Yocket Prep

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dMAT General Academic Module | Practice Set 2

Four passage-based exercises
with answers and explanations

4 exercises **27** questions **90 min** exam pace

The General Academic Module is the Subject Module of the dMAT. This set follows its format: each exercise has a passage, often with a table or a figure, followed by single-choice questions. The exercises are original practice material prepared by Yocket Prep and are not taken from any official dMAT paper.

Prepared by the Yocket Prep team

How to use this set

This set contains four new practice exercises in the format of the dMAT Subject Module (General Academic Module), on topics that are not covered in the official preparatory materials: computational science, economics, physics and history.

Each exercise has a passage followed by single-choice questions with four options. Exactly one option is correct. Everything needed to answer is in the passage, the tables and the figures, so no memorised specialist knowledge is required.

Work without notes, as in the exam. To match the exam pace of 90 minutes in total, allow about 20 to 22 minutes per exercise. Solutions with short explanations are at the end of the document and should be opened only after all four exercises have been attempted.

Exercise 1 | Data Compression and Run-Length Encoding

Computers store text, images and sound as long sequences of symbols. Data compression reduces the number of symbols that are needed to store the same information. A compression method is called lossless if the original data can be rebuilt exactly from the compressed version, and lossy if some detail is permanently lost. Photographs and music are often stored with lossy methods, whereas documents and programs need lossless methods.

A simple lossless method is run-length encoding (RLE). A run is a block of identical symbols that follow one another without interruption. RLE replaces each run by the symbol followed by the length of the run, written as an ordinary decimal number. For example, the text AAAABBC consists of three runs and is encoded as A4B2C1. To decode, each symbol is repeated as often as the number after it says.

For the purpose of this exercise, every letter and every digit counts as one symbol, so that a run of length 12 needs two digits. The compression ratio is the number of symbols before compression divided by the number of symbols after compression. A ratio above 1 means that the data became shorter, and a ratio below 1 means that it became longer.

Text	RLE version	Symbols before	Symbols after
AAAABBC	A4B2C1	7	6
ABCDEF	A1B1C1D1E1F1	6	12
AABBAABB	A2B2A2B2	8	8
WWWWWWWWWWWW (12 times W)	W12	12	3

Table 1. Four texts and their run-length encoding

RLE works well when the data contains long runs, as in a simple drawing with large areas of one colour. It works badly when neighbouring symbols are mostly different, because every single symbol then needs an additional digit.

Question 1

Which is the run-length encoding of the text XXXYYZZZZZ?

a) X3Y2Z4
b) 3X2Y5Z
c) X3Y2Z5
d) X3Y3Z5

Question 2

Which text is obtained by decoding A3B1C4?

a) AAABCCC
b) AAABCCCC
c) ABBBCCCC
d) AAABBCCCC

Question 3

A text consists of 12 letters W in a row and is encoded as W12. What is the compression ratio?

a) 12
b) 3
c) 0.25
d) 4

Question 4

For which of the following texts does run-length encoding produce a longer result?

a) ABABAB
b) AAAAAAAAAA
c) AAAABBBB
d) AAAAAABBBBBB

Question 5

One row of a black-and-white image has 100 pixels: 60 white, then 15 black, then 25 white. It is written as W for white and B for black. How many symbols does the encoded row have?

a) 3
b) 6
c) 9
d) 100

Question 6

Why is run-length encoding called a lossless method?

a) The original text can be rebuilt exactly from the encoded version.
b) The encoded version is always shorter than the original.
c) It removes details that readers are unlikely to notice.
d) It uses fewer digits than letters.

Question 7

A text of 1,000 symbols consists of four runs of equal length: 250 letters A, then 250 letters B, then 250 letters C, then 250 letters D. What is the compression ratio of its RLE version?

a) 250
b) 62.5
c) 4
d) 16

Exercise 2 | Opportunity Cost and Comparative Advantage

Resources such as time, workers and land are limited, so using them for one purpose means giving up another. The opportunity cost of a choice is the value of the best alternative that is given up. If a worker can produce either 2 machines or 12 tonnes of grain in one week, the opportunity cost of one machine is the amount of grain that the same worker could have produced instead.

A country has an absolute advantage in a good if it can produce more of it with the same resources than another country. A country has a comparative advantage in a good if its opportunity cost of producing it is lower than that of the other country. A country can have an absolute advantage in every good and still have a comparative advantage in only one of them, because opportunity costs are relative.

