

**Bangladesh Army University of Science and Technology**  
**Department of Civil Engineering**  
Final Examination, Summer 2022

Course Code: PHY 1109  
Time: 03 (Three) hours

Level-1 Term-I  
Full Marks: 180

**Course Title: Physics I**

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- N.B.:
- Figures in the margin indicate full marks allotted to each question.
  - Symbols and abbreviations bear their standard meaning.
  - Use separate answer script for each PART.
  - The corresponding course outcomes (COs) are given in the right most column.
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**PART- A (Marks: 90)**

(Answer any three questions from 1 to 4 including Q. No. 1)

		Marks	COs
1.	a) Explain electromagnetic waves with graphical representation.	05	1
	b) Derive the differential equation of a particle executing simple harmonic oscillation and hence show that $y = a \sin(\omega t + \phi)$ .	20	2
	c) If the displacement of a particle is represented by $y = A \sin \omega t + B \cos \omega t$ , show that the motion of a particle is simple harmonic and find the amplitude of the motion when $A = 12$ m and $B = 9$ m.	05	3
2.	a) Define Lissajous figures.	05	1
	b) Derive the differential equation of damped harmonic motion and calculate its solution.	20	2
	c) The equation for displacement of a point on a damped oscillator is given by, $x = 5e^{-0.25t} \sin \frac{\pi}{2} t$ meter. Find the velocity of the oscillating point at $t = \frac{T}{4}$ .	05	3
3.	a) Define moment of inertia.	05	1
	b) Obtain an expression for the path of motion of a projectile with proper diagram.	20	2
	c) The horizontal range of a projectile is 80 m and time period is 6 sec. Find the initial velocity of projection and the angle of projection.	05	3
4.	a) What are stress and strain?	05	1
	b) Find an expression for elastic potential energy per unit volume.	20	2
	c) A wire of 2 m long and 0.5 mm in radius is stretched by a load of 10 N. Find the work done. ( $Y = 2 \times 10^{11} \text{ Nm}^{-2}$ )	05	3

**PART- B (Marks: 90)**

(Answer any three questions from 5 to 8 including Q. No. 5)

	Marks	COs
5. a) Write down four postulates of kinetic theory of gases.	05	1
b) Obtain Maxwell's expression for mean free path $\lambda = \frac{1}{\sqrt{2}nd^2n}$ , on the basis of kinetic theory of gases.	15	2
c) Calculate the volume occupied by 3.2 grams of oxygen at 76 cm of Hg and 27°C.	10	3
6. a) What are the critical constants of a gas?	05	1
b) Calculate the values of critical constants in terms of the constants of the Van der Waals equation.	15	2
c) Calculate the values of Van der Waal constants $a$ and $b$ in Van der Waal's equation for He, when critical pressure is $0.23 \times 10^6 \text{ N/m}^2$ and critical volume is $58 \times 10^{-8} \text{ m}^3/\text{mol}$ , $P_c = 37.2 \text{ atm}$ , $R$ per mol = $82.07 \text{ cm}^3 \cdot \text{atm} \cdot \text{K}^{-1}$ .	10	3
7. a) What is thermodynamic equilibrium?	05	1
b) For the first law of thermodynamics, prove that $C_p - C_v = R$ .	15	2
c) A Carnot's engine working as a refrigerator between 260 K and 300 K receives 500 calories of heat from the reservoir at the lower temperature. Calculate the amount of heat rejected to the reservoir at the higher temperature. Also calculate the amount of work done in each cycle to operate the refrigerator. (1 calorie = 4.2 joules).	10	3
8. a) Define streamline motion and turbulent motion of a fluid.	05	1
b) Derive an expression for surface tension of liquid by capillary rise method.	15	2
c) Calculate the terminal velocity of an air bubble of radius $2 \times 10^{-5} \text{ m}$ rising in a water of viscosity $10^{-3} \text{ Ns/m}$ . Density of water is $10^3 \text{ kg/m}^3$ . [Neglect density of air in comparison to that of water].	10	3

