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Augmented Reality vs Virtual Reality

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Augmented Reality vs Virtual Reality

Augmented reality (AR) adds digital things to the real world you see. Virtual reality (VR) shuts the real world out. UPSC asked how they differ in 2019.

Think of AR as a sticky note on a window and VR as closed curtains. This is only an analogy.

> **At a glance**
>
> Three key facts on this topic
>
> 01 **AR**Overlays digital content onto the real world. You still see your surroundings.
>
> 02 **VR**Replaces the physical world with a computer-generated one, typically through a headset.
>
> 03 **The key difference**In AR you still see the real world. In VR you do not.

Must Know · Understand the words

1 What AR and VR are

1.1 What is augmented reality?

Augmented reality (AR) adds digital content to what you already see. IBM describes it as digital information added to a user's surroundings in real time. It overlays content onto the real world. It enriches what a user

perceives. It does not replace reality.

Users still see and interact with their physical surroundings. IBM says AR overlays content onto the real world.

AR devices carry cameras, sensors and displays. IBM lists smartphones and tablets. It also lists wearables such as smart glasses and headsets.

Here is a familiar picture. Imagine your phone camera pointed at the floor. A cartoon character stands on it. You still see the floor. That is AR. The game IBM names is Pokemon GO. It blends virtual creatures into real places. The cartoon character is a made-up example.

1.2 What is virtual reality?

Virtual reality (VR) immerses users in a digital environment. IBM says this is usually done with a VR headset or VR goggles. Unlike AR, VR completely replaces the physical world. It surrounds users with a 360-degree view of computer-generated environments.

Microsoft says the same in one line. Experiences that block your view to give a fully immersive digital experience are virtual reality. To occlude means to block.

A **head-mounted display** is a screen worn on the head.



A virtual reality headset, Facebook Oculus, at Gamescom 2019. Photo by dronepicr, 20 August 2019, via Wikimedia Commons. Licensed CC BY 2.0.

1.3 How do the two compare side by side?

AR and VR side by side

Point	Augmented reality (AR)	Virtual reality (VR)
Your view of the real world	Still visible, with digital content overlaid	Replaced by a computer-generated environment
Devices IBM names	Smartphones, tablets, smart glasses, headsets	VR headset, head-mounted display, VR goggles
Examples IBM names	Ikea Place furniture app, Snapchat filters, mapping apps with arrow overlays	The VR Museum of Fine Art
Quick test	Surroundings still visible: yes.	Surroundings still visible: no.

The table covers only AR and VR. Mixed reality is in card 5. The quick-test row is our own summary of the IBM and Microsoft lines above.

7. **Think it through:** A phone app uses the camera to show a dinosaur on your living-room carpet. Is this AR or VR? The dinosaur is a made-up example. See answer ↓

Quick check 1. True or false: In virtual reality, the user keeps seeing the real room, with digital objects added on top. *(True or False?)* See answer ↓

