Name _____

Mission to the Black Hole Answer Key

Problem 1: **2.67×10^6 Newtons**

$$F = \frac{GMm}{r^2} = \frac{(6.674 \times 10^{-11})(4 \times 10^{30})(1000)}{(1 \times 10^7)^2}$$

$$F = \frac{2.6696 \times 10^{20}}{1 \times 10^{14}} = 2.6696 \times 10^6 \,\text{N}$$

Problem 2: **7.3×10^6m/s**

$$v = \sqrt{\frac{2GM}{r}} = \sqrt{\frac{2(6.674 \times 10^{-11})(4 \times 10^{30})}{1 \times 10^7}}$$

$$v = \sqrt{\frac{5.3392 \times 10^{20}}{1 \times 10^7}} = \sqrt{5.3392 \times 10^{13}} \approx 7.3 \times 10^6 \,\text{m/s}$$

Problem 3: **1.48×10^{13}m**

$$r = \frac{2GM}{c^2} = \frac{2(6.674 \times 10^{-11})(1 \times 10^{40})}{(3 \times 10^8)^2}$$

$$r = \frac{1.3348 \times 10^{30}}{9 \times 10^{16}} = 1.483 \times 10^{13} \,\text{m}$$

Problem 4: **6.3 seconds**

$$d = \frac{1}{2}gt^2 \Rightarrow 20,000 = \frac{1}{2}(1000)t^2 \Rightarrow 20,000 = 500t^2 \Rightarrow t^2 = 40 \Rightarrow t = \sqrt{40} \approx 6.32\,\text{s}$$