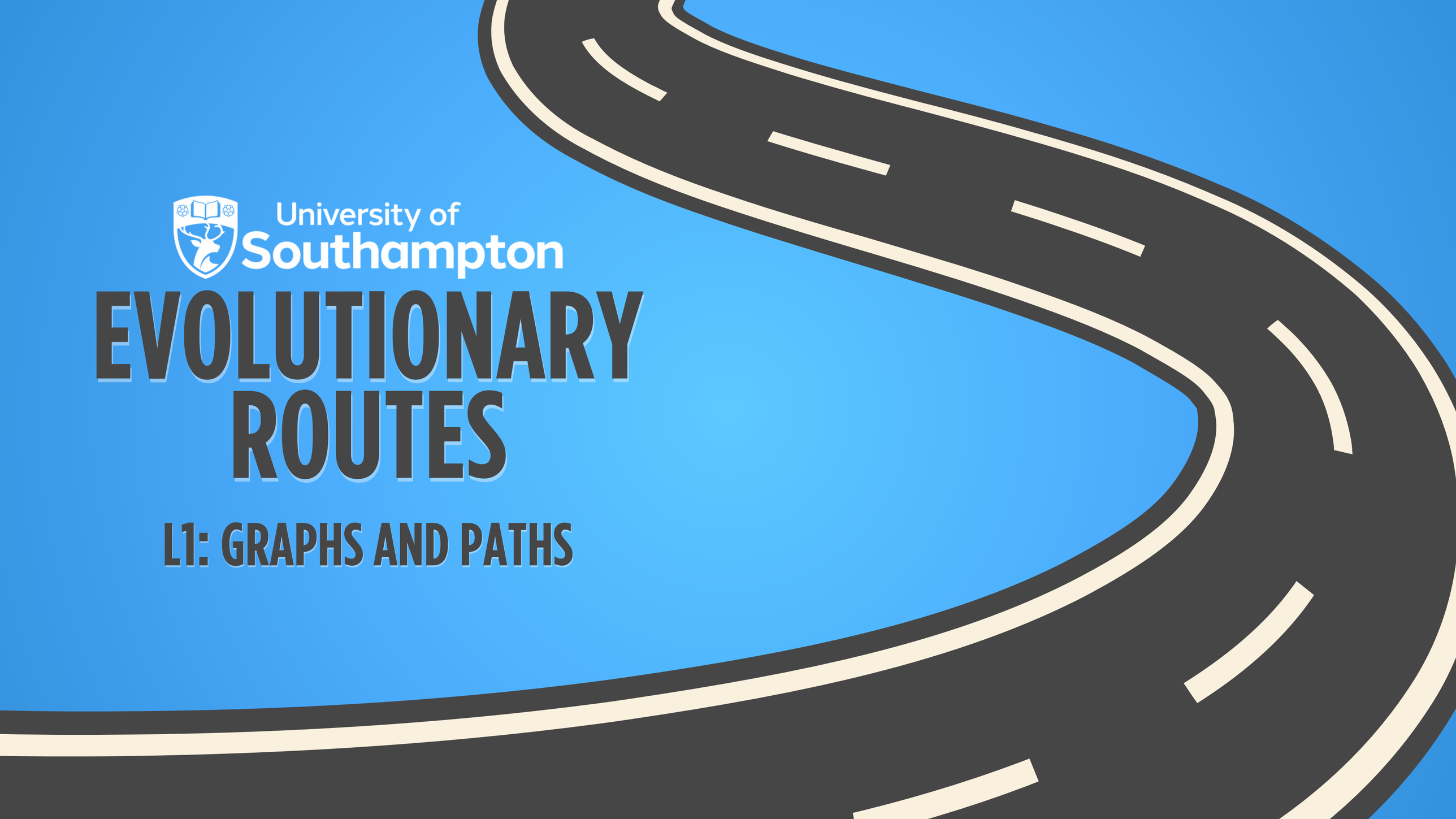

University of
Southampton
EVOLUTIONARY
ROUTES
L1: GRAPHS AND PATHS

LESSON OUTCOMES

LO1: Give a definition for a **graph**, **vertices**, and **edges**.

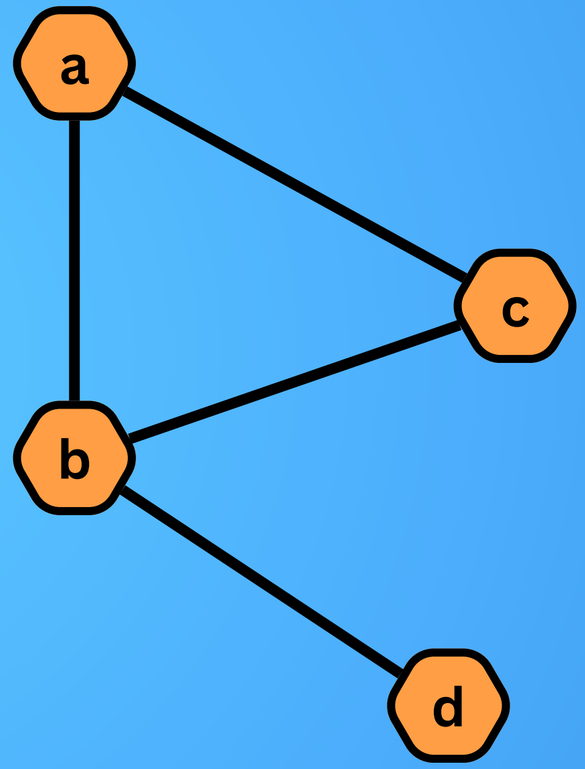
LO2: Construct **adjacency matrices** and find the **degrees** of the vertices.

