Indicate if each of the following statements is either true (T) or false (F). A correct response is awarded +1, an incorrect response is awarded –1/2, and no response is awarded 0 points. Ambiguous marks are counted as incorrect responses.

1. ___ A transition regime flow is one for which the gas becomes rarefied enough that it cannot support laminar flow, only turbulent flow.

2. ___ The conservation equations, referred to as the Euler equations and the Navier-Stokes equations represent, respectively, the first-order and second-order Chapman-Enskog solutions of the Boltzmann equation. In each case, the five conservation equations correspond to the five moment equations formed by setting \( Q \) equal to \( m, mc, \) and \( \frac{1}{2}mc^2 \) in

\[
\frac{\partial}{\partial t} (n\vec{Q}) + \Delta \cdot (n\vec{c}\vec{Q}) - n\vec{F} \cdot \frac{\partial \vec{Q}}{\partial \vec{c}} = \Delta[Q].
\]

Because mass, momentum, and energy are conserved in collisions, the term \( \Delta[Q] \) vanishes.

3. ___ In transition-regime flows, continuum flow solutions that are based on the Navier-Stokes equations are improved if the usual ‘no-slip’ boundary condition is modified to allow for velocity and temperature slips at solid surfaces. The Chapman-Enskog distribution adjusts to the surface distribution in a region called the Maxwell layer, that has a thickness of the order of the mean free path.

4. ___ Results for the Mott-Smith moment method, applied to flow through a normal shock wave, are more accurate at relatively large freestream Mach numbers than at smaller values because the actual distribution function becomes increasingly bimodal at higher Mach numbers.

5. ___ The moment method has been successfully applied to many one-dimensional problems with remarkably good agreement with experiment in some instances. However, the solutions are not unique since they are based on several arbitrary choices. Moment methods have not been applied to two-dimensional flows.

6. ___ The model equation approach involves an approximation to the form of the Boltzmann equation.

7. ___ The BGK (Bhatnagar, Gross, and Crook) equation modifies the collision integral such that the Boltzmann equation is written

\[
\frac{\partial}{\partial t} (nf) + c \cdot \frac{\partial}{\partial c} (nf) + F \cdot \frac{\partial}{\partial c} (nf) = n\nu(f_0 - f).
\]

This immediately satisfies the requirement that the collision integral is zero when the velocity distribution is the Maxwellian distribution.

8. ___ For the computation of flow through a strong shock, the BGK model is most inaccurate in the upstream region of the shock because the BGK uses a collision frequency that is independent of \( f \), and related to quantities based on a near-equilibrium theory.

9. ___ Bird concludes that for nonlinear problems that involve large perturbations and complex physical effects, analytical solutions provide more realistic solutions than numerical methods.

10. The Mott-Smith moment method applied to the problem of flow through a normal shock wave starts with a bimodal distribution that is a linear combination of the distributions in the uniform flow upstream and downstream of the shock. Knowing what happens to the temperature through a normal shock wave, make a comparative sketch of the velocity distribution function upstream of the shock relative to that downstream of the shock.