Part I. Multiple choice questions *(1.5pt each)*

1. Which statement is correct about the pressure under a fluid in a container?
   (A) It depends on the volume of the fluid
   (B) It depends on the shape of the container
   (C) It depends on the density of the fluid
   (D) It is independent of the depth of the fluid
2. A table-tennis ball which is spherical in shape has a diameter of 6 cm and average density of 0.4 g/cm^3. What force is required to hold it completely submerged under water?
   (A) 0.68 N downward
   (B) 0.68 N upward
   (C) 1.13 N downward
   (D) 1.13 N upward
3. Lead has a greater density than iron, and both are denser than water. Comparing the buoyant force on the lead object to the buoyant force on the iron object of same volume,
   (A) the buoyant force on the lead object is greater than the buoyant force on an iron object
   (B) the buoyant force on the lead object is less than the buoyant force on an iron object
   (C) the buoyant force on the lead object is equal to the buoyant force on an iron object
   (D) None of the above
4. Two tubes of different cross-sectional areas are connected together horizontally. Which of the following is a true statement about a fluid flowing through the tubes
   (A) The amount of fluid that leaves the wider tube is less than the amount of fluid that enters the narrower tube in the same interval of time.
   (B) The speed of the fluid in the narrower tube is greater than the speed of the fluid in the wider tube.
   (C) The pressure of the fluid in the narrower tube is greater than that in the wider tube.
   (D) The speed of the fluid in the narrower tube is less than the speed of the fluid in the wider tube.
   (E) The amount of fluid that leaves the wider tube is greater than the amount of fluid that enters the narrower tube in the same interval of time.
5. A garden hose has an inside diameter of 16 cm. The hose can fill a 10 liter bucket in 20 seconds. If the diameter of the nozzle is reduced to 8 cm,
   (A) Water exits with a speed twice the speed inside the hose.
   (B) A 10 litter bucket can be filled in 10 seconds
   (C) A 20 litter bucket can be filled in 40 seconds
   (D) Water exits with a speed half the speed inside the hose.

Adama Science and Technology University

School of Applied Natural Science

Department of Applied Physics

General Physics *Final-Exam for Regular Pre-engineering Students for 2020-2021 Ac. yr*

Time Allowed: 2:30hrs *and Maximum Mark allotted:* 45 %

Full Name_____ID. No_____Section:_____

General Direction

- The exam has three parts: Multiple choice, short answer and work out problems.
- Use of ***red pen, pencil & cell phone*** is not permitted in the exam hall.
- Written manuscripts and printed materials are strictly prohibited in an exam hall.
- You are not allowed to use any extra paper; rather you can use the back page of each paper for your rough work.
- Sharing calculator is strictly prohibited!

Use the following constants wherever applicable:-

$density\ of\ water\ (\rho_w) = 1000\ kg/m^3$

$specific\ heat\ of\ water\ (c_w) = 4190\ J/kg\ ^0C$

$Earth's\ gravitational\ acceleration\ g = 10m/s^2$

Atmospheric pressure $P = 1.01x10^5 pa$

Specific heat capacity $c_{Al} = 900\ J/kg.^0C$

Linear thermal expansion of Al ($\propto_{Al} = 24x10^{-6}/^0C$)

Density of aluminum ($\rho_{Al} = 2700kg/m^3$)

For Instructors use only!

Multiple choice/15pt/	Short answer/15pt/	Workout /15pt/	Total (45%)

6. When a load of 500 kg is hanging from a steel wire of length 3 m and cross sectional area 0.2 cm^2 , the wire stretches beyond its no load length. If the young's modulus for the wire made of steel is $Y = 2 \times 10^{11}$ Pa, what is the change in length of the wire beyond its no-load length?

