Practice Problems for Common Exam 1

Chapter 9 Sect. 5-6 Chapt 10 Sect.1-10 Chapt. 13 Sect. 1-9

1. How large a force is necessary to stretch a 2.0-mm-diameter steel wire ($E = 2.0 \times 10^{11}$ N/m^2) by 1.0%?

A) 3.1×10^3 N
B) 6.3×10^3 N
C) 9.4×10^3 N
D) 1.3×10^4 N
E) 3.1×10^7 N

$\sigma = E\cdot\varepsilon = 2x10^{11}\text{Pa}\cdot 0.01 = 2x10^9$
$F = \sigma\pi r^2 = 2x10^9 \cdot\pi(0.001\text{m})^2 = 6300\text{N}$

2. A nylon string on a tennis racket is under a tension of 300 N. If its diameter is 1 mm, by how much is it lengthened from its original length of 30 cm? Use $E_{Nylon}=5.0*10^9$ N/m^2.

A) 2 cm
B) 2.3 cm
C) 2.8 cm
D) 3.3 cm
E) 3.8 cm

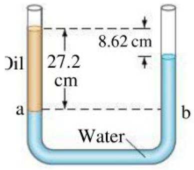
3. Crew members attempt to escape from a damaged submarine 80 m below the surface. What force must they apply to a pop-out hatch of radius of 18 cm to push it out? Assume the density of ocean water 1025 kg/m^3.

A) 82 kN
B) 124 kN
C) 165 kN
D) 186 kN
E) 252 kN

$F = pA = \rho g h\pi r^2 = 1025\text{kg/m}^3\cdot 9.8\text{m/s}^2\cdot\pi(0.18\text{m})^2$

4. Consider a brick that is totally immersed in water, with the long edge of the brick vertical. The pressure on the brick is
A) the same on all surfaces of the brick.
B) greatest on the face with largest area.
C) greatest on the top of the brick.
D) greatest on the sides of the brick.
E) greatest on the bottom of the brick.

5. Water and the oil (which don't mix) are poured onto a U-shaped tube, open at both ends. They come to equilibrium as shown in the figure below. What is the dentiy of the oil if density of water is 1000 kg/m^3?



A. 683 kg/m^3
B. 720 kg/m^3
C. 570 kg/m^3
D. 868 kg/m^3
E. 434 kg/m^3

6. In a hydraulic garage lift, the small piston has a radius of 5.0 cm and the large piston has a radius of 15 cm. What force must be applied on the small piston in order to lift a car weighing 20,000 N on the large piston? Assume the pistons each have negligible weight.

A) 6700 N
B) 5000 N
C) 2900 N
D) 2200 N
E) 1200 N

7. A block of wood has density 0.50 g/cm^3 and mass 1 500 g. It floats in a container of oil (the oil's density is 0.75 g/cm^3). What volume of oil does the wood displace?

A) 3 000 cm^3 $mg=F_B$ $mg=\rho gV$ $m=\rho V$ $V= 1500g/0.75g/cm^3 = 2000\ cm^3$
B) 2 000 cm^3
C) 1 500 cm^3
D). 1 000 cm^3
E) 500 cm^3

8. A sample of unknown material appears to weigh 300 N in air and 200 N when immersed in water. The density of the material is closest to

A) 1200 kg/m^3 300 N – 200 N = ρgV solve for V solve for density m/V
B) 2000 kg/m^3
C) 3000 kg/m^3
D) 4000 kg/m^3
E) 6500 kg/m^3

9. A 10 kg iron block (density = 7900 kg/m^3) is hanging from the rope. What is the tension in the rope if the block is immersed in a liquid of density of 850 kg/m^3?
A) 98 N
B) 86 N $T = mg - F_b$
C) 72 N
D) 64 N
E) 55 N

10. A hot air balloon along with its cargo has a mass of 4.0 x 10^5 kg, and it holds 7.0 x 10^5 m^3 of hot air. It is floating at a constant height in air with a density of 1.29 kg/m^3. What is the density of the hot air in the balloon?

A. 1.4 kg/m^3
B. 0.72 kg/m^3
C. 0.57 kg/m^3
D. 0.86 kg/m^3
E. 0.43 kg/m^3

10. A steel ball sinks in water but floats in a pool of mercury, which is much denser than water. Where is the buoyant force on the ball greater?

A) floating on the mercury
B) submerged in the water
C) It is the same in both cases.
D) It cannot be determined from the information given.
E) none of the above

11. A water hose of radius of 1.2 cm is used to fill a bucket of volume of 0.075 m^3. If it takes 2.2 min to fill the bucket, what is the speed at which the water leaves the hose?

A) 0.5 m/s volume/time = Av $v = 0.075m^3/(2.2x60\cdot\pi\cdot 0.012m^2) = 1.3$ m/s
B) 1.3 m/s
C) 3.0 m/s
D) 4.9 m/s
E) 8.8 m/s

12. If wind (density of air =1.29 kg/m^3) blows at 30 m/s parallel to a flat roof having an area of 475 m^2, what is the force exerted on the roof?