Economists argue that countries gain when each specialises in the good in which it has a comparative advantage and then trades. Trade is mutually beneficial if the price at which the goods are exchanged lies between the two countries' opportunity costs. Table 1 shows what one worker can produce in one week in two countries, Alpha and Beta. A worker produces either machines or grain in a given week, and production is proportional to the time used.

Country	Machines per worker-week	Tonnes of grain per worker-week
Alpha	2	12
Beta	1	3

Table 1. Weekly output of one worker in two countries (hypothetical values)

Question 1

What is the opportunity cost of producing one machine in Alpha?

a) 12 tonnes of grain
b) 6 tonnes of grain
c) 2 tonnes of grain
d) 0.5 tonnes of grain

Question 2

What is the opportunity cost of producing one machine in Beta?

a) 1 tonne of grain
b) 6 tonnes of grain
c) 1/3 tonne of grain
d) 3 tonnes of grain

Question 3

Which country has a comparative advantage in producing machines?

a) Beta, because its opportunity cost of a machine is lower.
b) Alpha, because it produces more machines per worker.
c) Alpha, because it is more productive in both goods.
d) Neither, because Alpha is more productive in both goods.

Question 4

Which statement about the two countries is correct?

a) Alpha has a comparative advantage in both goods, because it has an absolute advantage in both.

b) Beta has an absolute advantage in machines, because its opportunity cost is lower.

c) Alpha has an absolute advantage in both goods, but a comparative advantage only in grain.

d) Trade cannot benefit Alpha, because Beta is less productive in both goods.

Question 5

Alpha specialises in grain, Beta specialises in machines, and they trade at the price of 1 machine for 4 tonnes of grain. Who benefits compared with producing everything at home?

a) Only Alpha.

b) Both countries.

c) Only Beta.

d) Neither country.

Question 6

Between which prices, measured in tonnes of grain per machine, is trade mutually beneficial?

a) Between 1 and 3 tonnes

b) Between 6 and 12 tonnes

c) Between 3 and 6 tonnes

d) Above 12 tonnes

Question 7

Beta's workers become twice as productive in machines and now make 2 machines per week, while their grain output stays at 3 tonnes. What is Beta's new opportunity cost of one machine?

a) 3 tonnes of grain

b) 6 tonnes of grain

c) 0.67 tonnes of grain

d) 1.5 tonnes of grain

Exercise 3 | Waves, Frequency and Echoes

A wave transports energy through a medium without transporting the medium itself over a long distance. Sound is a wave in which air or another material is alternately compressed and expanded. The frequency f of a wave is the number of oscillations per second and is measured in hertz (Hz). The period T is the duration of one oscillation, so T = 1 ÷ f. The wavelength λ is the distance between two successive crests.

The speed v of a wave is linked to its frequency and wavelength by the relation:

$$v = f \cdot \lambda$$

The speed of sound depends on the medium but not on the frequency of the sound. In air it is about 340 m/s, and in water it is about 1,500 m/s. When a wave passes from one medium into another, its frequency stays the same, while its speed and wavelength change.

An echo is sound that is reflected by an obstacle. If a sound signal needs a time t to travel to an obstacle and back, the distance d to the obstacle is d = v · t ÷ 2, because the signal covers the distance twice. Ships use this principle in sonar to measure the depth of the sea.

Tone	Frequency (Hz)
A	170
B	340
C	680

Table 1. Three sound tones, played in air

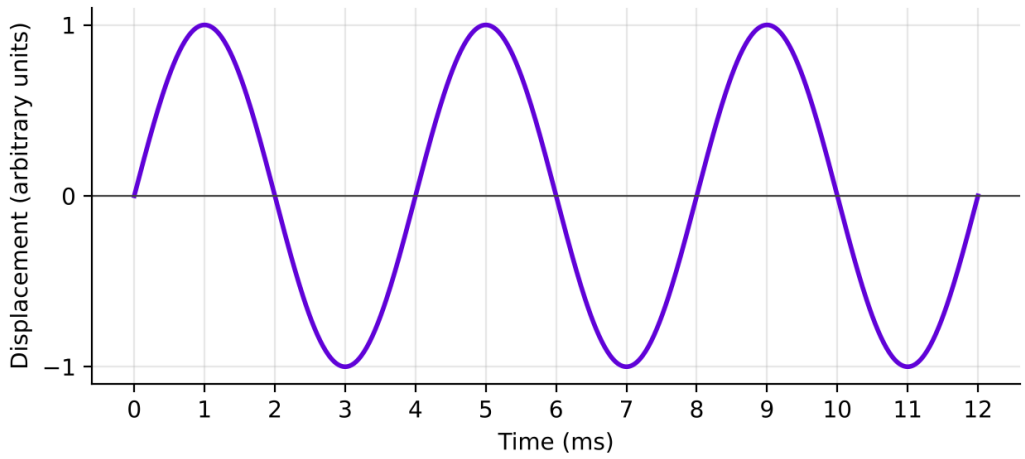


Figure 1. Displacement of the air at one point over time for a sound wave (constructed example)

Question 1

What is the wavelength of tone B in air?

a) 0.5 m
b) 2.0 m
c) 1.0 m
d) 340 m

Question 2
Which tone has the shortest wavelength in air?

a) Tone A
b) Tone C
c) Tone B
d) All three have the same wavelength.