Sources: ibm.com; learn.microsoft.com

2 Two kinds of headset

2.1 What is a see-through display?

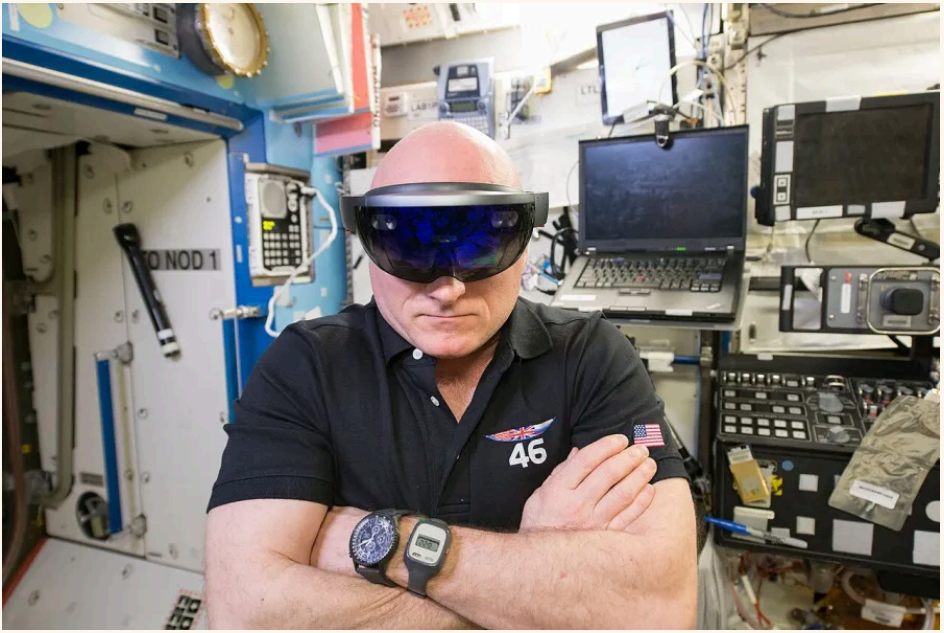
Microsoft's documentation describes two kinds of headset. It calls them holographic devices and immersive devices. The difference lies in the display.

Two headset types, as Microsoft describes them

Point	Holographic device	Immersive device
Example Microsoft names	Microsoft HoloLens	Samsung HMD Odyssey+
Display	See-through display	Opaque display
Your view of the room	Allows the user to see the physical environment while wearing the headset	Blocks out the physical environment while wearing the headset

Point	Holographic device	Immersive device
Movement	Full six-degrees-of-freedom movement, both rotation and translation	Also full six-degrees-of-freedom movement, both rotation and translation

The wording is Microsoft's. Microsoft also says a device may be tethered to a PC or untethered. That does not decide its type. The table does not cover phone-based AR.



NASA astronaut Scott Kelly with a Microsoft HoloLens aboard the International Space Station, 20 February 2016. The Commons description says the device is part of NASA's project Sidekick. The project explores augmented reality to reduce crew training requirements. It also aims to increase the efficiency at which astronauts can work in space. Photo by NASA, public domain, via Wikimedia Commons.

The see-through display matches the AR idea. It keeps the real world in view. The opaque display matches the VR idea. It closes the real world off. This link is our own reading; Microsoft calls these devices holographic and immersive.

2.2 Does AR need a headset?

No. IBM lists smartphones and tablets as AR devices. It adds smart glasses and headsets. The UPSC statement in card 9 names the camera of a smartphone or PC.

2.3 Does VR always hide the room completely?

Microsoft adds one detail. In virtual reality, nearby walls and furniture are shown digitally inside the experience. The user can then avoid colliding with them.

> **Quick check 2.** True or false: A see-through display lets the wearer see the physical environment while wearing the headset. *(True or False?)* See answer ↓

Sources: learn.microsoft.com; ibm.com

3 The exam trap

3.1 Why do students mix up AR and VR?

The two terms are easy to swap. It is easy to attach the right description to the wrong name.

UPSC used this in its 2019 question. Two statements swapped the descriptions. Two statements gave them correctly.

3.2 Which statements were right and which were wrong?

The four statements, shortened

Statement	What it says	Correct?	Why

Statement	What it says	Correct?	Why
1	AR creates a simulated environment and completely shuts out the physical world	No	That fits VR, which IBM says completely replaces the physical world
2	VR projects computer images onto real-life objects or surroundings	No	That fits AR, which IBM says overlays content onto the real world
3	AR lets people be present in the world, using the camera of a smartphone or PC	Yes	IBM says AR users still see their physical environment
4	VR closes the world and gives a complete immersion experience	Yes	Microsoft says VR occludes your view for a fully immersive experience

Statement wording is shortened here. The full official wording is in card 9.

3.3 Is there a quick memory aid?

Try this. **AR adds to the real world. VR visits a made-up world.** This is a memory aid, not a source line. It works because AR keeps you where you are. VR moves your view elsewhere.

3.4 How can you eliminate options step by step?

- Statement 1 describes VR, so any option that includes statement 1 is out.

