

Negation and Quantifiers Worksheet 3

Question 1

A set S of integers is said to be **step-happy** if:

For every number a in S , there exists a number b in S such that for every number c in S , if $c > a$, then $c \geq b$.

Which of the following means that S is **not step-happy**?

- A** There exists a number a in S such that, for every number b in S , there exists a number c in S with $c > a$ and $c < b$.
- B** For every number a in S , there exists a number b in S such that there exists a number c in S with $c > a$ and $c < b$.
- C** There exists a number a in S , there exists a number b in S , and there exists a number c in S with $c > a$ and $c < b$.
- D** For every number a in S , for every number b in S , there exists a number c in S with $c > a$ and $c < b$.

Question 2

A function f is said to be **mirror-calm** at 0 if:

For every positive number ϵ , there exists a positive number δ such that for every real number x , if $|x| < \delta$, then $|f(x) - f(0)| < \epsilon$.

Which of the following means that f is **not mirror-calm** at 0?

- A** For every positive number ϵ , there exists a positive number δ such that there exists a real number x with $|x| < \delta$ and $|f(x) - f(0)| \geq \epsilon$.
- B** There exists a positive number ϵ such that there exists a positive number δ such that for every real number x , $|x| < \delta$ and $|f(x) - f(0)| \geq \epsilon$.
- C** There exists a positive number ϵ such that, for every positive number δ , there exists a real number x with $|x| < \delta$ and $|f(x) - f(0)| \geq \epsilon$.
- D** For every positive number ϵ , for every positive number δ , there exists a real number x with $|x| < \delta$ and $|f(x) - f(0)| < \epsilon$.

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Question 3

A triangular mesh M is said to be **vertex-bright** if:

For every triangle T in M , there exists a vertex v of T such that for every edge e of T , v lies on e or e is red.

Which of the following means that M is **not vertex-bright**?

- A There exists a triangle T in M such that there exists a vertex v of T such that for every edge e of T , v does not lie on e and e is not red.
- B For every triangle T in M , for every vertex v of T , there exists an edge e of T such that v does not lie on e or e is not red.
- C There exists a triangle T in M such that for every vertex v of T , for every edge e of T , v does not lie on e and e is not red.
- D There exists a triangle T in M such that for every vertex v of T , there exists an edge e of T such that v does not lie on e and e is not red.

Question 4

A clan of quorls is said to be **echo-clean** if:

For every quorl q in the clan, there exists a bell b owned by q such that for every note n played by b , n is silver.

Which of the following means that the clan is **not echo-clean**?

- A For every quorl q in the clan, for every bell b owned by q , there exists a note n played by b such that n is not silver.
- B There exists a quorl q in the clan such that, for every bell b owned by q , there exists a note n played by b such that n is not silver.
- C There exists a quorl q in the clan such that there exists a bell b owned by q such that for every note n played by b , n is not silver.
- D For every quorl q in the clan, there exists a bell b owned by q such that there exists a note n played by b such that n is not silver.

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Question 5

A road network G is said to be **route-guarded** if:

For every town u in G , there exists a station s in G such that for every town v in G , if v is adjacent to u , then v is connected to s .

Which of the following means that G is **not route-guarded**?

- A For every town u in G , for every station s in G , there exists a town v in G such that v is adjacent to u and v is not connected to s .
- B There exists a town u in G such that there exists a station s in G such that for every town v in G , v is adjacent to u and v is not connected to s .
- C There exists a town u in G such that, for every station s in G , there exists a town v in G such that v is adjacent to u and v is not connected to s .
- D There exists a town u in G such that, for every station s in G , for every town v in G , if v is adjacent to u , then v is not connected to s .

Question 6

A collection A of sequences is said to be **deep-linked** if:

For every sequence (a_n) in A , there exists a positive integer N such that for every positive integer $n > N$, there exists a positive integer $m > n$ with $a_m > a_n$.

Which of the following means that A is **not deep-linked**?

- A For every sequence (a_n) in A , for every positive integer N , there exists a positive integer $n > N$ such that for every positive integer $m > n$, $a_m \leq a_n$.
- B There exists a sequence (a_n) in A such that, for every positive integer N , there exists a positive integer $n > N$ such that for every positive integer $m > n$, $a_m \leq a_n$.
- C There exists a sequence (a_n) in A such that there exists a positive integer N such that for every positive integer $n > N$, for every positive integer $m > n$, $a_m \leq a_n$.
- D There exists a sequence (a_n) in A such that, for every positive integer N , for every positive integer $n > N$, there exists a positive integer $m > n$ with $a_m \leq a_n$.