Question 3
What is the frequency of the sound wave shown in Figure 1?

a) 250 Hz
b) 4 Hz
c) 25 Hz
d) 0.25 Hz

Question 4
A person shouts towards a cliff in air and hears the echo after 1.0 s. How far away is the cliff?

a) 340 m
b) 680 m
c) 85 m
d) 170 m

Question 5
A ship sends a sonar signal downwards. The echo from the seabed returns after 0.4 s. How deep is the water at that point?

a) 600 m
b) 300 m
c) 150 m
d) 3,750 m

Question 6
A sound wave of constant frequency passes from air into water. What happens to its wavelength?

a) It decreases, because the speed increases.
b) It stays the same, because the frequency stays the same.
c) It increases, because the speed increases while the frequency stays the same.
d) It increases, because the frequency increases.

Question 7
In air, the frequency of a sound is doubled. What happens to the wavelength?

a) It is halved.
b) It is doubled.
c) It stays the same.
d) It is multiplied by four.

Exercise 4 | Chronology and Periodisation

Historians place events in time with the help of a calendar. In the system used in most of the world, years are counted forwards from a starting point, written CE for years after it, and backwards for years before it, written BCE. There is no year 0: the year 1 BCE is followed directly by the year 1 CE. Because of this, the time between two years on different sides of the starting point is one year less than the sum of the two year numbers.

Centuries are counted in the same way. The 1st century CE consists of the years 1 to 100, the 2nd century CE of the years 101 to 200, and so on. For BCE, the order is reversed: the 1st century BCE consists of the years 100 BCE to 1 BCE, and the 2nd century BCE of the years 200 BCE to 101 BCE.

To handle long stretches of time, historians divide the past into periods, such as Antiquity or the Middle Ages. This is called periodisation. The boundaries between periods are not found in the sources but are chosen by historians, who select an event or a development that seems to mark a turning point. Different historians, or different regions, may choose different turning points, so the same year can belong to different periods. Period names such as the Middle Ages were usually introduced later, by people looking back at the past.

Table 1 lists four events in the history of the fictional city of Varen.

Event	Year
Founding of the city	120 BCE
Great fire	45 BCE
Treaty of the two rivers	31 CE
Completion of the harbour	215 CE

Table 1. Events in the history of the fictional city of Varen

Question 1

In which century CE was the harbour completed?

a) 2nd century
b) 3rd century
c) 4th century
d) 1st century

Question 2

In which century was the city founded?

a) 1st century BCE
b) 3rd century BCE
c) 2nd century BCE
d) 12th century BCE

Question 3
How many years passed between the great fire and the treaty?

a) 76
b) 14
c) 74
d) 75

Question 4
How many years passed between the treaty and the completion of the harbour?

a) 184
b) 185
c) 246
d) 215

Question 5
Which statement about periodisation is correct?

a) The boundaries between periods are objective facts that every source states.
b) The boundaries are chosen by historians and can differ depending on the question and the region.
c) All historians must use the same dates for the same periods.
d) Every period began on a precise year that contemporaries recorded.

Question 6
A historian claims that people living in the Middle Ages knew that they lived in an age between Antiquity and a later era. What does the passage suggest about this claim?

a) It is correct, because period names were used by the people living in the period.
b) It is correct, because every period name is taken from the sources.
c) It is doubtful, because period names were usually introduced later by people looking back.
d) It is irrelevant, because periods have no names.

Solutions

Exercise	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1 – Data Compression and Run-Length Encoding	C	B	D	A	C	A	B
2 – Opportunity Cost and Comparative Advantage	B	D	A	C	B	C	D
3 – Waves, Frequency and Echoes	C	B	A	D	B	C	A
4 – Chronology and Periodisation	B	C	D	A	B	C	–

Exercise 1 – Data Compression and Run-Length Encoding

Question 1 – **Solution: C.** The text has three runs: three X, two Y and five Z. Written as symbol plus length, this gives X3Y2Z5.