**Bangladesh Army University of Science and Technology**  
**Department of Civil Engineering**  
Final Examination, Summer 2022

Course Code: CHEM 1109  
Time: 03 (Three) hours

Level-1 Term-I  
Full Marks:180

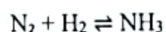
**Course Title: Chemistry**

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• The corresponding course outcomes (COs) are given in the right most column.
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**PART- A (Marks: 90)**

(Answer any three questions from 1 to 4 including Q. No. 1)

	Marks	COs
1. a) Describe Bohr's atom model with its limitations.	10	1
b) Find out the position of the following elements in the periodic table using electronic configuration- (i) Nitrogen (ii) Chlorine (iii) Iron.	10	2
c) What is hydrogen bond? Explain why H <sub>2</sub> S exists as a gas whereas H <sub>2</sub> O exists as a liquid.	10	2
2. a) What is meant by Portland Cement? Write down the reactions involved during the manufacturing of cement.	20	3
b) Write down the roles of gypsum and lime in cement.	10	3
3. a) Explain the term paint. Show the manufacturing process of paints.	15	3
b) What do you mean by sp <sup>3</sup> hybridization? Explain with proper example.	15	2
4. a) Derive the relation between K <sub>p</sub> and K <sub>c</sub> .	15	2
b) Define K <sub>p</sub> . Using the value of K <sub>p</sub> show what will happen if the pressure of the reaction is increased?	15	3



**PART- B (Marks: 90)**

(Answer any three questions from 5 to 8 including Q. No. 5)

		Marks	COs
5.	a) What is meant by order of a reaction? Derive the integrated rate equation for a first order reaction.	15	2
	b) Define half-life of a reaction. Prove that half-life of a first order reaction is independent of the initial concentration of the reactant.	15	2
6.	a) What is boiling point? Deduce the Clausius-Clapeyron equation.	20	2
	b) Explain why $\text{AlCl}_3$ exists as a dimer.	10	2
7.	a) State the 1 <sup>st</sup> and 2 <sup>nd</sup> law of thermodynamics and show between them which one is obeyed by Hess's law.	15	2
	b) Heat of neutralization for HCN by $\text{NH}_4\text{OH}$ is $-12.33\text{kJ/mol}$ . Calculate the heat of ionization of HCN. If, $\text{H}^+ + \text{OH}^- \longrightarrow \text{H}_2\text{O}$ ; $\Delta H = -55.9\text{ kJ/mol}$	15	2
8.	a) What is polymerization? Show the polymerization reaction for the formation of Nylon 6:6 with mechanism.	15	3
	b) Explain the term periodic properties. Show the periodic properties of atomic size along the group and period of a periodic table.	15	2

**Bangladesh Army University of Science and Technology**  
**Department of Civil Engineering**  
 Final Examination, Summer 2022

Course Code: MATH 1109

Level-I Term-I

Time: 03 (Three) hours

Full Marks: 180

**Course Title: Math I (Differential Calculus, Integral Calculus and Coordinate Geometry)**

- N.B.:
- Figures in the margin indicate full marks allotted to each question.
  - Symbols and abbreviations bear their standard meaning.
  - Use separate answer script for each PART.
  - The corresponding course outcomes (COs) are given in the right most column.