LO3: Find the **shortest path** in a graph

This a graph

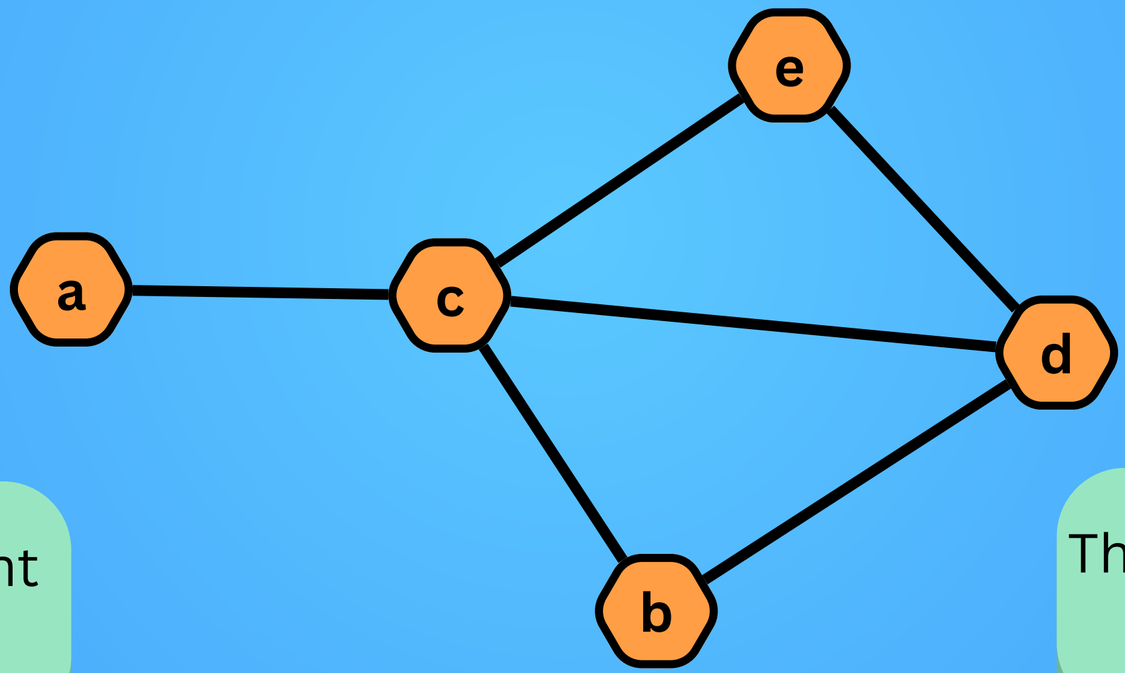
It has vertices a

and edges —



DEFINITION

A **graph** is a model of how entities (people, places, things) are related.



The **vertices** represent the entities.

The **edges** represent the relationships.

Social media networks use graphs to model friendships.






IDEA

The edges of a graph can be given a value called a “**weight**”.

The weight of an edge indicates how strong the relationship is.

