Directions:

I. A. Review the chapter using the book, your notes, and the packet
   B. Put them aside and take the test using only the provided useful information sheet with a black pen or pencil
   C. Grade your test following the rubric provided with the solutions (Black grade)

II. A. Review the chapter using the book, your notes, and the packet one more time.
   B. Redo any problems you got right partially or you did not get right at all using your text, notes, and the packet
   C. Grade your test following the rubric provided with the solutions (Blue grade, include the black grade)

III. A. Review the chapter using the book, your notes, and the packet one final time.
   B. Redo any problems you got right partially or you did not get right at all using the solutions
   C. Grade your test following the rubric provided with the solutions (Red grade, include the black and blue grades)

Chapters 11 and 12

1. When a mass of 2.51 kg is hung from a ceiling by a wire of radius 0.2 m, the wire stretches by 20%. What is the Young modulus of the wire?
2. A full 10-kg cylindrical paint container is placed on a level ground. The height of the container is 0.25 m. It exerts 20 Pa of pressure on the floor. What is the radius of the container?
3. What is the density of the container in the first question?

Questions 4-8 You will be guided through the derivations of the buoyant force and the pressure difference in a liquid between two depths in terms of the depths h_1 and h_2.

4. Consider a section of a liquid of mass m_{liq}. Which diagram represents the correct FBD showing the forces in the vertical direction on the liquid.
5. Remembering that the section of the liquid in question is at rest and in equilibrium, use Newton's first law to obtain the buoyant force. Show work!
6. Use your FBD from question 3 to write down the net force remembering that the section of the liquid is in equilibrium.
7 Use the relation between force and pressure to obtain the pressure difference between depth h_1 and h_2. Show work!
8 Make the necessary assumptions (explain each assumption) to obtain the pressure at a depth h in terms of the zero-level pressure P_o at the surface and the density of water.
9 Derive the equation of continuity $A_1 v_1 = A_2 v_2$. *Hint: Start with $m_1 = m_2$ and use the fact that the flow is steady. Show work!*

Questions 10-13 You will be guided through the derivation of Bernoulli's Equation. Consider a long pipe carrying a fluid from a height of h_1 to a height of h_2. There is a force F_1 applied at the initial height and F_2 at the final height. The speed of the liquid is v_1 and v_2 at the respective heights and travels a distance Δx_1 and Δx_2 respectively.

10. How much work is done by each force during time Δt?
11. What is the PE of the liquid at each height?
12. What is the KE of the liquid at each height?
13. Write down the conservation of Work-Energy for each end and do the necessary manipulations to obtain Bernoulli's Equation. Show work!
14. Density of water is $1\times10^3\ kg/m^3$. Obtain the pressure 4 km below the surface. Assume the pressure at the surface level is 1×10^5 Pa.
15. A wooden piece of mass m is placed in water. How much buoyant force does it experience? Show your work!

Questions 16-19 An open water container of height h_1 is filled with an unknown liquid of density ρ_{liq} to the rim. A small whole is drilled at a height h_2 above the bottom of the container ground.

16. Find the speed of the water leaving the whole.
17. How would your answer change if the container were closed?
18. How long does it take the water to hit the ground once it leaves the whole?
19. How far from the bottom of the container does the water strike the ground?
20. Use dimensional analysis to show that the fundamental frequency of vibrating strings is given by $v = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$ where T is the tension in the string of length and ℓ and line density μ. **Hint:** *You may want to start by obtaining v first, then v. What could be the relation between v, ℓ, T and ℓ and λ?*
21. In a drawing, demonstrate the formation of waves
    [A] on strings with both ends stationary
    [B] on strings with one end stationary
    [C] on strings with neither end stationary
    [D] in pipes with one end open
    [E] in pipes with both ends open
22. Derive the wave equation for travelling waves and obtain the solutions to the equation.
23. Deduce the change in frequency depending on the motions of the observer and the source.