(A) 3.75 mm (B) 2.75 mm (C) 1.75 mm (D) 0.75 mm

7. What is Thermal expansion?

A) The transfer of thermal energy between materials by the collisions of particles

B) Is a decrease in a materials size when temperature decreases

C) An increase in a materials size when temperature increases

D) All

8. Which of the following statements is false?

A) Gaps need to be left in lengths of railway lines to prevent buckling in hot weather

B) Bimetallic strips are used in thermostats, a thermostat being a temperature- operated switch

C) As the temperature of water is decreased from 4 ^{0}C to 0 ^{0}C contraction occurs

D) A change of temperature of 15 ^{0}C is equivalent to a change of temperature of 15 K

9. If the coefficient of linear expansion is A, the coefficient of superficial expansion is B and the coefficient of cubic expansion is C, which of the following is false?

A. C = 3A B. A=B/2 C. B=3C/2 D. A=C/3

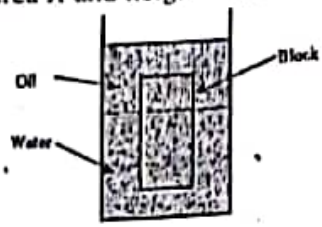
10. The temperature of land rises more quickly than that of the sea because the specific heat of soil is

A) more than water C) less than water

B) equal to water D) neutral

Part II. Give short answer /1.5pt each/

1. A layer of oil with density 800 kg/m^3 floats on top of a volume of fresh water. A block of some material of density 950 kg/m^3, a uniform cross-sectional area A and height h floats at oil-water interface, as shown in figure below.



   (a) What fraction of the block is in water? _____

   (b) What fraction of the block is in oil? _____

2. An object is suspended by a cord as shown in *figure 'a'* and the tension in the cord is T_1 = 10 N. The object is then immersed to the water as shown in *figure 'b'*. In this case the tension in the cord is T_2 = 6 N.

   Determine the density of the object. _____

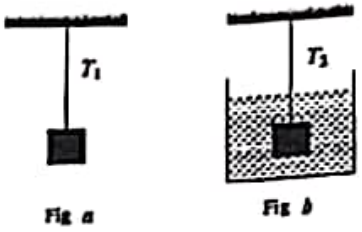


Fig a Fig b

3. A small block of wood, of density 0.4 x 10^{3}kg/m^3, is submerged in water at a depth of 2.9m. Find

   (a) The acceleration of the block towards the surface when the block is released. :

   _____

   (b) The time for the block to reach the surface. _____

4. If a pendulum clock keeps perfect time at the base of a mountain, will it also keep perfect time when it is moved to the top of the mountain? Explain. _____

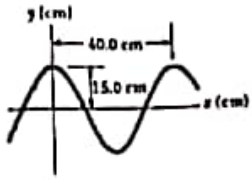
5. A mass–spring system moving with simple harmonic motion has amplitude A. When the kinetic energy of the object equals twice the potential energy stored in the spring, what is the position x of the object? _____

6. If the spring having spring constant k is cut in to two equal parts, the spring constant of either half will be _____

½

7. The condition of resonance occurs when the driving frequency becomes equal to_____ _____ of the oscillator.

8. A sinusoidal wave traveling in the positive x-direction has a wavelength of 40cm, and a frequency of 8Hz. The vertical position of an element of the medium at t = 0 and x = 0 is also 15cm as shown in figure below. The period T & linear speed of the wave are _____and _____respectively.



9. A car with a mass of 1300 kg is constructed so that its frame is supported by four springs. Each spring has a force constant of 20,000 N/m. Two people riding in the car have a combined mass of 160 kg. Find the frequency of vibration of the car after it is driven in the road and the car oscillates vertically.

10. Rubber has a negative average coefficient of linear expansion. What happens to the size of a piece of rubber as it is warmed?

Part III. Workout: Show all the necessary steps clearly for the following problems */15pt/*

1. A horizontal pipe of 10 cm in diameter has a smooth reduction to a pipe of 5 cm in diameter. If the pressure of the water in the larger pipe is 80kPa and the pressure in the smaller is 60kPa, at what rate does the water flow through the smaller pipe? *[4pts]*

2. In an engine, a piston oscillates with simple harmonic motion so that its position varies according to the expression : $x(t) = 5\cos\left(2t + \frac{\pi}{6}\right)$

Where x is in meters and t is in seconds. find *[4pts]*

(a) The position of the particle, at $t = 0$

(b) Its time varying velocity

(c) Its maximum acceleration

(d) The period

3. A 1kg block of aluminum is heated at atmospheric pressure so that its temperature increases from 22°C to 40°C. Find *[4pts]*

