Solutions

2.1

- Does machine M halt when run on input w? ✓.

2.2

- Runs $H(M, M)$: if it answers halts, loop forever; otherwise halt ✓.

2.3

- Every nontrivial semantic property of programs (what they compute, not how they are written) ✓.

3.1

- $D(M)$: run $H(M, M)$; if the answer is "halts", enter an infinite loop; if "loops", halt immediately ✓.
- $D(D)$: $H(D, D)$ must answer something; either answer makes D do the opposite of what the answer says about itself ✓.
- Contradiction: no consistent H exists – halting is undecidable ✓.
- Mistakes: undecidable is about a general decider for ALL pairs, and specific instances often are answerable – the theorem is not about any program stopping ✓.

3.2

- (1) Decidable: finite graph – check whether any accepting state is reachable from the start ✓.
- (2) Undecidable: $L(M) \neq \emptyset$ is a nontrivial property of what M computes – Rice, or reduce halting by making M accept exactly when the halting computation finishes ✓.
- (3) Undecidable by Rice: wrap P so banana prints only after the wrapped computation halts – a banana-detector would decide halting ✓.

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