- Statement 2 describes AR, so any option that includes statement 2 is out.
- That removes the options “1 and 2 only” and “1, 2 and 3”.
- Statement 3 is correct, so “4 only” is incomplete.
- The option “3 and 4” is left, and it matches the official key.

> **Quick check 3.** True or false: A statement saying AR completely shuts out the physical world is correct. *(True or False?)* See answer ↓

Sources: upsc.gov.in; ibm.com; learn.microsoft.com

Good to Know · See how it works

4 How phone AR works

4.1 How does a phone know where it is?

Google’s ARCore is a toolkit for phone AR. As the phone moves, ARCore runs a process called **SLAM**. The full name is simultaneous localization and mapping. This helps it understand where the phone is relative to the world around it.

ARCore detects visually distinct features in the camera image. It calls them **feature points**. It uses these points to compute the phone’s change in location.

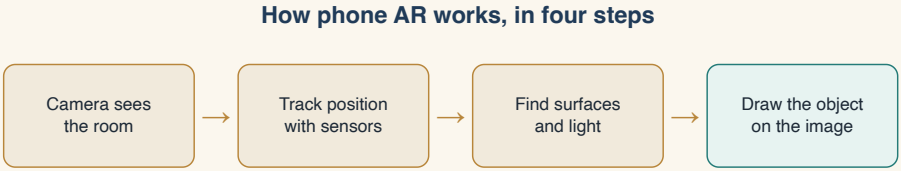
ARCore also combines this with inertial measurements from the device’s IMU. The IMU is a motion-sensor unit. Together they estimate the camera’s pose over time. Pose means its position and orientation.

IBM says AR software may also use data from accelerometers, gyroscopes, GPS or lasers. This comes alongside a video stream.

4.2 How does a virtual object sit on a table?

- **Surfaces:** ARCore identifies horizontal and vertical surfaces as geometric planes. Virtual objects can then be placed on them.
- **Depth:** ARCore can create depth maps that show the distance of surfaces.
- **Light:** ARCore provides information about environmental lighting. Virtual objects can then be lit realistically.

ARCore also warns about a limit. Flat surfaces without texture may not be detected properly. A white wall is one example.



Original diagram of the steps Google describes for ARCore.

Original diagram. The four steps follow the ARCore concepts: motion tracking, environmental understanding, light estimation and drawing over the camera image.

4.3 Do all AR apps need a trigger?

IBM names two basic types of AR.

- **Marker-based AR** overlays digital content onto a physical trigger. The trigger might be a QR code, an image or another target marker.
- **Marker-less AR** needs no specific trigger. It relies on device sensors such as GPS, accelerometers and cameras to map the user's surroundings in real time.

ARCore says the rendered virtual image can be overlaid on the camera image. That makes the content appear to be part of the real world.

> **Quick check 4.** True or false: Google's ARCore can identify horizontal and vertical surfaces so that virtual objects can be placed on them. *(True or False?)* See answer ↓

Sources: developers.google.com; ibm.com

5 What mixed reality adds

5.1 What is mixed reality?

Mixed reality blends the physical and digital worlds. Microsoft says some experiences can move between augmented and virtual realities. These form mixed reality.

IBM frames it a little differently. It calls mixed reality an umbrella term for some advanced forms of AR. Digital content interacts with the real world. Virtual objects blend with the physical environment.

For the exam, keep to the two terms in the question. Use mixed reality only as background.

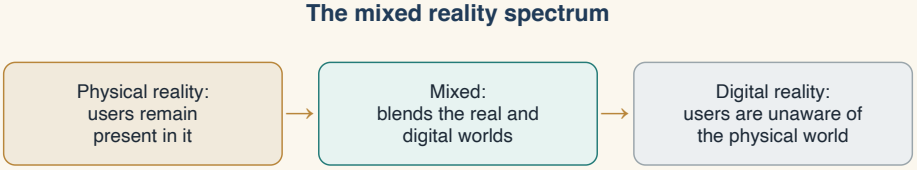
5.2 What is the reality spectrum?