A) $2.76x10^5$ N, up
B) $8.75x10^5$ N, down $F = (p_1 - p_2)A = 580.5Pa\cdot 475\ m^2$
C) $4.26x10^6$ N, up $p_1+½\rho v_1^2 = p_2 +½\rho v_2^2$ $p_1 - p_2 = ½\ \rho(v_1^2 - v_2^2) = ½\cdot 1.29kg/m^3(30^2-) = 580.5$
D) $6.16x10^6$ N, down
E) $1.23x10^7$ N, up

13. In a section of horizontal pipe with a diameter of 3.0 cm, the pressure is 100 kPa and water is flowing with a speed of 1.5 m/s. The pipe narrows to 2.0 cm. What is the pressure in the narrower region? Treat the water as an ideal incompressible fluid.
A) 95 kPa
B) 48 kPa $A_1v_1=A_2v_2$
C) 44 kPa $p_1+½\varrho v_1^2 = p_2 +½\varrho v_2^2$
D) 230 kPa
E) 67 kPa

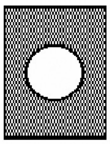
14. The temperature of the iron cube, 5 cm on edge, should be changed by what amount for the volume of the cube to increase by 0.35 cm^3. (The coefficient of linear expansion of iron is 1.2 x 10^{-5} per ^0C)

A) 55^0C
B) 167^0C $0.35cm^3 = (5cm)^3 3\alpha\Delta T$ solve for ΔT
C) 78^0C
D) 355^0C
E) 431^0C

15. For mercury to expand by 2%, what change in temperature is necessary? ($\beta = 180x10^{-6}/^0C$, $\Delta T_F = 9/5\Delta T_c$).

A) 720^0F
B) 267^0F $\quad 0.02 = \beta\Delta T$
C) 200^0F
D) 458^0F
E) 5.5^0F

16. Consider a flat steel plate with a hole through its center as shown in the figure. When the temperature of the plate is increased, the hole will



A) expand only if it takes up more than half the plate's surface area.
B) contract if it takes up less than half the plate's surface area.
C) always contract as the plate expands into it.
D) always expand with the plate.
E) remain the same size as the plate expands around it.

17. Approximately how many argon atoms are needed to fill the space between two panes of glass in a window, if the absolute gas pressure is 2 atm., the volume of the space is 0.2 m^3, and the temperature is 30^0C? (1atm=$1.013x10^5$Pa, $N_{av} = 6.023x10^{23}$/mol , R = 8.31 J/Kmol)
A) 9.7×10^{24} N
B) 5.6×10^{20} N
C) 1.3×10^{31} N $\quad pVT = nR \quad T = 273+30^0C = 303$ K $\quad p = 2*1.013x10^5Pa = 2.023x10^5Pa$
D) 6.5×10^{28} N $\quad$ solve for n
E) 6.5×10^{15} N $\quad N = n*6.023x10^{23}$

18. An air bubble originating from under water diver has a volume of 1.45 cm^3 at some depth ***h.*** When the bubble reaches the surface of the water, it has a volume of 2.14 cm^3. Assuming the temperature of the air in the bubble remains constant determine the depth ***h.***

A) 1.0 m
B) 2.0 m
C) 3.0 m
D) 4.0 m
E) 5.0 m

$P_1 V_1 = P_2V_2 \quad p_1=(1atm*2.14cm^3)/1.45cm^3=1.48atm = 1.5x10^5Pa$
$P_1=1.013x10^5 + \rho gh \quad h = 5.0$ m

19. A 3.9-L volume of ideal neon gas (monatomic) is at a pressure of 5.6 atm and a temperature of 57^0C. The temperature of the gas is now increased to 157^0C. and the volume is increased to 5.9 L. What is the final pressure of the gas?

A) 4.8 atm
B) 4.3 atm
C) 5.3 atm

D) 5.8 atm
E) 6.3 atm

Conversions: 1 cm $= 0.01$ m 1 mm $= 0.001$ m 1μm $= 10^{-6}$ m 1 nm $= 10^{-9}$ m 1 L $= 10^{-3}$ m^3

1 kg = 1000 g 1 MJ = 10^6 J 1 mm^2 $= 10^{-6}$ m^2 1 mile = 1609 m 1 mph = 0.447 m/s 1 atm $= 1.013 \times 10^5$ Pa

$T(°C) = \frac{5}{9}[T(°F) - 32]$ $T(°F) = \frac{9}{5}T(°C) + 32$ $T(K) = T(°C) + 273$

Areas and Volumes: $A_{circle} = \pi r^2$ $A_{sphere} = 4\pi R^2$ $A_{cylinder} = 2\pi r \cdot L$ $V_{cube} = a^3$ $V_{sphere} = \frac{4}{3}\pi R^3$

$\rho = \frac{m}{V}$ $\sigma = E \cdot \varepsilon$ $\sigma = \frac{F}{A}$ $\varepsilon = \frac{L - L_0}{L_0}$ $P = \frac{F}{A}$ $P_h = \rho g h$ $F_B = \rho g V$

$A_1 \cdot v_1 = A_2 \cdot v_2$ $A \cdot v$ -volume flow rate; $P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$

for a horizontal pipe: $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$

$L - L_0 = \alpha \cdot L_0 \cdot (T - T_0)$ $A - A_0 = 2\alpha \cdot A_0 \cdot (T - T_0)$ $V - V_0 = 3\alpha \cdot V_0 \cdot (T - T_0)$ $\sigma = E \cdot \alpha \cdot (T - T_0)$

Ideal gas: $P \cdot V = n \cdot R \cdot T$ n -number of moles $n = \frac{m}{\text{molar mass}}$ T-in Kelvins R=8.313 J/mol·K

$P \cdot V = N \cdot k_B \cdot T$ $k_B = \frac{R}{N_A} = 1.38 \times 10^{-23}$ J/K $N = n \cdot N_A$ $N_A = 6.02 \times 10^{23}$ molecules/mole $\frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$