a place of mind

FACULTY OF EDUCATION

Department of
Curriculum and Pedagogy

Physics
Buoyancy

Science and Mathematics Education Research Group

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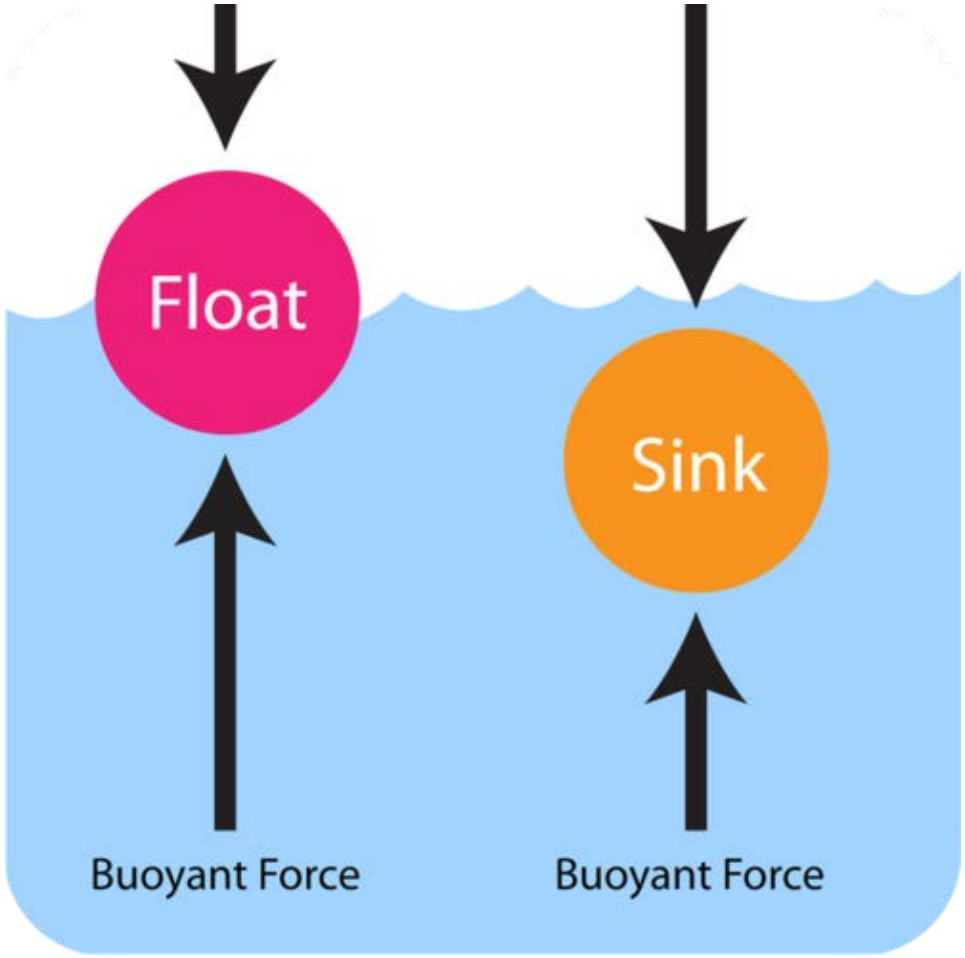
Buoyancy



