Yocket Prep

FREE DOWNLOADABLE PRACTICE SET

dMAT General Academic Module | Practice Set 1

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 | Algorithmic Complexity and Searching

An algorithm is a precise, step-by-step procedure for solving a problem. How efficient an algorithm is depends mainly on how the number of elementary operations grows as the size of the input, n, grows. For example, n can be the number of elements in a list.

Computer scientists describe this growth with Big-O notation. Big-O notation looks only at very large inputs. It therefore ignores constant factors and terms that grow more slowly. An algorithm that needs $3n^2 + 5n + 2$ operations is said to be in $O(n^2)$, because for large n the term n^2 dominates. Two algorithms in the same class can still differ considerably in practice for small inputs, since the ignored constant factors may be very different.

Table 1 lists common complexity classes, ordered from slowest-growing to fastest-growing.

Class	Name	Typical example	Effect of doubling n on the running time
$O(1)$	constant	reading one element of a list by its position	unchanged
$O(\log n)$	logarithmic	binary search	increases by a small constant amount
$O(n)$	linear	linear search	doubles
$O(n \log n)$	linearithmic	efficient sorting algorithms	slightly more than doubles
$O(n^2)$	quadratic	comparing every element with every other element	quadruples
$O(2^n)$	exponential	checking every possible subset of a set	is squared

Table 1. Common complexity classes

A classic task is searching for a target value in a list. Linear search checks the elements one after another until it finds the target or reaches the end of the list. It works on any list. In the worst case, when the target is in the last position or not in the list at all, it needs n comparisons.

Binary search only works on a list that is sorted. It compares the target with the middle element of the remaining range. If the target is smaller, the search continues in the left half; if it is larger, in the right half. Each comparison therefore halves the range that is still possible. In the worst case, binary search needs approximately $\log_2 n$ comparisons.

If a list is unsorted, it must be sorted before binary search can be used. Efficient sorting algorithms need $O(n \log n)$ operations. Whether sorting is worthwhile therefore depends on how often the list will be searched afterwards.

Question 1

An algorithm needs $4n^2 + 100n + 7$ operations for an input of size n. To which complexity class does it belong?

a) $O(n)$
b) $O(n \log n)$
c) $O(n^2)$
d) $O(2^n)$

Question 2

Binary search is used on a sorted list of 1,024 elements. Approximately how many comparisons are needed in the worst case?

a) about 10
b) about 32
c) about 512
d) 1,024

Question 3

An algorithm in $O(n^2)$ takes 2 seconds to process 10,000 elements. Approximately how long will it take to process 30,000 elements?

a) 6 seconds
b) 9 seconds
c) 18 seconds
d) 54 seconds

Question 4

Which statement about binary search is correct?

a) It can be applied to any list, regardless of the order of its elements.
b) It requires a sorted list, and each comparison halves the range in which the target can still be.
c) It always needs fewer comparisons than linear search, whatever the position of the target.
d) It belongs to the class $O(n)$, because in the worst case every element must be checked.

Question 5

A company needs to find one particular record in an unsorted list of n customer records. The search is carried out exactly once. Which approach is the most efficient, and what is its cost?

a) Linear search directly on the unsorted list, with a total cost of $O(n)$.
b) Sorting the list first and then using binary search, with a total cost of $O(\log n)$.
c) Sorting the list first and then using binary search, with a total cost of $O(n \log n)$.
d) Binary search directly on the unsorted list, with a total cost of $O(\log n)$.

Question 6

The same unsorted list of n records must now be searched n times, each time for a different record. Which approach is the most efficient overall?

a) Linear search for every query, with a total cost of $O(n)$.
b) Linear search for every query, with a total cost of $O(n^2)$.
c) Sorting the list once and then using binary search for every query, with a total cost of $O(n \log n)$.
d) Both approaches cost the same, because each query is treated separately.

Question 7

Algorithm A needs exactly 100n operations and algorithm B needs exactly n^2 operations. For which input sizes does algorithm A need fewer operations than algorithm B?

a) For all input sizes n.

b) Only for n greater than 100.

c) Only for n smaller than 100.

d) For none, because Big-O notation ignores constant factors, so both are equally fast.