FORM A

1. When a mass of 2.51 kg is hung from a ceiling by a wire of radius 0.2 cm, the wire stretches by 20%. What is the Young modulus of the wire? A. $8\times10^4 \frac{N}{m^2}$ B. $4\times10^4 \frac{N}{m^2}$ C. $5\times10^2 \frac{N}{m^2}$ D. $2\times10^3 \frac{N}{m^2}$ E. $1\times10^3 \frac{N}{m^2}$
2. A full 10-kg cylindrical paint container is placed on a level ground. The height of the container is 0.25 m. It exerts 20 Pa of pressure on the floor. What is the radius of the container?
   A. 0.25 m B. 0.5 m C. 1.00 m D. 1.25 m E. 2.50 m
3. What is the density of the container in the previous question?
   A. $2\ kg/m^3$ B. $4\ kg/m^3$ C. $8\ kg/m^3$ D. $16\ kg/m^3$ E. $32\ kg/m^3$

Next several questions you will be guided through the derivations of the buoyant force and the pressure difference in a liquid between two depths in terms of the depths h_1 and h_2.

4. Consider a section of a liquid of mass m_{liq}. Which diagram represents the correct FBD showing the forces in the vertical direction on the liquid.
   A. $F_T\uparrow$ $F_g\downarrow$ B. $F_2\uparrow$ $F_g\downarrow\downarrow F_1$ C. $F_1\uparrow\uparrow F_2$ $F_g\downarrow$ D. $F_g\downarrow$ E. $F_g\uparrow$ $F_1\downarrow\downarrow F_2$

   [FRQ I] Remembering that the section of the liquid in question is at rest and in equilibrium, use Newton's first law to obtain the buoyant force. Show work!

5. Use your FBD from the previous questions to write down the net force–remember this section of the liquid is in equilibrium.
   A. $F_2 - F_1 = mg$ B. $F_2 + F_1 = mg$ C. $F_2 + F_1 + mg = 0$
   D. $F_2 = F_1 + mg$ E. $F_1 = F_2 + mg$

   [FRQ IIA] Use the relation between force and pressure to obtain the pressure difference between depth h_1 and h_2. Show work!

   [FRQ IIB] Make the necessary assumptions (explain each assumption) to obtain the pressure at a depth h in terms of the zero-level pressure P_o at the surface and the density of water.

   [FRQ III] Derive the equation of continuity $A_1v_1 = A_2v_2$. *Start with $m_1 = m_2$ and use the fact that the flow is steady. Show work!*

Next several questions, you will be guided through the derivation of Bernoulli's Equation. Consider a long pipe carrying a fluid from a height of h_1 to a height of h_2. There is a force F_1 applied at the initial height and F_2 at the final height. The speed of the liquid is v_1 and v_2 at the respective heights and travels a distance Δx_1 and Δx_2 respectively.

6. How much work is done by each force during time Δt?
   A. $\frac{1}{2}mv_1^2$ and $\frac{1}{2}mv_2^2$ B. 0 C. $F_1\Delta x_1$ and $F_2\Delta x_2$
   D. mgh_1 and $\frac{1}{2}mv_2^2$ E. mgh_1 and mgh_2
7. What is the PE of the liquid at each height?
   A. $\frac{1}{2}mv_1^2$ and $\frac{1}{2}mv_2^2$ B. 0 C. $F_1\Delta x_1$ and $F_2\Delta x_2$
   D. mgh_1 and $\frac{1}{2}mv_2^2$ E. mgh_1 and mgh_2
8. What is the KE of the liquid at each height?
   A. $\frac{1}{2}mv_1^2$ and $\frac{1}{2}mv_2^2$ B. 0 C. $F_1\Delta x_1$ and $F_2\Delta x_2$
   D. mgh_1 and $\frac{1}{2}mv_2^2$ E. mgh_1 and mgh_2

   [FRQ IV] Write down the conservation of Work-Energy for each end and do the necessary manipulations to obtain Bernoulli's Equation. Show work!

9. Density of water is $1\times10^3\ kg/m^3$. Obtain the pressure 4 km below the surface. Assume the pressure at the surface level is 1×10^5 Pa.
   A. 4×10^5 Pa B. 5×10^5 Pa C. 1×10^5 Pa
   D. 4.01×10^7 Pa E. 1.04×10^7 Pa
10. A wooden piece of mass m is placed in water. How much buoyant force does it experience?
    A. $mg\downarrow$ B. $\rho_w V_m g\downarrow$ C. $mg\uparrow$ D. $4.01\,\rho_w V_m g\uparrow$ E. 0

Next three questions: An open water container of height h_1 is filled with an unknown liquid of density ρ_{liq} to the rim. A small whole is drilled at a height h_2 above the bottom of the container ground.