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Question 7

A height function h on a set E is said to be **drift-soft** if:

For every positive number r , there exists a positive number s such that for every point P in E , there exists a point Q in E with $d(P, Q) < s$ and $h(Q) < h(P) + r$.

Which of the following means that h is **not drift-soft**?

- A There exists a positive number r such that, for every positive number s , there exists a point P in E such that for every point Q in E , $d(P, Q) \geq s$ or $h(Q) \geq h(P) + r$.
- B There exists a positive number r such that, for every positive number s , for every point P in E , there exists a point Q in E with $d(P, Q) \geq s$ or $h(Q) \geq h(P) + r$.
- C For every positive number r , for every positive number s , there exists a point P in E such that for every point Q in E , $d(P, Q) \geq s$ and $h(Q) \geq h(P) + r$.
- D There exists a positive number r such that there exists a positive number s such that for every point P in E , for every point Q in E , $d(P, Q) < s$ and $h(Q) \geq h(P) + r$.

Question 8

A circle diagram D is said to be **pin-centred** if:

For every point P in D , there exists a line l in D such that for every circle C in D passing through P , there exists a marked point Q that lies on both l and C .

Which of the following means that D is **not pin-centred**?

- A For every point P in D , for every line l in D , there exists a circle C in D passing through P such that for every marked point Q , Q does not lie on both l and C .
- B There exists a point P in D such that there exists a line l in D such that for every circle C in D passing through P , for every marked point Q , Q does not lie on both l and C .
- C There exists a point P in D such that, for every line l in D , for every circle C in D passing through P , there exists a marked point Q that does not lie on both l and C .
- D There exists a point P in D such that, for every line l in D , there exists a circle C in D passing through P such that for every marked point Q , Q does not lie on both l and C .

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Question 9

A cave system is said to be **lantern-faithful** if:

For every island i in the system, there exists a guardian g on i such that for every cave c on i , there exists a lantern l in c that g can see.

Which of the following means that the cave system is **not lantern-faithful**?

- A For every island i in the system, for every guardian g on i , there exists a cave c on i such that for every lantern l in c , g cannot see l .
- B There exists an island i in the system such that there exists a guardian g on i such that for every cave c on i , for every lantern l in c , g cannot see l .
- C There exists an island i in the system such that, for every guardian g on i , there exists a cave c on i such that for every lantern l in c , g cannot see l .
- D There exists an island i in the system such that, for every guardian g on i , for every cave c on i , there exists a lantern l in c that g cannot see.

Question 10

A family \mathcal{F} of sets of numbers is said to be **cross-balanced** if:

For every set A in \mathcal{F} , there exists a number a in A such that for every set B in \mathcal{F} , there exists a number b in B with $a + b = 0$.

Which of the following means that \mathcal{F} is **not cross-balanced**?

- A For every set A in \mathcal{F} , for every number a in A , there exists a set B in \mathcal{F} such that for every number b in B , $a + b \neq 0$.
- B There exists a set A in \mathcal{F} such that, for every number a in A , there exists a set B in \mathcal{F} such that for every number b in B , $a + b \neq 0$.
- C There exists a set A in \mathcal{F} such that there exists a number a in A such that for every set B in \mathcal{F} , for every number b in B , $a + b \neq 0$.
- D There exists a set A in \mathcal{F} such that, for every number a in A , for every set B in \mathcal{F} , there exists a number b in B with $a + b \neq 0$.

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Question 11

A student is **perfectly prepared** for the TMUA if:

For every question on jzmaths.com, there exists a method such that the student used that method to solve the question, and in every week after first solving it, the student recalled that method from memory at least once.

Which of the following means that the student is **not perfectly prepared** for the TMUA?

- A** There exists a question on jzmaths.com such that, for every method, either the student did not use that method to solve the question, or there exists a week after first solving it in which the student did not recall that method from memory.
- B** For every question on jzmaths.com, there exists a method such that the student did not use that method to solve the question, and in every week after first solving it, the student did not recall that method from memory.
- C** There exists a question on jzmaths.com such that there exists a method which the student used to solve the question, but the student forgot that method forever.
- D** For every question not on jzmaths.com, there exists a method such that the student used that method to solve the question, and in every week after first solving it, the student recalled that method from memory at least once.

Don't worry — nobody is perfectly prepared by this definition! :)