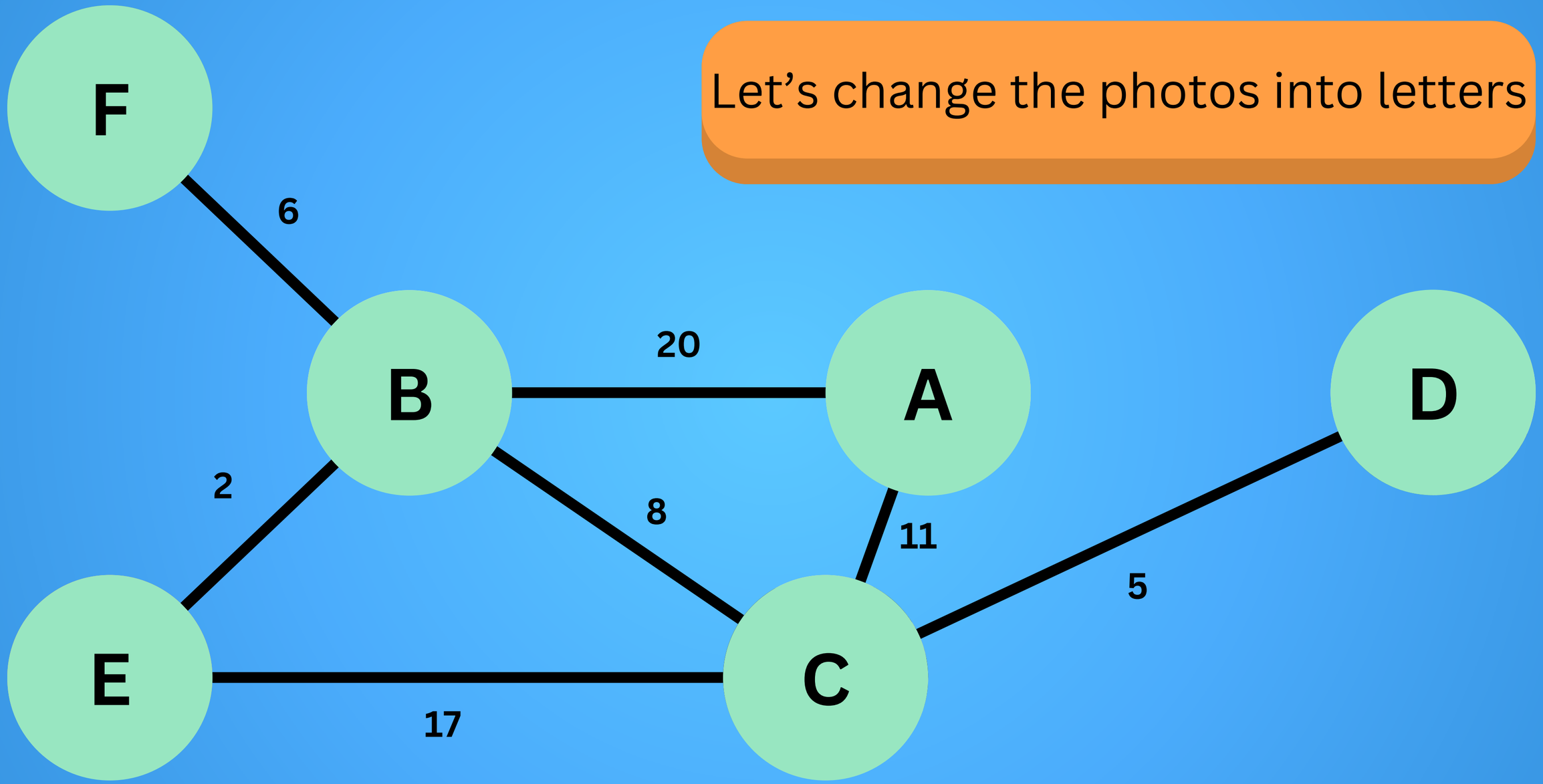
Shared likes per post





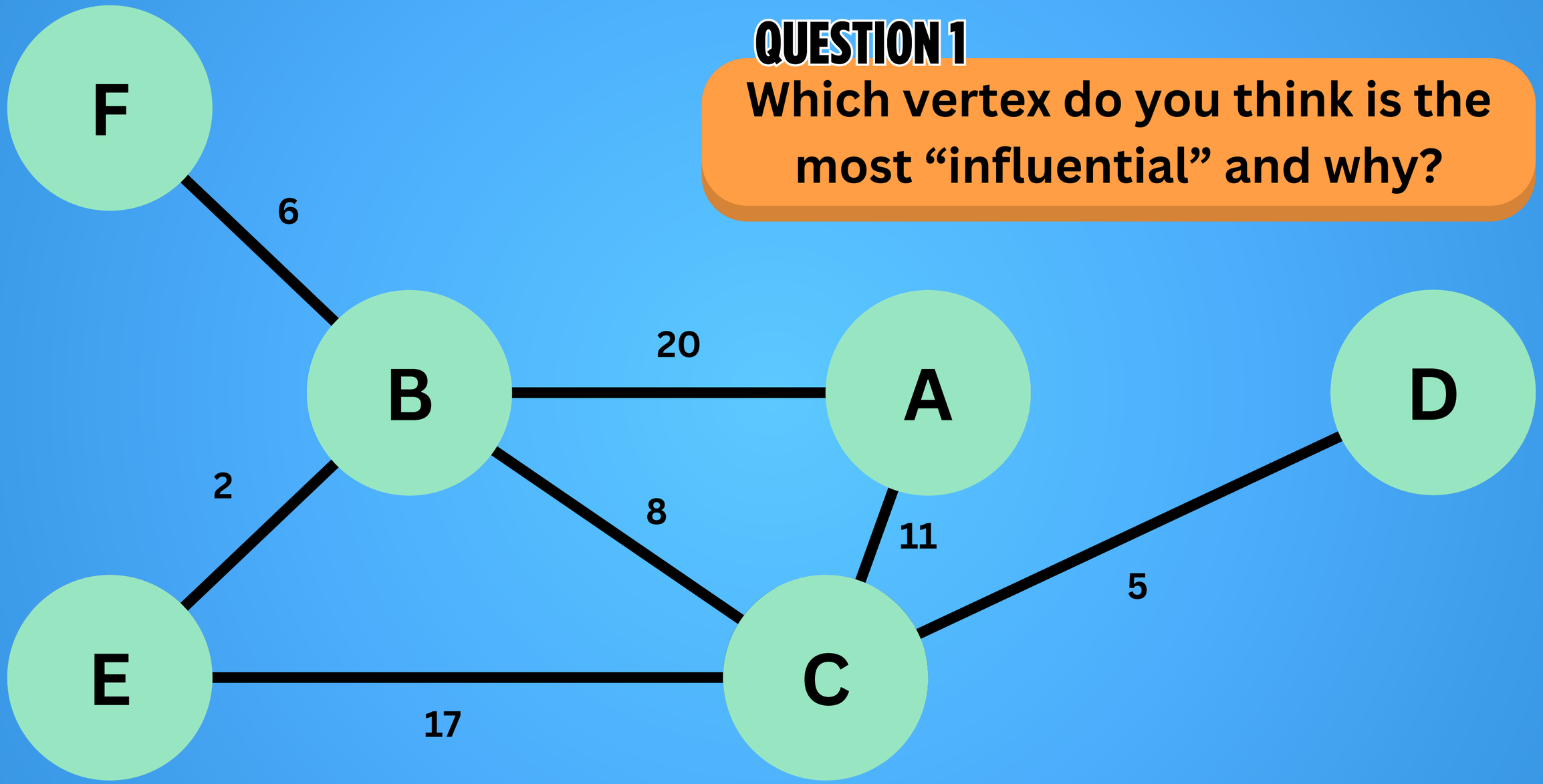

6
20
2
8
11
5
17

Let’s change the photos into letters



QUESTION 1

Which vertex do you think is the most “influential” and why?



	A	B	C	D	E	F
A	0	20	11	0	0	0
B	20	0	8	0	2	6
C	11	8	0	5	17	0
D	0	0	5	0	0	0
E	0	2	17	0	0	0
F	0	6	0	0	0	0

ANSWER 1

All the vertices that have edges between them are “**adjacent**”.

We write down the edge weights in an “**adjacency matrix**”.

	A	B	C	D	E	F
A	0	20	11	0	0	0
B	20	0	8	0	2	6
C	11	8	0	5	17	0
D	0	0	5	0	0	0
E	0	2	17	0	0	0
F	0	6	0	0	0	0

ANSWER 1

Next we add up each value in each row to find the “**degree**” of the vertex.

deg(A) = 20 + 11 = 31

	A	B	C	D	E	F	
A	0	20	11	0	0	0	deg(A) = 31
B	20	0	8	0	2	6	deg(B) = 36
C	11	8	0	5	17	0	deg(C) = 41
D	0	0	5	0	0	0	deg(D) = 5
E	0	2	17	0	0	0	deg(E) = 19
F	0	6	0	0	0	0	deg(F) = 6

