Yocket Prep

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dMAT General Academic Module | Practice Set 3

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 statistics.

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 | Sorting and Counting Operations

Sorting a list means arranging its elements in increasing order. Many sorting procedures exist, and one of the simplest is bubble sort. It works in passes. In each pass, the procedure compares two neighbouring elements, starting with the first two, and swaps them if the left one is larger than the right one. It then moves one position to the right and repeats this until the end of the unsorted part of the list is reached. After the first pass, the largest element is in its final place at the end of the list.

The next pass does the same for the remaining part of the list, which is now one element shorter, and so on. For a list of n elements, the procedure carries out n - 1 passes. The first pass makes n - 1 comparisons, the second n - 2, and the last pass makes 1 comparison. The procedure always carries out all these comparisons, even if the list is already sorted. A swap is only made when two neighbours are in the wrong order.

Table 1 shows the procedure for the list [4, 3, 1, 2].

Pass	List after the pass	Comparisons	Swaps
1	[3, 1, 2, 4]	3	3
2	[1, 2, 3, 4]	2	2
3	[1, 2, 3, 4]	1	0

Table 1. Bubble sort applied to the list [4, 3, 1, 2]

The total number of comparisons grows quickly with the length of the list. Computer scientists describe how the number of operations grows with the length n of the list by a class written O(…). For example, a procedure whose number of operations is roughly proportional to n is in the class O(n), and a procedure whose number of operations is roughly proportional to n × n is in the class $O(n^2)$. Terms that grow more slowly and constant factors are ignored.

Question 1

The list [5, 2, 4, 1, 3] is sorted with bubble sort. What does the list look like after the first pass?

a) [2, 5, 4, 1, 3]
b) [2, 4, 1, 3, 5]
c) [1, 2, 3, 4, 5]
d) [2, 4, 5, 1, 3]

Question 2

How many swaps are made in the first pass for the list [5, 2, 4, 1, 3]?

a) 2
b) 3
c) 4
d) 5

Question 3
How many comparisons does bubble sort make in total for a list of 5 elements?

a) 10
b) 5
c) 20
d) 25

Question 4
How many comparisons does bubble sort make in total for a list of 100 elements?

a) 100
b) 200
c) 9,900
d) 4,950

Question 5
The list is made longer from 1,000 to 2,000 elements. By roughly what factor does the number of comparisons grow?

a) It roughly doubles.
b) It becomes about four times as large.
c) It becomes about eight times as large.
d) It stays about the same.

Question 6
Bubble sort is applied to the list [1, 2, 3, 4, 5], which is already sorted. How many swaps and comparisons are made?

a) 0 swaps and 4 comparisons
b) 10 swaps and 10 comparisons
c) 0 swaps and 10 comparisons
d) 4 swaps and 10 comparisons

Question 7
To which class does the number of comparisons of bubble sort belong?

a) $O(n^2)$
b) $O(n \log n)$
c) $O(n)$
d) $O(1)$

Exercise 2 | Supply, Demand and Market Equilibrium

In a market, buyers and sellers meet. The quantity that buyers want to buy at a given price is called the quantity demanded. It normally falls when the price rises. The quantity that sellers want to sell at a given price is called the quantity supplied. It normally rises when the price rises, because a higher price makes production more worthwhile. A table of these quantities for different prices is called a demand schedule and a supply schedule.

The market is in equilibrium at the price at which the quantity demanded equals the quantity supplied. At a higher price, the quantity supplied exceeds the quantity demanded, so there is a surplus, and sellers tend to lower their prices. At a lower price, the quantity demanded exceeds the quantity supplied, so there is a shortage, and prices tend to rise. In this way the price moves towards the equilibrium price.

If the income of buyers rises, they usually want to buy more of a normal good at every price. The demand schedule then shifts: the quantity demanded increases by the same amount at each price, while the supply schedule is unchanged. A price ceiling is a legal maximum price. If it is set below the equilibrium price, the quantity actually traded is the smaller of the quantity demanded and the quantity supplied. Between the prices listed in Table 1, both schedules change evenly.

