SCHOOL NAME Answer Key TEAM # ____

Hovercraft Exam Answer Sheet

1. A
2. C
3. A
4. C
5. B
6. D
7. C
8. D
9. E
10. D
11. A
12. B
13. E
14. B
15. A
16. D
17. B
18. B
19. B
20. A
21. C
22. B
23. A
24. D
25. Emmanuel Swedenborg
26. Ivanov
27. 100
28. Peripheral annular jet system
29. 2 hours

3 points each (30-36)

30. 0.89
31. 1.41×10^5 N/m² or 141,000 N/m
32. 1.04×10^4 N or 10,400 N
33. 1.9×10^5 N or 190,000 N
34. 1.50×10^5 N or 150,000 N
35. 0.16 m/s2
36. 2.6 m/s

30. The specific gravity of the mixture is the ratio of the density of the mixture to that of water. To find the density of the mixture, the mass of antifreeze and the mass of water must be known.

$$m_{\text{antifreeze}} = \rho_{\text{antifreeze}} V_{\text{antifreeze}} = SG_{\text{antifreeze}} \rho_{\text{water}} V_{\text{antifreeze}} \qquad m_{\text{water}} = \rho_{\text{water}} V_{\text{water}}$$

$$SG_{\text{mixture}} = \frac{\rho_{\text{mixture}}}{\rho_{\text{water}}} = \frac{m_{\text{mixture}}/V_{\text{mixture}}}{\rho_{\text{water}}} = \frac{m_{\text{antifreeze}} + m_{\text{water}}}{\rho_{\text{water}} V_{\text{mixture}}} = \frac{SG_{\text{antifreeze}} \rho_{\text{water}} V_{\text{antifreeze}} + \rho_{\text{water}} V_{\text{water}}}{\rho_{\text{water}} V_{\text{mixture}}}$$

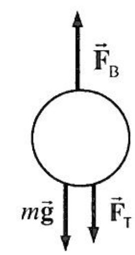
$$= \frac{SG_{\text{antifreeze}} V_{\text{antifreeze}} + V_{\text{water}}}{V_{\text{mixture}}} = \frac{(0.80)(5.0\text{ L}) + 4.0\text{ L}}{9.0\text{ L}} = \boxed{0.89}$$

31. The pressure in the tank is atmospheric pressure plus the pressure difference due to the column of mercury, as given by $P = P_0 + \rho gh$.

(a) $P = P_0 + \rho gh = 1.04\text{ bar} + \rho_{\text{Hg}} gh$

$$= (1.04\text{ bar})\left(\frac{1.00 \times 10^5\ \text{N/m}^2}{1\text{ bar}}\right) + (13.6 \times 10^3\ \text{kg/m}^3)(9.80\ \text{m/s}^2)(0.280\ \text{m}) = \boxed{1.41 \times 10^5\ \text{N/m}^2}$$

32. There are three forces on the chamber: the weight of the chamber, the tension in the cable, and the buoyant force. See the free-body diagram.



The buoyant force is the weight of water displaced by the chamber.

$$F_{\text{buoyant}} = \rho_{H_2O} V_{\text{chamber}} g = \rho_{H_2O} \tfrac{4}{3}\pi R^3_{\text{chamber}} g$$
$$= (1.025 \times 10^3\ \text{kg/m}^3)\tfrac{4}{3}\pi(2.60\ \text{m})^3(9.80\ \text{m/s}^2)$$
$$= 7.3953 \times 10^5\ \text{N} \approx \boxed{7.40 \times 10^5\ \text{N}}$$

To find the tension, use Newton's 2nd law for the stationary chamber.

$$F_{\text{buoyant}} = mg + F_T \quad \rightarrow$$
$$F_T = F_{\text{buoyant}} - mg = 7.3953 \times 10^5\ \text{N} - (7.44 \times 10^4\ \text{kg})(9.80\ \text{m/s}^2) = \boxed{1.04 \times 10^4\ \text{N}}$$

33. We assume that there is no appreciable height difference between the two sides of the roof. Then the net force on the roof due to the air is the difference in pressure on the two sides of the roof, times the area of the roof. The difference in pressure can be found from Bernoulli's equation.

$$P_{\text{inside}} + \tfrac{1}{2}\rho v^2_{\text{inside}} + \rho g y_{\text{inside}} = P_{\text{outside}} + \tfrac{1}{2}\rho v^2_{\text{outside}} + \rho g y_{\text{outside}} \quad \rightarrow$$
$$P_{\text{inside}} - P_{\text{outside}} = \tfrac{1}{2}\rho_{\text{air}} v^2_{\text{outside}} = \frac{F_{\text{air}}}{A_{\text{roof}}} \quad \rightarrow$$
$$F_{\text{air}} = \tfrac{1}{2}\rho_{\text{air}} v^2_{\text{outside}} A_{\text{roof}} = \tfrac{1}{2}(1.29\ \text{kg/m}^3)(35\ \text{m/s})^2(240\ \text{m}^2) = \boxed{1.9 \times 10^5\ \text{N}}$$

34. $P = F / A$, so $F = PA$

$A = (2.50 \text{ m})(1.20 \text{ m}) = 3.00 \text{ m}^2$

$P = 7.25 \text{ psi } (101.325 \text{ kPa} / 14.7 \text{ psi}) = 49.97 \text{ kPA} = 49{,}970 \text{ Pa}$

$F = (49{,}970 \text{ Pa})(3.00 \text{ m}^2) = 149{,}910 \text{ N} = 1.50 \times 10^5 \text{ N}$ (or $15\underline{0},000$ N)

35. $F_{thrust} - F_f = ma$

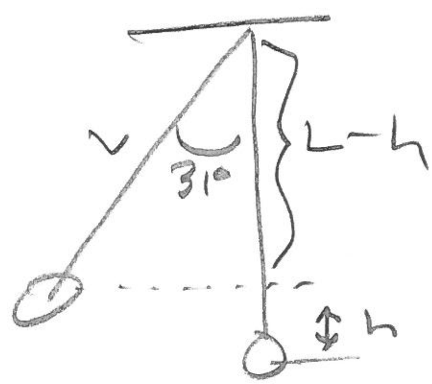
$a = (F_{thrust} - F_f) / m$

$\text{mass} = 5100 \text{ N} / 9.8 \text{ m/s}^2 = 520.4 \text{ kg}$

$F_f = \mu F_{normal} = (0.15)(5100 \text{ N}) = 765 \text{ N}$

$a = (850 \text{ N} - 765 \text{ N}) / 520.4 \text{ kg} = 0.16 \text{ m/s}^2$

36. $PE_{initial} = KE_{final}$



$PE = mgh$, $KE = ½ mv^2$

Mass cancels out

$gh = ½ v^2$

$v = [2gh]^{1/2}$

$L - h = L \cos 31$

$h = L - L \cos 31 = 10.0 \text{ m} - (10.0) \cos 31 = 1.43 \text{ m}$

$v = [2(9.8 \text{ m/s}^2)(1.43 \text{ m})]^{1/2} = 5.3 \text{ m/s}$