Exercise 2 | Price Elasticity of Demand

For most goods, the quantity demanded falls when the price rises. How strongly it falls differs greatly between goods. Economists measure this sensitivity with the price elasticity of demand, E. It compares the percentage change in quantity demanded with the percentage change in price that caused it. Each percentage change is calculated relative to the initial value.

$$E = \%\Delta Q \div \%\Delta P$$

Because price and quantity usually move in opposite directions, E is normally negative. For simplicity, economists usually refer to its absolute value, |E|:

- Elastic demand ($|E| > 1$): the quantity changes by a larger percentage than the price.
- Inelastic demand ($|E| < 1$): the quantity changes by a smaller percentage than the price.
- Unit elastic demand ($|E| = 1$): both change by the same percentage.

Several factors determine the elasticity of a good. Demand is more elastic when close substitutes are available, when the good takes up a large share of the buyer's budget, and when the good is a luxury rather than a necessity. Demand is also more elastic in the long run than in the short run. Over time, consumers can find alternatives and change their habits.

Elasticity is important for a seller's total revenue, $R = P \times Q$. If demand is elastic, a price increase reduces revenue, because the loss in quantity outweighs the higher price. If demand is inelastic, a price increase raises revenue. If demand is unit elastic, revenue stays approximately the same when the price changes.

Good	Elasticity, short run (absolute value)	Elasticity, long run (absolute value)
Petrol	0.2	0.7
Bread	0.3	0.4
Cinema tickets	1.4	2.0
One specific brand of coffee	2.5	3.2

Table 1. Illustrative estimates of price elasticity of demand (hypothetical values)

Question 1

The price of a product rises from €10 to €11. As a result, the quantity sold falls from 1,000 to 950 units. What is the absolute value of the price elasticity of demand, and how is demand classified?

a) 0.5; demand is inelastic.
b) 0.5; demand is elastic.
c) 2.0; demand is elastic.
d) 2.0; demand is inelastic.

Question 2
Using the figures from Question 1, how does the seller's total revenue change?

a) It falls by €500.
b) It stays the same.
c) It rises by €450.
d) It rises by €1,000.

Question 3
According to Table 1, what happens in the short run if a cinema raises its ticket prices by 10%?

a) The number of tickets sold falls by about 1.4%, and revenue rises.
b) The number of tickets sold falls by about 14%, and revenue falls.
c) The number of tickets sold falls by about 14%, and revenue rises.
d) The number of tickets sold stays the same, because cinema is a luxury.

Question 4
Why is demand for one specific brand of coffee much more elastic than demand for bread?

a) Coffee is a necessity, whereas bread is a luxury.
b) Bread has more close substitutes than one specific brand of coffee.
c) Other coffee brands are close substitutes, so buyers can easily switch when the price rises.
d) The demand for a single brand is always less elastic than the demand for the product category as a whole.

Question 5
In Table 1, every good has a higher long-run elasticity than short-run elasticity. What is the best explanation?

a) Prices are always higher in the long run.
b) Consumers' incomes fall over time.
c) Sellers lower the quality of their goods over time.
d) Over a longer period, consumers can adjust, for example by finding substitutes or changing their habits.

Question 6
A government introduces a tax that raises the price of each good in Table 1 by the same percentage. For which good would the quantity sold fall the least in the short run?

a) Bread
b) Petrol
c) Cinema tickets
d) One specific brand of coffee

Question 7
A firm faces unit elastic demand. It lowers its price by 5%. What happens to its total revenue, approximately?

a) It rises by about 5%.
b) It falls by about 5%.
c) It stays approximately the same.
d) It rises by about 10%.

Exercise 3 | Radioactive Decay and Half-Life

The nuclei of some atoms are unstable. They change spontaneously into other nuclei and emit radiation in the process. This is called radioactive decay. When a particular nucleus will decay cannot be predicted: for a single nucleus, decay is a purely random event. For a very large number of nuclei, however, decay follows a precise statistical law. In every interval of equal length, the same fraction of the nuclei still present decays.

This behavior is described by the half-life, T½. The half-life is the time after which half of the original nuclei remain. After two half-lives a quarter remain, after three half-lives an eighth, and so on. If N_0 is the number of nuclei at the start, the number N remaining after a time t is:

$$N(t) = N_0 \cdot (½)^{(t / T½)}$$

The activity A of a sample is the number of decays per second, measured in becquerel (Bq). It is proportional to the number of nuclei still present, so it follows the same law. The half-life is a fixed property of each isotope. It does not depend on the size of the sample, nor on external conditions such as temperature, pressure or the chemical compound the atom is part of.

