer is not in a position to remove the mass of background from the view of the spectator and can only underline what he sees as the most essential elements, the film director makes the camera lens his spectator’s eye, and to create filmic form he selects those elements from which this form will later be assembled. 15

In the same way as the mathematician integrates dissected elements into a whole, so does the film director integrate these elements into a filmic image in accordance with that which exists in his head. 20

15 In Pudovkin’s view a film director most needs powers of

- A delegation.
- B theatricality.
- C discrimination.
- D technical expertise.

- 16 For Pudovkin the film spectator is 'ideal' (line 13) because his or her observations are
- A restricted and focused.
 - B objective and balanced.
 - C subjective and personal.
 - D critical and wide-ranging.
- 17 Pudovkin sees film as a
- A clarifying force.
 - B dramatic experience.
 - C means of entertainment.
 - D representation of reality.

COMMENTS BY EISENSTEIN

The shot is by no means an element of montage*.

The shot is a montage cell.

Just as cells in their division form a phenomenon of another order, the organism or embryo, so, on the other side of the dialectical leap from the shot, there is montage.

By what, then, is montage characterised and, consequently, its cell—the shot?

5

By collision. By the conflict of two pieces in opposition to each other. By conflict. By collision.

In front of me lies a crumpled yellowed sheet of paper. On it is a mysterious note: 'Linkage—P' and 'Collision—E.'

This is a substantial trace of a heated bout on the subject of montage between P (Pudovkin) and E (myself).

10

He loudly defends an understanding of montage as a linkage of pieces. Into a chain. Again, 'bricks'. Bricks, arranged in series to expound an idea.

I confronted him with my viewpoint on montage as a collision. A view that from the collision of two given factors arises a concept.

15

So, montage is conflict.

As the basis of every art is conflict (an 'imagist' transformation of the dialectical principle).

If montage is to be compared to something, then a phalanx of montage pieces, of shots, should be compared to the series of explosions of an internal combustion engine driving forward its automobile or tractor: for, similarly, the dynamics of montage serve as impulses driving forward the total film.

20

* Montage is the process in films whereby separate shots are edited and reassembled to create a whole.

- 18 Eisenstein views the constructed film as
- A a new form of modern art.
 - B a triumph of technology.
 - C an essential icon.
 - D a living force.
- 19 Eisenstein's theory of montage is that it should be
- A a defined poetic sequence.
 - B a means to creating film dynamic.
 - C an architectural arrangement of bricks.
 - D a mathematical integration of dissected elements.
- 20 Eisenstein considers that art communicates its essence chiefly by
- A enhancement.
 - B enchantment.
 - C contention.
 - D threat.
- 21 The crucial difference between Pudovkin's and Eisenstein's theories of montage in the passages centres on their perceptions of the
- A political value of the film.
 - B process of shooting.
 - C film as an art form.
 - D nature of the shot.

Questions 22 – 24

This passage is taken from a play. Carr (now old) is reminiscing about his time in Zurich in 1917, when he met James Joyce among people who became famous. In his mind he is writing his official memoirs and recalls the famous writer James Joyce, who wrote the novel Ulysses.

CARR: *Memories of James Joyce ... It's coming.*

To those of us who knew him, Joyce's genius was never in doubt. To be in his presence was to be aware of an amazing intellect bent on shaping itself into the permanent form of its own monument – the book the world now knows as Ulysses! Though at that time we were still calling it (I hope memory serves) by its original title, *Elasticated Bloomers*.

5

A prudish, prudent man, Joyce, in no way profligate or vulgar, and yet convivial, without being spend-thrift, and yet still without primness towards hard currency in all its transmutable and transferable forms and denominations, of which, however, he demanded only a sufficiency from the world at large, exhibiting a monkish unconcern for worldly and bodily comforts, without at the same time shutting himself off from the richness of human society, whose temptations, on the other hand, he met with an ascetic disregard tempered only by sudden and catastrophic aberrations – in short, a complex personality, an enigma, a contradictory spokesman for the truth, an obsessive litigant and yet an essentially private man who wished his total indifference to public notice to be universally recognised – in short a liar and a hypocrite, a tight-fisted, sponging, fornicating drunk not worth the paper.

10

15

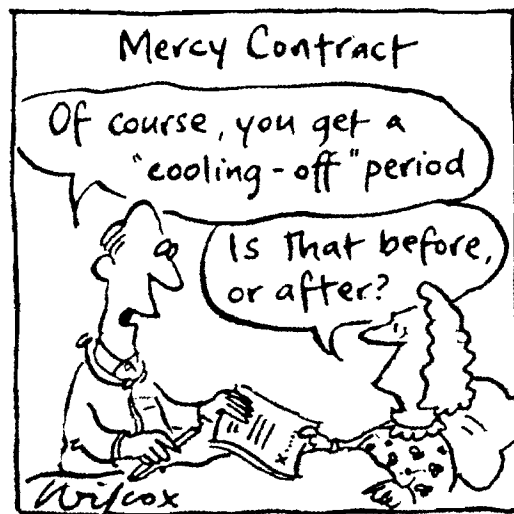
- 22 Carr's description of Joyce as being 'without primness towards hard currency' (line 8) is a polite way of saying that he was
- A squeamish about money.
 - B not squeamish about money.
 - C not at all interested in money.
 - D more interested in honour than in money.
- 23 'An essentially private man who wished his total indifference to public notice to be universally recognised' (lines 15–16) suggests that to Carr, Joyce was
- A other-worldly and indifferent to fame.
 - B pretentious and attention-seeking.
 - C affected adversely by publicity.
 - D suffering from social phobia.
- 24 The passage suggests that Carr remembers Joyce with
- A less formality than pride.
 - B more affection than envy.
 - C less warmth than constraint.
 - D more rancour than pleasure.

UNIT 6

Questions 25 and 26

The following cartoons pertain to the Northern Territory's (N.T.) 1995 legislation permitting euthanasia (voluntary, assisted and pain-free life termination of terminally ill patients) under certain conditions.

One aspect of the N.T. Euthanasia Bill was its stipulation that a terminally ill patient, having requested life termination, be given a 'cooling-off' period of seven days in order to think carefully about the consequences, before a medical practitioner could act to fulfil the patient's request.



Cartoon I

25 Cartoon I might be interpretable in more than one way.

Consider the following four comments:

- I The complexities and sensitivities of euthanasia will be reduced to sterile legalese.
- II Terminally ill patients will have the full backing of the law in their quest to die with dignity.
- III The contractual nature of legalised euthanasia will diminish patients' freedom of choice and understanding.
- IV Legalised euthanasia is intended to protect the rights of doctors more than those of patients.

Which of these comments offer(s) a plausible interpretation of Cartoon I?

- A Comment I only
- B Comments II and III only
- C Comment IV only
- D Comments I and III only



Cartoon II

- 26 Cartoon II portrays in a generally negative light
- A the N.T. spokesperson only.
 - B the Southern States Moral Leaders only.
 - C both the N.T. spokesperson and the Southern States Moral Leaders.
 - D neither the N.T. spokesperson nor the Southern States Moral Leaders.

UNIT 7

Questions 27 – 33

Consider the following advice to rulers given by a fifteenth-century writer:

- I Everyone realises how praiseworthy it is for a ruler to honour his word and to be straightforward rather than crafty in his dealings; nonetheless, contemporary experience shows that rulers who have achieved great things have been those who have given their word lightly, who have known how to trick men with their cunning and who, in the end, have overcome those abiding by honest principles.
- II A ruler should have a flexible disposition. He should not deviate from what is good if that is possible, but he should know how to do evil if that is necessary.
- III It is far better to be feared than loved if you cannot be both; only endeavour to escape being hated.
- IV A person who wants to act virtuously in every way, necessarily comes to grief among so many who are not virtuous.
- V It cannot be called prowess to kill fellow citizens, to betray friends, to be treacherous, pitiless and irreligious. These ways can win a ruler power but not glory.

27 The advice offered by the writer is

- A moral.
- B utopian.
- C humane.
- D pragmatic.

28 The writer suggests that citizens and subjects are

- A conservative and compliant.
- B indifferent and apathetic.
- C gullible and unreliable.
- D loyal and law-abiding.

- 29 Which one of the following proverbs underlies the writer's advice?
- A Set good against evil and you need never fear.
 - B Never do evil even if good may come of it.
 - C Judge a ruler's morality by his deeds.
 - D The intention excuses the action.
- 30 The advice given suggests that a key quality needed by a ruler is
- A intransigence.
 - B benevolence.
 - C astuteness.
 - D severity.
- 31 The danger for a ruler in incurring hatred implied by Comment III is that its force
- A is deleterious to personal prestige.
 - B weakens the state internationally.
 - C eliminates any pursuit of glory.
 - D is resistant to political control.
- 32 According to the comments, the writer sees honesty in politics as
- A the epitome of cynicism.
 - B laudable but creating vulnerability.
 - C prestigious and creating political capital.
 - D mostly disastrous but possibly naively effective.
- 33 The comments attest to the writer's
- A open acknowledgment of double standards.
 - B meretriciousness and equivocalty.
 - C scholarliness and erudition.
 - D bold social conscience.

UNIT 8

Questions 34 and 35

How to tie a fixed-loop knot for attaching lures to fishing lines

This is an excellent method of producing a loop in heavy monofilament leaders for attaching lures.

1. Tie a simple overhand knot in the leader and pass the tag through the eye of the lure.
2. Pass the tag through the overhand loop and around the main line forming a second loop.

3. Wrap the main line and one side of the second loop together with the tag.

4. Complete three or four wraps so that the tag protrudes from the second loop to form a 'water knot' or 'grinner'.

5. Close the grinner and the overhand knot and slide them together. The result is a secure, fixed loop.

Diagram 1

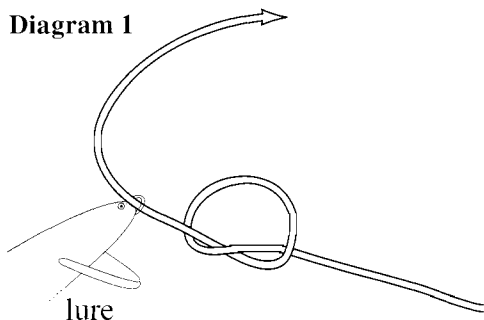


Diagram 2

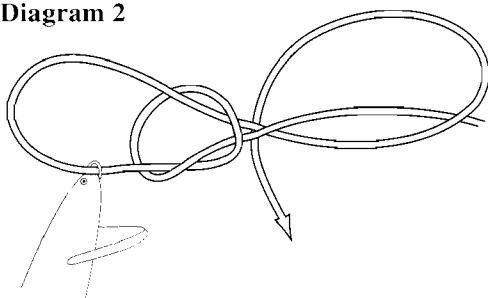


Diagram 3

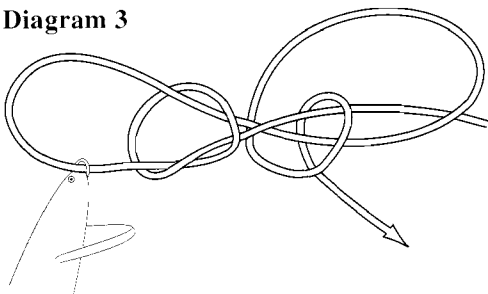


Diagram 4

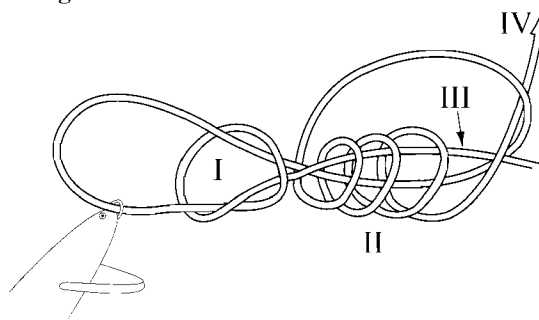
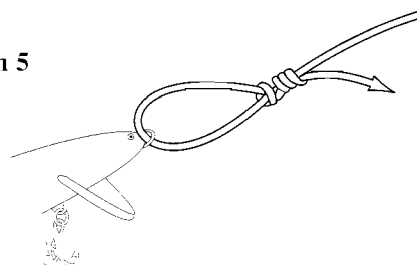


Diagram 5



34 Employment of a fixed-loop knot, in preference to any other kind of knot, is related most

- A the kind of lure used.
- B the kind of leader used.
- C the size of fish that one wants to catch.
- D whether one wants a fixed or movable loop.

35 In reference to Diagram 4, what do the parts labelled I, II, III, and IV respectively represent?

- A overhand loop, grinner, leader, main line
- B second loop, water knot, tag, main line
- C grinner, overhand loop, main line, tag
- D overhand loop, grinner, main line, tag

3 Written Communication

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 what you have to say in 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 attitude you express.

* * * * *

Technology is the science of arranging life so that one need not experience it.

Anonymous

The machine does not isolate man from the great problems of nature but plunges him more deeply into them.

Saint-Exupery

If there is technological advance without social advance, there is, almost automatically, an increase in human misery.

Michael Harrington

The new electronic interdependence recreates the world in the image of a global village.

Marshall McLuhan

Only science can hope to keep technology in some sort of moral order.

E.Z. Frieberg

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 what you have to say in 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 attitude you express.

* * * * *

The belief that youth is the happiest time of life is founded on a fallacy. The happiest person is the person who thinks the most interesting thoughts, and we grow happier as we grow older.

William Lyon Phelps

When I was a boy of fourteen, my father was so ignorant I could hardly stand to have the old man around. But when I got to be twenty-one, I was astonished at how much the old man had learned in seven years.