	A	B	C	D	E	F
A	0	20	11	0	0	0
B	20	0	8	0	2	6
C	11	8	0	5	17	0
D	0	0	5	0	0	0
E	0	2	17	0	0	0
F	0	6	0	0	0	0

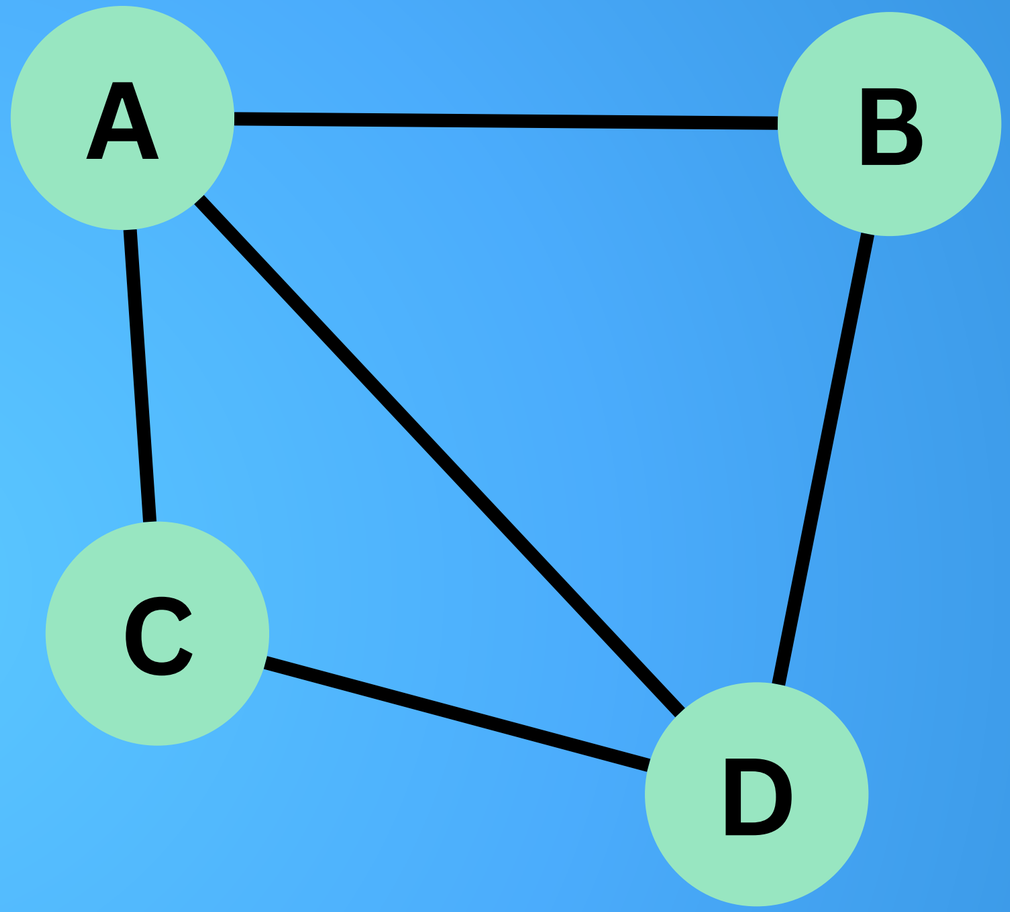
ANSWER 1

Then we pick the highest value!

deg(C) = 41

This is called **“degree centrality”.** It’s one of many kinds of “centrality” metrics.

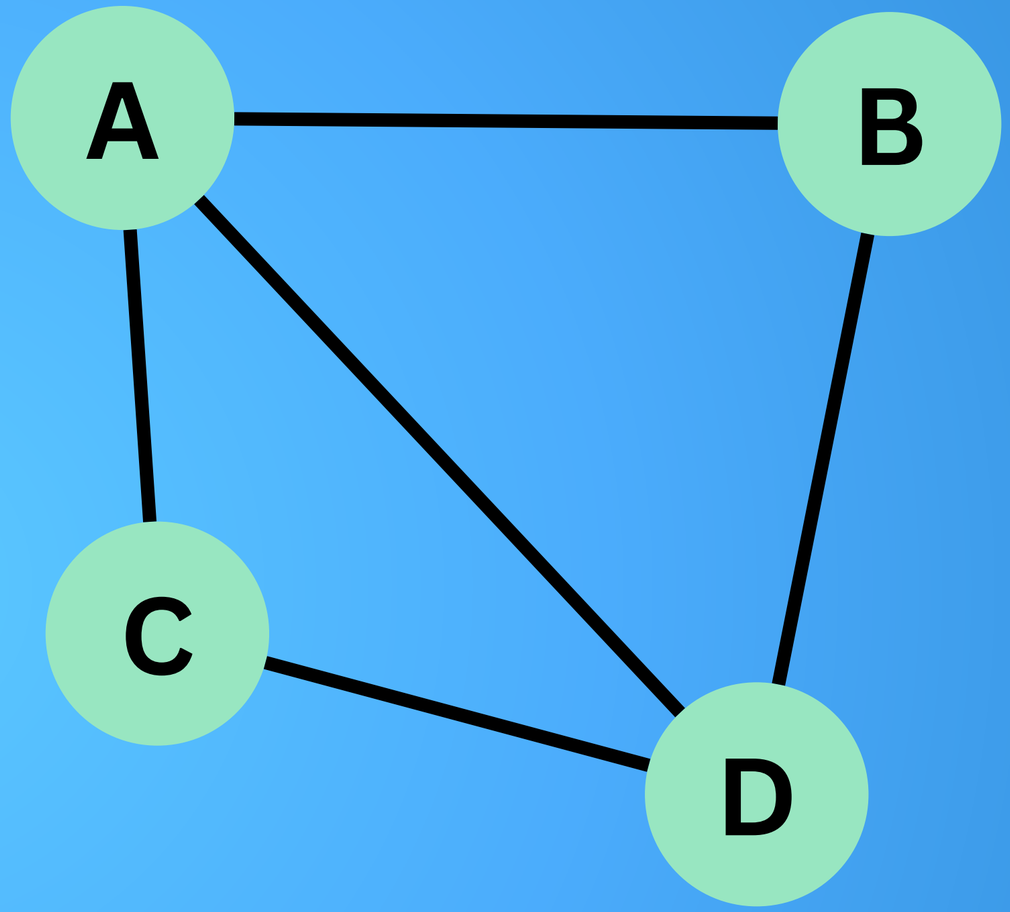
	A	B	C	D
A	0	1	1	1
B	1	0	0	1
C	1	0	0	1
D	1	1	1	0



QUESTION 2

What is deg(A), deg(B), deg(C), and deg(D)?