One application is radiocarbon dating. Living organisms constantly take in carbon from their environment, so the proportion of the radioactive isotope carbon-14 in their bodies stays the same as in the atmosphere. When an organism dies, this intake stops. From then on, the carbon-14 it contains decays with a half-life of about 5,730 years. By measuring how much carbon-14 is left in a sample of bone or wood, compared with a living organism, scientists can estimate how long ago the organism died. After about ten half-lives, less than 0.1% of the original carbon-14 remains. This amount is too small to be measured reliably.

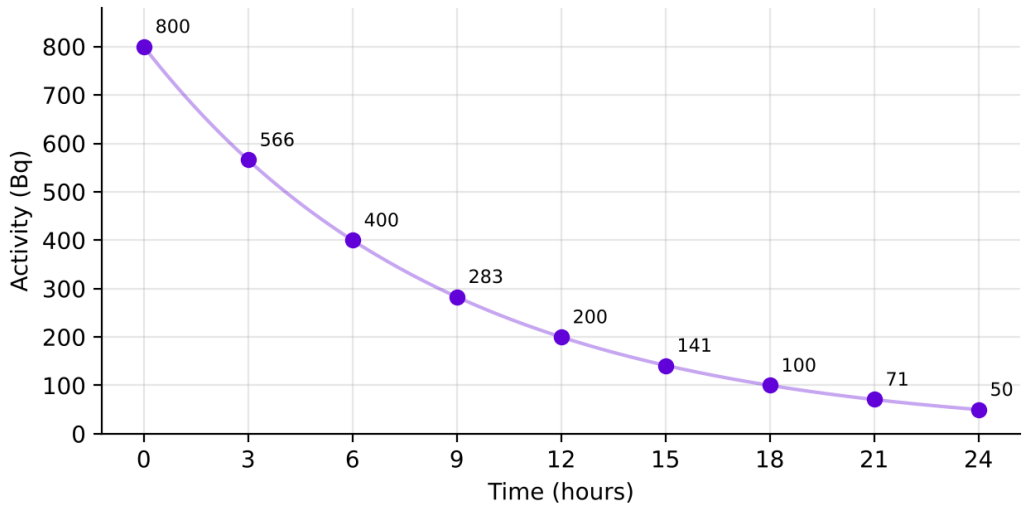


Figure 1. Constructed example: measured activity of one sample every 3 hours

Question 1
What is the half-life of the isotope in the sample shown in Figure 1?

a) 3 hours
b) 6 hours
c) 12 hours
d) 24 hours

Question 2
The measurement in Figure 1 is continued. What activity is expected after 30 hours?

a) 0 Bq
b) 12.5 Bq
c) 25 Bq
d) 40 Bq

Question 3
A sample contains 8 g of an isotope with a half-life of 10 days. How much of this isotope remains after 30 days?

a) 0 g
b) 1 g
c) about 2.67 g
d) 4 g

Question 4
The sample from Figure 1 is heated from 20 °C to 500 °C. How does this affect the half-life?

a) It stays the same, because the half-life does not depend on external conditions.
b) It becomes shorter, because the nuclei move faster at higher temperatures.
c) It becomes longer, because heat stabilizes the nuclei.
d) It falls to zero, because all nuclei decay at once.

Question 5
A bone fragment contains 25% of the carbon-14 found in a living organism. Approximately how old is the bone fragment?

a) about 5,700 years
b) about 8,600 years
c) about 11,500 years
d) about 22,900 years

Question 6
Why can radiocarbon dating not be used reliably to date a fossil that is 200,000 years old?

a) The half-life of carbon-14 becomes longer as a sample ages.
b) Organisms living 200,000 years ago did not take in any carbon.
c) Carbon-14 only began to form in the atmosphere about 50,000 years ago.
d) After about 35 half-lives, the remaining carbon-14 is far too small to be measured reliably.

Question 7

A sample contains only two nuclei of an isotope. What can be said about the situation after exactly one half-life?

a) It cannot be predicted with certainty; the half-life only describes the behavior of very large numbers of nuclei.

b) Exactly one of the two nuclei will have decayed.

c) Each of the two nuclei will have lost half of its mass.

d) Both nuclei will have decayed, because the half-life has been reached.

Exercise 4 | Historical Source Criticism

Historians cannot observe the past directly. They reconstruct it from sources: texts, objects, images and other traces that have survived. A basic distinction is made between primary and secondary sources. Primary sources were created at the time of the events under study, or by people directly involved in them. Examples are letters, diaries, official records and photographs. Secondary sources are later interpretations based on other sources, such as scholarly books or textbooks.