Mark Twain

The young suffer less from their own errors than from the cautiousness of the old.

Vauvenargues

It is better to waste one's youth than to do nothing with it at all.

Georges Courteline

A majority of young people seem to develop mental arteriosclerosis about forty years before the physical kind.

Aldous Huxley

4 Reasoning in Biological and Physical Sciences

UNIT 1

Questions 1 – 5

Figure 1 illustrates the circulation of the human fetus. Normally, at birth both the *ductus arteriosus* and the *foramen ovale* close.

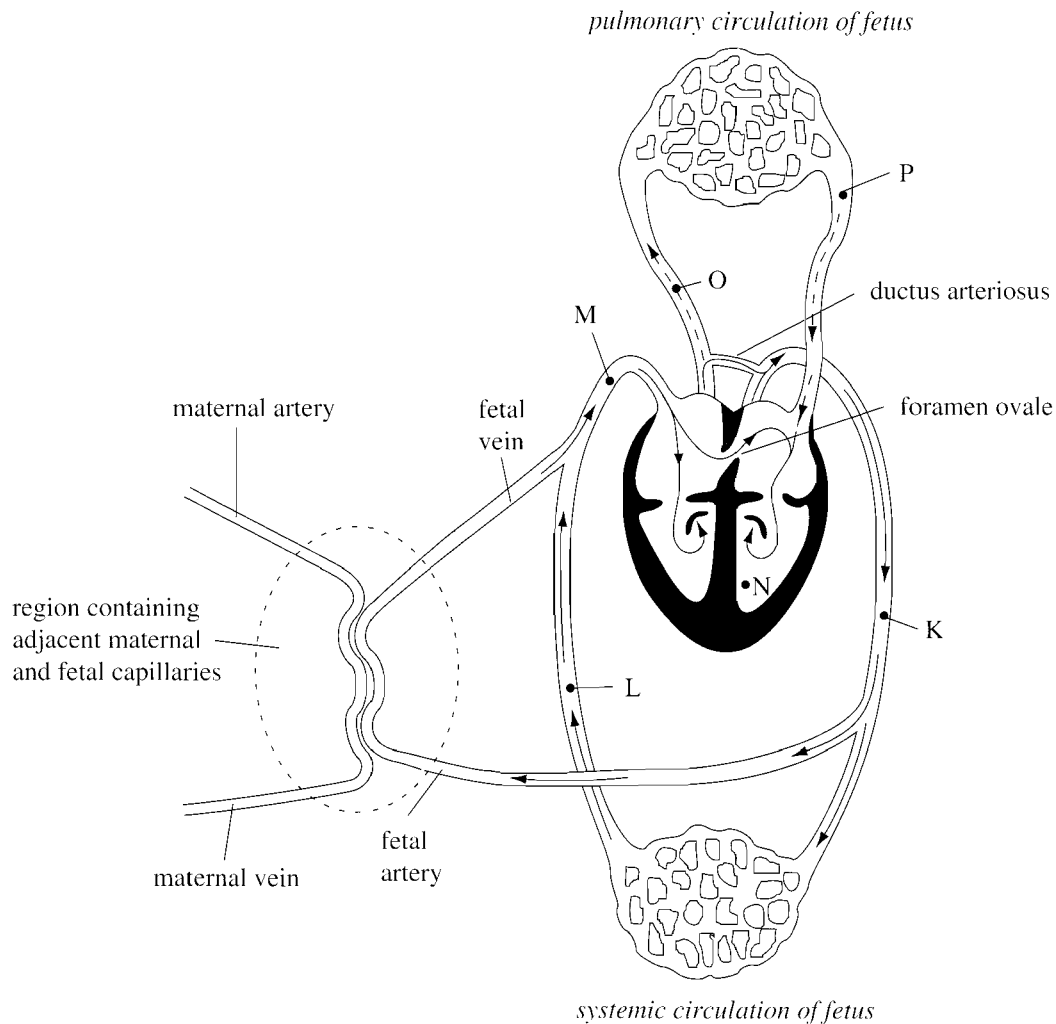


Figure 1

- 1 At which one of the following points will the blood passing the point be more oxygenated after birth than before it?
 - A M
 - B N
 - C L
 - D neither A nor B nor C

- 2 At which one of the following points will the blood passing the point be significantly more dilute than before it?
 birth than before it?
- A K
 B L
 C P
 D neither A nor B nor C

Question 3 refers to the following additional information:

The Fick dye method is a way of measuring the rate of flow of blood through a blood vessel. The technique is illustrated in Figure 2.

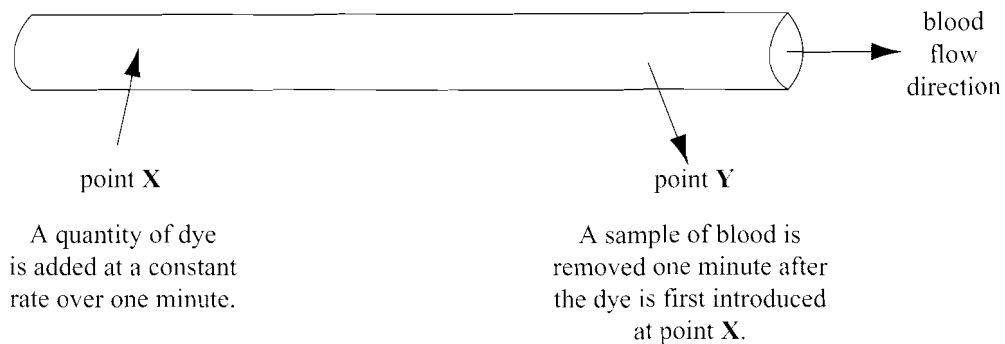


Figure 2

A known quantity of dye is injected at a constant rate over one minute at point **X**. One minute after the injection begins, a sample of blood, with the dye evenly mixed through it, is taken at point **Y**.

$$\text{Flow rate (litre/min)} = \frac{\text{Quantity of dye injected at point X over the minute (gram/min)}}{\text{Concentration of dye at point Y one minute later (gram/litre)}} \quad \text{Equation (1)}$$

or, put more simply: $F = \frac{Q}{C}$

- 3 The unit gram/litre is equivalent to
- A min/litre \times min/gram
 B litre/min \times gram/min
 C $\frac{\text{litre/min}}{\text{gram/min}}$
 D $\frac{\text{gram/min}}{\text{litre/min}}$

Questions 4 and 5 refer to the following additional information:

If, when the Fick method is used to determine blood flow, the chemical that is introduced is not a dye but instead a substance which already exists in the blood at a certain concentration, Equation (1) becomes:

$$F = \frac{Q}{\Delta C} \quad \text{Equation (2)}$$

where ΔC is the change in the concentration of the substance in the blood at point Y due to the addition of the substance at point X over one minute.

Figure 3 indicates for an adult chimpanzee that the lungs add 240 mL of oxygen to the blood flowing through it each minute. The oxygen concentration of blood flowing into the right atrium is 120 mL/litre and of blood leaving the left ventricle is 180 mL/litre.

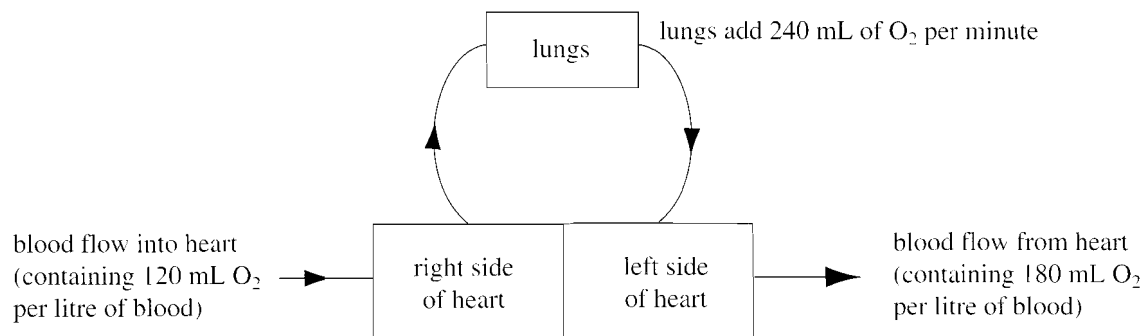


Figure 3

The flow rate of blood from the heart into the aorta is called the *cardiac output*.

4 For the situation depicted in Figure 3, point X (Figure 2) is in the

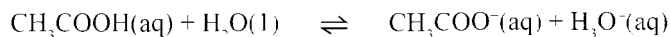
- A lungs.
- B pulmonary artery.
- C right side of the heart.
- D vein entering the heart.

5 For the situation depicted in Figure 3, the cardiac output is

- A 40 mL/min .
- B 60 mL/min .
- C 4 litre/min .
- D 6 litre/min .

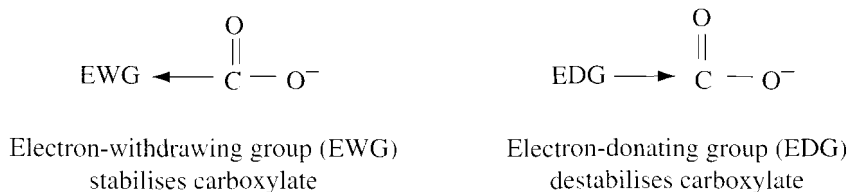
Questions 6 –8

When acetic acid, CH_3COOH , dissociates in water, the equilibrium shown below exists:



Since the dissociation is an equilibrium reaction, any structural feature that stabilises the CH_3COO^- with respect to CH_3COOH will drive the equilibrium toward increased CH_3COO^- and result in increased acidity.

Two factors that affect the stability of CH_3COO^- , and thus the acid strength of CH_3COOH , are: (i) inductive effect of other atoms or groups attached to CH_3COO^- as shown below; and (ii) solvation of CH_3COO^- .



- 6 Based on the $\text{p}K_{\text{a}}$ values given below, which one of the following species is the strongest base?

	$\text{p}K_{\text{a}}$
FCH_2COOH	2.7
ClCH_2COOH	2.8
BrCH_2COOH	2.9
CH_3COOH	4.8

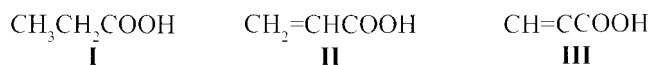
- | | |
|---|--|
| A FCH_2COO^-
B $\text{ClCH}_2\text{COO}^-$ | C $\text{BrCH}_2\text{COO}^-$
D CH_3COO^- |
|---|--|

- 7 In which one of the following pairs is acid strength correctly predicted?

- A** $\text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{OH}$
B $\text{FCH}_2\text{COOH} < \text{F}_2\text{CHCOOH}$
C $\text{CH}_3\text{COOH} < \text{CH}_3\text{CH}_2\text{COOH}$
D $\text{CH}_3\underset{\text{I}}{\text{CH}}\text{COOH} < \text{ICH}_2\text{CH}_2\text{COOH}$

- 8 The increasing s character of the hybrid orbitals of carbon in the series $sp^3 \rightarrow sp^2 \rightarrow sp$ means increasing electronegativity of the carbon.

Which one of the following is the correct order of acidity for the compounds **I**, **II** and **III** shown below?



- | | |
|--|--|
| A I > II > III
B III > I > II | C II > I > III
D III > II > I |
|--|--|

UNIT 3

Questions 9–11

Figure 1 represents a section of the human intestine. Utilise Figure 1 and the facts that follow in answering the questions.