Price per unit (€)	Quantity demanded	Quantity supplied
2	90	10
4	70	30
6	50	50
8	30	70
10	10	90

Table 1. Demand and supply schedule for a good (hypothetical values)

Question 1

What is the equilibrium price of the good in Table 1?

a) €4
b) €6
c) €8
d) €10

Question 2

What happens at a price of €8?

a) There is a shortage of 40 units.
b) There is a shortage of 20 units.
c) The market is in equilibrium.
d) There is a surplus of 40 units.

Question 3
What happens at a price of €4?

a) There is a shortage of 40 units.
b) There is a surplus of 40 units.
c) There is a shortage of 70 units.
d) The market is in equilibrium.

Question 4
The price is €10. What is most likely to happen to it?

a) It rises, because sellers want to sell more.
b) It stays at €10, because sellers set the price permanently.
c) It falls, because the quantity supplied exceeds the quantity demanded.
d) It rises, because a shortage develops.

Question 5
The income of buyers rises, so that the quantity demanded is 20 units higher at every price. What are the new equilibrium price and quantity?

a) €6 and 50 units
b) €7 and 60 units
c) €8 and 50 units
d) €7 and 40 units

Question 6
A price ceiling of €4 is introduced. What is the result?

a) 70 units are sold, because demand is 70 units.
b) 40 units are sold and there is no shortage.
c) 50 units are sold, as in equilibrium.
d) Only 30 units are sold, and there is a shortage of 40 units.

Question 7
How much do buyers spend in total when the market is in equilibrium?

a) €100
b) €200
c) €300
d) €600

Exercise 3 | Motion and Speed–Time Graphs

The motion of a vehicle along a straight road can be shown in a speed–time graph. The time is plotted on the horizontal axis and the speed on the vertical axis. A horizontal line means that the speed is constant. A rising line means that the vehicle speeds up, and a falling line means that it slows down.

The acceleration is the change of speed divided by the time in which this change happens, a = Δv ÷ Δt, and it is measured in metres per second squared (m/s²). The acceleration is zero when the speed is constant, and negative when the vehicle slows down. The distance covered in a time interval is equal to the area between the graph and the time axis in this interval. For a rectangle, this is speed × time, and for a triangle, it is half of the base times the height.

The average speed of a whole journey is the total distance divided by the total time. It is generally not the same as the arithmetic mean of the highest and lowest speed. Figure 1 shows the speed of a vehicle during a test drive. The vehicle starts at rest.

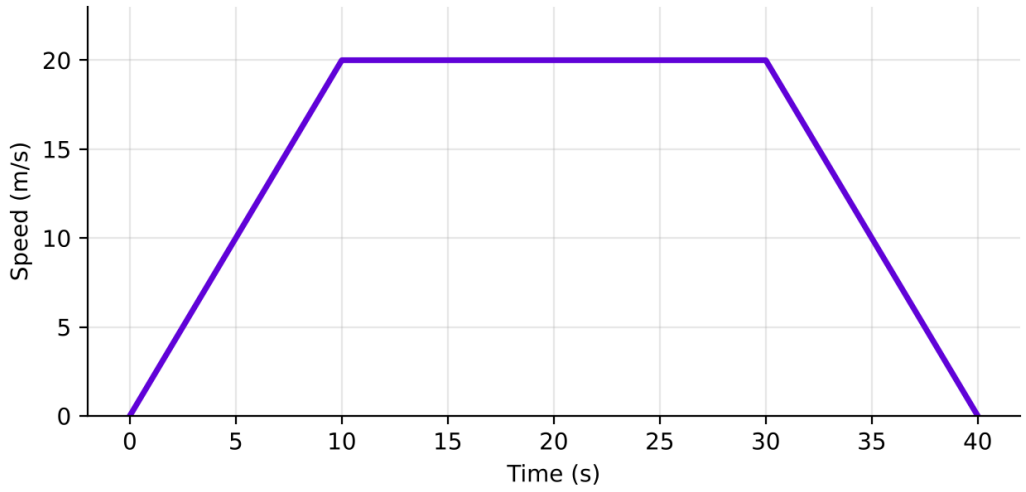


Figure 1. Speed of a test vehicle (constructed example)

Question 1

What is the acceleration of the vehicle during the first 10 seconds?

a) 0.5 m/s²
b) 20 m/s²
c) 2 m/s²
d) 200 m/s²

Question 2

How far does the vehicle travel during the first 10 seconds?

a) 100 m
b) 200 m
c) 20 m
d) 400 m

Question 3

Which statement describes the motion between 10 s and 30 s?

a) The vehicle accelerates at 2 m/s^2.
b) The vehicle moves at a constant speed, so its acceleration is zero.
c) The vehicle is at rest.
d) The vehicle slows down.

