UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 1
SESSION 2009/2010

SUBJECT	:	BASIC ENGINEERING SCIENCE
CODE	:	BSF 2812
COURSE	:	2 BPC
DATE	:	NOVEMBER 2009
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER ALL QUESTIONS IN **PART A** AND **THREE (3)** QUESTIONS IN **PART B**

THIS EXAMINATION PAPER CONSISTS OF **8 PAGES**

PART A

Q1 (a) (i) Expansion joint is very important for the roadbed, as shown in **Figure Q1 (a).** Explain the importance of the expansion joint based on your knowledge in thermal expansion.

(ii) A highway made of concrete slabs is 15 m long at 20.0°C. If the temperature range at the location of the highway is from -20.0°C to 40.0°C, what size of expansion gap should be left at 40.0°C to prevent buckling of the highway? Given the coefficient of linear expansion of concrete, $\alpha_{concrete} = 12 \times 10^{-6}\ {}^{\circ}C^{-1}$.

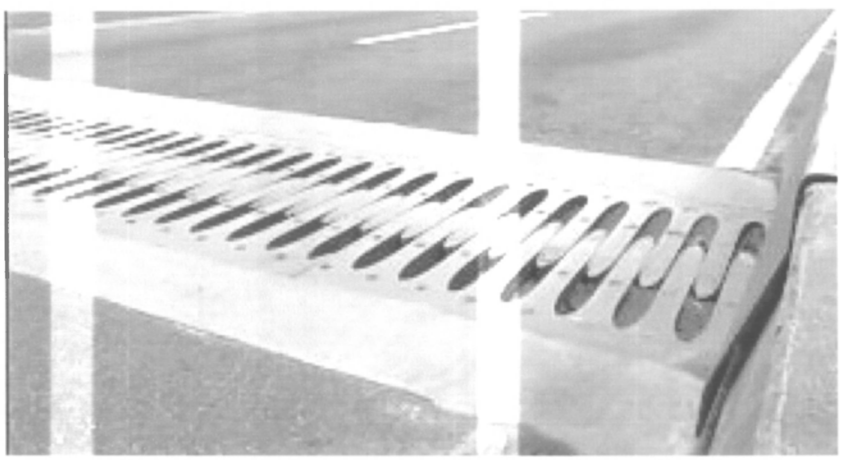

Figure Q1 (a)

(6 marks)

(b) What is the change in volume of a block of steel with dimensions 8.0 cm x 9.0 cm x 10.0 cm, when the temperature changes from 15 °C to 50 °C? Given the coefficient of linear expansion of steel, $\alpha_{steel} = 12 \times 10^{-6}\ {}^{\circ}C^{-1}$.

(3 marks)

(c) (i) Explain what is meant by thermal equilibrium?

(ii) What is the difference between **heat capacity, *C*** and **latent heat, *L***?

(iii) An ice cube at -10 °C has a mass of 0.5 kg. How much heat is required to change the ice completely into water at 0 °C? Given the specific heat of ice, $c_{ice} = 2.1$ kJ/kg.°C and the latent heat of fusion of water, $L_{water} = 333.7$ kJ/kg.

(11 marks)

Q2 (a) (i) How is wave generated? Give one example.

(ii) There are two types of mechanical waves: these are transverse waves and longitudinal waves. What is the **difference** between both waves?

(8 marks)

(b) A transverse wave with frequency of 12 Hz is illustrated in **Figure Q2 (b)**. Find

(i) the amplitude, A.

(ii) the wavelength, λ.

(iii) the period, T.

(iv) the speed of the waves, v.

(v) wave number, k.

(vi) angular frequency, ω.