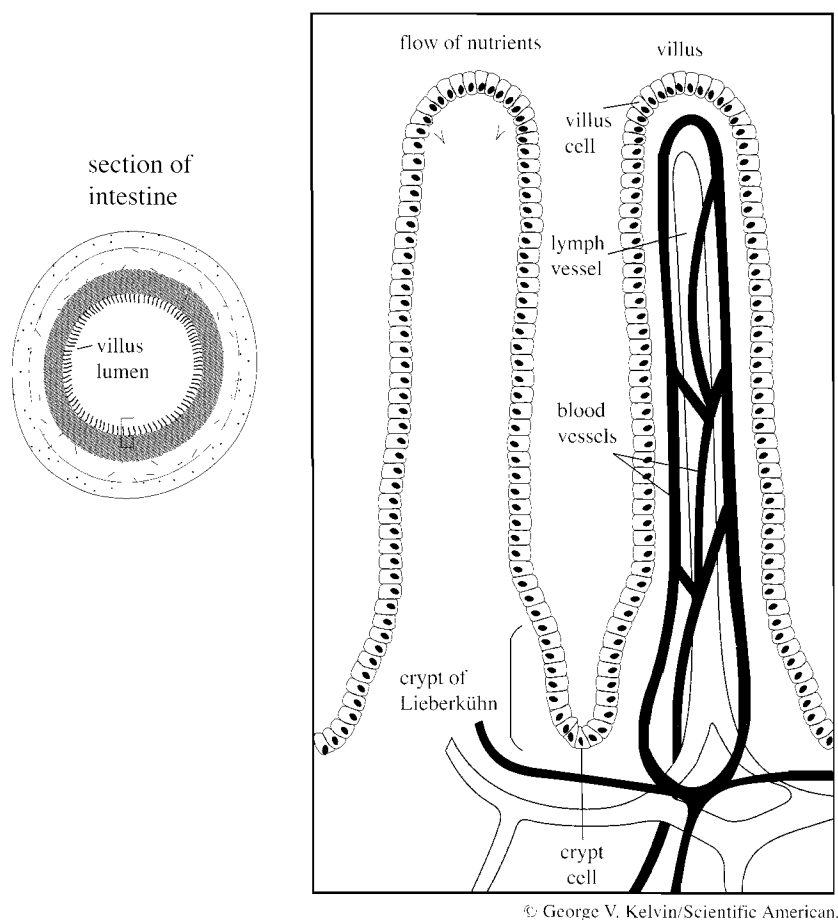


Figure 1

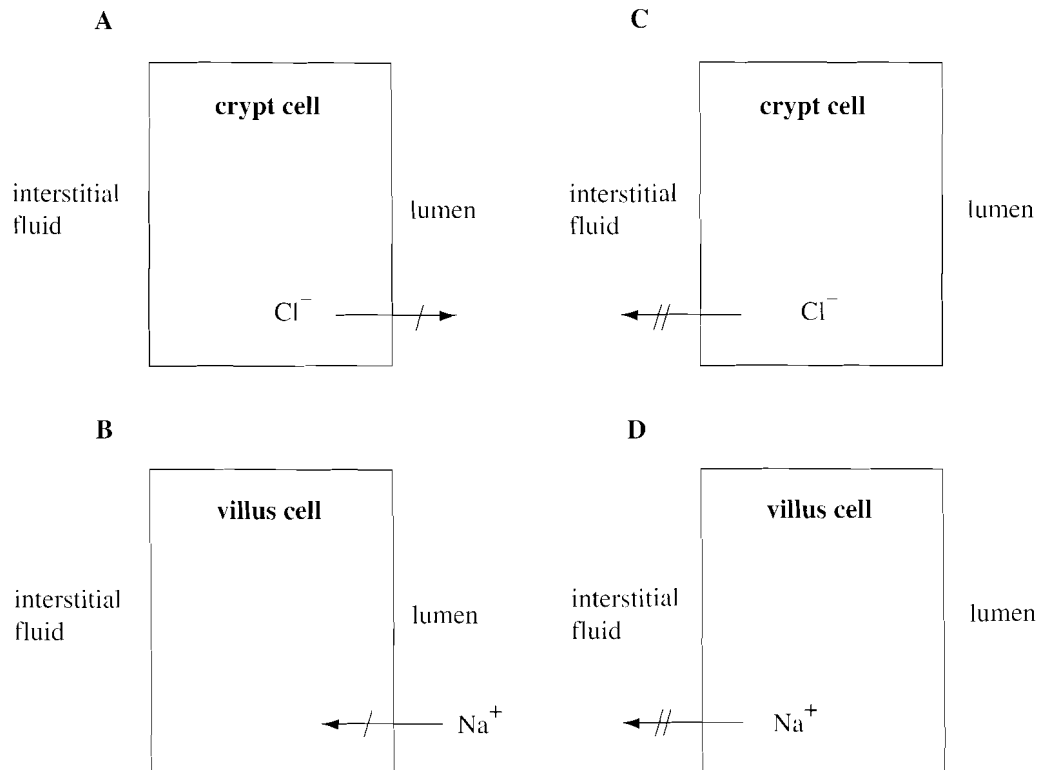
- When the stomach empties partly-digested food into the intestine, crypt cells, located in the intestinal wall, actively transport chloride from the interstitial fluid into the intestinal lumen at an increased rate.
- As digestion proceeds, villus cells, located in the intestinal wall, transport sodium more rapidly (and actively) from the lumen into the interstitial fluid.
- Diarrhoea is a condition in which there is an increased fluidity and frequency of faecal evacuations.

- 9 Which one of the following best describes the relative situation when water moves across a semipermeable membrane by osmosis from Side 1 to Side 2?

	Side 1	Side 2
A	higher solute concentration	lower solute concentration
B	higher solvent concentration	lower solute concentration
C	lower solute concentration	lower solvent concentration
D	lower solvent concentration	lower solute concentration

- 10 Which one of the following diagrams is the best representation of a mechanism that would lead to diarrhoea?

Note that / means the process is inhibited whereas // means the process is stimulated.



- 11 Of the following, diarrhoea-causing organisms would most likely act by
- A inhibiting osmosis via crypt cells.
 - B blocking the sodium pumps of villus cells.
 - C inhibiting crypt cell secretion of chloride into the lumen.
 - D enhancing villus cell absorption of sodium from the lumen.

UNIT 4

Question 12

In a human body, the speed of blood through the arterial pathway generally decreases with distance from the heart.

In an experiment it was observed that the speed of blood flow was 0.30 m s^{-1} at one point in an artery and 0.20 m s^{-1} at another point 0.50 m further along the arterial pathway. Assume that the blood flow slowed at a constant rate.

12 The blood flow between the two points slowed at a rate of

- A 0.01 m s^{-2} .
- B 0.05 m s^{-2} .
- C 0.10 m s^{-2} .
- D 0.20 m s^{-2} .

UNIT 5

Question 13

The ratio of brain weight to body weight for a number of animal species is as follows:

squirrel monkey	1: 12
porpoise	1: 38
house mouse	1: 40
tree shrew	1: 40
modern human	1: 45
macaque	1: 170
gorilla	1: 200
elephant	1: 600
blue whale	1: 10 000

13 From the available information, it can be concluded that animals with brains of equal weight are a

- A house mouse and a tree shrew.
- B porpoise and a modern human.
- C 1.5 kg tree shrew and a 5 kg squirrel monkey.
- D 150 kg gorilla and a 450 kg elephant.

Questions 14 and 15

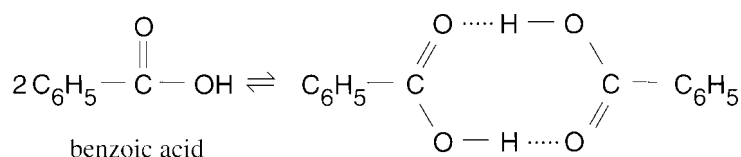
The body fluids of fish in Arctic and Antarctic oceans do not freeze even though they are swimming in water where the temperature is below 0 °C. This is because the presence of solute particles (ions or molecules) in the solvent lowers its freezing point. In dilute solutions, the freezing point depression ΔT_f caused by a solute is directly proportional to its molal concentration m (moles per kg of solvent). Mathematically,

$$\Delta T_f = K_f m$$

where ΔT_f = the decrease in the freezing point,
and K_f = the molal freezing point depression constant.

Freezing point depression is a physical property of a solution which depends on the concentrations of particles, not on their chemical identity. Because an electrolyte releases more ions in solution than indicated by the molal concentration, a solution of an electrolyte has a more pronounced effect on the freezing point than a solution of a molecular compound (non-electrolyte) at the same concentration.

- 14 In benzene, benzoic acid molecules form dimers which are held together by hydrogen bonds as shown by (...) in the equation below.



Because of this association, the freezing point depression of a 0.010 molal solution of benzoic acid in benzene will be

- A half the theoretical value.
 B twice the theoretical value.
 C four times the theoretical value.
 D the same as the theoretical value.
- 15 A solution of 40 g of a non-electrolyte solute in 1000 g of water has a freezing point that is 0.40 °C below that of pure water. The molal freezing point depression constant K_f for water is 1.86 °C per mole per kg. The molecular weight of the compound is

- A 160 .
 B 168 .
 C 180 .
 D 186 .

UNIT 7

Questions 16–18

As it begins to dive, a seal, unlike a human, typically exhales air from its lungs, and drops its heart rate dramatically (e.g. from 140 to 20 beats per minute). Seals commonly dive hundreds of metres below the surface and stay down for an hour.

Table 1 accounts for virtually all the free O_2 in a typical 70 kg human and a typical 30 kg seal as they begin to dive. The muscle oxygen is attached to myoglobin, which has properties similar to haemoglobin.

Table 1

Seal (30 kg)	
Air in lungs	(350 mL, 16% O_2)
Blood	(4.5 litres, 25 mL O_2 per 100 mL)
Muscle	(6 kg, 45 mL O_2 per kg)
Tissue water	(20 litres, 5 mL O_2 per litre)
Human (70 kg)	
Air in lungs	(4.5 litres, 16% O_2)
Blood	(5 litres, 20 mL O_2 per 100 mL)
Muscle	(16 kg, 15 mL O_2 per kg)
Tissue water	(40 litres, 5 mL O_2 per litre)

Figure 1 indicates the blood flow to various organs in a seal before and during a dive. The light-shaded columns represent pre-dive blood flow and the dark columns represent blood flow during the dive. In addition, the diving flow rate is given as a percentage of the pre-dive flow rate.

The reduced blood flow to the muscles represented in Figure 1 is typical of the change of blood flow to all muscles.

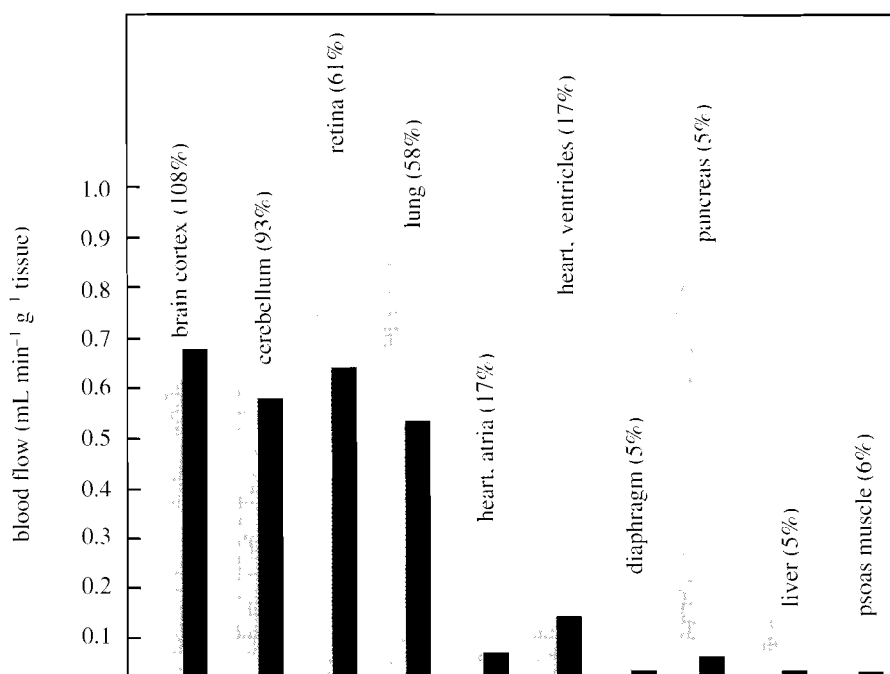


Figure 2 indicates the blood levels of CO_2 , O_2 and lactic acid (the major organic product of anaerobic respiration) in a seal before, during and after a dive. During a dive, muscles rely heavily on the anaerobic respiration that occurs within them.

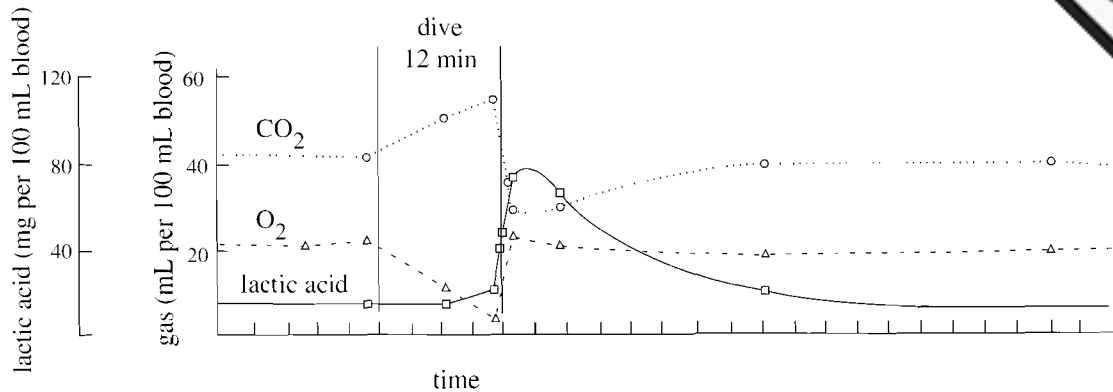


Figure 2

- 16 According to Table 1, of the following, most of the seal's oxygen is located in
- A blood.
 - B muscle.
 - C tissue water.
 - D air in the lungs.
- 17 Of the following, the best explanation as to why the lactic acid level rises markedly as the seal resurfaces (Figure 2) is that
- A lactic acid is the product of anaerobic respiration.
 - B blood flow resumes to the muscles.
 - C the rate of lactic acid production increases.
 - D carbon dioxide is converted into lactic acid.
- 18 In accounting for a particular change in the blood flow to one or more organs (Figure 1), of the following, the **least** reasonable explanation of the change is that
- A light barely penetrates more than 10 m below the water surface.
 - B complex mental processing is required during a dive.
 - C lactic acid is toxic to muscle cells.
 - D metabolism slows during a dive.

UNIT 8

Questions 19–21

The structures of monosaccharides such as glucose and fructose can be illustrated in many ways. Two common representations of glucose are the Haworth structure shown in Figure 1 and the Fischer structure shown in Figure 2. The Haworth structure of fructose is shown in Figure 3.