Question 4

How far does the vehicle travel between 10 s and 30 s?

a) 20 m
b) 200 m
c) 600 m
d) 400 m

Question 5

What is the total distance covered by the vehicle during the 40 seconds?

a) 500 m
b) 600 m
c) 800 m
d) 1,200 m

Question 6

What is the average speed over the whole 40 seconds?

a) 10 m/s
b) 20 m/s
c) 15 m/s
d) 12.5 m/s

Question 7

What is the speed of the vehicle after 35 seconds?

a) 10 m/s
b) 5 m/s
c) 15 m/s
d) 20 m/s

Exercise 4 | Surveys, Sampling and Bias

Researchers often want to know the opinion or behaviour of a large group, called the population. Because asking everyone is rarely possible, they ask a smaller group, called the sample, and draw conclusions about the population. This only works if the sample is representative, which means that it reflects the population in the characteristics that matter. The most reliable way to obtain a representative sample is random selection, in which every member of the population has the same chance of being chosen.

A sample can be misleading because of bias. In self-selection bias, people decide for themselves whether to take part, and those who feel strongly or who are connected to the topic are more likely to respond. A larger sample reduces the effect of pure chance, but it does not remove bias that comes from the way the respondents were chosen. A large biased sample can therefore be less trustworthy than a small random one.

A further source of wrong conclusions is the confusion of correlation with causation. Two quantities can rise and fall together without one causing the other. Often a third factor influences both. For example, hot weather increases both the sales of ice cream and the number of sunburns, although eating ice cream does not cause sunburn.

Survey	How respondents were chosen	Respondents	Share in favour of online lectures
A	Randomly selected from the list of all students	400	55%
B	Anyone who clicked a poll on the website of the online lecture platform	2,000	80%
C	Students asked outside the library	100	40%

Table 1. Three surveys on whether students prefer online lectures

Question 1

How many respondents in survey A are in favour of online lectures?

a) 55
b) 220
c) 400
d) 180

Question 2

Which survey is the most likely to be representative of all students?

a) Survey B, because it has the most respondents.
b) Survey C, because the students were asked in person.
c) Survey A, because the respondents were chosen at random from all students.
d) None of them, because the results differ.

Question 3

Why is the result of survey B likely to overestimate the support for online lectures among all students?

a) The respondents chose themselves by clicking the poll on the platform, so those who like online lectures are more likely to take part.
b) The respondents were too young to give a reliable opinion.
c) A result as high as 80% cannot be correct for any survey.
d) Online surveys always produce results that are too high.

Question 4

Survey B has 2,000 respondents and survey A has 400. Which conclusion is justified?

a) Survey B is more reliable, because a larger sample is always better.
b) The results of A and B should be averaged, because both are valid.
c) The larger size of survey B removes any bias, so 80% is the true value.
d) The size of survey B does not remove the bias that comes from how its respondents were chosen.

Question 5

In a city, fires that are attended by more fire engines tend to cause more damage. Which explanation is the most plausible, based on the passage?

a) Fire engines cause damage to the buildings.
b) Larger fires cause more damage, and larger fires also lead to more fire engines being sent.
c) Damage that has already happened causes fires to start.
d) The number of fire engines has no relation to the size of the fire.

Question 6

How many respondents in survey B are not in favour of online lectures?

a) 200
b) 1,600
c) 400
d) 800

Solutions

Exercise	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1 – Sorting and Counting Operations	B	C	A	D	B	C	A
2 – Supply, Demand and Market Equilibrium	B	D	A	C	B	D	C
3 – Motion and Speed–Time Graphs	C	A	B	D	B	C	A
4 – Surveys, Sampling and Bias	B	C	A	D	B	C	–

Exercise 1 – Sorting and Counting Operations

Question 1 – **Solution: B.** The 5 is swapped with each of its right neighbours in turn: 2, 4, 1 and 3. This gives [2, 4, 1, 3, 5], and the largest element is at the end.