(12 marks)

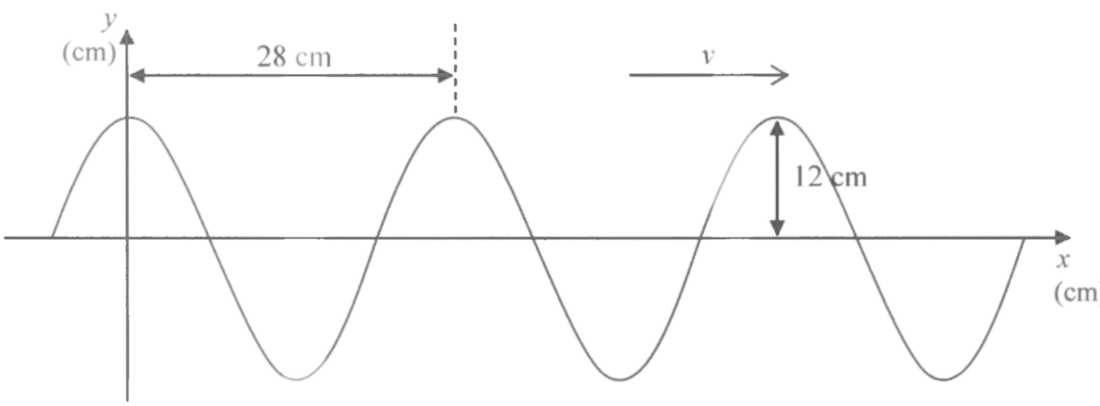

Figure Q2 (b)

PART B

Q3 (a) (i) List **four (4)** of the basic quantities and their respective units in SI.
(ii) Derive the units for the physical quantity of work, W.

(5 marks)

(b) Water has a density of 1000 kg/m^3. What is the density of water in units of g/cm^3?

(5 marks)

(c) Two forces F_1 and F_2 with magnitudes 50 N and 70 N respectively, act on a plastic container. The force F_1 acts at an angle 30° to the horizontal and force F_2 acts at 50° to the horizontal as in **Figure Q3 (a)**. Determine the resultant of these two forces.

(10 marks)

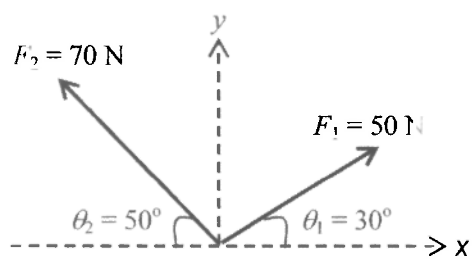

Figure Q3 (a)

Q4 (a) A brick is hung with a light rope to a ceiling as shown in **Figure Q4 (a)**.
(i) Draw a free body diagram (FBD) and label the forces acted on the system.
(ii) Explain the forces acted on the brick, rope and ceiling based on the Newton's Third Law.

(8 marks)

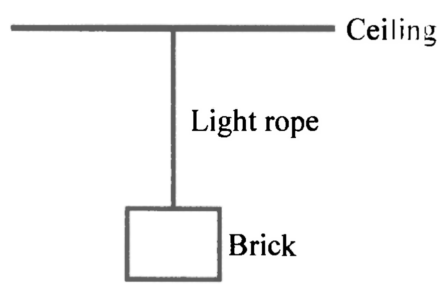

Figure Q4 (a)

(b) A car with a mass of 1000 kg moves from rest to reach a speed of 20 m/s. Calculate the
(i) initial kinetic energy, K_i.
(ii) final kinetic energy, K_f.
(iii) the work done, W by the car.

(9 marks)

(c) Rahim does work of 300 J in 10 s. What is his power?

(3 marks)

Q5 (a) (i) State the Pascal's Law.
(ii) In a hydraulic lift, if the radius of the smaller piston is 2.0 cm and the radius of the larger piston is 20.0 cm, what weight can the larger piston support when a force of 250 N is applied to the smaller piston?

(7 marks)

(b) Archimedes' Principle says that fluid exerts an upward buoyant force on a submerged object is equal in magnitude to the volume of fluid displaced by the object. Is this a correct statement? If not, explain why?

(3 marks)

(c) An ice with volume 20×10^{-6} m^3 is floating freely on a glass of water. Given the density of ice, ρ_{ice} = 917 kg/m^3, density of water, ρ_{water} = 1000 kg/m^3 and gravity acceleration, g =10 m/s^2, determine the
(i) weight of ice floating on the water.
(ii) buoyancy force.
(iii) volume of water displaced.
(iv) volume of ice submerged below water surface.

(10 marks)

Q6. (a) (i) States Hooke's Law on elasticity.

(ii) By using one example, explain the difference between elasticity and plasticity?