11. Find the speed of the water leaving the whole.
    A. $\sqrt{2gh_1}$ B. $\sqrt{2g(h_1-h_2)}$ C. $\sqrt{2gh_2}$
    D. $\sqrt{2gh_1/h_2}$ E. $\sqrt{2gh_2/h_1}$

    [FRQ V] How would your answer change if the container were closed? Show work.

12. How long does it take the water to hit the ground once it leaves the whole? A. $\sqrt{\frac{2h_2}{g}}$ B. $\sqrt{\frac{2h_1}{g}}$ C. $\sqrt{\frac{2g}{h_1}}$ D. $\sqrt{\frac{2(h_1-h_2)}{g}}$ E. $\sqrt{\frac{2gh_1}{h_2}}$
13. How far from the bottom of the container does the water strike the ground? A. h_1 B. h_2 C. $\sqrt{h_1h_2}$
    D. $2\sqrt{h_1(h_1-h_2)}$ E. $2\sqrt{h_2(h_1-h_2)}$

    [FRQ VI] Derive an expression for the atmospheric pressure as a function of height z from the sea level.

    [VI.A] Assume $P_o \propto \rho_o$ and $P(z) \propto \rho(z)$ and obtain a relation among these quantities

    [VI.B] Use $P(z) = P_o - \rho(z)gz$ to obtain dP in terms of dz assume $\rho(z)$ does not change significantly during dz

    [VI.C] Combine the expressions in A&B to obtain a diff'l equation

    [VI.D] Integrate the differential equation in E to obtain

    $$P(z) = P_o e^{-z/\zeta} \text{ where } \zeta = \frac{P_o}{\rho_o g} = 8\ km\text{. Use } \int_a^x \frac{dx}{x} = \ln\frac{x}{a}$$

14. Obtain the ratio of the pressure at the top to the bottom of Burj Khalifa in Dubai–the highest building on Earth (830 m) and the sea level.
    A. 0.034 B. 0.90 C. 0.33 D. 1.0 E. 1.11 F. 3 G. 30
15. Obtain the ratio of the pressure at the summit of Mount Everest (8,850 m) to the atmospheric pressure at the sea level.
    A. 0.034 B. 0.90 C. 0.33 D. 1.0 E. 1.11 F. 3 G. 30
16. The summit of the highest mountain on Mars 27 km (the highest known in the Solar System). Obtain the ratio of the pressure at that height here on Earth to the atmospheric pressure at the sea level.
    A. 0.034 B. 0.90 C. 0.33 D. 1.0 E. 1.11 F. 3 G. 30
17. A pin placed properly does not sink in water primarily because of the
    A. Capillary Action B. Bernoulli's Principle C. Archimedes' Principle
    B. Pascal's Principle D. Buoyancy E. Surface Tension
18. A metal ship does not sink in water primarily because of the
    A. Capillary Action B. Surface Tension C. Archimedes' Principle
    B. Pascal's Principle D. Buoyancy E. Bernoulli's Principle
19. Bernoulli's Principle principle for incompressible ideal fluids is a result of
    A. conservation of linear momentum
    B. conservation of angular momentum
    C. conservation of work-energy
    D. Newton's Laws for linear mechanics
    E. Newton's Laws for rotational mechanics

20. Longitudinal waves
    A. are perpendicular to the wave propagation
    B. are along the wave propagation
    C. can be both along and perpendicular to the wave propagation
21. Transverse waves
    A. are perpendicular to the wave propagation
    B. are along the wave propagation
    C. can be both along and perpendicular to the wave propagation
22. Sound waves
    A. are longitudinal
    B. are transverse
    C. can be both longitudinal or transverse
23. EM and radio waves
    A. are longitudinal
    B. are transverse
    C. can be both longitudinal or transverse
24. Traveling waves can be described by wave functions in which form
    A. only $\psi(\vec{r}-\vec{v}t)$
    B. only $\psi(\vec{r}+\vec{v}t)$
    C. either $\psi(\vec{r}-\vec{v}t)$ or $\psi(\vec{r}+\vec{v}t)$
    D. either $\psi(\vec{k}\cdot\vec{r}-\omega t)$ or $\psi(\vec{k}\cdot\vec{r}+\omega t)$
    E. only $\psi(\vec{k}\cdot\vec{r}-\omega t)\pm\psi(\vec{k}\cdot\vec{r}+\omega t)$
25. Standing waves can be described by wave functions in which form
    A. only $\psi(\vec{r}-\vec{v}t)$
    B. only $\psi(\vec{r}+\vec{v}t)$
    C. either $\psi(\vec{r}-\vec{v}t)$ or $\psi(\vec{r}+\vec{v}t)$
    D. either $\psi(\vec{k}\cdot\vec{r}-\omega t)$ or $\psi(\vec{k}\cdot\vec{r}+\omega t)$
    E. only $\psi(\vec{k}\cdot\vec{r}-\omega t)\pm\psi(\vec{k}\cdot\vec{r}+\omega t)$