Whether a source counts as primary or secondary is not fixed. It depends on the research question. A history textbook from the 1950s is a secondary source on the French Revolution. For a study of how history was taught in schools in the 1950s, however, the same textbook is a primary source.

Before a source can be used, it must be examined critically. This source criticism is traditionally divided into two steps. External criticism asks whether the source is authentic, that is, whether it really is what it claims to be. It examines the author, the date, the place of origin, the material and how the source has been passed down. If a document is written on a material that did not yet exist at its supposed date, it cannot be authentic in that form. Internal criticism asks whether the content of an authentic source is credible. It considers how close the author was to the events (an eyewitness or someone repeating hearsay), how much time passed before the account was written, who the intended audience was, and what interests the author may have had.

Historians also distinguish between two kinds of sources by the purpose for which they were created. Tradition comprises sources deliberately created to inform others or later generations about events, such as chronicles, memoirs or commemorative inscriptions. Remains are sources created for a practical purpose at the time, without any intention of informing posterity, such as invoices, tax lists or court files. Remains are generally less likely to present a deliberately shaped image of the past. They can, however, still contain errors.

Finally, a statement is considered better supported if several independent sources confirm it. Sources that all go back to a common original, for example because they copied from one another, do not count as independent confirmation.

Question 1

A historian is studying trade in a port city in the 17th century. Which of the following is a primary source for this research?

a) A scholarly book on the history of the port, published in 2015.
b) An encyclopedia article on European trade in the 17th century.
c) A documentary film about the port city, produced in 1998.
d) A customs register from 1652 recording the cargo of incoming ships.

Question 2

In which of the following research projects would a school textbook on the Middle Ages, published in 1965, be a primary source?

a) A study of how schools in the 1960s presented the Middle Ages.
b) A study of agriculture in medieval villages.
c) A study of the causes of the Crusades.
d) In none of them, because textbooks are always secondary sources.

Question 3

A letter is supposedly dated 1820. An analysis shows that its paper contains a material that was first produced in 1870. Which step of source criticism reveals this problem, and what follows from it?

a) Internal criticism; the author of the letter was not a reliable eyewitness.
b) External criticism; the letter cannot be an authentic document from 1820.
c) External criticism; the content of the letter is exaggerated.
d) Internal criticism; the letter must be classified as a secondary source.

Question 4

Two accounts of the same battle have survived. Account A was written by the general who commanded the losing army, in his memoirs published 30 years later. Account B was written by a merchant who watched the battle from the town walls and described it in his private diary the next day. Which assessment best reflects internal criticism?

a) Account A is more credible, because a general had more information than a merchant.
b) Account B is true, because a private diary has no audience.
c) Both accounts must be examined: A may be shaped by self-justification and fading memory, while B was written soon after the events but from a limited point of view.
d) Neither account can be used, because both authors had personal interests.

Question 5

Which of the following sources belongs to the category of remains?

a) A receipt for the purchase of grain by a medieval monastery.
b) A chronicle of his reign commissioned by a king.
c) The memoirs of a retired politician.
d) A commemorative inscription on a monument to a victory.

Question 6

Three medieval chronicles describe an event in almost identical words. The historian discovers that two of the chroniclers copied their account from the third. How should the support for this event be assessed?

a) It is confirmed by three independent sources.
b) It is confirmed by two independent sources.
c) It rests on only one independent account, because the copies add no independent confirmation.
d) The event must be invented, because copied accounts are always false.

Solutions

Exercise	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1 – Algorithmic Complexity and Searching	C	A	C	B	A	C	B
2 – Price Elasticity of Demand	A	C	B	C	D	B	C
3 – Radioactive Decay and Half-Life	B	C	B	A	C	D	A
4 – Historical Source Criticism	D	A	B	C	A	C	–

Exercise 1 – Algorithmic Complexity and Searching

Question 1 – **Solution: C.** Big-O ignores constant factors and slower-growing terms. For large n, the term $4n^2$ dominates $100n + 7$, so the algorithm is in $O(n^2)$.

Question 2 – **Solution: A.** Binary search needs about $\log_2 n$ comparisons in the worst case. Since $2^{10} = 1{,}024$, $\log_2 1{,}024 = 10$.

Question 3 – **Solution: C.** In $O(n^2)$, the running time grows with the square of the input size. Tripling n multiplies the time by $3^2 = 9$, so 2 s × 9 = 18 s.

Question 4 – **Solution: B.** Binary search only works on sorted lists, and each comparison halves the remaining range. Option C is wrong: if the target is the first element, linear search finds it with a single comparison.