(7 marks)

(b) A 500 N object is hung from the end of a wire of cross-sectional area 0.010×10^{-4} m^2 as in **Figure Q6 (b)**. The wire stretches from its original length of 200.00×10^{-2} m to 200.50×10^{-2} m.

(i) What is the stress on the wire?

(ii) What is the strain on the wire?

(iii) Determine the Young's modulus of the wire.

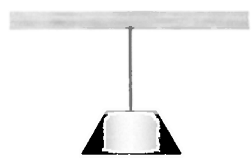

Figure Q6 (b)

(9 marks)

(c) An anchor made of cast iron is lowered over the side of the ship to the bottom of the harbour where its pressure is greater than sea level pressure by 1.75×10^6 Pa. If the of bulk modulus, β and the volume, V of the anchor are 60.0×10^9 Pa and 0.230 m^3 respectively, find the change in volume of the anchor.

(4 marks)

LIST OF CONSTANTS

1. Acceleration of gravity, $g = 10$ m/s^2
2. Coefficient of linear expansion of steel, $\alpha_{steel} = 12 \times 10^{-6}$ °C^{-1}
3. Coefficient of volume expansion of glass, $\gamma_{glass} = 28 \times 10^{-6}$ °C^{-1}
4. Coefficient of volume expansion of water, $\gamma_{water} = 207 \times 10^{-6}$ °C^{-1}
5. Specific heats of iron, $c_{iron} = 450$ J/kg.°C
6. Atmospheric pressure, $P_{atm} = 1.0 \times 10^5$ Pa
7. Specific heat of water, $c_{water} = 4.186$ kJkg^{-1}K^{-1}
8. Specific heat of ice, $c_{ice} = 2.1$ kJkg^{-1}K^{-1}
9. Specific heat of steam, $c_{steam} = 2.01$ kJkg^{-1}K^{-1}
10. Latent heat of fusion of water, $L_f = 333.7$ kJ/kg
11. Latent heat of evaporation of water, $L_v = 2{,}256$ kJ/kg
12. Coefficient of thermal conduction of asbestos, $\kappa_{asbesto} = 0.17$ Wm^{-1}K^{-1}
13. Coefficient of thermal conduction of copper, $\kappa_{copper} = 401$ Wm^{-1}K^{-1}.
14. Density of sea water, $\rho_{sea} = 1030$ kg/m^3
15. Density of water (fresh water), $\rho_{water} = 1000$ kg/m^3
16. Young's modulus of copper, $Y_{copper} = 120 \times 10^9$ Pa
17. Young's modulus of steel, $Y_{steel} = 200 \times 10^9$ Pa

LIST OF FORMULAS

$\Delta L = \alpha L_0 \Delta T$	$T_K = T(K/°C) + 273.15K$	$PE_{spring} = \frac{1}{2}kx^2$
$\Delta A = 2\alpha A_0 \Delta T$	$R = d/\kappa A$	$W = Fs\cos\theta$
$\Delta V = \beta V_0 \Delta T$	$Q = \kappa A \Delta T t/d$	$\Delta U = -W$
$\gamma_{apparent} = \gamma_{absolute} - \gamma_{glass}$	$v = f\lambda = \omega/k = (\tau/\mu)^{1/2}$	$\Delta K = W$
$V_{apparent} = V_{absolute} - V_{glass}$	$\mu = m/L$	$P = W/t$
$PV = nRT = Nk_BT$	$\omega = 2\pi f$	$\omega^2 = k/m$
$N = M/m$	$f = 1/T$	$\rho = m/V$
$n = N/N_A$	$k = 2\pi/\lambda$	$P = F/A = \rho gh$
$R = N_A k$	$f = nv/2L$	$P_{absolute} = P_{gauge} + P_{atm}$
$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	$F = ma$	$F_B = \rho gV$
$Q = mc\Delta T$	$F_f = \mu_k N$ $F_f = \mu_s N$	$\frac{F}{A} = Y\frac{\Delta L}{L}$
$Q = L_f m$	$U = mgh$	$\frac{F}{A} = S\frac{\Delta x}{L}$
$Q = L_v m$	$K = \frac{1}{2}mv^2$	$\Delta P = -B\frac{\Delta V}{V}$
$T_c = \frac{T_F - 32°F}{1.8°F/°C}$	$W_{spring} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$	