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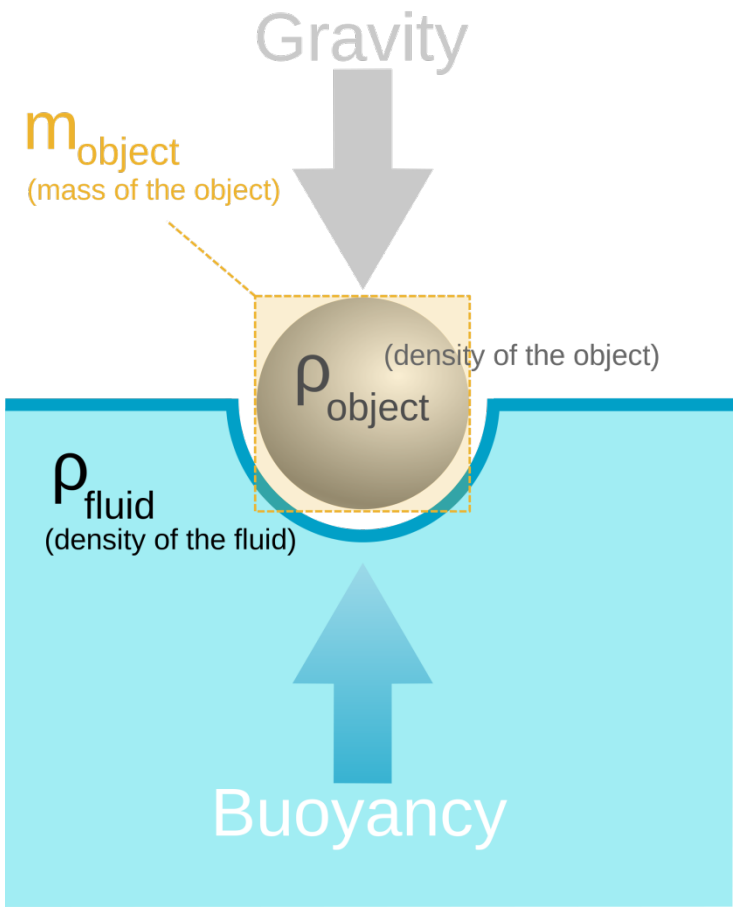


https://en.wikipedia.org/wiki/Buoyancy

Buoyancy

The following questions have been compiled from a collection of questions submitted on PeerWise (https://peerwise.cs.auckland.ac.nz/) by teacher candidates as part of the EDCP 357 physics methods courses at UBC.

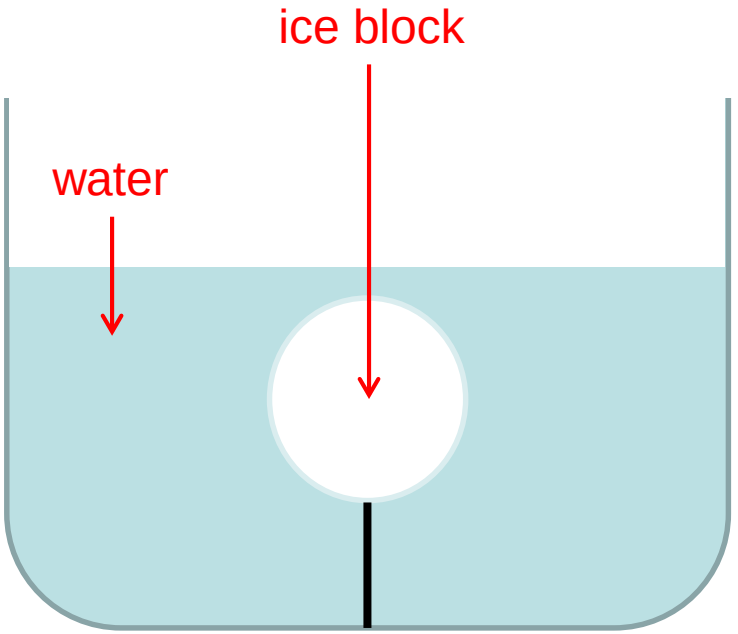
Buoyancy Problems I

A completely submerged block of ice is tethered to the bottom of the container, as shown below. What will happen to the water level when the block of ice melts?