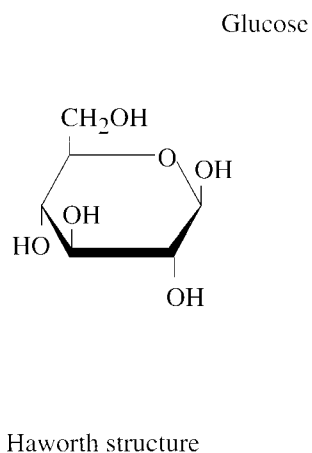


Figure 1

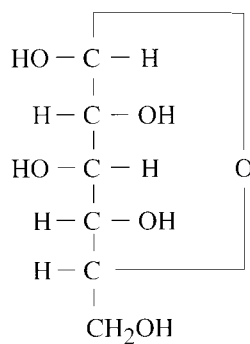


Figure 2

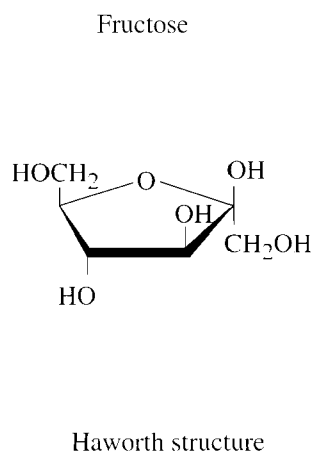
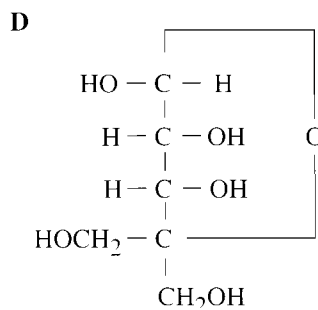
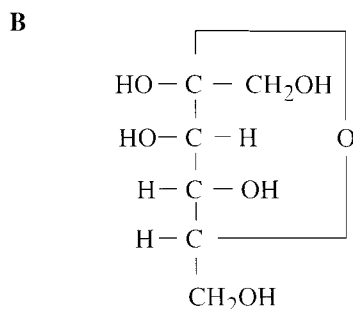
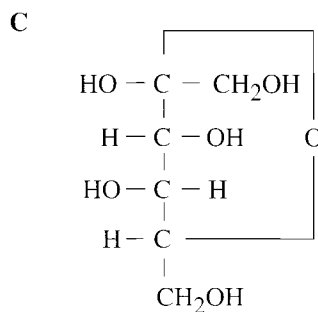
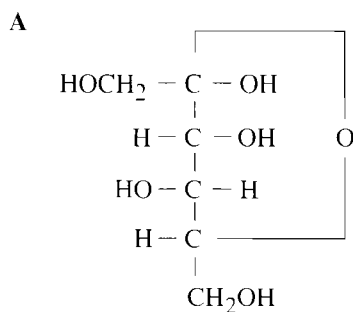


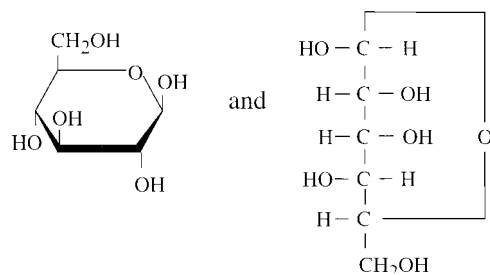
Figure 3

19 The Fischer structure corresponding to the Haworth structure of fructose (Figure 3) is

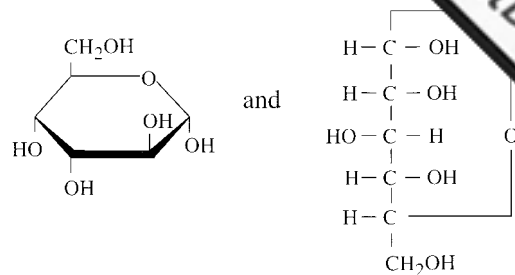


20 Of the following, the pair of Haworth and Fischer structures that represents the same molecule is

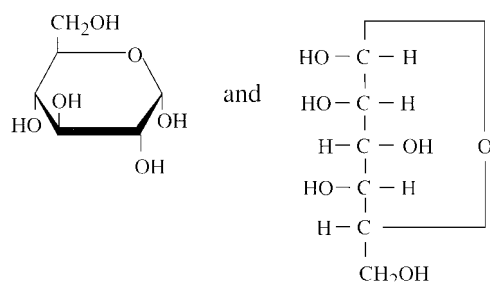
A



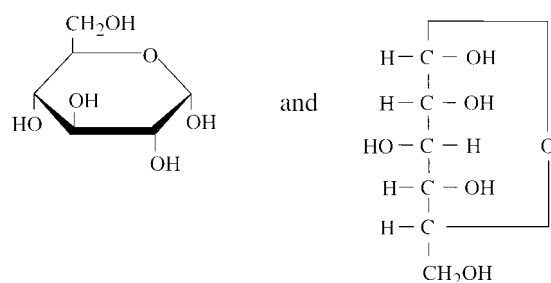
C



B



D



- 21 Consider that the Haworth representation (Figure 1) is viewed from above and that the point of view is moved in a clockwise direction starting from the oxygen atom in the ring. In the Fischer representation, the carbon atoms of the ring are viewed as shown in Figure 2, i.e. arranged in a line with the —CH₂OH group at the bottom.

For these two views, the groups attached uppermost to the carbon atoms in the ring of the Haworth representation are in the same order as the groups attached to the line of carbon atoms in the Fischer representation that are

- A** on the left side reading down the page.
- B** on the right side reading down the page.
- C** on the left side reading up the page.
- D** on the right side reading up the page.

UNIT 9

Questions 22 and 23

A thin luminous rectangular plate, $2\text{ cm} \times 3\text{ cm}$, faces a thin converging lens of focal length 20 cm . The plate is perpendicular to the principal axis of the lens and its centre lies on this axis. When the plate is placed at certain distances from the lens, real rectangular images of the plate are formed on a moveable screen held perpendicular to the principal axis.

For thin lenses two useful formulae are

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \quad \text{and} \quad M = \frac{h}{H} = \left| \frac{v}{u} \right|$$

where f = focal length of the lens
 u = distance from lens to object
 v = distance from lens to image
 M = magnitude of magnification
 H = height of object
 h = height of image

- 22** If the plate is positioned 30 cm from the lens, the distance of its real image from the lens will be
- A** 10 cm .
 - B** 20 cm .
 - C** 30 cm .
 - D** 60 cm .
- 23** If the plate is positioned 30 cm from the lens, the dimensions of the rectangular image formed on the screen will be
- A** $1\text{ cm} \times 1.5\text{ cm}$.
 - B** $2\text{ cm} \times 3\text{ cm}$.
 - C** $4\text{ cm} \times 6\text{ cm}$.
 - D** $8\text{ cm} \times 12\text{ cm}$.

Questions 24 and 25

In mice, a number of independently segregating genes control the phenotype of the coat.

One gene controls spotting in the coat. Non-spotting, or plain, is dominant to the alternative phenotype spotting.

Another gene controls the colour of the coat. The heterozygous condition is yellow. Homozygous yellow mice do not survive to birth. The alternative colour is black.

Note: For the two genes considered, assume that each occurs as either the dominant or recessive allele as suggested above, and no other alleles exist.

- 24** Of the following, the most likely proportion of phenotypes in offspring born from a cross between two yellow mice is
- A** all yellow.
 - B** 3 yellow : 1 black.
 - C** 2 yellow : 1 black.
 - D** 1 yellow : 1 black.
- 25** Two yellow-coated spotted mice were crossed repeatedly.
- Of the following, the phenotypes of offspring born would most likely include
- A** 25% black spotted.
 - B** 25% yellow spotted.
 - C** $33\frac{1}{3}\%$ black spotted.
 - D** 50% yellow non-spotted.

UNIT 11

Questions 26–28

Magnetic resonance imaging (MRI) is a noninvasive technique for visualising the living human body. It depends on a phenomenon called *nuclear magnetic resonance* (NMR) which occurs when certain atoms are placed in very strong magnetic fields. All nuclei that have odd mass numbers exhibit NMR as do all nuclei that have even mass numbers but odd atomic numbers. Nuclei having both even mass numbers and even atomic numbers do not exhibit NMR.

- 26 Of the three isotopes of hydrogen, those that exhibit NMR are
- A ^2H only.
 - B ^1H and ^2H only.
 - C ^1H and ^3H only.
 - D ^1H , ^2H and ^3H .
- 27 In which one of the following lists does NMR occur in all of the nuclei?
- A ^4He , ^8Be , ^{16}O and ^{32}S .
 - B ^3He , ^{14}N , ^{19}F and ^{31}P .
 - C ^6Li , ^{13}C , ^{18}O and ^{39}K .
 - D ^{10}B , ^{12}C , ^{17}O and ^{35}Cl .
- 28 The number of neutrons in the nucleus of an atom in which NMR occurs is always
- A odd.
 - B even.
 - C odd if the number of protons is even.
 - D even if the number of protons is odd.

Questions 29–33

The tendency for a half-reaction to proceed as a reduction, relative to the reduction of H^+ , is determined by the standard reduction potential, E° . A positive reduction potential represents a system that is more easily reduced (gains electrons) than H^+ . Those systems with negative reduction potentials are less easily reduced than H^+ .

When two half-reactions are combined into a full redox reaction the half-reaction with the more positive E° runs as a reduction and forces the other to run as an oxidation.

Table 1 shows standard reduction potentials for several common compounds.

Table 1

Half-reaction	$E^\circ(\text{V})$
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$	+1.36
$\text{Br}_2(\text{aq}) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$	+1.07
$\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$	+0.54
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$	+0.34
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0.00
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$	-0.76

29 Which of the following will take place if Br_2 is added to a solution that contains Cl^- and I^- ions?

- A Cl^- will be oxidized.
- B I^- will be oxidized.
- C Br_2 will be oxidized.
- D No redox change will take place.

30 Which of the following species would reduce a solution of H^+ to H_2 ?

- I I_2
- II Cu
- III Zn
- A I only
- B II only
- C III only
- D I and II only

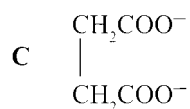
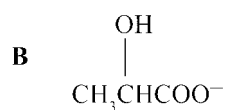
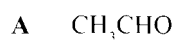
Questions 31–33 refer to the following additional information:

Table 2 lists reduction potentials, $E^{\circ'}$, of some oxidation-reduction half-reactions which take place in biological systems. A prime (') is added to indicate that the reaction is taking place at pH 7.0.

Table 2

Half-reaction	$E^{\circ'} \text{ (V)}$
$\frac{1}{2}\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2\text{O}$	+0.82
$\begin{array}{c} \text{HCCOO}^- \\ \\ \text{OOCCH} \end{array} + 2\text{H}^+ + 2\text{e}^- \rightarrow \begin{array}{c} \text{CH}_2\text{COO}^- \\ \\ \text{CH}_2\text{COO}^- \end{array}$	+0.03
$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CCOO}^- \end{array} + 2\text{H}^+ + 2\text{e}^- \rightarrow \begin{array}{c} \text{OH} \\ \\ \text{CH}_3\text{CHCOO}^- \end{array}$	-0.19
$\text{CH}_3\text{CHO} + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{CH}_3\text{CH}_2\text{OH}$	-0.20

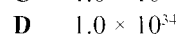
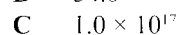
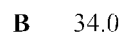
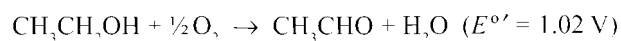
31 Based on Table 2, which one of the following is the strongest reducing agent?



32 If $E^{\circ'}_{\text{cell}}$ and K_{eq} at 25 °C are related by

$$E^{\circ'}_{\text{cell}} = \frac{0.06}{n} \log_{10} K_{\text{eq}}$$

where n is the number of moles of electrons transferred in the reaction, what is the value of K_{eq} for the following reaction?



- 33 The magnitudes, but not the signs, of the standard electrode potentials of two organic compounds M and N, are as follows



When two half-cells containing M and N are connected, electrons flow from the M/M²⁻ half-cell to the N/N²⁻ half-cell. When M is connected to a standard hydrogen electrode (SHE), electrons flow from the M/M²⁻ half-cell to the SHE.

What would be the potential of a cell made up from standard M/M²⁻ and N/N²⁻ half-cells?

- A 0.60 V
- B 0.30 V
- C 0.08 V
- D 0.04 V

UNIT 13

Questions 34 and 35

In order to make inferences about dinosaur locomotion, a scientist studied living four-legged mammals. The legs of mammals move in the same way as those of dinosaurs (being directly below the animal, whereas reptile legs extend out from the sides of the animal).

The study found the relationship represented by the curve of best fit shown in Figure 1. Each point in Figure 1 indicates a measurement done on a single animal moving at a particular speed (v) in a straight line. Measurements were done at several speeds for some of the animals.

More specifically, Figure 1 shows the relationship between relative stride length ($\frac{s}{l}$) and Froude number ($\frac{v^2}{gl}$), where

s is stride length in metres;

l is height of the hip above the ground in metres;

g is a constant related to the force of gravity (which equals about 10 metres per second per second); and

v is speed in metres per second.