Question 2 – **Solution: C.** The pairs (5, 2), (5, 4), (5, 1) and (5, 3) are each out of order, so 4 swaps are made.

Question 3 – **Solution: A.** The passes make 4, 3, 2 and 1 comparisons, which gives 4 + 3 + 2 + 1 = 10 comparisons.

Question 4 – **Solution: D.** The total is 99 + 98 + … + 1 = 99 × 100 ÷ 2 = 4,950.

Question 5 – **Solution: B.** The number of comparisons is n × (n - 1) ÷ 2, which grows roughly with n^2. Doubling n therefore multiplies the number by about 4.

Question 6 – **Solution: C.** No pair is out of order, so no swap is made. According to the passage, the procedure still carries out all its comparisons, which are 4 + 3 + 2 + 1 = 10.

Question 7 – **Solution: A.** The total n × (n - 1) ÷ 2 is roughly proportional to n × n, so bubble sort is in the class $O(n^2)$.

Exercise 2 – Supply, Demand and Market Equilibrium

Question 1 – **Solution: B.** At €6 the quantity demanded and the quantity supplied are both 50 units.

Question 2 – **Solution: D.** At €8, 30 units are demanded and 70 units are supplied. The surplus is 70 - 30 = 40 units.

Question 3 – **Solution: A.** At €4, 70 units are demanded and only 30 units are supplied. The shortage is 70 - 30 = 40 units.

Question 4 – **Solution: C.** At €10, 90 units are supplied and only 10 are demanded. The surplus pushes sellers to lower their prices.

Question 5 – **Solution: B.** At €7 the original demand is 40 units (halfway between 50 and 30), so the new demand is 60 units. The supply at €7 is 60 units (halfway between 50 and 70). At €7 the two are equal.

Question 6 – **Solution: D.** At €4, 70 units are demanded but only 30 are supplied. The quantity traded is the smaller value, 30 units, and 40 units of demand remain unmet.

Question 7 – **Solution: C.** The equilibrium price is €6 and the quantity is 50 units, so the spending is 6 × 50 = €300.

Exercise 3 – Motion and Speed–Time Graphs

Question 1 – **Solution: C.** The speed rises from 0 to 20 m/s in 10 s, so a = 20 ÷ 10 = 2 m/s^2.

Question 2 – **Solution: A.** The area is a triangle with base 10 s and height 20 m/s, so the distance is ½ × 10 × 20 = 100 m.

Question 3 – **Solution: B.** The line is horizontal, which means that the speed stays at 20 m/s and the acceleration is zero.

Question 4 – **Solution: D.** The area is a rectangle: 20 m/s × 20 s = 400 m.

Question 5 – **Solution: B.** The distances are 100 m (speeding up), 400 m (constant speed) and 100 m (slowing down, again a triangle with base 10 s and height 20 m/s). The total is 600 m.

Question 6 – **Solution: C.** Average speed = total distance ÷ total time = 600 m ÷ 40 s = 15 m/s.

Question 7 – **Solution: A.** Between 30 s and 40 s the speed falls evenly from 20 m/s to 0, which is 2 m/s each second. After 5 s of slowing down the speed is 20 - 10 = 10 m/s.

Exercise 4 – Surveys, Sampling and Bias

Question 1 – **Solution: B.** 55% of 400 is 0.55 × 400 = 220 respondents.

Question 2 – **Solution: C.** Random selection from all students gives every student the same chance of being chosen, which is the most reliable way to obtain a representative sample.

Question 3 – **Solution: A.** Survey B is affected by self-selection bias: people who use and like the platform are more likely to find and answer the poll.

Question 4 – **Solution: D.** A larger sample reduces random error but does not remove bias from the selection method.

Question 5 – **Solution: B.** A third factor, the size of the fire, influences both quantities. The correlation does not show that fire engines cause the damage.

Question 6 – **Solution: C.** 80% are in favour, so 20% are not. 20% of 2,000 is 400 respondents.

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