

**Cell phones must be turned off entirely - no ringers, no vibrating (even that is noticeable) - to provide a nondistracting environment for all.**

- (a) [9 pts] Precisely state all five of Euclid's Postulates.

(b) [3 pts] State and name any one of the other Parallel Postulates.
- [15 pts] Precisely state the three Incidence Axioms. then explain whether the following interpretation satisfies each one of them: Points are  $A, B, C$ , and  $D$ . Lines are  $\{A, B, C, D\}$ ,  $\{A, B, C\}$ ,  $\{A, B\}$ .
- [8 pts] State two Betweenness Axioms (or portions thereof) that fail in the great-circles-on-the-globe model of geometry, then explain why.
- [15 pts] State Pasch's Theorem, then prove it.
- [16 pts] State and prove the ASA congruence criterion.
- [10 pts] Given the Parallel Postulate (and consequently the entire AIP Theorem), prove that the angle total of any triangle is exactly 180 degrees.
- [12 pts] Prove that the median to the base of an isosceles triangle is also the perpendicular bisector of the base and the angle bisector of the "apex" angle.
- (a) [6 pts] Draw a random triangle, then *construct* the median to one of its sides. Leave all construction marks clearly in place, and briefly explain your techniques verbally.

(b) [6 pts] Draw another random triangle, then construct a line through one vertex that is parallel to the opposite side. Leave all construction marks clearly in place, and briefly explain your techniques verbally.
- (a) [3 pts] State the Exterior Angle Theorem.

(b) [3 pts] State the Saccheri-Legendre Theorem.

(c) [4 pts] State any version of the Archimedean Axiom.
- [12 pts] Given a line  $\ell$  and a point  $P \notin \ell$ , prove that there exists a line through  $P$  that is perpendicular to  $\ell$ .
- [16 pts] Without assuming existence of a perpendicular bisector or even a midpoint, prove that given any segment, there exist two points that are each equidistant from its endpoints.
- [12 pts] Prove that in any Saccheri quadrilateral, the upper base angles are congruent.