26. A beat is a result of two waves that are
    A. identical in magnitude and frequency
    B. identical in frequency
    C. identical in magnitude and different in frequency
    D. different in magnitude and identical in frequency
27. Which one is the one that carries energy in waves
    A. Phase velocity
    B. Group velocity
    C. Neither
    D. Both

28. The Fourier analysis is used to describe functions in terms sinusoidal functions
    A. only if the function has a periodicity
    B. only if the function lacks periodicity
    C. to describe a function precisely in terms of sinusoidal functions
    D. to describe a function approximately in terms of sinusoidal functions
29. Fourier analysis leads to the uncertainty relation because
    A. all functions are periodic
    B. all functions lack periodicity
    C. a function can be described in terms of sinusoidal functions
    D. a function can be described approximately in terms of sinusoidal functions

A train moving at a speed of v_s sounds its whistle with a frequency f_s. Determine the frequency f_o a stationary observer hears as the train

30. approaches toward the observer.
    A. $f_o = f_s$
    B. $f_o = f_s\left(\frac{v-v_s}{v}\right)$
    C. $f_o = f_s\left(\frac{v+v_s}{v}\right)$
    D. $f_o = f_s\left(\frac{v}{v-v_s}\right)$
    E. $f_o = f_s\left(\frac{v}{v+v_s}\right)$
31. moves away from the observer.
    A. $f_o = f_s$
    B. $f_o = f_s\left(\frac{v-v_s}{v}\right)$
    C. $f_o = f_s\left(\frac{v+v_s}{v}\right)$
    D. $f_o = f_s\left(\frac{v}{v-v_s}\right)$
    E. $f_o = f_s\left(\frac{v}{v+v_s}\right)$

[FRQ VII] Use dimensional analysis to show that the fundamental frequency of vibrating strings is given by $\nu = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$ where T is the tension in the string of length and ℓ and line density μ. **Hint:** *You may want to start by obtaining v first, then ν. What could be the relation between v, ℓ, T and ℓ and λ?*

[FRQ VIII] In a drawing, demonstrate the formation of waves
[VIII.A] on strings with both ends stationary
[VIII.B] on strings with one end stationary
[VIII.C] on strings with neither end stationary
[VIII.D] in pipes with one end open
[VIII.E] in pipes with both ends open

11, 12 Test

Black 22 MC 20
Blue 10 MC 2
Red 1, plus others w/ no solutions MC 8

1) $E = \frac{F/A}{\Delta l / l} = \frac{(2.5 \, kg)(9.8 \, m/s^2) / \pi(0.2 \, m)^2}{0.2}$ +1

$= \boxed{979 \, N/m^2}$ +1

2) $P = F/A$

$A = \frac{F}{P}$

$\pi r^2 = \frac{F}{P}$ $r = \sqrt{\frac{mg}{\pi P}}$ +1

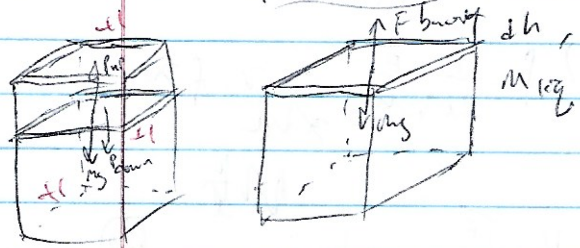
$= \sqrt{\frac{(10 \, kg)(9.8 \, m/s^2)}{\pi (20 \, Pa)}}$

$= \boxed{1.25 \, m}$ +1

3) $\rho = \frac{m}{V} = \frac{m}{\pi r^2 h} = \frac{10 \, kg}{\pi (1.25 \, m)^2 (0.25 \, m)}$ +1

