Choose the correct answer, (1 Mark each)

1- A rock saturated with oil has a unit weight of 29.3 kN/m^3. When dry the rock has a unit weight of 26.4 kN/m^3. If the porosity of the rock is 0.47, find the density of the oil in (g/cm^3)

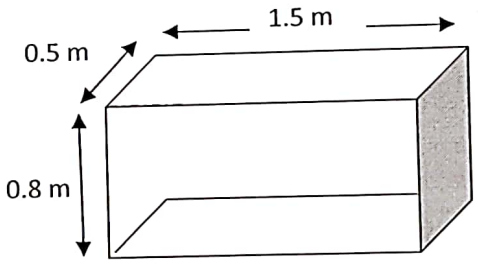
$\gamma_{sat} = \gamma_{dry} + n\gamma_L$
$29.3 = 26.4 + 0.47$
$\gamma_L = 6.17$
$\gamma = \rho g$

a) 0.80
b) 0.63 ✓
c) 0.52
d) 0.35

2- A block of rock saturated with water has edge lengths as shown in the figure. The porosity of the rock is 27.4%, find the maximum volume of the water (in m^3) squeezed out of the rock,

$V = 0.6$
$n = 0.274$
Voids

a) 0.16 ✓
b) 0.17
c) 0.18
d) 0.19



3- Calculate the load needed (in kN) to provide a stress of 726 kPa on a surface area of 2.82 cm^2.

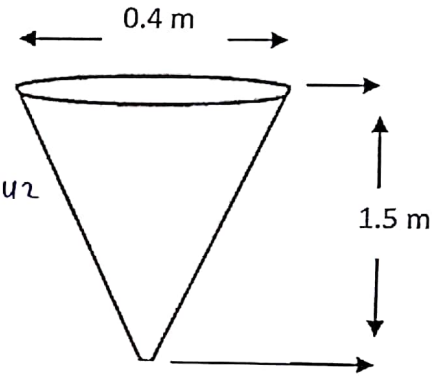
a) 0
b) 2.05
c) 20.47 ✗
d) 0.20

4- If subsurface rocks have density of 3.08 g/cm^3, find the lithostatic stress (in kPa) at a depth of 6.75 km is,

a) 143.37
b) 173.56
c) 203.74
d) 223.61

$\rho = 3.080$
$\sigma = ?$
$h = 6.75$
$\sigma = \rho g h$

A Cone shape container was filled with a mixture of 35% sandstone powder and 65% concrete. The initial porosity of the mixture inside the container was found to be 0.30. Find



5- Unit weight of the mixture (kN/m^3)

a) 26.31
b) 20.26
c) 30.04
d) 35.61

$V = 0.0942$
$f_1 = 0.35$
$f_2 = 0.65$
$n = 0.30$
$\gamma = \rho g = f_1\rho_1 + f_2\rho_2$
$\rho g = 0.35\rho g + 0.65\rho g$
$\rho g = \rho(0.35 + 0.65)$
$\rho g = \rho$
$n_{mixture} = 0.3$

6- The density of the mixture inside the container (kg/m^3)

a) 14179
b) 18419
c) 20511
d) 23121

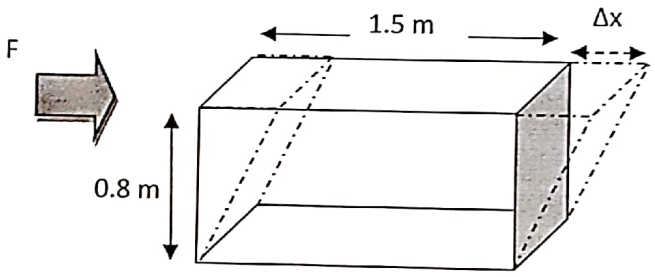
$\gamma = \rho g$
$\rho = \frac{\gamma}{g}$
$\gamma = \rho g$
$\rho = \frac{\gamma}{g}$

$\rho g = 0.35\rho_1 + 0.65\rho_2$
$0.35\rho_1 + 0.65\rho_2 = \frac{\rho}{(1-n)}$
0.7
$0.245\rho_1 + 0.455\rho_2 = \rho$
$\rho - 0.455\rho_2 = 0.245\rho_1$
$\rho - 0.455\rho_2 + 0.455\rho_2 = \rho$
$\rho g = 2930.1$

7- If the mixture is compressed to maximum, how much will be the subsidence in (m) inside the cone container.

a) 0.35
b) 0.45
c) 0.55
d) 0.25

8- A Block made of Marble stone has a shear modulus of 27 GPa and bulk modulus of 71.9 GPa, and dimensions of 0.8 m, 1.3 m and 1.5. If the Block is resting on a horizontal surface and was subjected to a force F=30 MW. Find, the linear deflection Δx in mm. **(3 marks)**