Question 5 – **Solution: A.** For a single search, sorting costs $O(n \log n)$, which is already more than one linear search at $O(n)$. Option B ignores the cost of sorting. Option D is impossible, because binary search needs a sorted list.

Question 6 – **Solution: C.** n linear searches cost $n \times O(n) = O(n^2)$. Sorting once costs $O(n \log n)$, and n binary searches cost $n \times O(\log n) = O(n \log n)$. The total, $O(n \log n)$, grows more slowly than $O(n^2)$.

Question 7 – **Solution: B.** A is faster when $100n < n^2$. Dividing by n gives $100 < n$. For $n < 100$, B is faster; at $n = 100$ both need 10,000 operations. Option D confuses the growth class with the actual number of operations, which the passage says can differ.

Exercise 2 – Price Elasticity of Demand

Question 1 – **Solution: A.** The price changes by +10% (€1 of €10) and the quantity by -5% (50 of 1,000). $|E| = 5\% \div 10\% = 0.5$. Since $0.5 < 1$, demand is inelastic.

Question 2 – **Solution: C.** Revenue before: €10 × 1,000 = €10,000. Revenue after: €11 × 950 = €10,450. Revenue rises by €450, as expected when demand is inelastic and the price rises.

Question 3 – **Solution: B.** With $|E| = 1.4$, a 10% price increase reduces the quantity by about 1.4 × 10% = 14%. Demand is elastic, so revenue falls ($1.10 \times 0.86 \approx 0.95$, a drop of about 5%).

Question 4 – **Solution: C.** The passage names close substitutes as a factor that makes demand more elastic. Buyers of one brand can easily switch to another brand. Option D states the opposite of what Table 1 shows.

Question 5 – **Solution: D.** The passage states that demand is more elastic in the long run, because consumers can find alternatives and change their habits over time.

Question 6 – **Solution: B.** The smaller $|E|$, the less the quantity responds to a price change. Petrol has the lowest short-run value in Table 1 (0.2).

Question 7 – **Solution: C.** With unit elastic demand, a 5% fall in price raises the quantity by about 5%. Revenue changes by a factor of about $0.95 \times 1.05 \approx 1.00$, so it stays approximately the same.

Exercise 3 – Radioactive Decay and Half-Life

Question 1 – **Solution: B.** The activity falls from 800 Bq to 400 Bq, half its starting value, after 6 hours. It halves again every further 6 hours (200 Bq at 12 h, 100 Bq at 18 h).

Question 2 – **Solution: C.** At 24 hours the activity is 50 Bq. Thirty hours is one further half-life of 6 hours, so the activity halves to 25 Bq.

Question 3 – **Solution: B.** Thirty days are three half-lives of 10 days: 8 g → 4 g → 2 g → 1 g. Option C wrongly assumes that the amount decreases linearly.

Question 4 – **Solution: A.** The passage states that the half-life does not depend on external conditions such as temperature.

Question 5 – **Solution: C.** 25% = ½ × ½, which is two half-lives. 2 × 5,730 years ≈ 11,500 years.

Question 6 – **Solution: D.** 200,000 ÷ 5,730 ≈ 35 half-lives. After only ten half-lives, less than 0.1% remains, which is already too little to measure reliably.

Question 7 – **Solution: A.** The decay of a single nucleus is random. The half-life is a statistical law that only holds for very large numbers of nuclei, so with two nuclei the outcome cannot be predicted.

Exercise 4 – Historical Source Criticism

Question 1 – **Solution: D.** The customs register was created in the 17th century as part of the trade itself. The other options are later interpretations, so they are secondary sources.

Question 2 – **Solution: A.** Whether a source is primary depends on the research question. For a study of 1960s schooling, a 1960s textbook is itself evidence from that time.

Question 3 – **Solution: B.** Examining the material of a source is part of external criticism, which checks authenticity. A material produced from 1870 onwards rules out an authentic document from 1820.

Question 4 – **Solution: C.** Internal criticism weighs each author's closeness to the events, the time gap and possible interests. Neither account is automatically reliable or automatically useless.

Question 5 – **Solution: A.** A receipt served a practical purpose and was not meant to inform posterity, so it counts as remains. The other three sources were deliberately created to shape how events are remembered, so they count as tradition.

Question 6 – **Solution: C.** Sources that go back to a common original are not independent. Two of the chronicles merely copy the third, so there is effectively only one independent account.

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