$= \boxed{18.15 \, kg/m^3}$ +1

4)



5) $M_{liq} \, g = F_{buoy}$ ~

$\rho = \frac{m_{liq}}{V}$ $M_{liq} = \rho V$ ~

$\boxed{F_{buoy} = \rho V g}$ ~

6) $\Sigma F = ma = 0$

$mg - F_{buoy} = 0$ ~

7) $P = \frac{F}{A}$ $P_1 = \frac{\rho \cancel{A_1} h_1 g}{\cancel{A_1}}$ $A_1 = A_2$

$P_2 = \frac{\rho \cancel{A_2} h_2 g}{\cancel{A_2}}$ +1

$\Delta P = P_2 - P_1 = \rho g (h_2 - h_1)$

+1

8) assumptions: liquid is not moving and no internal movement or currents

$P = \frac{F}{A} = \frac{\rho V g}{A} = \frac{\rho \cancel{A} h g}{\cancel{A}} = \rho h g$

$P(y) = P_0 - \rho g y$ ~

since y is negative as you travel downwards from the surface

9) $A_1 v_1 = A_2 v_2$

CoE

$\cancel{\tfrac{1}{2}} m_1 v_1^2 = \cancel{\tfrac{1}{2}} m_2 v_2^2$

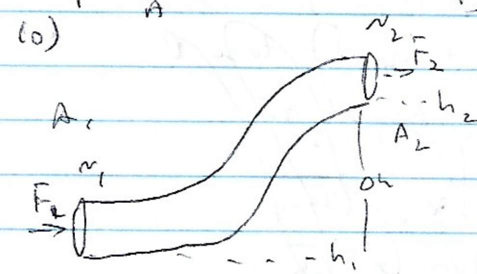
$m_1 v_1^2 = m_2 v_2^2$ ~

$v_1^2 = v_2^2$

$P = \frac{F}{A}$

$\boxed{9}$

10)



10) $W = F \Delta x \cos\theta$, $\theta = 0$

$W_1 = F_1 \Delta x_1$ $W_2 = F_2 \Delta x_2$ +1

11) $PE_1 = mgh_1 = \rho V g h_1 = \rho A_1 g h_1^2$

$PE_2 = \rho A_2 g h_2^2$ ~

12) $KE_1 = \frac{1}{2} m v_1^2 = \frac{1}{2} \rho V v_1^2 = \frac{1}{2} \rho A_1 h_1 v_1^2$ ~

$KE_2 = \frac{1}{2} \rho A_2 h_2 v_2^2$

13) $\rho A_1 g h_1^2 + \frac{1}{2} \rho A_1 h_1 v_1^2 = \rho A_2 g h_2^2 + \frac{1}{2} \rho A_2 h_2 v_2^2$ ~ ~ ~ ~

14) $P(y) = P_0 - \rho g y = -(1000 \, kg/m^3)(9.8 \, m/s^2)(-4000 \, m)$ +1

$+ 1 \times 10^5 \, Pa$

$= \boxed{4 \times 10^7 \, Pa}$ +1

15) 

assuming Oak - $\rho = 550\ kg/m^3$

$\rho_{water} = 1000\ kg/m^3$

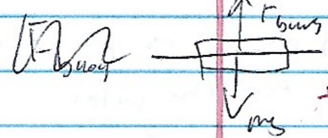
$\sim 55\%$

55% of the volume in the water?

$F_{buoy} = \cancel{\rho V g}$ ~~V_{mass}~~

$= \cancel{m_{displaced\ water}\, g}$

$= \cancel{\boxed{0.55\, mg}}$



$F_{buoy} = mg$ +1

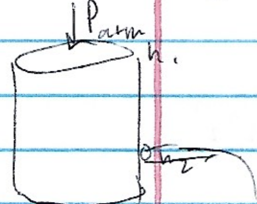
+1

(a) $\Delta x = \bar{v} t$

$= v_2 t$

$= \sqrt{2g(h_1 - h_2)} \sqrt{\frac{2h_2}{g}}$ +1

$= \boxed{2\sqrt{h_2(h_1 - h_2)}}$ +1

(6) 

$\cancel{P_1} + \cancel{\frac{1}{2}\rho v_1^2} + \rho g y_1 = \cancel{P_2} + \frac{1}{2}\rho v_2^2 + \rho g y_2$