(a) The work done on the aluminum,

(b) The energy added to it by heat, and

(c) The change in its internal energy

Answer

1 C 1 From $P = \frac{F}{A}$ and

$P = \rho g h$

Because $P = \rho g h$

So Pressure of Container depend on
- density
- gravity
- height

of Container

1 A Given

$r = 3 \times 10^{-2}$ m $d = 6$ cm $= 6 \times 10^{-2}$ m

$\rho = 0.4$ g/cm^3

$g = 10$ m/s^2

Required

F = ?

Solution

1 draw diagram

(2) solve problem

When Completely submerge the Velocity become Zero

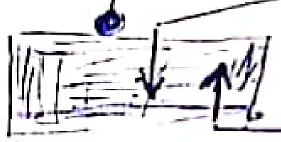
$F_{net} = F_{app} + F_g - F_b$

$F_{net} = 0 = F_{app} + F_g - F_b$ (Velocity & $\bar{a}$ is zero)

$-F_{app} = F_g - F_b$

$-F_{app} = mg - \rho g V_w$

$-F_{app} = \rho_{ball} V_{ball} g - \rho_w g V_w$



There three force.
(1) buoyant Force
(2) gravitational Force.
(3) Applied Force

$-F_{app} = 0.4$ g/cm^3 $\cdot \frac{4\pi r^3}{3} 10 - 1$ g/cm^3 $\times 10 \times \frac{4\pi r^3}{3}$

$F_b = \rho g V$

$F_g = mg$

$-F_{app} = 0.4$ g/cm^3 $\times \frac{4}{3} \times 3.14 \times (3$ cm$)^3 - \frac{1g}{cm^3} \times 10 \times \frac{4 \times 3.14 \times 27}{3} \times 10$

$V_{water} = V_{shape}$ when Completely submerge

$-F_{app} = (0.4$ g/cm^3 $\times \frac{27}{3} \times 4 \times 3.14)$

$-F_{app} = (113.04 \times 0.4 - 1g \times 113.04) \times 10$

$-F_{app} = 113.04 \times 0.4 \times 10 - 1130.4$

$-F_{app} = -678.24$

$F_{app} = 678.24$ g × m/s^2

$F_{app} = 0.678 \approx 0.68$ kg m/s^2

method II

Circumference ball

$m = \rho V$

$m = 0.6 \times 36\pi$

$m = 45.216\,g = 45.216 \times 10^{-3}\,kg$

$F_g = mg$

$= 45.216 \times 10^{-3}\,kg \times 10$

$= 0.45216\,N$

$F_b = \rho g V$

$= 1\,g/cm^3 \times 10 \times 36\pi\,cm^3$

$= 1\,g/cm^3 \cdot 10\,m/s^2 \cdot 36\pi\,cm^3$

$= 1\,g \cdot 113.04 \times 10$

$= 1130.4\,g\,m/s^2 = 1.1304\,kg\,m/s^2$ ——→ see there unit correct.

$F_b = 1.1304\,N$

$F_{net} = F_{app} + F_{gravity} - F_{buoyant}$

$F_{app} = (F_{gravity} - F_{buoyant})(-)$

$= (0.45216 - 1.1304)(-1)$

$F_{app} = 0.68\,N$ downward but this our answer : 1 downward?

our answer is downward because the density of ball less than density of water so our force applied downward.

3. B

Solution

$F_b = \rho g V$.

Since both are denser than water We Compare only their density not dens
of water and both has the same Volume.

$F_b = \rho g V$

gV ——→ Constant

$F_b \sim \rho$.

$\rho_b > \rho_e$

(1) b

What is our question?

Our question is about flow rate water

$A_1V_1 = A_2V_2$

r: radius

V: speed

$\pi r_1^2 V_1 = \pi r_2^2 V_2$

$r_1^2 V_1 = r_2^2 V_2$

From this equation we can conclude that

the large radius the small speed and the small radius the large speed

(5) This question the same as to question no four

$A_1V_1 = A_2V_2$

$\frac{\text{Volume}_1}{t_1} = \frac{\text{Volume}_2}{t_2}$ $\Big\}$ $Q_1 = Q_2$.