**PART- A (Marks: 90)**

(Answer any three questions from 1 to 4 including Q. No. 1)

	Marks	COs
1. a) Define Limit and Continuity of a function. Prove that if $\lim_{x \rightarrow x_0} f(x)$ exists, then it must be unique.	10	1
b) If $f(x) = \begin{cases} 5x - 4, & 0 < x \leq 1 \\ 4x^2 - 3x, & 1 < x < 2 \end{cases}$ then test the continuity and differentiability of $f(x)$ at $x = 1$ .	12	1
c) If $y = Ae^{mx} + Be^{-mx}$ then prove that $y_2 - m^2y = 0$	08	1
2. a) State Leibnitz's Theorem. If $y = \tan^{-1} x$ then prove that $(1 + x^2)y_2 + 2xy_1 = 0$ . Hence prove that $(1 + x^2)y_{n+2} + 2x(n + 1)y_{n+1} + (n^2 + n)y_n = 0$ .	15	2
b) Verify Rolle's Theorem for $f(x) = 2x^3 + x^2 - 4x - 2$ in the interval $(-\sqrt{2}, \sqrt{2})$ .	15	2
3. a) Define Euler's Theorem on Homogeneous function. If $v = \sin^{-1} \frac{x^2 + y^2}{x + y}$ then show that $x \frac{\partial v}{\partial x} + y \frac{\partial v}{\partial y} = \tan v$ .	15	3
b) A farmer has an adjustable fence that is 120m long. He uses this fence to enclose a rectangular grazing area on three sides, the fourth side being a fixed hedge. Find the maximum area he can enclose.	10	2
c) Show that, in the parabola $y^2 = 4ax$ , the sub tangent at any point is double of the abscissa and the subnormal is constant.	05	2
4. a) If $F(x, y, z) = \frac{1}{\sqrt{(x^2 + y^2 + z^2)}}$ then show that $F_{xx} + F_{yy} + F_{zz} = 0$ .	10	3
b) Using L'Hospital Rule find $\lim_{x \rightarrow 1} \frac{x^4 - 4x^3 + 6x^2 - 4x + 1}{x^3 - 3x^2 + 3x - 1}$ .	10	2
c) Find the radius of curvature at the point(2,3) on the curve $9x^2 + 4y^2 = 36x$ .	10	2

**PART- B (Marks: 90)**

(Answer any three questions from 5 to 8 including Q. No. 5)

	Marks	COs
5. a) Evaluate $\int_0^{\pi} \frac{x}{1+\sin x} dx$ .	07	2
b) Find the volume of the sphere $x^2 + y^2 + z^2 = a^2$ by triple integral.	08	2
c) Establish reduction formula for $\int \cos^n x dx$ . Hence find $\int \cos^6 x dx$ .	15	2
6. a) Prove that $\int_0^{\frac{\pi}{2}} \sin^p \theta \cos^q \theta d\theta = \frac{\Gamma(\frac{p+1}{2})\Gamma(\frac{q+1}{2})}{2\Gamma(\frac{p+q+2}{2})}$ .	15	2
b) Find the area of a region bounded by the curve $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$ .	15	3
7. a) Prove that $3y^2 - 8xy - 3x^2 - 29x + 3y - 18 = 0$ represent a pair of straight lines. Also find their equations, point of intersection and angle between them.	18	4
b) Find the angle between the lines whose direction ratios are $(3, 1, 2)$ and $(2, -2, 5)$ .	12	2
8. a) Find the shortest distance between the lines $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$ and $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$ . Also find the equation of the shortest distance.	15	2
b) Find the equation of the plane perpendicular to each of the planes $x - 4y + z = 0$ and $3x + 4y + z - 2 = 0$ and at a distance unity from the origin.	15	2



# Bangladesh Army University of Science and Technology

## Department of Civil Engineering Final Examination, Summer 2022

Course Code: HUM 1109  
Time: 03 (Three) hours

Level-1 Term-I  
Full Marks:120

Course Title: Professional English

- NB: • Questions are of equal value.  
• Figures in the margin indicate full marks allotted to each question.  
• Use a separate answer script for each PART.  
• The corresponding course outcomes (COs) are given in the right most column.