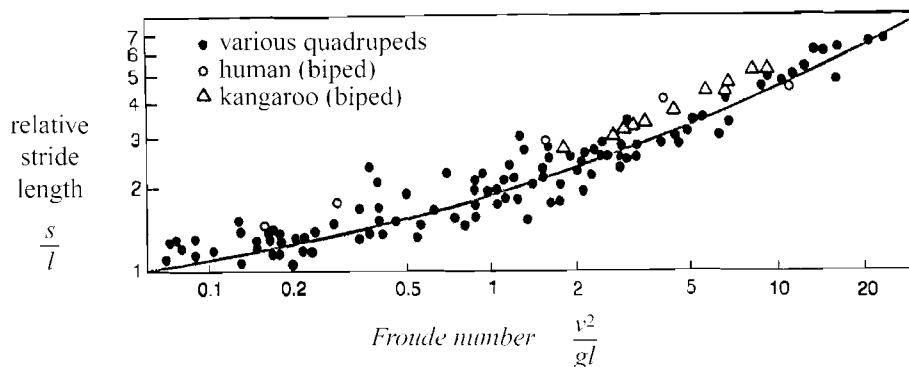


Figure 1

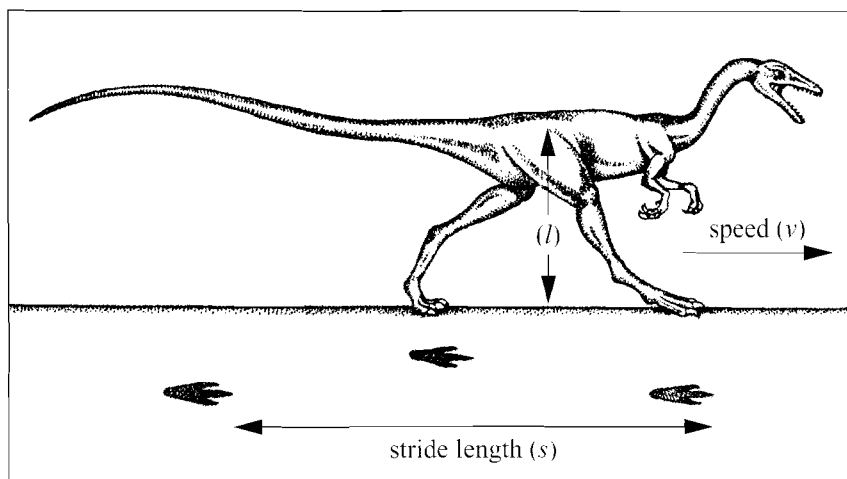


Figure 2

It was discovered that all the mammals studied changed from one gait (style of moving, such as trotting or galloping) to another at nearly the same Froude number. For example, a ferret changes from trotting to galloping when its Froude number reaches 2.5.

In fact, for the ferret, when the change occurs:

$$\frac{v^2}{gl} = \frac{(1.5 \text{ metres per second})^2}{10 \text{ metres per second per second} \times 0.09 \text{ metres}} = 2.5$$

Assume that the locomotion of the dinosaur depicted in Figure 2 can be represented by the model described for the mammals studied, including the curve of best fit given in Figure 1. In answering the following, if required, utilise the dimensions indicated in Figure 2 (e.g. stride length is about twice leg length).

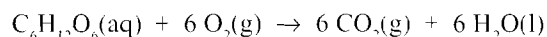
Note: In answering the following questions, utilise the curve of best fit rather than the individual datum points.

- 34 If the Froude number of the moving dinosaur depicted in Figure 2 were 20 and l were 0.2 metres, its stride length would be, of the following, closest to
- A 0.7 metres.
 - B 1.4 metres.
 - C 2.1 metres.
 - D 2.8 metres.
- 35 If l for the dinosaur depicted in Figure 2 were 1.2 metres, at what speed would the dinosaur change from trotting to galloping?
- A 1.5 metres per second
 - B 2.5 metres per second
 - C 4.5 metres per second
 - D 5.5 metres per second

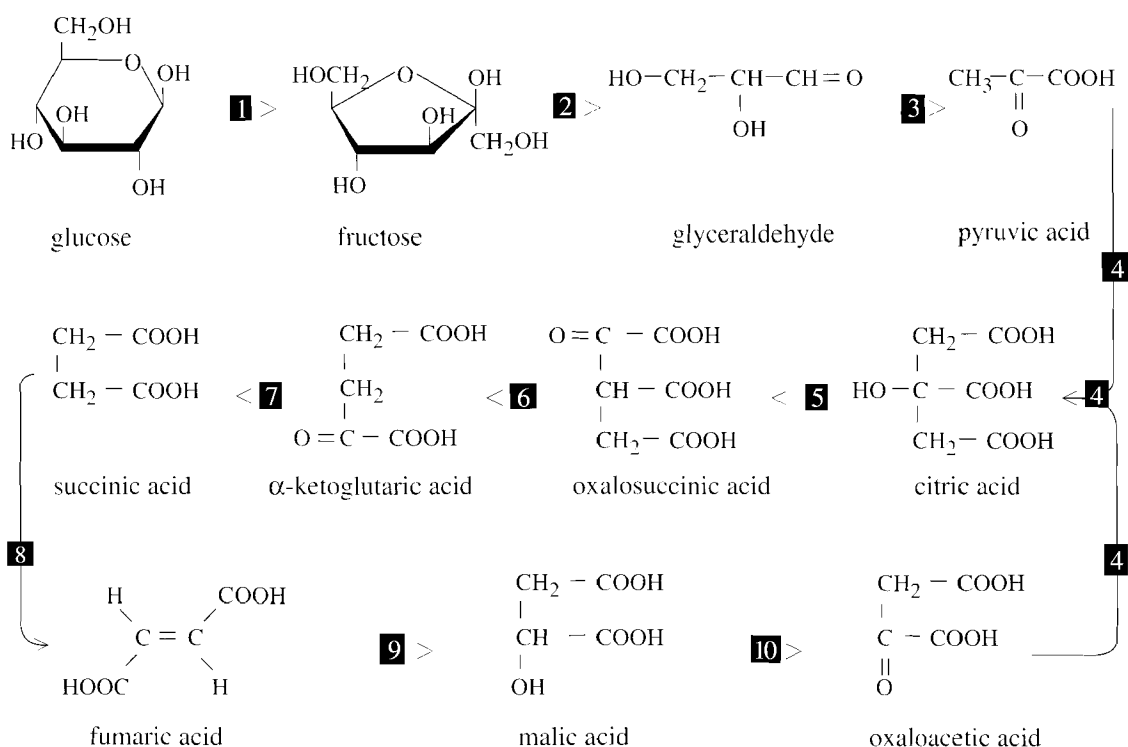
UNIT 14

Questions 36–39

In the body, cellular respiration produces energy from the oxidation of glucose. The overall reaction can be represented by the following equation:



As the glucose reacts, compounds that can be isolated from the reaction mixture include fructose, glyceraldehyde, pyruvic acid, citric acid, succinic acid, fumaric acid, malic acid and oxaloacetic acid. The structures of all of these are shown in Figure 1. These metabolites are in a pathway where reactions are labelled by numbered arrows, e.g. **1**→. The details of the reactions involved in each step have been omitted.



The last seven compounds (from citric acid to oxaloacetic acid) are involved in a cycle (called the Krebs Cycle). Citric acid is produced when pyruvic acid formed from glucose combines with oxaloacetic acid. This undergoes a series of reactions that eventually regenerates oxaloacetic acid.

36 A pair of structural isomers is

- A glucose and fructose.
- B citric acid and oxalosuccinic acid.
- C fumaric acid and oxaloacetic acid.
- D oxalosuccinic acid and oxaloacetic acid.

- 37 Two compounds that have the same empirical formula are
- A fructose and succinic acid.
 - B glucose and glyceraldehyde.
 - C oxalosuccinic acid and fumaric acid.
 - D oxalosuccinic acid and oxaloacetic acid.
- 38 The reaction producing malic acid from fumaric acid is an example of
- A a reduction reaction.
 - B an oxidation reaction.
 - C a hydration reaction.
 - D a hydrolysis reaction.
- 39 A new artificial sweetener has been produced by replacing all of the hydroxyl groups attached directly to the ring carbons in glucose with chlorine atoms.
- The empirical formula of this chlorinated glucose would be
- A CHClO .
 - B CH_2Cl .
 - C $\text{C}_3\text{H}_4\text{Cl}_2\text{O}$.
 - D $\text{C}_6\text{H}_{10}\text{Cl}_5\text{O}$.

UNIT 15

Questions 40–43

Figure 1 is a cross-sectional view of the main features of an apparatus for measuring the mass to charge ratio of ions. The apparatus is enclosed in an airtight container (not shown) that has been evacuated.

A beam of positive ions from a discharge tube (not shown) is introduced into the apparatus and a thin beam of ions is formed by circular holes S_1 and S_2 . The thin beam passes between metal plates M and N. The plates are connected to a battery (not shown) which maintains a uniform electric field \vec{E} (magnitude E) between them. Also, in the region between the plates there is a uniform magnetic field \vec{B}_1 (magnitude B_1) which is perpendicular to the plane represented in the figure.

By suitably adjusting the magnitudes E and B_1 the thin beam can be made to pass undeflected between plates M and N. Some of the ions in the thin beam subsequently pass through the narrow hole S_3 and enter a region of the apparatus in which there is a second uniform magnetic field \vec{B}_2 (magnitude B_2) perpendicular to the plane represented in the diagram. In this region, the ions are deflected by the magnetic field, so that they move along semicircular paths (diameter $2r$) until they strike a photographic plate. The figure shows the impact points, X and Y, of ions moving along two different semicircular paths.

Note: The formulas $F = QE$ and $F = QvB$ may be useful in answering the following questions.

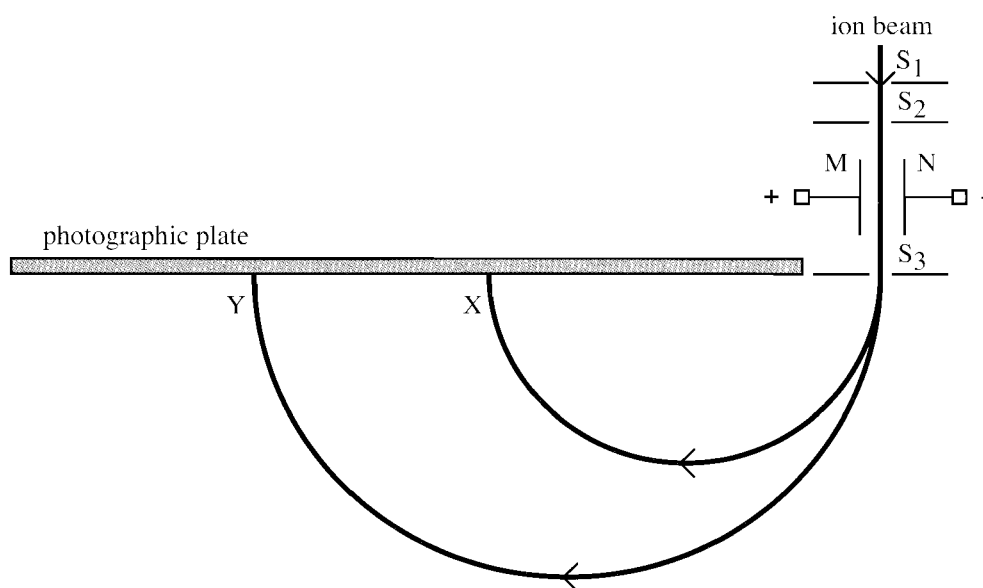


Figure 1

- 40 The speed of an ion passing through slit S_3 is given by
- A $\frac{B_1}{E}$.
 - B $\frac{E}{B_1}$.
 - C $E B_1$.
 - D $E - B_1$.
- 41 The particular arrangement of electric and magnetic fields in the region between plates M and N is designed to
- A obtain a thin beam of ions at slit S_3 .
 - B reduce the number of ions arriving at S_3 .
 - C ensure that ions passing through S_3 have the same velocity.
 - D ensure that ions passing through S_3 have the same charge.
- 42 The speed of an ion of mass m just before it strikes the photographic plate is given by
- A $\frac{QrB_2}{m}$.
 - B $\frac{m}{QrB_2}$.
 - C $\frac{2QB_1}{m}$.
 - D $\frac{m}{2QB_1}$.
- 43 If the mass to charge ratios of negatively charged ions were to be determined by the apparatus, it would be simplest to reverse the direction of
- A \vec{E} only.
 - B \vec{B}_2 only.
 - C \vec{E} and \vec{B}_1 only.
 - D \vec{B}_1 and \vec{B}_2 only.

UNIT 16

Question 44–47

The bacterium *Salmonella typhimurium* will grow on a particular *minimal unsupplemented medium* (mum). Table 1 shows the results of an experiment where *Salmonella typhimurium* mutants (e.g. try-1, try-2) were grown on mum or mum supplemented with one of anthranilic acid (a), indole glycerol phosphate (igp), indole (i) or tryptophan (t). Growth of the bacterium on a medium is indicated by + and failure to grow is indicated by –.

Table 1

Mutant	Growth response on mum with indicated supplement				
	nil	t	i	a	igp
try-3	–	+	+	–	–
try-8	–	+	+	+	+
try-1, -6, -7	–	+	–	–	–
try-2, -4	–	+	+	–	+

Consider the following pathway (Figure 1) proposed to explain the results summarised in Table 1. The numbers 1, 2, 3 and 4 correspond to particular steps in the pathway.