+1

$P_1 = P_2$

v_1 is negligible comp. v_2

$\cancel{\rho} g y_1 = \frac{1}{2}\cancel{\rho} v_2^2 + \cancel{\rho g y_2}$

~~take h_2 to be 0~~

~~$g y_1 = \frac{1}{2} v_2^2$~~

~~$v_2 = \sqrt{2gy_1}$~~

~~$v_2 = \sqrt{2gh_1}$~~

$g(y_1 - y_2) = \frac{1}{2} v_2^2$

$v_2 = \sqrt{2g(h_1 - h_2)}$

+1

20) $f = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$ $v = f\lambda$

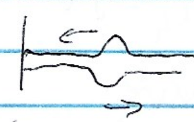
~~$\lambda = 2L$~~

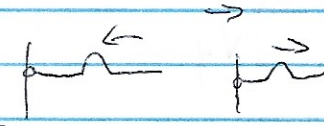
~~$f = \frac{v}{L}$~~

$v = \sqrt{\frac{F}{\mu}}$ - why?

$\boxed{20}$

21) a) 

b) 

c) 

d)  e) 

$\boxed{22}$ $\boxed{23}$

17) If the container was closed, there would be no pressure pushing the water out of the hole so $v_2 = 0$

18) $\Delta y = \cancel{v_y t} + \frac{1}{2} g t^2$ $v_{oy} = 0$

~~$\sqrt{2gh}$~~

$h_2 = \frac{1}{2} g t^2$ +1

$\boxed{t = \sqrt{\frac{2h_2}{g}}}$ +1

9), 10-13, 20, 22, 23

9) $dm = \rho A ds$ $\quad \frac{dm}{dt} = \rho A \frac{ds}{dt}$

$\frac{dm}{dt} = \rho A v$ +1

mass doesn't change ($m_1 = m_2$)

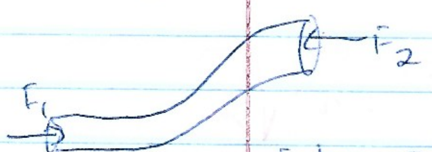
$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$ +1

ρ is constant

$A_1 v_1 = A_2 v_2$

10) $W_1 = F_1 dr_1$

$\cancel{\quad} = F_1 \Delta r_1$



$W_2 = F \cdot dr = F \Delta r \cos 180$

$= -F_2 \Delta r_2$

11) $PE_1 = mgh_1 = \cancel{\quad}$

$\rho V_1 g h_1$ +1

$PE_2 = mgh_2 = \rho V_2 g h_2$

12) $KE_1 = \frac{1}{2} m_1 v_1^2 = \frac{1}{2} \rho V_1 v_1^2$

$KE_2 = \frac{1}{2} m_2 v_2^2 = \frac{1}{2} \rho V_2 v_2^2$ +1

13) $W = \Delta KE + \Delta PE$ +1

$P = F/A \qquad F = PA$

$P_1 A_1 \Delta r_1 - P_2 A_2 \Delta r_2 = (\rho V_2 g h_2 - \rho V_1 g h_1) + \frac{1}{2}\rho(v_2^2 V_2 - v_1^2 V_1)$

$A_1 \Delta r_1 = V_1$ +1

$A_2 \Delta r_2 = V_2$ +1

$P_1 - P_2 = \rho g h_2 - \rho g h_1 + \frac{1}{2}\rho(v_2^2 - v_1^2)$

$$\boxed{P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2}$$ +1

20) $\mu = \frac{m}{l} \qquad \frac{dx}{dt} = v$

$m = \mu l \qquad dx = v dt$

$dm = \mu dx$

$dm = \mu v dt$

$v = \frac{dm}{dt} / \mu$? $\boxed{20}$

$\boxed{22}$ $\boxed{23}$

MC Form A

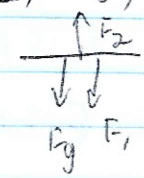
✓1) E (see FR 1)

✓2) D (FR 2)

✓3) C (FR 3)

✓4) B (FR 4)

5) $F_2 = F_g + F_1$ (D)



✓6) C ✓7) E ✓8) A

✓9) D (FR 14) ✓10) C (FR 15)

✓11) B (FR 16) ✓12) A (FR 18)