Given

$V_1 = 20\ L$

$t = 20\ sec$

$d = 16\ cm$ $r = 8\ cm$ inside

$r_{nozz} = 4\ cm$ $d_{no} = 8\ cm$

Required

Which one is correct?

Solution

$Q_1 = \frac{\text{Volume}}{t_1}$

$Q_1 = \frac{10}{20}$

$Q_1 = 0.5\ m^3/s$ ---- (*)

$A_1V_{speed} = A_2V_{speed}$

$\pi r_1^2 V_1 = \pi r_2^2 V_2$.

$(8cm)^2 V_1 = (4cm)^2 V_2$.

$64V_1 = 16V_2$.

$\frac{V_2}{V_1} = \frac{64}{16}$.

$\frac{V_2}{V_1} = 4$

$V_2 = 4V_1$

(A) is not answer because amount water leaves and enter the tube equa

that means $Q_1 = Q_2$

(C) is not answer

From fluid pressure formula

$F = \rho g h$

It depend the height of the shape

that the narrow shape has small height and wider has larger height

b) The speed of narrow tube is larger than wider therefore D is not correct

(E) - Amount water = Amount of leaves

so E is not correct

∴ B is not answer

v_2 → four times greater than V_1

C Q. E is not answer because

$Q_1 = Q_2$

$\frac{\text{Volume}_1}{\text{time}_1} = \frac{\text{Volume}_2}{\text{time}_2}$

$\frac{10}{20} \neq \frac{10}{40}$

C answer Why? look at the following answer

$\frac{\text{Volume}_1}{\text{Volume}_2} = \frac{\text{time}_1}{\text{time}_2}$.

$\frac{10}{20} = \frac{20}{40}$.

$\frac{1}{2} = \frac{1}{2}$.

What about D?

D also not correct answer because of reason of answer (A)

(6) A.

Given

$m = 500\,kg$

$Y = 2 \times 10^{11}$

$A = 0.2\,cm^2 = 0.2 \times 10^{-4}\,m^2$.

$L = 3\,m$

Required

ΔL

Solution

$Y = \frac{\text{Stress}}{\text{Strain}}$

$Y = \frac{\frac{F}{A}}{\frac{\Delta L}{L}}$

$Y = \frac{F/A}{\Delta L/L_0}$

$\Delta L = \frac{F L_0}{Y A}$.

$\Delta L = \frac{mg.L_0}{YA}$

$\Delta L = \frac{500 \times 10 \times 3m}{0.2 \times 10^{-4} \times 2 \times 10^{11}}$

$\Delta L = 0.00375\,m$

$= 3.75\,mm$.

10 As temperature increase thermal expansion increase
As temperature decrease thermal expansion decrease

8 ___

9. C

Given: Linear, Area: B, Cubic (Volume): C

required: the relation

Solution

expansion

Area: 2. Linear expansion

Cubic: 3 linear expansion

$B = 2A$

$C = 3A$

A: is correct because $C = 3A$

B is correct because $B = 2A = \frac{B}{2} = A$

C is not correct because $C = \frac{3B}{2}$ not $\frac{3C}{2} = B$.

but How? solution From $2A = B$

$3A = C$

$2A = B$

$A = \frac{B}{2} \Rightarrow 3\left(\frac{B}{2}\right) = C$

$= \frac{3B}{2} = C$

(D) also correct

11 C

Solution

This question about the relationship b/w temperature and Specific Heat Capacity.

Q: Why?

The more Temperature low Specific Heat

∴ The soil had low Specific heat.

4. A glass contains 0.25kg of Omni-Cola (mostly water) initially at 25°C. How much ice, initially at -20°C, must you add to obtain a final temperature of 0°C with all the ice melted? Neglect the heat capacity of the glass. (c_{water} = 4190 J / kg ^{0}C and c_{ice} = 2100 J/kg^{0}C, and L_f = 3.34 x10^5 J/kg) *[3pts]*