Microsoft describes a spectrum. Physical reality sits at one end and digital reality at the other. Mixed reality covers the space between them.

- Near the physical end, users remain present in their physical reality. They are not made to believe they have left it.
- In the middle, experiences blend the real world and the digital world.

- Near the digital end, users experience a digital reality. They are unaware of the physical reality around them.

That Microsoft page does not say where AR or VR sit on the line. So do not mark them on it yourself.



Original diagram. Labels follow Microsoft's description of the spectrum.

Original diagram of the spectrum between physical and digital reality.

5.3 Who introduced the term?

Microsoft says the term **mixed reality** comes from a 1994 paper. Paul Milgram and Fumio Kishino wrote it. The paper is titled "A Taxonomy of Mixed reality Visual Displays".

A related paper has the title "Augmented reality: a class of displays on the reality-virtuality continuum". Its authors are Milgram, Takemura, Utsumi and Kishino. Crossref lists it in SPIE Proceedings volume 2351.

> **Quick check 5.** True or false: Microsoft says the term mixed reality was introduced in a 1994 paper by Paul Milgram and Fumio Kishino. *(True or False?)* See answer ↓

Sources: learn.microsoft.com; ibm.com; doi.org

6 An early headset paper

6.1 Who wrote about a head-mounted display in 1968?

Ivan E. Sutherland wrote a paper titled “A head-mounted three dimensional display”. It appeared in the proceedings of the Fall Joint Computer Conference. The conference ran from 9 to 11 December 1968 in San Francisco.

The Computer History Museum says Sutherland introduced several concepts. These include 3-D computer modeling, visual simulations, computer aided design and virtual reality. It also says he received the ACM Turing Award in 1988.

6.2 Does this make Sutherland the inventor of VR?

The sources here do not say that. They record a 1968 paper and the museum’s description of his ideas. Treat the paper as an early landmark. Do not call it the first.

Sources: api.crossref.org; computerhistory.org

Great to Know · See where it is used

7 Where AR and VR help

7.1 What do everyday AR apps do?

IBM names several uses of AR.

- **Furniture:** Ikea Place lets users virtually place furniture in their homes.
- **Navigation:** mobile mapping apps add directional arrows and street names over the view.
- **Filters:** social media filters, such as Snapchat filters, alter the images seen through phone cameras in real time.
- **Games:** Pokemon GO blends virtual creatures and objects into real-world locations.
- **Healthcare:** AR can be used for medical training, surgical planning and patient education.

7.2 How does NASA use AR?

NASA's description on Wikimedia Commons says astronaut Scott Kelly checked out a Microsoft HoloLens. This was aboard the International Space Station. It says the device is part of project Sidekick. Sidekick is exploring AR. It aims to cut crew training needs and help astronauts work more efficiently in space.

7.3 How is VR used in training?

NASA's description of its second photo says astronaut Shane Kimbrough used a virtual reality headset. He used it to train for upcoming spacewalks. It says VR is used in training on the ground and in space. This keeps skills sharp.

A 2020 meta-analysis looked at laparoscopic surgery training. Laparoscopic surgery is operating through small cuts with a camera. The authors analysed 24 randomised controlled trials. These were published up to January 2018. The trials compared VR training with apprenticeship training.

The authors reported a clear gain in trainee skill in all their meta-analyses. They concluded that VR improves efficiency and also quality. Error rates fell and tissue handling improved.



NASA astronaut Shane Kimbrough uses a virtual reality headset to train for upcoming spacewalks, 12 December 2016. The Commons description adds that virtual reality is used during training on the ground and while in space to maintain proficiency. Image credit: NASA, public domain, from Wikimedia Commons.

> **Quick check 6.** True or false: The 2020 meta-analysis authors concluded that VR training improved efficiency and quality in laparoscopic surgical training. *(True or False?)* See answer ↓

Sources: ibm.com; pmc.ncbi.nlm.nih.gov

8 What India's Budget says nearby

8.1 Does the Union Budget mention this sector?

The Union Budget 2026-27 speech was delivered on 1 February 2026. Paragraph 60 is under the heading Orange Economy. It speaks about the Animation, Visual Effects, Gaming and Comics (AVGC) sector.