✓13) E (FR 19)

14) $P_0 = 101325 \text{ Pa}$

$P_y = P_0 e^{(-\frac{\rho_0}{P_0} g y)}$

$= (101325 \text{ Pa}) e^\wedge \left(\frac{-1.2 \text{ kg/m}^3}{101325 \text{ Pa}} (9.8 \text{ m/s}^2)(830 \text{ m}) \right)$

$= 92019 \text{ Pa}$

$\frac{92019 \text{ Pa}}{101325 \text{ Pa}} = 0.91$ (B) ✓

15) $\frac{P_y}{P_0} = \frac{P_0 e^\wedge \left(\frac{-1.2 \text{ kg/m}^3}{101325 \text{ Pa}} (9.8 \text{ m/s}^2)(8850 \text{ m}) \right)}{P_0}$

$= 0.36$ (C) ✓

16) $\frac{P_y}{P_0} = e^\wedge \left(\frac{-1.2 \text{ kg/m}^3}{101325 \text{ Pa}} (9.8 \text{ m/s}^2)(27000 \text{ m}) \right)$

$= 0.044$ (A) ✓

17) B 20) B 21) A

18) C 19) C 22) C 23) B

24) C 25) D 26) C 27) D

28) D 29) D 30) $f' = f\left(\frac{v \pm v_{obs}}{v \mp v_{sour}}\right)$

obs. is stationary

− if moving towards

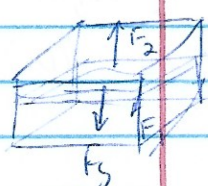
+ if moving away

30) D 31) E

MC 5) C 17) E 18) D 19) C

22) A 24) A 25) E 27) B

5)



$F_2 = F_g + F_1$ +1

$F_2 = F_1 + mg$

6) $\sum F = ma = 0$

$F_2 = F_g + 1$

$F_2 = F_1 + mg$ +1

5) $mg = F_2 - F_1$

5) $F_2 - F_1 = mg = F_b$

$F_b = m_{fl} g = \rho V g$ +1

20) $\mu = \frac{m}{l}$ $dx = v\,dt$

$dm = \mu\,dx = \mu v\,dt$

$dp = (\mu v\,dt) v_y \hat{j} - (0 \cdot v_y) \hat{j}$

$= \mu v\,dt\,v_y \hat{j}$

$T \sin\theta\,dt\,\hat{j} = J$

$T \sin\theta\,dt\,\hat{j} = \mu v\,dt\,v_y \hat{j}$

$T \sin\theta = \mu v v_y$

$\tan\theta = \frac{v_y}{v}$ $\frac{\sin\theta}{\cos\theta} = \frac{v_y}{v}$

$\sin\theta = \cos\theta \frac{v_y}{v}$

$T \cos\theta \frac{v_y}{v} = \mu v v_y$

$v^2 = \frac{T}{\mu} \cos\theta$ $\cos\theta \approx 1$

$v = \sqrt{\frac{T}{\mu}} = v = \sqrt{\frac{F}{\mu}}$

1. $\frac{F}{A} = Y\frac{\Delta \ell}{\ell_o} \Rightarrow \frac{2.51kg \times 10\,m/s^2}{\pi(0.2m)^2} = Y \times 20\%$ 1 pt

$Y = 1\times 10^3\ \frac{N}{m^2}$ 1 pt

2. $P = \frac{F}{A} \Rightarrow 20\,Pa = \frac{10kg \times 10\,m/s^2}{\pi r^2} \Rightarrow \pi r^2 = 5\,m^2$ 1 pt