$G = 27\ GPa$
$E = 71.9\ GPa$
$F = 30$

$G = \frac{\tau}{\theta}$

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

$\tau = \frac{30 \times 10^6}{0.8 * 1.3}$

$\tau = 28.85 \times 10^6\ Pa$

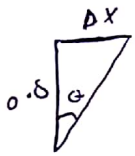
$G = \frac{\tau}{\theta}$

$27 \times 10^9 = \frac{28.85 \times 10^6}{\theta}$

$\theta = 1.0685 \times 10^{-3}$

$\theta = 1.0685 \times 10^{-3} * \frac{\pi}{180}$

$\theta = 1.8649 \times 10^{-5}\ rad$



$\tan\theta = \frac{\Delta x}{0.8}$

$\tan 1.8649 \times 10^{-5} = \frac{\Delta x}{0.8}$

$\Delta x = 1.49 \times 10^{-5}\ m$

$\Delta x = 0.0149\ mm$

1 m → 1000 mm
$1.49 m$
1.49×10^{-5} → x m

9- Clay sediment of porosity 48.2% is deposited into a square trench to a depth equal to 7.26 m. Find the porosity of the clay when it has settled by 54.5 cm. **(2 marks)**

$n_o = 0.482$

$H_o = 7.26\ m$

$\Delta H = 0.545\ m$

$$\Delta H = H_o \left[\frac{n_o - n}{1-n}\right]$$

$$0.545 = 7.26 \left[\frac{0.482 - n}{1-n}\right]$$

$$n = 0.439946$$

2

Part I: Earthquake

1- The region of initiation of seismic energy within the Earth is called the:

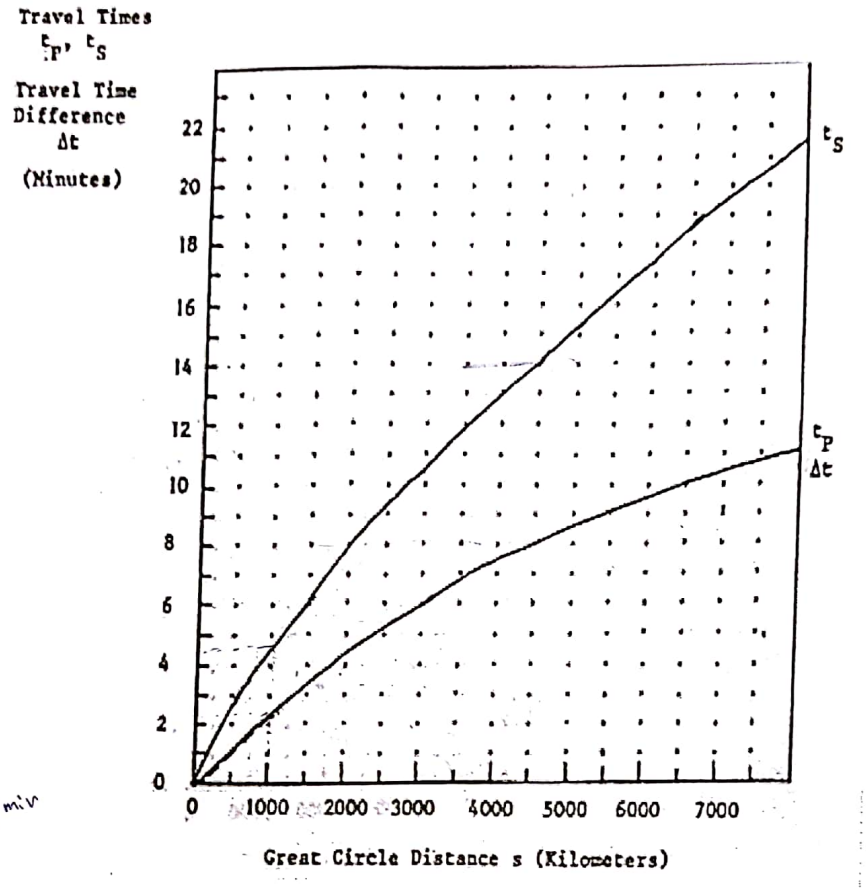
a) area of greatest building damage
b) area of least building damage
c) epicentre
d) focus

2- S-waves produce a series of:

a) Up and down motion perpendicular to Earth's surface
b) Contractions and expansions that are in the direction of wave propagation.
c) Shearing motions that are at right angles to the direction of wave propagation.
d) Snake-like motions parallel to the Earth's surface.