	A	B	C	D
A	0	1	1	1
B	1	0	0	1
C	1	0	0	1
D	1	1	1	0



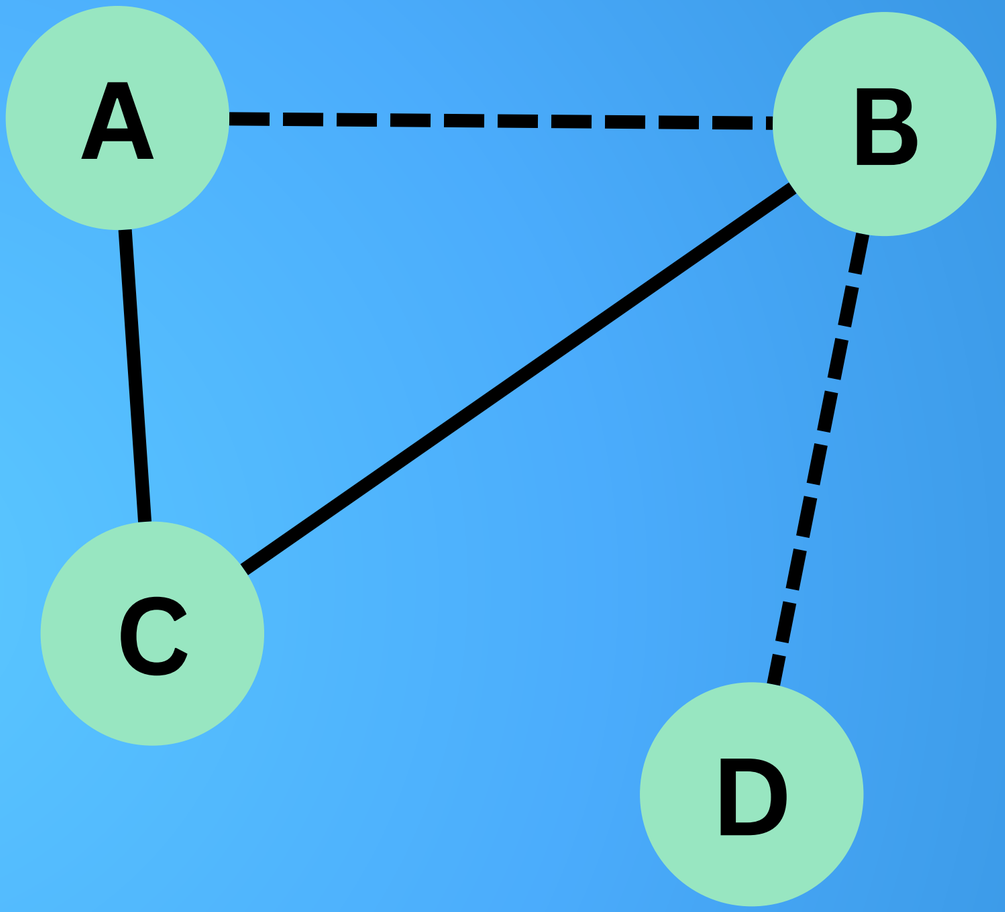
ANSWER 2

deg(A) = 3, deg(B) = 2, deg(C) = 2, and deg(D) = 3

IDEA

Even though two vertices aren't "adjacent", they can be **connected**.

A connects to D through B.