### PART-A

(Answer question 1 and one other)

- |   | Marks | CO      |
|---|-------|---------|
| 1. Correct the following sentences:   | 30    | 1, 2    |
| a) The police was on the hunt for the murderers.  |       |         |
| b) Our chief competitor, as well as ourselves, are obliged to increase prices.  |       |         |
| c) Many a man come to see the temple every year.  |       |         |
| d) None of the sardines have been eaten.  |       |         |
| e) We found that one of the boys were ill.  |       |         |
| f) Neither the buyer nor the salesman is in favour of the system.   |       |         |
| g) It are the students who should not miss any class.   |       |         |
| h) A lot of news in those papers are unrealistic.   |       |         |
| i) One-third of the students is from abroad.  |       |         |
| j) No boy and no girl perform well.   |       |         |
| k) My friend and benefactor have come.  |       |         |
| l) The cost of all these articles have risen.   |       |         |
| m) While the man worked in the field, suddenly a dog came and bit him.  |       |         |
| n) I know John for 20 years.  |       |         |
| o) Mrs Paul with her son and daughter are going to the theatre this evening.  |       |         |
| 2. Identify the underlined phrases and make a sentence of your own with each of them:   | 30    | 1, 2, 3 |
| a) He has proved his case <u>to my satisfaction</u> .   |       |         |
| b) He denies <u>stealing the money</u> .  |       |         |
| c) The movie was <u>not too terrible</u> .  |       |         |
| d) <u>The bewildered tourist</u> was lost.  |       |         |
| e) The new outfit was <u>very pricey but really beautiful</u> .   |       |         |
| f) You <u>might enjoy</u> a massage.  |       |         |
| g) The shepherd shouted to them <u>at the top of his voice</u> .  |       |         |
| h) It was <u>a story as old as time</u> .   |       |         |
| i) He is a man <u>without a friend</u> .  |       |         |
| j) Nothing can live <u>on the moon</u> .  |       |         |
| 3. Change the following words as directed and make a sentence with each changed form:   | 30    | 1, 2, 3 |
| advance (noun), happy (adverb), deep (verb), man (adjective), practice (adjective), large (verb), able (noun), fright (verb), civil (noun), wise (adverb), society (adjective), young (Noun), rich (verb), danger (verb), system (adverb) |       |         |

### PART-B

(Answer question 6 and one other)

- |  |    |      |
|--|----|------|
| 4. Identify the clauses in the following sentences:                            | 30 | 1, 2 |
| a) <u>Whether you like it or not</u> , you have to go to bed now.              |    |      |
| b) Here is the book <u>you want</u> .  |    |      |
| c) I want to know <u>how far it is from here</u> .                             |    |      |
| d) <u>Before we go on vacation</u> , we must make reservations.                |    |      |
| e) The workers, <u>who were weary with their exertions</u> , lay down to rest. |    |      |

- f) Whatever you want is fine with me.
- g) I do not understand how it all happened.
- h) Elephants, although they are large, are not predators.
- i) I like pizza which is also the favourite of my sister Jean.
- j) Since you have already decided, why do you ask my opinion?

5. Transform the following sentences as directed: 30 1, 2, 3
- a) He worked hard yet did not succeed. (into simple)
  - b) They are forbidden to enter the sacred place on pain of death. (into compound)
  - c) Your father is the man to help you in this matter. (into complex)
  - d) Feeling out of sorts, he went to bed. (into complex)
  - e) All believed that he was guilty of murder. (into simple)
  - f) He was too excited to hear the reason. (into complex)
  - g) The moment which is lost is lost forever. (into simple)
  - h) Waste not, want not. (into complex)
  - i) I shall not go unless I am invited. (into compound)
  - j) Life has few enjoyments; still we cling to it. (into complex)
6. a) Write a paragraph on "The Reasons of Failures in Examinations". 10 4
- b) Write an essay on "Campus violence in the Educational Institutions". 20 4



# Bangladesh Army University of Science and Technology

*Department of Civil Engineering  
Final Examination, Summer 2022*

Course Code: CE 1103  
Time: 03 (Three) hours

Level- 1      Term-I  
Full Marks: 180

Course Title: Surveying

- N.B. • The questions are of equal value.  
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 • Symbols and abbreviations bear their standard meaning.  
 • Use a separate answer script for each PART.  
 • The corresponding course learning outcomes (CLOs) are given in the right most column.