A. Water level will rise.

B. Water level will drop.

C. Water level will remain the same



Solution

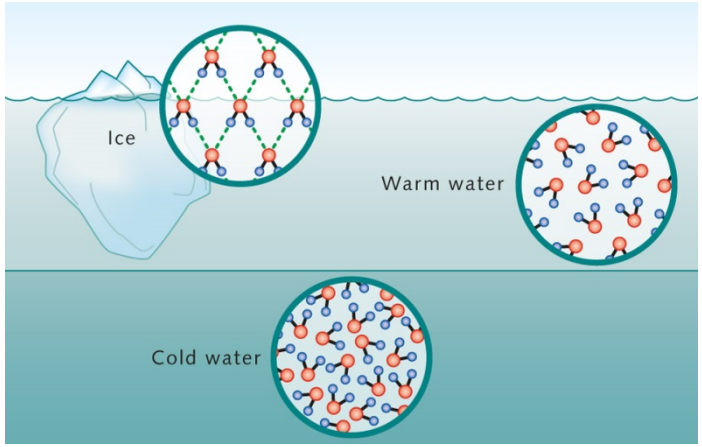
Answer: B

Justification: Have you noticed that ice cubes float in water instead of sinking? The fact that ice floats in water suggests that ice is less dense than water, which appears to be counterintuitive. Most materials are denser when they are solid than when they are liquid. As water is cooled down, the water molecules have less energy and hydrogen bonding takes over. As a result, the water molecules form a ordered crystal through hydrogen bonding, which spaces the water molecules farther apart than when they were in a liquid. This makes ice less dense than water, allowing ice to float in water.

Solution continued

Answer: B

This means that if we compare the volumes for samples of ice and water of equal mass, the ice would occupy more space. When the ice melts, we have an equivalent mass of water that takes up less space and the result is a lowered water level.



Therefore, **B** is the correct answer.

Watch: https://www.youtube.com/watch?v=UukRgqzk-KE

Buoyancy Problems II

Suppose a basketball, with a mass of 100 grams and a volume of 4 liters, tethered to a bag is maintaining a neutral buoyancy in water. If the mass of the bag is 8 kilograms, what is the buoyancy of the bag?