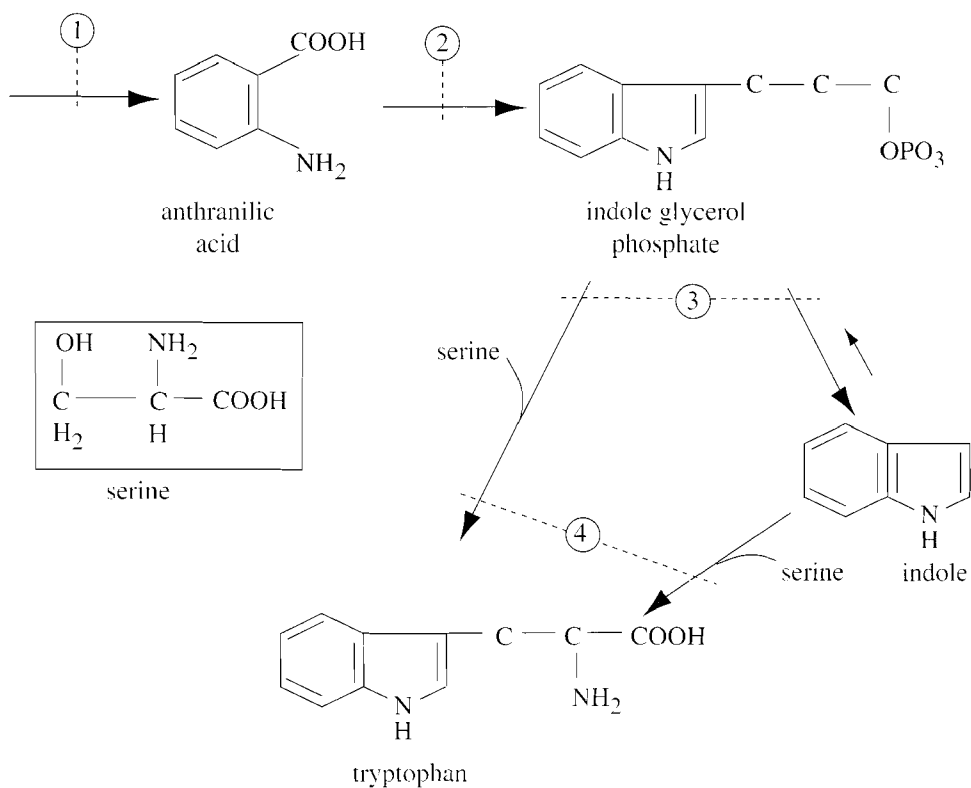


Figure 1

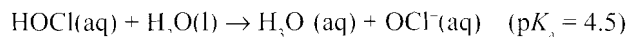
Tryptophan is formed by combination of serine either with free indole or another product or may be indole (or a closely related substance) attached to an enzyme.

- 44 According to Table 1 and Figure 1, indole would most likely build up in cells of
- A try-1 .
 - B try-2 .
 - C try-3 .
 - D try-8 .
- 45 On the basis of the information provided, which one of the following is the most valid statement? Figure 1 could be
- A correct because it does not contradict Table 1.
 - B correct because a single enzyme catalyses steps 3 and 4.
 - C incorrect because it is not sufficiently consistent with Table 1.
 - D incorrect because a single enzyme could not catalyse steps 3 and 4.
- 46 According to Table 1 and Figure 1, the defect in try-3 could *directly* affect only step
- A 1 .
 - B 2 .
 - C 3 .
 - D 4 .
- 47 *Salmonella typhimurium*, being a bacterium, would
- A have a cell wall.
 - B contain mitochondria.
 - C reproduce asexually only.
 - D have all of the above characteristics.

UNIT 17

Questions 48–50

To kill the bacteria in water, a strong oxidising agent such as hypochlorous acid (HOCl) can be added. It is a weak acid that ionises in water according to the equation:



The HOCl can easily pass through the cell walls and oxidise the substances within, destroying the organism's metabolites. The hypochlorite ion is not as effective, because its charge means that it cannot enter the cell as easily.

In commercial swimming pools, gaseous chlorine is bubbled through the water where it reacts to form hypochlorous acid (HOCl) and hydrochloric acid (HCl). The 'dry chlorine' added to home swimming pools is really the calcium salt of hypochlorous acid, calcium hypochlorite $\text{Ca}(\text{OCl})_2$. Commercial bleaches usually contain sodium hypochlorite (NaOCl). Other compounds that could be used as bactericides include nitrogen trichloride (NCl_3) and chlorine oxide (Cl_2O) as these completely hydrolyse to form hypochlorous acid.

(Relative atomic mass: H = 1.0, N = 14.0, O = 16.0, Na = 23.0, Cl = 35.5, Ca = 40.1)

- 48 As the hydrochloric acid that is formed when chlorine reacts with water is (effectively) completely ionised,
- A its $\text{p}K_{\text{a}}$ value must be negative.
 - B its concentration must be very low.
 - C the pool water must have been basic initially.
 - D it must be a weaker acid than hypochlorous acid.
- 49 A mass equivalent to 0.50 moles of calcium hypochlorite is completely dissolved in a bucket containing 10.0 litres of water. This solution is added to a swimming pool containing 20 000 litres of water and mixed thoroughly.
- The concentration of hypochlorite ion in this swimming pool would be about
- A $2.5 \times 10^{-5} \text{ M}$.
 - B $5.0 \times 10^{-5} \text{ M}$.
 - C $2.5 \times 10^{-6} \text{ M}$.
 - D $5.0 \times 10^{-6} \text{ M}$.
- 50 Of the following, the greatest amount of hypochlorite ions per kilogram of 'chlorinating agent' would be produced by
- A NaOCl.
 - B $\text{Ca}(\text{OCl})_2$.
 - C NCl_3 .
 - D Cl_2O .

5 Notes on Assessment and Solutions to Practice Questions

Reasoning in Humanities and Social Sciences

UNIT 1

In this unit, based on the poem 'Sandpiper' by the twentieth century American writer Elizabeth Bishop, candidates are asked to interpret a complex piece of text. With the exception of a few words such as 'finical' and 'amethyst', the vocabulary is unlikely to present any difficulty. The challenge lies rather in dealing with the poem's unconventional syntax, and in construing the nature of the poem's response to its subject.

Question 1 **B** and

Question 2 **D**

Both of these questions focus on the starting point for the poem: the speaker's fascination with the fact that the little bird seems quite oblivious to its vast and tumultuous surroundings. In the first line the phrase 'he takes for granted' makes it clear that the sandpiper is untroubled by the sea; this impression is reinforced repeatedly, for instance in the fourth stanza where, after a description taking in the larger perspective of the sea with its rhythms and changes, we are told that the bird not only doesn't know but doesn't care about this perspective ('He couldn't tell you... he is preoccupied...'). Thus the correct answer to Question 1 is **B**, 'untroubling'. The further important dimension is the speaker's reaction to this large-scale scene. This is implied in images of the sea which emphasise its power and magnitude ('hisses', 'sheet of interrupting water'), while the sandpiper seems unaware of the potential threat: 'he runs straight through it, watching his toes.' The correct answer to Question 4, **D**, captures the starting point for the attempt by the speaker to define and understand the sandpiper's disturbingly different perspective on the world.

Question 3 **C**

This question asks students to recognise an accurate description of the way a particular linguistic feature of the poem contributes to its meaning. Alternative **A** accurately describes a feature of the poem, but the regular rhyming pattern is unobtrusive and does not contribute to an effect of panic. The descriptions of the sea referred to in alternative **B** are ruled out because they offer the speaker's perspective, not the sandpiper's. Similarly, the uncertainty conveyed in 'watching his toes./ — Watching, rather ...' (alternative **D**) is the speaker's, correcting herself in the search for a more precise description. On the other hand, the words and phrases indicated in alternative **C** mimetically enact the sandpiper's frenetic, obsessive behaviour which is explicitly evoked in the phrase 'in a state of controlled panic'.

Question 4 **B**

This question asks students to recognise a description that might plausibly connect a poet with the sandpiper as he is characterised in the poem. Alternative **A** is excluded because of the word 'engulfing', which implies being overwhelmed by something large and irresistible like the sea. This is precisely, in the poem's perception, what the sandpiper is not. The coupling of 'intensity' and 'obsessiveness' in **B** makes it the strongest alternative, since both words fit with the description of the sandpiper offered, and could be plausibly applied to a creative genius. The question does not assume any background knowledge about the poet Blake in particular although those candidates with such a background are likely to find the association witty and satisfying.

Question 5 **A**

Candidates need to consider 'Sandpiper' globally to determine which of the four quotations best characterises the poem. In moving between the speaker's focus on the huge and powerful Atlantic ocean, and the sandpiper's minute microcosm, the poem can clearly be described as featuring 'shifts of physical scale'. This quotation (alternative **A**) take into account both the sandpiper's and the human perspective, the juxtaposition of which forms the centre of the poem. A sense of 'the engulfing power of the world' (alternative **B**) is an accurate enough summary of the

initial human view offered in the poem, but does not accommodate the sandpiper's preoccupation. Alternative suggests a poem devoted to introspection or an exclusive interest in the human: again it leaves out the sandpiper's view. There is no allusion to 'long perspectives of time' (alternative D).

UNIT 2

This unit tests candidates' ability to understand a combination of verbal and spatial material, particularly by applying rules of logic to a symbolic system of representation. A number of the questions in this unit are inferential, in that they test candidates' ability to apply the concepts given in the stimulus material to real situations.

Question 6 A

In order to choose the correct response candidates need to understand that Gamma Maps treat all architectural spaces equally, irrespective of their social meaning or function. **A** is therefore the correct response. The other three responses incorrectly assume an intrinsic relation between Gamma Maps and social meanings or functions.

Question 7 A

To answer this question correctly candidates need to understand, and interrelate, three things: (1) 'matriarch' relates to 'power and privilege'; (2) 'accessibility' refers to the degree of separation of a spatial unit from the outside; and (3) 'inversely proportional to accessibility' means the least accessible. Of the four options given, the least accessible from the outside is IV.6, since in order to reach it from the outside one has to go through four other rooms (1, 2, 3, 5). By contrast, Rooms III.5, II.1 and I.1 are all directly accessible from the outside.

Question 8 C

In this scenario it is clear that the building needs at least two doorways, and preferably three, opening to the outside: one for the admission of all patients (casualty and emergency), one for the discharge of minor casualties, and one for the 'speedy removal' of emergency patients to the central hospital. This rules out Buildings I, II and IV. Even if only two outside doorways were feasible, Building II is less likely than Building III because the two rooms that open to the outside (1 and 2) each have only one exit door, rather than the two which would be required if the incoming patients are to be separated into casualties and emergencies.

With Building III, registration of all patients takes place in Room 2. Minor casualties are directed to Room 1, receive their prescriptions then exit the building. More serious casualties are directed into the 'large room' 4, and will be treated by specialists in either Room 5 or Room 6. Emergency patients are taken into Room 7. Then, if necessary, they are sent to wait in Room 3—which connects to the outside—for evacuation by ambulance. Other emergency patients (and the most serious casualties) will be taken care of in Room 8.

Question 9 B

This question tests candidates' ability to apply the verbal/logical definitions of the terms 'symmetrical' and 'distributed' to a complex Gamma Map. Spaces 8 and 1 are symmetrical with each other with respect to Space 4 in that they have an identical spatial relationship with Space 4, which indicates an identical pattern of access. Spaces 8 and 1 are in a non-distributed relationship because the only means of access between 8 and 1 is through a third space, namely 4.

Question 10 D

This question focuses on the ways in which information conveyed by Gamma Maps differs from that conveyed by ground plans, the more common method for representing buildings. The 'number of portals' is shown on both; therefore **A** is incorrect. Neither the Gamma Maps nor the ground plans show the sizes of each of the sanctuaries: the ground plans show only shape and organisation: a measuring scale would have to be included to show size; therefore **B** is incorrect. **C** is incorrect for the same reasons as **B**: since the ground plans do not show the sizes (i.e. widths) of the portals, we do not know the sizes of the portals of one sanctuary relative to those of the other.

Question 11 A

This question draws upon candidates' conceptual, verbal and spatial abilities, by asking them to compare situations to both the ground plans and Gamma Map. Response **B** implies that from the vestibule of the temple, from the outside court one is able to look directly at the cult image in the 'holy-of-holies'. This situation is possible only by Ground Plan I, so **B** is incorrect. Response **C** contains information about the relative alignments of portals of the 'holy-of-holies', vestibule, and court (i.e. they are all in a direct line so that the 'goddess', i.e. the cult image, can look to the outside). Gamma Maps do not contain information of portal alignments, while in Ground Plan II there is not a direct alignment of portals; only Ground Plan I is consistent with the statement. With response **D**, candidates need to understand that 'sacred distance' refers to the existence of one or more spatial units between the outside of the sanctuary and the 'holy-of-holies'; the two ground plans and the Gamma Map contain this kind of information (i.e. Spaces b and e are separated by Spaces c and d). With response **A**, neither the ground plans nor the Gamma Map tell us who is allowed to enter the 'holy-of-holies', but only that some kind of entry is present; **A** is therefore the correct answer.

UNIT 3

The definitions from *The Devil's Dictionary* parody conventional dictionary definitions in their formal and serious style. To interpret their meaning candidates need to perceive the cutting wit embedded in the bland manner. Use of the word 'cynically' in the introduction directs candidates to the broad tonal character of the definitions.

Question 12 C

The usual meaning of 'impartial' is closest to alternative **D**, lack of prejudice. However *The Devil's Dictionary's* definition undermines the very possibility of such a notion of impartiality. The unstated premise is that people are motivated by self-interest, and that no-one would bother to take sides on an issue unless they had something to gain by doing so. 'Personal advantage' is the key phrase in this explanation of 'impartial'. There is no suggestion in the definition that one who is impartial is indecisive (alternative **A**). Alternative **B** is more seductive, since the phrase 'unable to perceive' might be construed in another context as lack of insight. However, here the point of the criticism is not that people are too blind to recognise personal advantage, but that they are all too likely to recognise nothing else.