Question 2 – **Solution: B.** Each symbol is repeated as often as the number after it says: A three times, B once and C four times, giving AAABCCCC.

Question 3 – **Solution: D.** The text has 12 symbols before and 3 symbols after compression, so the ratio is 12 ÷ 3 = 4.

Question 4 – **Solution: A.** ABABAB has six runs of length 1 and is encoded as A1B1A1B1A1B1, which has 12 symbols instead of 6. The other texts have long runs and become shorter.

Question 5 – **Solution: C.** The row is encoded as W60B15W25. The symbols are W, 6, 0, B, 1, 5, W, 2 and 5, which makes 9 symbols.

Question 6 – **Solution: A.** A method is lossless if the original can be rebuilt exactly. Decoding RLE repeats each symbol as often as stated, which restores the original text completely.

Question 7 – **Solution: B.** Each run is encoded as a letter and the number 250, which makes 4 symbols. Four runs need 16 symbols. The ratio is 1,000 ÷ 16 = 62.5.

Exercise 2 – Opportunity Cost and Comparative Advantage

Question 1 – **Solution: B.** In one week Alpha can make 2 machines or 12 tonnes of grain. One machine therefore costs 12 ÷ 2 = 6 tonnes of grain.

Question 2 – **Solution: D.** In one week Beta can make 1 machine or 3 tonnes of grain, so one machine costs 3 tonnes of grain.

Question 3 – **Solution: A.** Beta gives up 3 tonnes of grain per machine, Alpha gives up 6 tonnes. The country with the lower opportunity cost has the comparative advantage.

Question 4 – **Solution: C.** Alpha produces more of both goods, so it has an absolute advantage in both. Grain costs Alpha 1/6 machine per tonne and Beta 1/3 machine per tonne, so Alpha's comparative advantage lies in grain.

Question 5 – **Solution: B.** Alpha obtains a machine for 4 tonnes of grain instead of the 6 tonnes it would give up at home. Beta obtains 4 tonnes of grain for one machine instead of the 3 tonnes it could produce itself. Both gain.

Question 6 – **Solution: C.** Beta will sell a machine only for more than the 3 tonnes it gives up, and Alpha will buy only if it pays less than the 6 tonnes it would give up. The price must lie between 3 and 6 tonnes.

Question 7 – **Solution: D.** Beta now gives up 3 tonnes of grain for 2 machines, so one machine costs 3 ÷ 2 = 1.5 tonnes. Its comparative advantage in machines becomes even larger.

Exercise 3 – Waves, Frequency and Echoes

Question 1 – **Solution: C.** $\lambda = v \div f = 340\ \text{m/s} \div 340\ \text{Hz} = 1.0\ \text{m}$.

Question 2 – **Solution: B.** The speed is the same for all tones, so the wavelength is smaller when the frequency is higher. Tone C has the highest frequency (680 Hz) and therefore the shortest wavelength (0.5 m).

Question 3 – **Solution: A.** One full oscillation takes 4 ms = 0.004 s. The frequency is $f = 1 \div T = 1 \div 0.004\ \text{s} = 250\ \text{Hz}$.

Question 4 – **Solution: D.** The sound travels there and back, so $d = 340\ \text{m/s} \times 1.0\ \text{s} \div 2 = 170\ \text{m}$.

Question 5 – **Solution: B.** d = 1,500 m/s × 0.4 s ÷ 2 = 300 m.

Question 6 – **Solution: C.** The frequency stays the same and the speed rises from about 340 m/s to about 1,500 m/s. Because λ = v ÷ f, the wavelength becomes longer.

Question 7 – **Solution: A.** The speed of sound in air stays the same. Since λ = v ÷ f, doubling the frequency halves the wavelength.

Exercise 4 – Chronology and Periodisation

Question 1 – **Solution: B.** The 3rd century CE consists of the years 201 to 300, so the year 215 CE falls into it.

Question 2 – **Solution: C.** The 2nd century BCE consists of the years 200 BCE to 101 BCE. The year 120 BCE lies in this range.

Question 3 – **Solution: D.** From 45 BCE to 1 BCE are 44 years, one more year leads to 1 CE, and a further 30 years lead to 31 CE. The total is 75 years. This equals 45 + 31 - 1, since there is no year 0.

Question 4 – **Solution: A.** Both years are CE, so the difference is 215 - 31 = 184 years.

Question 5 – **Solution: B.** The passage states that boundaries are chosen by historians, who may select different turning points. They are not found in the sources.

Question 6 – **Solution: C.** The passage states that period names were usually introduced later by people looking back. The claim that contemporaries used the name is therefore doubtful.

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