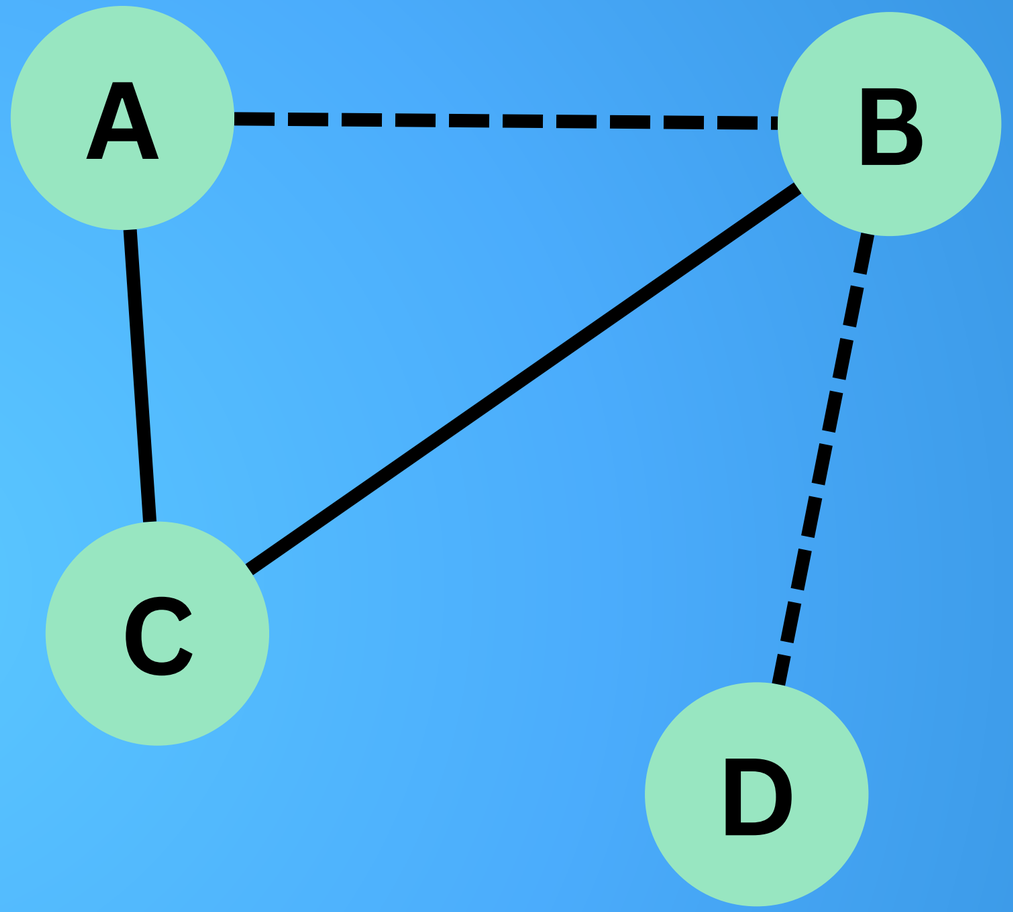


IDEA

If we don’t repeat the vertices we travel along we form a “**path**”.

