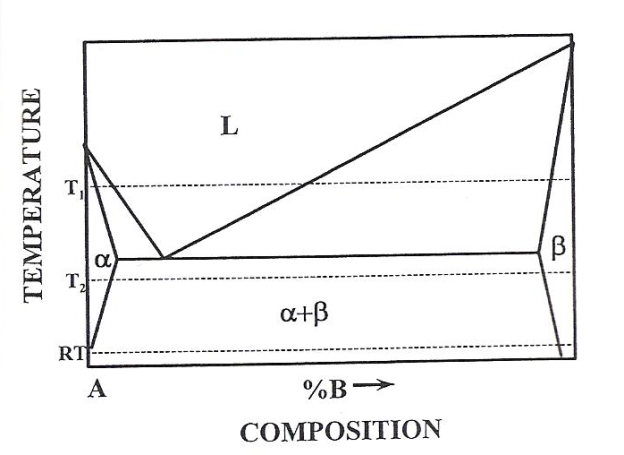
Question: A phase diagram is the sole source needed to fully describe the microstructure in a slow cooled binary alloy.

Answer: The Statement is almost true.

To prove it, we are going to extract all the information we can get by looking at a random binary alloy phase diagram. Before starting it is important to remember that everything that is going to be said here is by considering that slow cooled means: cooled slowly enough to be at equilibrium. Otherwise, the statement would have been wrong. But the last part of the question will give more detailed about this.

  
Figure 1: AB phase diagram

The AB phase diagram given in the assessment package is considered. The overall B composition for the whole alloy will always be 50%. Starting from single phase liquid to two solid phases at room temperature, here is everything which can possibly be extracted from this diagram:

1. From very high temperature to liquidus temperature the alloy is a single phase liquid.
2. At Tliquidus first B crystals start to grow. Their composition is approximately 95% of B
3. As the temperature decrease, more and more β crystals are formed. At T1, the proportion of each phase is approximately: 10% of β crystals and 90% liquid (diagram is no very accurate). The composition of each is respectively 95% of B and around 45% of B. Therefore, a quick calculation shows that is makes 50% of B overall.
4. At Teutectic + ε there is still 55% liquid in the material. Its composition is 15% of B. But at Teutectic liquid is not stable anymore. The 55% remaining liquid transforms in a 2 solid phase component called eutectic.

Also, at Teutectic there is now 55% of a bi-phase eutectic solid and 45% of β solid. The composition for the eutectic is around 90% of A and 10% of B; and for the β solid, around 95% of B.

1. As the cooling continues nothing really moves. The composition of each phase just slightly changes and so at room temperature it is possible to tell that a 1:1 alloy of elements A and B will be made of 55% eutectic and 45% B. The compositions of each are given in 4.

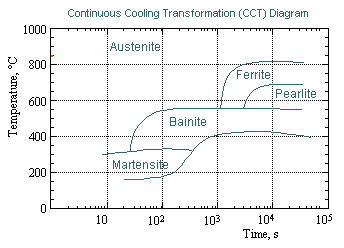
Therefore, the only thing unpredictable is the size or the shape of the grains. This can only be found out by looking at the specimen with a microscope. However, anyone a little bit used to steels could be able to predict it just by looking at the phase diagram.

As a consequence, it has clearly been shown that at equilibrium, (which means enough time has been given to the material to organise while cooling) it is possible to describe most of the microstructure. To summarise what has been just done, it is proven that the following information can be extracted from a phase diagram:

* The overall composition
* The number of phases
* The composition of each phase
* The proportion of each phase

And as said before, the only thing missing is grain size and shape information.

However we could take this discussion a little bit deeper. Indeed, as it has been underlined at the beginning of this answer, until now it has been considered that “slow cooled” meant “at equilibrium”. But this is not very clearly specified in the question... For instance, slow cooled could also have meant cooled in 1000s instead of 105s.

  
Figure 2: CCT diagram for a 0.4% C, 1.5% Mn, 0.5% Mo steel[[1]](#footnote-2)

As this random CCT diagram shows, the cooling rate has still have influence on the microstructure of the alloy even after 105s. Also sometimes on very specific alloys, equilibrium cannot be reached before days. As a consequence, even with a slow cooling rate like said in the statement, the material would still not be at equilibrium and the microstructure could absolutely not be described with a simple phase diagram only. Time-depending curves like on CCT and TTT diagrams would be needed.

Considering all of what have been said in this answer, the statement is partially true but could be also wrong and misinterpreted because of the way it is formulated.

1. http://www.matter.org.uk/steelmatter/metallurgy/7\_1\_2.html, viewed Nov 11 2008. [↑](#footnote-ref-2)