BANGLADESH UNIVERSITY OF PROFESSIONALS
Military Institute of Science and Technology
B.Sc. in Environmental Water Resource and Coastal Engineering, Term Final (Fall) Examination 2021: Jan-Feb 2022
Student Group: 0 < Earned Credit Hours ≤ 36

Subject: Phy-103, Physics A (Waves and Oscillations, Structure of Matter and Environmental Physics)

Time: 3.00 hours **Full Marks: 180**

INSTRUCTIONS:

a. Use **SEPARATE** answer scripts for each section.
b. **Question-1** in **Section-A** and **Question-5** in **Section-B** are compulsory
c. Answer any other **TWO** questions out of **THREE** from each section.
d. Figures in the margin indicate **full marks**.
e. Assume reasonable data if necessary.
f. **Symbols** and **abbreviations** used have their usual meanings.

SECTION-A

Question 1 (Compulsory)

a. Write down the characteristics of ionic and covalent bond. **12**

b. What is interplanar spacing? Derive an expression for Bragg's law of X-ray diffraction. **12**

c. Lead is face centered cubic with an atomic radius of r = 1.746 Å. Find the spacing of (111) plane. **6**

Question 2

a. What is pressure gradient force? Show that the pressure gradient force can be written as, $\frac{F}{m} = -\frac{1}{\rho}\vec{\nabla}P$. **12**

b. Show that the equation of continuity in case of mass flow into a fixed (Eulerian) control volume as a result of motion parallel to the x-axis is, $\frac{1}{\rho}\frac{D\rho}{Dt} + \vec{\nabla}.\vec{U} = 0$. **12**

c. Briefly discuss the formation of thunderstorm. **6**

Question 3

a. What do you mean by conduction band and valence band? **4**

b. With the help of energy level diagram, explain the differences between insulator, conductor and semiconductor. **13**

c. Distinguish between plasticity and elasticity. **7**

d. The atomic weight of silver is 108 gm. It has lattice constant 4.077 Å. Calculate the density of silver if it has the fcc structure. **6**

Question 4

a. Define the following terms: **9**
(i) Bravais lattice, (ii) Crystal structure and (iii) Lattice parameters.

b. Define packing factor. Prove that the body centered cubic is less packed than the face centered cubic structure. **15**

c. Calculate the value of interplanar spacing of (223) plane of a tetragonal crystal system whose lattice constants are a = b = 4.23 Å and c = 5.43 Å.

SECTION-B

Question 5 (Compulsory)

a. Distinguish between simple pendulum and compound pendulum. In case of a simple pendulum show that the equation of motion obeys the law of simple harmonic motion.

b. Define progressive wave. Derive the equation of progressive wave and find out the equation of motions.

c. A mass of 1.70 kg moves as a function of time as follows:

$$x = 4\,cos\left(1.33t + \frac{\pi}{5}\right).$$

Calculate potential energy and kinetic energy after 2 s.

Question 6

a. State and explain laws of thermodynamics.

b. What do you mean by lapse rate? Discuss different types of heat transfer process.

c. Define entropy. Show that the change of entropy in reversible process is always null.

Question 7

a. Define periodic motion. If a body is oscillating simple harmonically prove that average kinetic energy is half of its total mechanical energy.

b. Consider a body is executing simple harmonic motion. Derive the displacement equation followed by the body and explain amplitude, phase, time period and angular frequency. 1

c. The amplitude and frequency of an object executing simple harmonically are 0.01 m and 10 Hz respectively. What is the velocity of the object at displacement 0.003 m? What is the maximum velocity of the object?

Question 8

a. What is reduced mass? Establish a differential equation for two body oscillation. 8

b. Discuss analytically the theory of forced oscillation in the presence of damping force which is proportional to the velocity of the vibrating particle and obtain the condition of resonance. 15

c. An under damped harmonic oscillator has its amplitude reduced by $1/10^{th}$ of its initial value after 150 oscillations. Its time period is 2 sec. 7
(i) Calculate the damping constant and relaxation time and
(ii) If the observed value of the first amplitude of the oscillator is 2 cm, what would be its value in the absence of damping?