Question 13 C

The essence of this definition is its even-handedness: in a marriage the husband is both master and slave, the wife is both mistress and slave. Both husband and wife are defined as simultaneously dominant and dominated within the relationship, pointing directly to alternative **C**, and precluding **B** and **D**, both of which suggest that one partner exclusively has authority over the other. In its fastidious choice of words, 'the state or condition...', the definition implies that this paradoxical 'community' is peculiar and special, rather than representative of society at large (alternative **A**).

Question 14 A

Although this is ostensibly a definition of the word 'obstinate', what is actually being defined is the character of those who apply the word 'obstinate' to others. According to *The Devil's Dictionary* 'obstinate' is a word used by the vain and self-righteous. The word 'our' ('our advocacy') makes it clear that we are hearing the voice of a character, someone who calls others 'obstinate'. The arrogance of such a person is betrayed by their vanity in using the plural pronoun ('our' instead of 'my'), their pompous language ('manifest', 'splendour'), and by their conviction that they have certain access to the truth.

Alternatives **B**, **C** and **D** focus on construing the attitude of an 'obstinate' person, about which the definition is effectively neutral. The correct answer, **A**, is the only alternative that focuses on the character of the person offering the definition.

UNIT 4

Unit 4 asks candidates to assess, distinguish and compare the very different attitudes to montage and filmmaking of two closely associated film-making contemporaries. Pudovkin and Eisenstein. Answering the questions requires careful reading of explicit and implicit meanings.

Question 15 **C**

Pudovkin views the film as the finite design of the director, its artist, with the process by which the film is put together depending entirely on the director's choices, or discrimination. Clearly 'technical expertise' (**D**) is necessary, but according to Pudovkin it is the director's capacity to discriminate between the superfluous and the significant that makes film an art.

Question 16 **A**

The range of answers was set up to get candidates to identify the meaning of ideal in the context of the passage. Compared to a theatre director's degree of control over what his viewer sees, the film director's is absolute, and this is what makes his spectator 'ideal'.

Question 17 **A**

This question is somewhat harder than Question 16 in that it asks candidates to generalise from the evidence in the passage (including language) concerning the director's perception of the film itself as the goal and focus of his thoughts. 'Clarifying force' is a summation both of his vision and the processes which attain it. Pudovkin refers to the audience distantly as an 'observer' and 'spectator' rather than as immersed in any kind of 'experience' (**B**).

Question 18 **D** and

Question 19 **B**

As with Question 15, the purpose of these first questions on the Eisenstein passage is to appreciate the film maker's special attitude to film and its construction. Eisenstein's forceful language as well as his descriptive view of Pudovkin's attitude to shots make it very clear that for Eisenstein, film is essentially dynamic.

Question 20 **C**

It is an original concept that art arises not from an arrangement of elements but from the struggle between them. The candidate is asked to be aware of this in selecting an answer which relies on process rather than on descriptive effect.

Question 21 **D**

Pudovkin regards the shot as precise and unchanging, whereas Eisenstein views it as a living cell. This means that their concepts of montage, the 'phalanx' (for Eisenstein) or 'sequence' (for Pudovkin) of shots, are essentially different. Distractors about the film's use (**A**) or shooting the film (**B**) are irrelevant. Both passages as well as the question focus on the concept of composition (**D**) rather than the end result (**C**).

UNIT 5

This piece requires careful scrutiny of language and the ability to distinguish between different registers of language used by the theatrical character Carr. Candidates (like the audience in the theatre) need to recognise Carr's real opinion of James Joyce beneath the publically acceptable form of literary expression he uses in his memoirs.

Question 22 **B**

Candidates in this question need to consider what 'without primness' means in relation to hard cash. Carr has worked out from 'tight-fisted' and 'sponging' in the last line.

Question 23 **B**

The paradox of the language should guide the candidate to appreciate how Carr undercuts what looks like a compliment with a phrase which totally reverses it. Thus to describe a person as wanting the world to know how private he would like to be, is to say that the person is a sickening show-off.

Question 24 **D**

There is little evidence in the passage to indicate that Carr felt much pride or affection or constraint towards James Joyce from his reactions to him; hence **A**, **B** and **C** are incorrect. There is for Carr an element of pleasure in including his association with Joyce in his memoirs, but recalling his actual dealings with him makes him utterly incensed. This is indicated in the way the language changes from restrained elegance to spitting invective.

UNIT 6

This unit requires candidates to understand the combination of verbal and pictorial information conveyed by cartoons.

Question 25 **D**

This question tests candidates' ability to think laterally and flexibly in evaluating the plausibility of several propositions, even if they prefer one of them above the others, or an entirely different interpretation. Comment I is clearly plausible, because the cartoon shows an impersonal juxtaposition of a legalistic contract (with its 'cooling-off' clause) and a terminally ill, vulnerable and apprehensive person: the words spoken by the doctor (especially the 'Of course') seem remote and matter-of-fact, suggesting that the 'Mercy Contract' is insensitive and simplistic. Comment II is not plausible, because the cartoon implies that the 'contract' contains legal clauses that may concern or disturb terminally ill patients. Comment III is plausible, because it reiterates the cartoon's message that the legalese in the contract will diminish patients' understanding; though the patient in this cartoon may well not sign the proffered contract, she is clearly in a very vulnerable position, with the doctor standing over her and expecting her to sign the contract without reading the 'fine-print' (note that he gives her a pen along with the contract, as if to say, 'Don't worry, just sign here'); this graphic device may be construed as showing the patient's diminished freedom of choice. Comment IV is implausible because, on the face of it, the cartoon suggests that the explicit intention of the Mercy Contract is to protect the rights of terminally ill patients above all. The correct response is therefore **D**.

Question 26 **C**

This question requires candidates to assess the attitude or tone of the cartoon, in terms of its two main pictorial entities: the Northern Territory spokesperson on euthanasia and the Southern States Moral Leaders. The former is portrayed in a mainly negative light: illiterate (misspellings on the placard), inarticulate (vernacular greeting), uncultured (shorts, thongs, floral shirt, beer can in hand), and dirty (flies buzzing around hat). Though some of these graphic devices might be construed as representing the down-to-earth and 'folksy'—typifying a 'dinkum Aussie battler'—in an endearing way, the cartoon suggests that this serious, central issue is being handled in an improperly parochial manner. The Moral Leaders are portrayed as impersonal, nameless and colourless (similar clothes, similar facial features and expressions), while use of the abbreviation 'Inc.' (for 'Incorporated') in the title suggests a completely inappropriate framework (big business) for dealing with such an issue.

UNIT 7

This unit involves the analysis, interrelation and assessment of arguments. The extracts are taken from Machiavelli's *The Prince* and illustrate that his political advice is not in reality as diabolical as history often relates. The unit is designed to test the ability of candidates to make themselves aware of positions both implied and stated in the material.

Question 27 **D**

This question asks for a global description of the considerations underpinning the extracts.

Question 28 **C**

Answering this question correctly depends on working out what the kind of advice offered assumes about human nature. People may of course be **A**, **B** or **D**, but this does not make them a threatening problem for a ruler. However if they can be tricked (I), if they are able to be made to fear (III), and if they are likely to be 'not virtuous' (IV), it is implied that they deserve the kind of treatment recommended by the writer.

Question 29 **D**

The writer regards prowess as desirable (V) but not at the expense of success as a ruler. Comment II specifically sets necessity above morality: thus necessity is the criterion for judgment and not morality as **C** would suggest. Candidates who suppose **C** to be the answer are missing the thrust of the passage, whose central purpose is to indicate the means by which success may be achieved. Hence the action, whatever it may be, is justified by its purpose or intention (**D**).

Question 30 **C**

According to Machiavelli, ruling is very much an ad hoc process and not at all finite or categorical: hence the ruler needs most to be able to evaluate each situation as it comes. General benevolence (**B**) or degrees of stubbornness or severity (**A** and **D**) are relevant in some instances but what always counts is the ruler's ability to assess the situation of the moment.

Question 31 **D**

This question asks the candidate to consider what the consequence of hatred is from the point of view of the ruler's security. What is key here is the degree of intransigence of the ruled, as subjects who hate will not fear but will go to any lengths to get back at the ruler and thus will form a threat to his control.

Question 32 **B**

The writer's attitude in the text is not cynical (**A**) but purely analytical. The writer acknowledges in II and V that goodness has intrinsic merit even if it is subject to the pitfalls referred to in Comment IV: hence the answer, **B**. **C** is wrong because it focuses only on the merits of goodness, and **D** is wrong because it does not make sufficient allowance for the value of honesty and suggests that any advantages gained by an honest ruler will have only occurred by accident.

Question 33 **A**

The comments consistently emphasise the frank acknowledgment that human nature and human behaviour are contradictory. Alternative **A** summarises this idea.

UNIT 8

This unit tests candidates' ability to understand a complex process that is shown both verbally and spatially, as to understand the rationale behind the process.

Question 34 **B**

The purpose of the loop is specified in the sentence before Step 1. Of all the factors mentioned in that sentence (loops, leaders and wires), it is only the type of leader (monofilament) that is specified. Thus **B** is the correct response.

Question 35 **D**

This question requires candidates to relate the various parts of the fixed-loop knot given in the verbal directions to the illustrations. The written instruction Step 1, together with Diagram 1, identifies the 'tag' as the free (arrowed) end of the leader, labelled IV in Diagram 4. Step 1 also identifies the 'overhand loop' (I), and Step 4 describes the 'grinner' (II). Thus alternative **D** is the correct answer.

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 socio-cultural issues and calls for an expository or argumentative response. Task B deals with more interpersonal and intrapersonal issues and invites a more personal and discursive response.

From 2004 there will be a slight change in the format of this section. Each task provides a theme and a number of ideas relating to that theme. Candidates must respond to one or more of the ideas given.

Performances on the Written Communication section of GAMSAT are assessed against the criteria shown below. Markers take into account both the quality of a candidate's thinking about a topic and the control of language demonstrated in their development of a piece of writing. Although both these issues are important, more emphasis is given to generative thinking (thought and content) than to control of language (organisation and expression).

CRITERIA FOR THE ASSESSMENT OF GAMSAT WRITING

THOUGHT AND CONTENT

(the quality of what is said)

- what is made of and developed from the task
- the kinds of thoughts and feelings offered in response to the task

ORGANISATION AND EXPRESSION

(the quality of the structure developed and the language used)

- the shape and form of the piece
- the effectiveness and fluency of the language

Reasoning in Biological and Physical Sciences

UNIT 1

A basic understanding of human circulation would help in answering the questions in this unit.

Question 1 B

Before birth, oxygen is supplied through the placenta and the resulting oxygenated blood passes through the fetal vein. The oxygenated blood from the fetal vein mixes with deoxygenated blood just before point M, producing a partially oxygenated mixture. After birth, oxygen is (instead) supplied by the lungs. Thus, after birth, point N will be close to a source of highly oxygenated blood whereas, before birth, the blood reaching it had a lower degree of oxygenation. After birth, oxygenation of blood at point L will not be much different than before, the blood still being deoxygenated, and oxygenation of blood at point M will be less than before because the placenta no longer supplies oxygen.

Question 2 D

Based on the explanation given for Question 1, blood should be more oxygenated at P and K, and equally oxygenated at L.

Question 3 D

This can be obtained by a simple transformation of the units given in Equation (1).

Question 4 A

By analogy with the situation depicted in Figure 2, the source of additional substance (in this case oxygen) is the lungs.

Question 5 C

$$\begin{aligned}\text{cardiac output } (F) &= \frac{\text{quantity of O}_2 \text{ per minute}}{\text{change in concentration of O}_2} \\ &= \frac{240 \text{ mL/min}}{180 - 120 \text{ mL/litre}} \\ &= 4 \text{ litre/min}\end{aligned}$$

UNIT 2

This unit requires candidates to have a knowledge of acid/base theory and to be able to use the information supplied to deduce the effects of electronegativity on acid strength.

Question 6 D

The strongest base is the conjugate of the weakest acid, CH_3COOH .

Question 7 B

Fluorine has the strongest electron withdrawing ability, and the effect of having two fluorine atoms will be greater than the effect of just one.

Question 8 D

The three compounds I, II and III, have single, double and triple bonds between the carbon atoms in the chain and so hybrid orbitals that are sp^3 , sp^2 and sp respectively. As the sp hybrid orbitals have the strongest electron withdrawing ability, they will produce the strongest acid.

UNIT 3

This unit requires an understanding of the basic principles of osmosis. A general understanding of topics such as the GI tract, interstitial fluid and the sodium pumps would help.

Question 9 C

This requires knowledge and application of basic principles relating to osmosis. Note that option **B** can be seen as contradictory, and is therefore not the **best** answer.

Question 10 B

Diarrhoea requires an increase of water in the intestine. Only in the representation given in **B** is there an indication that the intra-intestinal ion level could be raised, keeping water in the intestinal lumen.

Question 11 B

Like the previous question, this item tests understanding of the relationship between ion concentration and water movement, as well as knowledge of the basic function of sodium pumps. Only in **B** would a high sodium level occur in the lumen, retaining water there and leading to diarrhoea.

UNIT 4

This unit deals with change in speed of blood flow between two points in an artery, assuming constant acceleration for the blood flow.

The unit assesses candidates' knowledge of motion with constant acceleration and the ability to solve a problem for this kind of motion.

Question 12 B

One approach to the solution is to use the average speed of the blood flow between the two points, which was

$$\frac{0.30 \text{ m s}^{-1} + 0.20 \text{ m s}^{-1}}{2} = 0.25 \text{ m s}^{-1}.$$

The time the blood took to flow between the two points was

$$\frac{0.50 \text{ m}}{0.25 \text{ m s}^{-1}} = 2.0 \text{ s}.$$

Thus the acceleration of the blood flow was

$$\frac{0.20 \text{ m s}^{-1} - 0.30 \text{ m s}^{-1}}{2.0 \text{ s}} = \frac{-0.10 \text{ m s}^{-1}}{2.0 \text{ s}} = -0.05 \text{ m s}^{-2}.$$

That is, the blood flow slowed at a rate of 0.05 m s^{-2} .