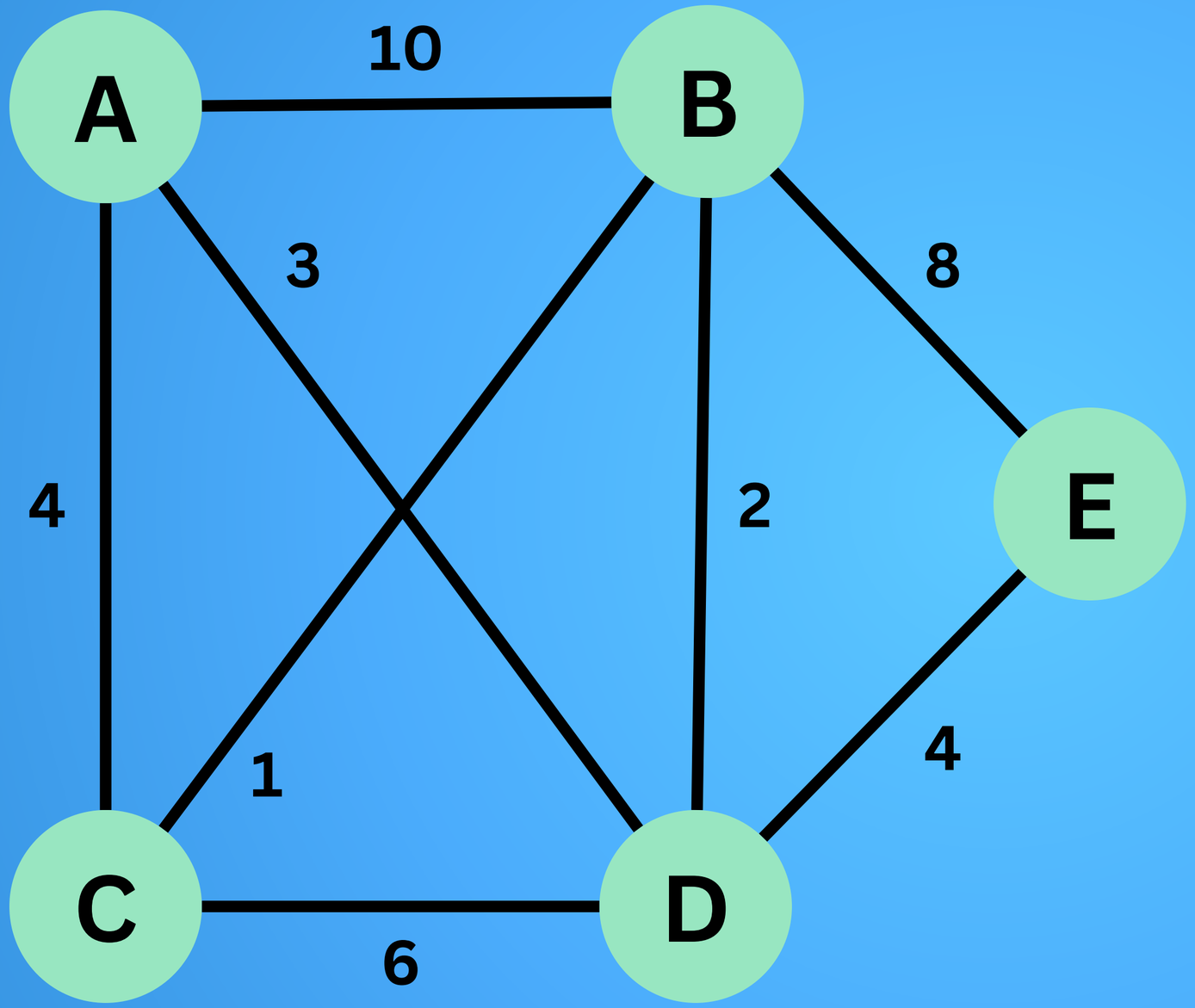
A > B > D

A > C > B > D



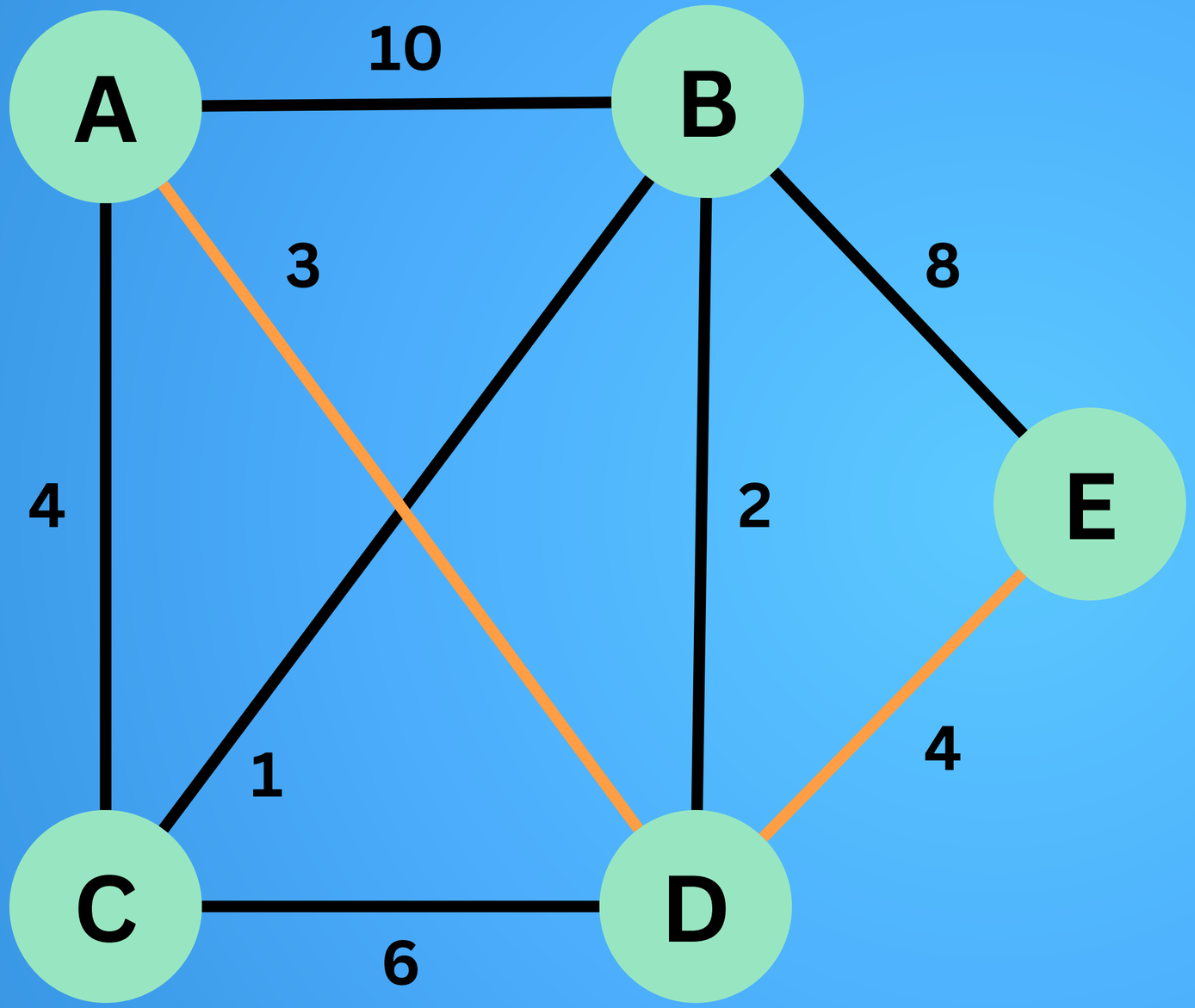
IDEA

When the edges have weights we are often interested in finding out the “**shortest path**”.



QUESTION 3

What is the shortest path from A to E?



ANSWER 3

What is the shortest path from A to E?

A > D > E = 3 + 4 = 7

RECAP

A **graph** is a model of how entities (people, places, things) are related.

Graphs have **vertices** that represent people, places, or things, and **edges**, that show the relationships between entities.

Edges can have **weights**.

Vertices have a **degree** which tells us how connected it is within the graph.

A **path** is a list of vertex connections with no repeats.