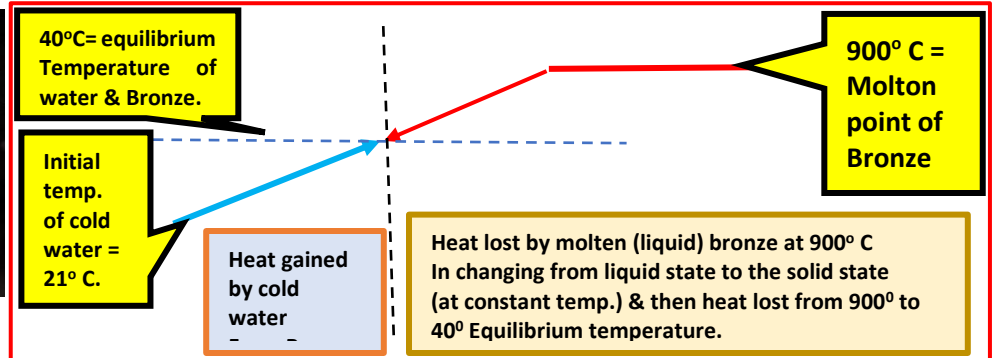


HEAT LOST = HEAT GAINED

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'No Two Are Exactly the Same': How the Heisman Trophy Is Made



The Heisman Trophy **is forged in bronze inside a ceramic shell known as investment**. When it returns from the foundry to MTM Recognition, the company in Oklahoma that produces the trophy each year, that coating is removed with a hammer. DEL CITY, Okla. — Even among famous awards, the Heisman Trophy stands out. The Heisman is gritty verisimilitude. It depicts an athlete in action, dynamically stiff-arming an unseen opponent. It is the color of a scuffed shoe sole, and its chiseled features — deep-set eyes, wrinkled trousers, one bulging calf muscle — are beautiful but not pretty. **On Saturday in New York, Oklahoma quarterback Baker Mayfield is the heavy favorite to win the 83rd Heisman Trophy.**



INTRODUCTION: Application goal is to find amount of water needed to cool 35 lb Molten Bronze Heisman Trophy to 40° C. See graphics above for further data.

QUESTIONS: (a) Convert 35 lb. to kg.?, (b) Find heat needed to change 35 lb. of liquid bronze to a solid at 900° temperature?, (c) Find heat needed to cool 35 lb. of solid bronze at 900° to 40° C ?, (d) Find mass of water initially at 21° C needed to cool 35 lb. of liquid bronze to the solid state at 40° C ?

Jack Nortz demonstrated how alterations on a wax mold of the Heisman Trophy are made. Though the materials have changed, the casting process would have been familiar to the ancient Egyptians. Hot wax is poured into the molds — one a sturdy, plastic mother mold and the second, inside that, a silicone mold that is sensitive enough to pick up the contours of the figure's nose, the parallel lines on his helmet and the pebbly base. The mold is hardened to make a cast. The wax cast is then dipped in what is known as investment, a kind of liquid ceramic, which hardens and, crucially, is heat resistant. This is then heated, melting the wax, which escapes out a hole in the bottom of one of the player's feet. The hole is not visible once the trophy is mounted on its base.



HINTS: 2.2 lb. = 1 kg., $C_{\text{WATER}} = 4184 \text{ J/kg} \cdot ^\circ\text{K}$, $C_{\text{BRONZE}} = 365 \text{ J/kg} \cdot ^\circ\text{K}$, $L_{\text{BRONZE}} = 171.4 \text{ KJ/kg}$, that's latent heat of fusion of bronze = 171.4 KJ/kg., $Q = C m \Delta t$, $Q = L m$, NOTE: Bronze is 90% copper & 10 % tin, in contrast: Brass is 85% copper & 15 % zink

ANSWERS: (a) $m = 15.91 \text{ kg.}$, (b) $Q_{\text{CHANGE LIQ. TO SOLID}} = 2,726.974 \text{ J}$, (c) $Q_{900 \text{ degree solid to } 40^\circ \text{ solid}} = 4,994,149 \text{ J}$, (d) $m_{\text{WATER}} = 97.125 \text{ kg.}$ or about 214 lb. of water or about 3.4 ft.³ of water.

A Heisman Trophy, fresh from the foundry and still enrobed in its ceramic shell.

The **empty cast made of heat-resistant investment is next sent to a foundry, where molten bronze — hotter than 2,000 degrees Fahrenheit — is poured inside it. Enough bronze to assume the shape of the mold is used**, but not so much as to fill it entirely: If the largely hollow Heisman were actually a dense hunk of bronze, it would weigh more than 200 pounds. (**The finished model handed to winners is about 35 pounds**, roughly double that with its base.) The object is then returned to MTM Recognition, where the investment, now brittle, is hammered off the ashy bronze. The bronze is treated with acid and fire to give it the familiar patina that makes it look as if it is a few decades or centuries old