1. A black hole is defined to be an object from which the escape velocity exceeds $c$, the speed of light. At what distance from a $5 \, M_\odot$ star would the escape velocity equal $c$?

   A) $7.4 \times 10^{-30}$ km
   B) 15 km
   C) 2100 km
   D) $1.5 \times 10^8$ km

2. What is the tension in a cable holding a 1500-kg cannon above the floor of the ocean? The cannon displaces 0.20 m$^3$, and seawater has a density of 1025 kg/m$^3$.

   A) 2 kN
   B) 13 kN
   C) 15 kN
   D) 17 kN

Useful equations and constants:

$$\begin{align*}
U &= -GMm/r \\
v_e &= (2GM/R)^{1/2} \\
\Delta P &= \rho gh \\
g &= 9.80 \, \text{m/s}^2 \\
c &= 3.00 \times 10^8 \, \text{m/s} \\
1 \, \text{yr} &= 3.156 \times 10^7 \, \text{s} \\
1 \, M_\odot &= 1.99 \times 10^{30} \, \text{kg} \\
1 \, \text{AU} &= 1.496 \times 10^{11} \, \text{m} \\
K &= \frac{1}{2}mv^2 \\
T^2 &= \frac{4\pi^2}{G} \frac{a^3}{m_1 + m_2} \\
F_b &= \rho_d V_d g \\
G &= 6.67 \times 10^{-11} \, \text{N m}^2 \, \text{kg}^{-2}
\end{align*}$$
Physics 2305
Quiz 13—Form B

1. A binary star system consists of two stars separated by a mean distance of 32 AU. If they take 165 years to complete one orbit, what is the combined mass of the two stars?

   A) $3.6 \times 10^{-19} \, M_\odot$  
   B) $2.0 \times 10^{-12} \, M_\odot$  
   C) $2.3 \times 10^{-4} \, M_\odot$  
   D) $1.2 \, M_\odot$

2. A U-shaped tube is partially filled with water ($\rho=1000 \, \text{kg/m}^3$), and then someone adds 8.0 cm of oil ($750 \, \text{kg/m}^3$) to one side. How far above the level of the oil-water interface does the water rise on the other side?

   A) 2.0 cm  
   B) 6.0 cm  
   C) 8.0 cm  
   D) 10.7 cm

Useful equations and constants:

$U = -GMm/r$  
$v_e = (2GM/R)^{1/2}$  
$\Delta P = \rho \, g \, h$  
g = 9.80 m/s$^2$  
c = 3.00 $\times 10^8$ m/s  
1 yr = 3.156 $\times 10^7$ s

$K = \frac{1}{2} \, m \, v^2$  
$T^2 = (4\pi^2/G) \, a^3/(m_1 + m_2)$  
$F_b = \rho_d \, V_d \, g$  
$G = 6.67 \times 10^{-11} \, \text{N} \, \text{m}^2 \, \text{kg}^{-2}$  
$1 \, M_\odot = 1.99 \times 10^{30} \, \text{kg}$  
$1 \, \text{AU} = 1.496 \times 10^{11} \, \text{m}$
1. Io has a radius of 1815 km. If the escape velocity from its surface is 2.56 km/s, what is its mass?

A) $9.0 \times 10^{13}$ kg  
B) $4.5 \times 10^{22}$ kg  
C) $8.9 \times 10^{22}$ kg  
D) $1.8 \times 10^{23}$ kg

2. A block of balsa wood is observed to float in water ($\rho=1000$ kg/m$^3$) with only 15% of its mass submerged. What is its density?

A) 150 kg/m$^3$  
B) 670 kg/m$^3$  
C) 850 kg/m$^3$  
D) 6700 kg/m$^3$

Useful equations and constants:

- $U = -GMm/r$
- $v_e = (2GM/R)^{1/2}$
- $\Delta P = \rho \cdot g \cdot h$
- $g = 9.80 \text{ m/s}^2$
- $c = 3.00 \times 10^8 \text{ m/s}$
- 1 yr $= 3.156 \times 10^7 \text{ s}$
- $1 \text{ M}_\odot = 1.99 \times 10^{30} \text{ kg}$
- $1 \text{ AU} = 1.496 \times 10^{11} \text{ m}$
- $k = \frac{1}{2} m v^2$
- $T^2 = \frac{4\pi^2}{G} \cdot \frac{a^3}{m_1 + m_2}$
- $F_b = \rho_d \cdot V_d \cdot g$
- $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$