### PART- A (Marks: 90)

(Answer any three questions including Q. No. 1)

- |   | Marks | CLOs |
|---|-------|------|
| 1. a) State the purposes of leveling.   | (5)   | 1    |
| b) Discuss the conversion method of the whole circle bearing system to reduced bearing system.  | (10)  | 2    |
| c) A 20 m chain used for a survey was found to be 20.10 m at the beginning and 20.30 m at the end of the work. The area of the plan drawn to a scale of 1 cm = 10 m was measured with a planimeter and was found to be 32.56 sq. cm. Determine the true area of the ground.   | (15)  | 3    |
| 2. a) Explain chain surveying and different types of chain used in this surveying.  | (10)  | 1    |
| b) Explain project surveying. Classify an irrigation project survey based on completion.  | (10)  | 2    |
| c) An engineer's chain is used during the chaining procedure of a base line. The distance between the stations was found to be 3 full chains and 50 links. The chain was pulled with a constant force of 15 lb during each measurement. If the weight of the whole chain is 1.5 lbs, determine the corrected length of the chain. | (10)  | 3    |
| 3. a) State the advantages and disadvantages of plain table surveying.  | (7)   | 1    |
| b) Sketch contour lines for 50m, 49m, 48m, 47m, 46m in the following grid.  | (15)  | 3    |

<b>50.20</b>	<b>49.20</b>	<b>46.50</b>	<b>44.50</b>
<b>50.65</b>	<b>49.08</b>	<b>46.74</b>	<b>45.52</b>
<b>49.76</b>	<b>49.50</b>	<b>47.13</b>	<b>46.25</b>
<b>49.05</b>	<b>48.85</b>	<b>46.93</b>	<b>45.50</b>

- |   |      |   |
|---|------|---|
| c) Differentiate between theodolite and tacheometry.  | (8)  | 2 |
| 4. a) Explain traverse survey. Discuss the difference between chain and traverse surveying. | (10) | 2 |

- P b) Determine the value of Reduced Level (RL) at respective points using the rise and fall method. (20)

Station	B.S.	I.S.	F.S.	R.L.
A	0.865			560.500
B	1.025		2.105	
C	-	1.580	-	
D	2.230		1.865	
E	2.335		2.835	
F			1.760	

**PART- B (Marks: 90)**

(Answer any three questions including Q. No. 5)

- |    |   | Marks | CLOs |
|----|---|-------|------|
| 5. | a) Explain the importance of surveying in Civil Engineering.  | (12)  | 1    |
|    | b) Describe different types of Bench Mark (BM) used in surveying.   | (8)   | 1    |
|    | b) Explain GPS, GIS and EDM.  | (10)  | 3    |
| 6. | a) Write down the difference between the Trapezoidal rule and Simpson's rule.   | (10)  | 1    |
|    | b) The following offsets are taken from a survey line to a curved boundary line:  | (20)  | 2    |
|    | Distance (m)    0    4    8    12    16    24    32    44    56   |       |      |
|    | Offset (m)    2.70   4.80   3.23   4.55   5.67   5.40   5.80   4.50   3.40  |       |      |
|    | Find the area between the survey line, the curved boundary line, and the first and the last offsets by:   |       |      |
|    | i. The trapezoidal rule   |       |      |
|    | ii. Simpson's rule.   |       |      |
| 7. | a) Derive an expression between degree of curve and radius of curve.  | (10)  | 1    |
|    | b) Two tangents AB and BC intersect at a point B at chainage 150.5 m. Calculate all necessary data for setting out a circular curve of radius 100 m and deflection angle 30° by the method of offsets from the long chord.                          | (20)  | 3    |
| 8. | a) Define photogrammetry surveying.   | (5)   | 1    |
|    | b) A vertical photograph was taken at an altitude of 1200 meters above mean sea level (MSL). Determine the scale of the photograph for terrain lying at elevations of 80 meters from MSL and 300 meters if the focal length of the camera is 15 cm. | (25)  | 2    |