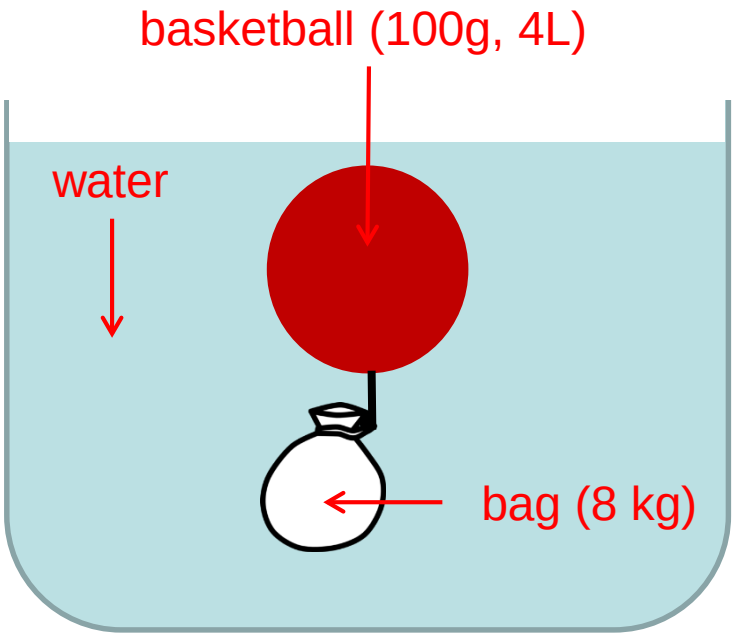
A. 121 N

B. 80 N

C. 41 N

D. 40 N

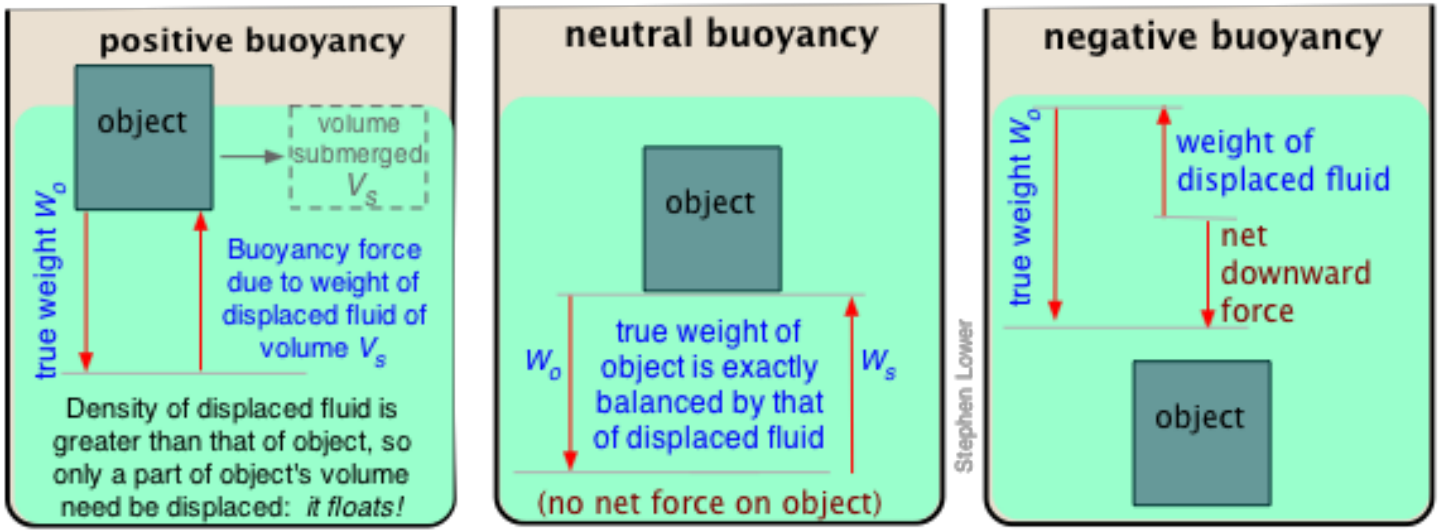
E. 39 N



Solution

Answer: C

Justification: **Buoyancy** is an upward force exerted by a liquid that opposes the weight of an immersed object. **Neutral buoyancy** is a condition in which the buoyancy is equal to the weight of an immersed object.



http://chemwiki.ucdavis.edu/Physical_Chemistry/Physical_Properties_of_Matter/Bulk_Properties/Density/Buoyancy

Solution continued

Answer: C

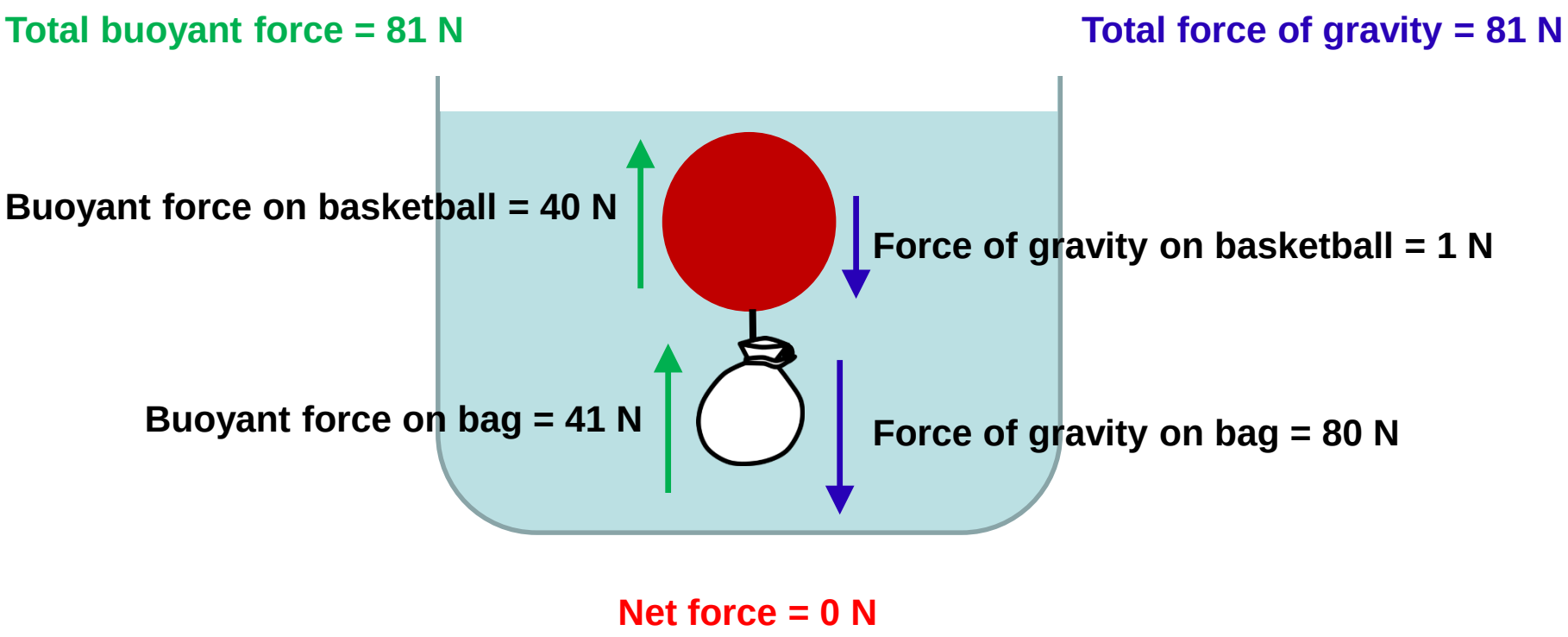
Note that the basketball displaces 4 litres of water, so there is an **upward** force of $4\ kg\ \times 10\frac{m}{s^2} = 40\ N$. But the mass of the basketball produces a **downward** force of $0.1\ kg\ \times 10\frac{m}{s^2} = 1\ N$. Therefore, the net buoyancy force (**upward** direction) acting on the basketball is $40\ N\ - 1\ N = 39\ N$. Now, the bag has a mass of $8\ kg$, which causes a **downward** force of $8\ kg\ \times 10\frac{m}{s^2} = 80\ N$. In order to maintain neutral buoyancy, there must be a net force of zero on the system. Therefore the bag must contribute a buoyant force of $80\ \mathrm{N}\ - 39\ \mathrm{N} = 41\ N$ (**upwards**).