3- At a seismic station, the first waves to arrive are

a) Shear waves
b) Pressure waves
c) Surface waves
d) All arrive at the same time



4.5
2.3
D × 1.96 min

4- The time (in minutes), the SS-wave needs to travel 2000 km from the epicentre.

a) 9
b) 16
c) 21
d) 13

$\frac{2000}{2} = 1000$

1000 → 4.5
4.5 × 2

5- If the P wave arrived at 2:30 p.m. a city 4500 km from the epicentre, at what time the S wave will arrive.

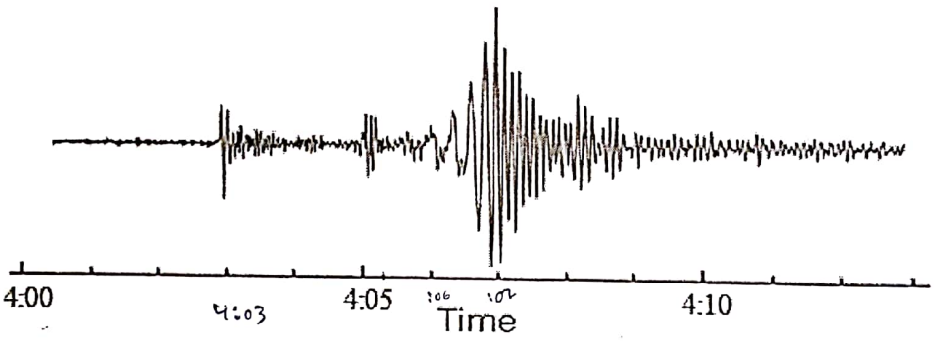
a) 02:24
b) 02:44
c) 02:38
d) 02:36

2:30 + 14 min
2:22 start
P 2:30 arrive
2:30 → 2:22
So 14 From the start
min
2:22 + 14 min
3 So S arrive 2:36

6- What is the megaton TNT equivalent of 8.5 on Richter scale earthquake?

a) 0.03
b) 1.06
c) 33.53
d) 45.2

7- If a station received earthquake waves as shown in the figure below. Using the figure and the travel time curve, find the distance (approximately) between the epicentre and the station (in km).



a) 500
b) 1500
c) 2500
d) 3000

$\Delta t = 2$

$t_P = 4:03$

$t_S = 4:05$

$\Delta t = 2$ min

we should be provided with Δt slope

1 Ci → 3.7×10^{10} Bq

x Ci → 2.7549×10^{14} Bq

x Ci →

Part II: Radioactivity

8- What will be the initial decay rate (in decays/s) for 10 kg tritium isotope $^{3}_{2}He$? **(2 marks)**

I will assume T = 2.52 year and t = 2.52 year

$R = \frac{N \ln 2}{T}$

$R_0 = ?$

$m = 10\,kg$

$N = \frac{10\,kg}{3 \times 1.661 \times 10^{-27}}$

$N = \frac{2.007 \times 10^{27}}{3}$ atoms

$R = \frac{2.007 \times 10^{27}}{3} \frac{\ln 2}{2.52 \times 365 \times 24 \times 60 \times 60}$

$R = 1.7504 \times 10^{19}$ Bq

$R = 473081081.1$ Ci

$R = R_0 \left(\frac{1}{2}\right)^{\frac{t}{T}}$

$473081081.1 = R_0 \left(\frac{1}{2}\right)^{2.52/2.52}$

$R_0 = 946162162.2$ Ci

9- How old is a rock that contains 3.86 mg of ^{235}U and 5.34 mg of ^{207}Pb? Given the half life time of Uranium 4.47 Gyrs? **(2 marks)**

$t = \left(\frac{T}{\ln 2}\right) \ln\left(1 + \frac{m_D}{m_P} \frac{A_P}{A_D}\right)$

$t = \frac{4.47}{\ln 2} \ln\left(1 + \frac{5.34 \times 10^{-6}}{3.86 \times 10^{-6}} \frac{235}{207}\right)$

$t = 6.088\,Gy$

10- The radioactive isotope of polonium $^{210}_{84}Po$ decays with a half-life of 138.4 days. What mass of this isotope has an activity of 9.00 mCi? **(1 mark)**

1 Ci → 3.7×10^{10} Bq

9×10^{-3} Ci → x Bq

$x = 9 \times 10^{-3} \times 3.7 \times 10^{10}$

$x = 333 \times 10^{6}$

$R = \frac{m \ln 2}{A_u T}$

$333 \times 10^{6} = \frac{m \ln 2}{210 \times 1.661 \times 10^{-27} \times 138.4 \times 24 \times 60 \times 60}$

$\frac{333 \times 10^{6}}{1.6618 \times 10^{17}} = \frac{m\ 1.6618 \times 10^{17}}{1.6618 \times 10^{17}}$

$m = 2.004\,\mu g$