$r = 1.26m$ 1 pt

3. $V = \pi r^2 h = 5m^2 \times 0.25m = 1.25m^3$ 1 pt

$\rho = \frac{10kg}{1.25m^3} = 8\frac{kg}{m^3}$ 1 pt

4. $F_2 \uparrow$

$F_g \downarrow \downarrow F_1$ 1+1+1 pts

5. Newton's 1st law: In a static equilibrium $\sum \vec{F} = 0$

$\vec{F}_2 + \vec{F}_1 + m\vec{g} = 0$. 1pt

Using the FBD above (4.) gives

$F_2 - F_1 = mg$. $F_2 - F_1 = F_B$. Thus 1 pt

$F_B = m_{liq} g$ or $F_B = \rho_{liq} V_{liq}\, g$ 1 pt

6. $F_2 - F_1 = mg$ 1 pt

7. $F_2 - F_1 = mg \Rightarrow P_2 A - P_1 A = \rho A(h_2 - h_1)g$ 1 pt

$P_2 - P_1 = \rho g(h_2 - h_1)$ 1 pt

8. Substitute $P_2 = P$, $P_1 = P_o$, $h_2 = h$, $h_1 = 0$ in 5A. 1 pt

$P = P_o + \rho g h$

9. $m_1 = m_2 \Rightarrow \rho V_1 = \rho V_2 \Rightarrow \frac{\rho A_1 \Delta x_1}{\Delta t} = \frac{\rho A_2 \Delta x_2}{\Delta t}$ 1+1pts

$A_1 v_1 = A_2 v_2$

10. $W_1 = F_1 \Delta x_1$ and $W_2 = F_2 \Delta x_2$ 1 pt

11. $PE_1 = mgh_1$ and $PE_2 = mgh_2$ 1 pt

12. $KE_1 = \frac{1}{2}mv_1^2$ and $KE_2 = \frac{1}{2}mv_2^2$ 1 pt

20, 22, 23 se textbook

13. $W_1 + PE_1 + KE_1 = W_2 + PE_2 + KE_2$

$F_1\Delta x_1 + mgy_1 + \frac{1}{2}mv_1^2 = F_2\Delta x_2 + mgy_2 + \frac{1}{2}mv_2^2$ 1 pt

Divide all terms by $V = A_1\Delta x_1 = A_2 \Delta x_2$

$\frac{F_1\Delta x_1}{V} + \frac{m}{V}gy_1 + \frac{1}{2}\frac{m}{V}v_1^2 = \frac{F_2\Delta x_2}{V} + \frac{m}{V}gy_2 + \frac{1}{2}\frac{m}{V}v_2^2$ 1 pt

$\frac{F_1\Delta x_1}{A_1\Delta x_1} + \rho g y_1 + \frac{1}{2}\rho v_1^2 = \frac{F_2\Delta x_2}{A_2\Delta x_2} + \rho g y_2 + \frac{1}{2}\rho v_2^2$ 1 pt

$\frac{F_1}{A_1} + \rho g y_1 + \frac{1}{2}\rho v_1^2 = \frac{F_2}{A_2} + \rho g y_2 + \frac{1}{2}\rho v_2^2$

$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$ 1 pt

14. $P = P_o + \rho g h$

$P = 10^5 Pa + 1\times 10^3 kg/m^3\, 10m/s^2\, 4\times 10^3 m$ 1 pt

$P = 4.01 \times 10^7$ Pa 1 pt

15. Newton's 1st law: In a static equilibrium $\sum \vec{F} = 0$

$\vec{F}_B + m\vec{g} = 0$ $\quad \vec{F}_B = mg \uparrow$ 1 +1 pts

16. $P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$

both end at approximately the same pressure:

$P_o + 0 + \rho g h_1 = P_o + \rho g h_2 + \frac{1}{2}\rho v_2^2$ 1 pt

$v = \sqrt{2g(h_1 - h_2)}$ 1 pt

17. Because the container is covered, the pressure at the top of the container is approximately zero (assuming the cover is strong enough):

$0 + 0 + \rho g h_1 = P_o + \rho g h_2 + \frac{1}{2}\rho v_2^2$ 1 pt

$v = \sqrt{2g(h_1 - h_2) - \frac{P_o}{\rho}}$ that is the speed is lower. 1 pt

18. The initial velocity in the vertical direction is zero. Thus,

$h_2 = \frac{1}{2}gt^2$, $t = \sqrt{\frac{2h_2}{g}}$ 1+1 pt

19. $x = vt = \sqrt{2g(h_1 - h_2)}\sqrt{\frac{2h_2}{g}}$ 1 pt

$x = 2\sqrt{h_1(h_1 - h_2)}$ 1 pt

1. E
2. D
3. C
4. B
5. C
6. C
7. E
8. A
9. D
10. C
11. B
12. A
13. E
14. B
15. C
16. A
17. E
18. D
19. A
20. B
21. A
22. A
23. B
24. A
25. E
26. C
27. B
28. D
29. D
30. D
31. E

A 7 B 6 C 6 D 6 E 6