Therefore, **C** is the correct answer.

Watch: https://www.youtube.com/watch?v=nMlXU97E-uQ

Solution continued

Here is a simplified diagram to illustrate the balance of the forces:



Buoyancy Problems III

Suppose a basketball, with a mass of 100 grams and a volume of 4 liters, tethered to a bag is maintaining a neutral buoyancy in water. If the basketball deforms by 10% (reduces volume) and the bag has a buoyant force of 30 N, what is the mass of the bag?

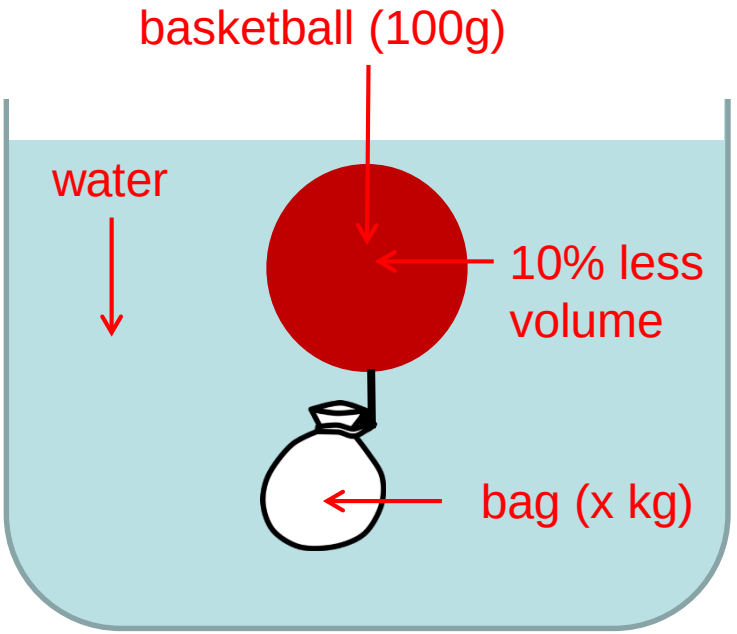
A. 7.0 kg

B. 6.9 kg

C. 6.5 kg

D. 6.1 kg

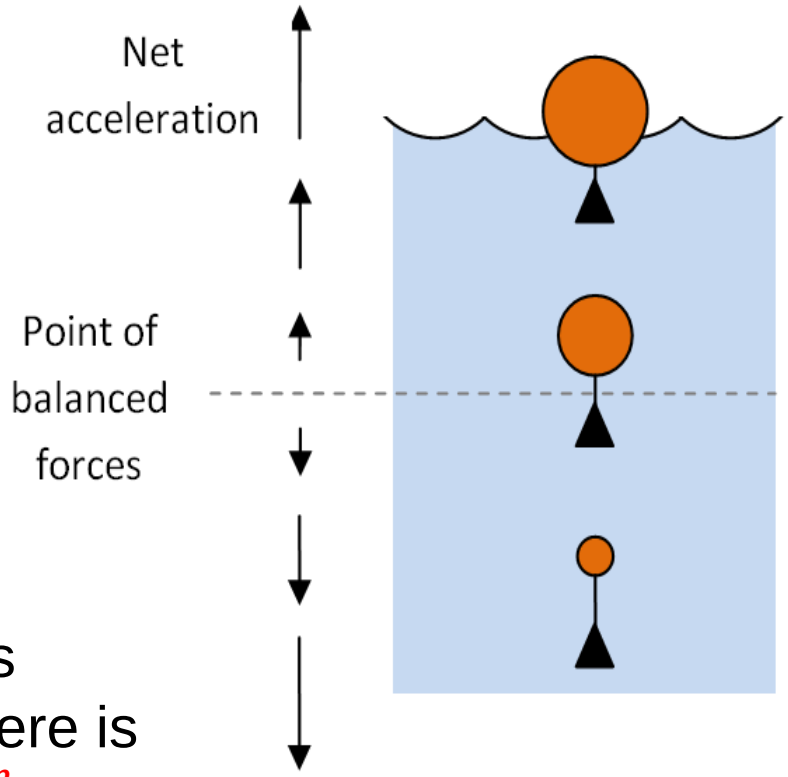
E. 6.0 kg



Solution

Answer: C

Justification: **Buoyancy** is an upward force exerted by a liquid that opposes the weight of an immersed object. **Neutral buoyancy** is a condition in which the buoyancy is equal to the weight of an immersed object.



Note that the basketball displaces $4\ L\ \times 90\% = 3.6\ L$ of water, so there is an **<u>upward</u>** force of $3.6\ kg\ \times 10\frac{m}{s^2} = 36N$.

Solution continued

Answer: C

But the mass of the basketball produces a downward force of $0.1\ kg\ \times 10\frac{m}{s^2} = 1\ N$. Therefore, the net buoyancy force acting on the basketball is $36\ N\ - 1\ N = 35\ N$. Also the bag contributes a buoyant force of $30\ N$. Note that the combined buoyant force is now $65\ N$. In order to maintain neutral buoyancy, the weight of the bag must be $65\ N$. Thus, the mass of the bag is $\frac{65N}{10\ m/s^2} = 6.5\ kg$.

Therefore, **C** is the correct answer.

Watch: https://www.youtube.com/watch?v=nMlXU97E-uQ

Solution continued

Answer: C

But the mass of the basketball produces a **<u>downward</u>** force of $0.1\ kg\ \times 10\frac{m}{s^2} = 1\ N$. Therefore, the net buoyancy force acting on the basketball is $36\ N\ - 1\ N = 35\ N$ (**<u>upwards</u>**). Also, the bag contributes an **<u>upwards</u>** buoyant force of $30\ N$. Note that the combined buoyant force is now $65\ N$ (**<u>upwards</u>**). In order to maintain neutral buoyancy, the weight of the bag (the force of gravity **<u>downwards</u>**) must be $65\ N$. Thus, the mass of the bag is $\frac{65N}{10\ m/s^2} = 6.5\ kg$.

Therefore, **C** is the correct answer.

Watch: https://www.youtube.com/watch?v=nMlXU97E-uQ