- The speech calls AVGC a growing industry.
- It says the sector is projected to require 2 million professionals by 2030.
- It proposes to support the Indian Institute of Creative Technologies, Mumbai.
- The support is for setting up AVGC Content Creator Labs in 15,000 secondary schools and 500 colleges.

These details are as of that speech. The speech does not name AR or VR. Treat AVGC as nearby context, not as an AR or VR scheme.

Sources: indiabudget.gov.in

Exam Practice

9 How UPSC tested it

9.1 What exactly did UPSC ask?

This appeared in the Civil Services (Preliminary) Examination 2019. It was Question 91 in the Series A booklet of General Studies Paper I. The official words are below.

UPSC's official Series A answer key gives option (b), 3 and 4, for Question 91.

See UPSC CSP 2019 GS Paper I, Q91. View this question.

9.2 What else was on the same page?

Question 95 on the same page of the booklet was about wearable technology. It asked which tasks are accomplished by wearable devices. Question 94 was about digital signatures. Both topics have

their own lessons under Related Articles.

9.3 Quick Q&A

Which statements were correct?
Statements 3 and 4. AR keeps the person in the real world, and VR closes it off.

Which statements swapped the two ideas?
Statements 1 and 2.

Which phone toolkit does the lesson use to explain phone AR?
Google’s ARCore.

Which term covers experiences between physical and digital reality?
Mixed reality, as Microsoft describes it.

Sources: upsc.gov.in

Remember this

- **AR:** overlays digital content onto the real world. You still see your surroundings.
- **VR:** replaces the physical world with a computer-generated one, typically through a headset.
- **UPSC trap:** statements 1 and 2 swapped the two descriptions.
- **Official answer:** statements 3 and 4, CSP 2019 GS Paper I, Question 91.
- **Phone AR:** tracks the phone, finds surfaces and light, and draws over the camera image.
- **Mixed reality:** a blend of physical and digital worlds. Microsoft dates the term to a 1994 Milgram and Kishino paper.

Explain it back: Say in your own words why a phone game with a character on your floor is AR. Then say why a headset that hides your room is VR.

Practice MCQs

1. In the context of digital technologies for entertainment, consider the following statements:

1. In Augmented Reality (AR), a simulated environment is created and the physical world is completely shut out.

2. In Virtual Reality (VR), images generated from a computer are projected onto real-life objects or surroundings.

3. AR allows individuals to be present in the world and improves the experience using the camera of smart-phone or PC.

4. VR closes the world, and transposes an individual, providing complete immersion experience.

Which of the statements given above is/are correct?

A. 1 and 2 only

B. 3 and 4

C. 1, 2 and 3

D. 4 only

See answer ↓

2. Which description fits augmented reality (AR)?

A. It replaces the physical world with a 360-degree computer-generated environment

B. It surrounds the user with a fully immersive digital world

C. It overlays digital content onto the user's view of the real world

D. It blocks the user's view of the room with an opaque display

See answer ↓

3. Which of these is an everyday example of AR rather than VR?

A. A camera filter that adds graphics to the live view from a phone

B. A pair of goggles that surrounds the user with a 360-degree virtual world

C. A headset that shows a museum tour inside a fully computer-generated world

D. A game played entirely inside a computer-generated environment

See answer ↓

4. Google's ARCore tracks where a phone is by combining which two kinds of data?

A. Weather forecasts and street maps

B. Heat maps and sound recordings

C. Camera images and inertial (motion-sensor) measurements

D. Voice commands and touch input

See answer ↓

5. Which term describes experiences in which digital content interacts with the real world, blending virtual objects with the physical environment?