Alternatively, the kinematics equation $v^2 = u^2 + 2 a s$ could be used.

UNIT 5

This item requires no specialist knowledge. It aims to test quantitative reasoning skill in a general way.

Question 13 D

$$\frac{1}{200} \times 150 = \frac{1}{600} \times 450$$

UNIT 6

This unit requires candidates to have a knowledge of colligative properties; in this case, freezing point depression. The information supplied must be interpreted and applied to the given formula.

Question 14 A

As the benzoic acid forms dimers, the number of particles in solution is effectively halved. As the freezing point depression depends on the number, not the size or type, of particles, it will be half of that expected.

Question 15 D

Let x be the molar mass of the solute. The molality of the solution m (i.e. the number of moles of solute in 1000 g of water) is equal to $\frac{40}{x}$. A drop in the freezing point of 0.40°C is produced in an aqueous solution. Water has a molal freezing point depression constant of 1.86°C per mole per kg. Substituting these values into the equation gives $0.40 = 1.86 \times m$. Thus, $0.40 = 1.86 \times \frac{40}{x}$ and so $x = \frac{(1.86 \times 40)}{0.40} = 186$. The molar mass (or molecular weight) is 186.

UNIT 7

In answering the questions in this unit it would be helpful to have a general knowledge of tissue and organ function, metabolic rate, and aerobic and anaerobic respiration.

Question 16 A

This item tests comprehension of the situation and the quantity conventions, and requires the appropriate calculation to be made on the basis of that comprehension (i.e. $25 \times \frac{4500}{100} = 1125$ mL, which is highest).

Question 17 B

Only **B**, the resumption of flow to the muscles that enables clearance of lactic acid, explains why blood lactic acid rises at this particular stage (e.g. against **A**, anaerobic respiration occurs throughout the dive; contrary to **C**, resurfacing should lead to a decline in lactic acid production; and contrary to **D**, carbon dioxide is not converted to lactic acid).

Question 18 C

Three of the options are reasonable: **A** (reduced blood flow to the retina in the dark), **B** (increased flow to brain cortex) and **D** (decreased flow to heart and lungs). However, the fact that lactic acid is toxic to muscle cells is not consistent with reducing the blood flow to muscle cells because the toxic lactic acid cannot be cleared. (Clearly there are other considerations which make this apparently poor adaptation an appropriate one.)

UNIT 8

This unit requires candidates to have a knowledge of the structure of organic molecules and to be able to apply this knowledge to the information supplied. Spatial relationships between two structural conventions for saccharides must be determined.

Question 19 B

The same groups ($-\text{CH}_2\text{OH}$ and an $-\text{OH}$) are attached in the same orientation to the two carbon atoms that are to the left of (anticlockwise) the cyclic oxygen atom in the two Haworth structures. Thus, the lower part of the Fischer structure of fructose must be the same as that for glucose.

Question 20 D

A comparison of the relative positions of the $-\text{OH}$ groups up and down on the Haworth structure and on each side of the Fischer structure needs to be made for the initial monosaccharide and this extended to the pairs of structures.

Question 21 A

A comparison of the relative positions of the $-\text{OH}$ groups up and down on the Haworth structures and on each side of the Fischer structures needs to be made in order to deduce the convention that is used.

UNIT 9

This unit deals with the formation of real images by a thin converging lens. It assesses candidates' knowledge of properties of thin converging lenses in forming images and their ability to derive image positions and magnification.

Question 22 D

One approach to the solution is geometrical, another is through the lens equation, $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$, with appropriate sign rule. The latter is given here.

With $u = 0.30 \text{ m}$ and $f = 0.20 \text{ m}$ the lens equation gives

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{0.20 \text{ m}} - \frac{1}{0.30 \text{ m}} = \frac{0.10}{0.06 \text{ m}}.$$

Question 23 C

A two-dimensional geometrical construction of rays from object to image via the lens shows that the linear (transverse) magnification produced by the lens is $\frac{v}{u}$, where u is the object distance and v is the image distance from the lens.

In this case $u = 30 \text{ cm}$ and $v = 60 \text{ cm}$ and hence the magnification is 2. The size of the image is thus $2 \times (2 \text{ cm} \times 3 \text{ cm}) = 4 \text{ cm} \times 6 \text{ cm}$.

UNIT 10

This unit requires an application of the basic rules of genetic crosses.

Question 24 **C**

Yy crossed with Yy produces one YY, two Yy and one yy. However, the YY is lethal.

Question 25 **C**

Since all the F_1 must be spotted, this can be treated as a $Yy \times Yy$ cross without resorting to a dihybrid cross technique.

UNIT 11

This unit assesses candidates' knowledge of the particles present in the nuclei of common atoms (all examples are from the first 20 elements of the Periodic Table).

Question 26 **D**

As the atomic number of all hydrogen atoms is 1, all of its isotopes will exhibit NMR regardless of whether their mass numbers are odd or even.

Question 27 **B**

Either the mass or the atomic number of all four nuclei in **B** are odd and so all will exhibit NMR. Nuclei that have even atomic and mass numbers, and so will not exhibit NMR, are present in each of the other alternatives (all four nuclei in **A**, oxygen-18 in **C** and carbon-12 in **D**).

Question 28 **C**

If the number of protons—the atomic number—is even, then the number of protons plus neutrons—the mass number—must be odd for the nucleus to exhibit NMR. Hence, the number of neutrons must be odd. If the number of protons is odd, NMR will be exhibited by nuclei with either odd or even mass numbers, i.e. the number of neutrons may be either odd or even.

UNIT 12

This unit requires candidates to have a knowledge of electrochemistry, particularly the application of reduction potentials to both inorganic and organic half equations.

Question 29 **B**

The reduction of Br_2 has an E° that is lower than that of Cl_2 but higher than I_2 . Thus, it will oxidise I^- but not Cl^- .

Question 30 **C**

To reduce the H^+ ions to H_2 , a reaction with a lower (negative) E° value is needed. Only the Zn^{2+}/Zn reaction has a negative E° value in the list given as Table 1.

Question 31 **D**

Reducing agents are themselves oxidised when they react and so are found on the right side of the table. The strongest reducing agent has the most negative reduction potential.

Question 32 **D**

Two moles of electrons are transferred in the reaction, so $n = 2$. Substituting this with the other values into the equation produces $\log_{10} K_{eq} = 2 \times \frac{1.02}{0.06} = 34$. Thus, $K_{eq} = 10^{34}$.

Question 33 **A**

As electrons flow from the M/M^{2-} half-cell to the SHE, the M/M^{2-} must have a negative $E^{\circ'}$ value, i.e. -0.26 V. As electrons flow from the M/M^{2-} to the N/N^{2-} , the N/N^{2-} must have an $E^{\circ'}$ that is more positive than the $E^{\circ'}$ for M/M^{2-} , i.e. it cannot be -0.34 V so it must be $+0.34$ V. The difference between these values is 0.60 V.

UNIT 13

This unit requires no special knowledge. It aims to test the ability of candidates to deal with information presented verbally and graphically, and apply this information to quantitative items.

Question 34 **B**

For a Froude number of 20, $\frac{s}{l}$ is approximately 6. Since $l = 0.2$, $s = 1.2$.

Question 35 **D**

Using the mammal model as indicated, the information suggests that the change occurs when the Froude number = 2.5 (i.e. solve for v when $2.5 = \frac{v^2}{gl}$, where g and l are known). Or, estimating on the basis of Figure 2 gives a Froude number of about 3 and a similar answer.

Unit 14

This unit assesses the candidates' knowledge of many aspects of organic chemistry—structural isomers, empirical formulae and identifying types of reactions.

Question 36 **A**

Structural isomers have the same molecular formula but differ in the arrangement of the atoms in the molecule. Both glucose and fructose have the same molecular formula— $C_6H_{12}O_6$ —but a different ring structure.

Question 37 **B**

The empirical formula (EF) is the simplest whole number ratio of the atoms in a molecule. They are as follows: fructose, glucose and glyceraldehyde are all CH_2O ; succinic acid is $C_2H_3O_2$; oxalosuccinic acid is $C_6H_6O_7$; fumaric acid is CHO ; oxaloacetic acid is $C_4H_4O_5$.

Question 38 C

The molecular formula of malic acid is $C_4H_6O_5$ while that of fumaric acid is $C_4H_4O_4$, i.e. a difference of H_2O . A water molecule has added across the double bond of the fumaric acid.

Question 39 C

There are four hydroxy groups attached directly to carbon atoms in the six-membered ring of the glucose molecule. Therefore, the molecular formula of this new artificial sweetener is $C_6H_8Cl_4O_2$ and so the empirical formula is $C_3H_4Cl_2O$.

UNIT 15

This unit deals with the physical principles that underpin the operation of a mass spectrograph, an apparatus for measuring the mass to charge ratio of ions. The mass spectrograph described involves a particular arrangement of electric and magnetic fields designed to channel ions onto a photographic plate.

The unit requires candidates to have a basic understanding of the motion of charged particles in electric and magnetic fields and the forces on the particles due to these fields. Formulas for these forces are provided for the particular situation illustrated.

Questions 40 to 42 deal with positively charged ions and Question 43 deals with negatively charged ions.

Question 40 B

For the positively charged ions to pass through the narrow circular hole S_3 , they must not be deflected from their initial straight path, fixed by holes S_1 and S_2 . No deflection will occur if in the regions between the plates M and N the force due to the electric field exactly cancels the force due to the magnetic field. That is, the forces are parallel, oppositely directed, and have the same magnitude.

This means, from the given formulas, that $QE = QvB_1$, where v is the speed of the ions in the beam.

This yields $v = \frac{E}{B_1}$.

Question 41 C

After passing through hole S_3 the ions enter a region of the apparatus where a magnetic field \vec{B}_2 acts. This field is perpendicular to the plane depicted in the figure. Because the velocity of each ion in the beam is perpendicular to this magnetic field, the force on an ion from this field is parallel to the plane and is directed such that the ion describes a circular path as illustrated. The centripetal force on an ion is given by $\frac{mv^2}{r} = QvB_2$, where m and v are the mass and speed of the ion. This yields $\frac{m}{Q} = \frac{rB_2}{v}$. This relation shows that when the velocity of an ion is fixed, the mass to charge ratio for the ion depends on only the radius of its circular path and the magnitude of the magnetic field. Thus the particular arrangement of electric and magnetic fields in the region between plates M and N is designed to achieve constant velocity for the ions. (See also the discussion for Question 40.)

Question 42 A

From the discussion for Question 41, $\frac{mv^2}{r} = QvB_2$. That is $v = \frac{QrB_2}{m}$.

Question 43 B

To use the apparatus with negatively charged ions, the ions would also have to pass undeflected through the region between the plates M and N, and then follow circular paths to the photographic plate in the region where \vec{B}_2 acts.

In the region between plates M and N the directions of the electric and magnetic forces on a negatively charged ion are just the reverse of those for a positively charged ion. In each case, by adjusting the magnitudes of the electric

and magnetic fields the two forces can be made to give a zero net force. When this occurs the ions pass undeflected through hole S_3 .

However, in the region where \vec{B}_3 acts, the direction of \vec{B}_2 must be reversed to allow the negatively charged ions to strike the photographic plate. If \vec{B}_2 were not reversed, the negatively charged ions would follow circular paths to the right of S_3 , away from the photographic plate.

Hence to accommodate the negatively charged ions it would be simplest to reverse the direction of \vec{B}_3 only.

UNIT 16

This unit can be tackled using a minimal understanding of metabolic pathways. However, the last item requires knowledge of the structure and function of bacteria as procaryotes.

Question 44 A

Indole most likely builds up if there is an error at step 4 (the last step), which corresponds to try-1.

Question 45 A

Figure 1 is consistent with Table 1.

Question 46 C

Since only indole or tryptophan will allow growth, the error is at step 3.

Question 47 A

This follows from a knowledge of bacterial (procaryote) structure and function.

UNIT 17

This unit requires candidates to have a knowledge of acid/base theory, stoichiometry and the interpretation of the supplied information.

Question 48 A

For any reaction that is effectively complete, the equilibrium constant (here it is K_a) must be extremely high. As $pK_a = -\log_{10} K_a$, then pK_a must be very negative.

Question 49 B

As one $\text{Ca}(\text{OCl})_2$ produces two OCl^- ions when dissolved, the concentration of OCl^- ions in the pool will be $2 \times \frac{0.50}{20\,000} = 5 \times 10^{-5}$ moles of OCl^- per litre.

Question 50 C

The hydrolysis reaction of NCl_3 is $\text{NCl}_3 + 3\text{H}_2\text{O} \rightarrow 3\text{HOCl} + \text{NH}_3$; its molar mass is 120.5.

Thus, the number of moles of OCl^- ions produced by 1000 g of NCl_3 would be $3 \times \frac{1000}{120.5} \approx 25$.

For the others, 1000 g of NaOCl produces $1 \times \frac{1000}{74.5} \approx 13$; 1000 g of $\text{Ca}(\text{OCl})_2$ produces $2 \times \frac{1000}{147} \approx 14$; and

6 Summary of Answers to Practice Questions

Reasoning in Humanities and Social Sciences

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

Reasoning in Biological and Physical Sciences

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