A. Mixed reality

B. Cloud computing

C. Virtual reality

D. A digital twin

See answer ↓

6. Which computer scientist wrote the 1968 paper titled 'A head-mounted three dimensional display'?

A. Paul Milgram

B. Ivan E. Sutherland

C. Fumio Kishino

D. Haruo Takemura

See answer ↓

7. Consider the following statements about AR and VR.

1. In AR, users still see their physical surroundings, with digital information overlaid.

2. VR typically uses a headset, head-mounted display or goggles and replaces the physical world.

3. AR can be experienced only through a head-mounted display.

Which statements are correct?

A. 1 and 2 only

B. 1 and 3 only

C. 2 and 3 only

D. 1, 2 and 3

See answer ↓

Answer Key

1. **B.** UPSC's official Series A key for CSP 2019 Question 91 gives 3 and 4. Those statements say AR keeps a person in the real world and VR closes it off. IBM says AR overlays content onto the real world rather than replacing it. IBM says VR completely replaces the physical world. So statement 3 is right for AR, and statement 4 is right for VR. Statement 1 swaps the two technologies, because it says AR shuts out the physical world. Statement 2 swaps them too, because it says VR projects images onto real surroundings. So any option that includes statement 1 or 2 is wrong. The option with only statement 4 is incomplete, because statement 3 is also correct. ↑ Q1
2. **C.** IBM says AR overlays content onto the real world and enriches a user's perception rather than replacing it. Microsoft says AR overlays graphics, video streams or holograms in the physical world. The other three options describe VR. IBM says VR completely replaces the physical world. Microsoft says VR occludes the view to present a fully immersive digital experience. ↑ Q2
3. **A.** IBM lists social media filters, such as Snapchat filters, as AR. They alter the images seen through phone cameras in real time. Microsoft also mentions the AR filters people use on Instagram. IBM lists the VR Museum of Fine Art as a VR example. IBM says VR surrounds users with a 360-degree view of computer-generated environments. ↑ Q3
4. **C.** Google says ARCore uses SLAM, tracking feature points in the camera image and combining visual and inertial data. IBM says AR software may draw on accelerometers, gyroscopes, GPS or lasers alongside a video stream. None of the other three pairs appear in either source. ↑ Q4
5. **A.** IBM says mixed reality creates experiences where digital content interacts with the real world, blending virtual objects with the physical environment. Microsoft says mixed reality is a blend of physical and digital worlds. IBM says VR completely replaces the physical world. IBM describes a digital twin as a 3-D copy of an object stored in the cloud. ↑ Q5
6. **B.** Crossref lists Ivan E. Sutherland as the author of this paper. It was presented at the Fall Joint Computer Conference, 9 to 11 December 1968. The Computer History Museum describes Sutherland as having introduced concepts such as virtual reality. Milgram, Kishino and Takemura are authors of later papers on mixed reality and augmented reality displays. ↑ Q6

7. **A.** IBM says AR users still see and interact with their physical environments while digital information is overlaid. IBM says VR is typically delivered with a headset, head-mounted display or goggles and completely replaces the physical world. So statements 1 and 2 are correct. IBM also lists smartphones and tablets as AR devices, so AR is not limited to head-mounted displays and statement 3 is wrong. ↑ Q7

Quick-check answers

1. **False.** That describes AR. IBM says VR completely replaces the physical world with a computer-generated environment. ↑ 1
2. **True.** Microsoft says a see-through display allows the user to see the physical environment while wearing the headset. ↑ 2
3. **False.** IBM says AR overlays content onto the real world rather than replacing it. Shutting out the world describes VR. ↑ 3
4. **True.** Google says ARCore identifies horizontal and vertical surfaces as geometric planes, allowing virtual objects to be placed on them. ↑ 4
5. **True.** Microsoft's documentation says the term was introduced in a 1994 paper by Paul Milgram and Fumio Kishino. ↑ 5
6. **True.** The authors concluded that virtual reality improves efficiency and also quality, with reduced error rates and improved tissue handling. ↑ 6
7. **Think it through.** It is AR. You still see your room. The app overlays a digital object on it. VR would replace the room with a computer-generated scene. ↑ 7

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