**Bangladesh Army University of Science and Technology**  
**Department of Civil Engineering**  
Final Examination, Summer 2022

Course Code: PHY 1109  
Time: 03 (Three) hours

Level-I Term-I  
Full Marks: 180

**Course Title: Physics I**

- N.B.:
- Figures in the margin indicate full marks allotted to each question.
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**PART- A (Marks: 90)**

(Answer any three questions from 1 to 4 including Q. No. 1)

	Marks	COs
1. a) Explain electromagnetic waves with graphical representation.	05	1
b) Derive the differential equation of a particle executing simple harmonic oscillation and hence show that $y = a \sin(\omega t + \varphi)$ .	20	2
c) If the displacement of a particle is represented by $y = A \sin \omega t + B \cos \omega t$ , show that the motion of a particle is simple harmonic and find the amplitude of the motion when $A = 12$ m and $B = 9$ m.	05	3
2. a) Define Lissajous figures.	05	1
b) Derive the differential equation of damped harmonic motion and calculate its solution.	20	2
c) The equation for displacement of a point on a damped oscillator is given by, $x = 5e^{-0.25t} \sin \frac{\pi}{2} t$ meter. Find the velocity of the oscillating point at $t = \frac{T}{4}$ .	05	3
3. a) Define moment of inertia.	05	1
b) Obtain an expression for the path of motion of a projectile with proper diagram.	20	2
c) The horizontal range of a projectile is 80 m and time period is 6 sec. Find the initial velocity of projection and the angle of projection.	05	3
4. a) What are stress and strain?	05	1
b) Find an expression for elastic potential energy per unit volume.	20	2
c) A wire of 2 m long and 0.5 mm in radius is stretched by a load of 10 N. Find the work done. ( $Y = 2 \times 10^{11} \text{ Nm}^{-2}$ )	05	3

**PART- B (Marks: 90)**

(Answer any three questions from 5 to 8 including Q. No. 5)

	Marks	COs
5. a) Write down four postulates of kinetic theory of gases.	05	1
b) Obtain Maxwell's expression for mean free path $\lambda = \frac{1}{\sqrt{2}nd^2n}$ , on the basis of kinetic theory of gases.	15	2
c) Calculate the volume occupied by 3.2 grams of oxygen at 76 cm of Hg and 27°C.	10	3
6. a) What are the critical constants of a gas?	05	1
b) Calculate the values of critical constants in terms of the constants of the Van der Waals equation.	15	2
c) Calculate the values of Van der Waal constants $a$ and $b$ in Van der Waal's equation for He, when critical pressure is $0.23 \times 10^6 \text{ N/m}^2$ and critical volume is $58 \times 10^{-6} \text{ m}^3/\text{mol}$ , $P_c = 37.2 \text{ atm}$ , $R$ per mol = $82.07 \text{ cm}^3\text{-atm}\cdot\text{K}^{-1}$ .	10	3
7. a) What is thermodynamic equilibrium?	05	1
b) For the first law of thermodynamics, prove that $C_p - C_v = R$ .	15	2
c) A Carnot's engine working as a refrigerator between 260 K and 300 K receives 500 calories of heat from the reservoir at the lower temperature. Calculate the amount of heat rejected to the reservoir at the higher temperature. Also calculate the amount of work done in each cycle to operate the refrigerator. (1 calorie = 4.2 joules).	10	3
8. a) Define streamline motion and turbulent motion of a fluid.	05	1
b) Derive an expression for surface tension of liquid by capillary rise method.	15	2
c) Calculate the terminal velocity of an air bubble of radius $2 \times 10^{-5} \text{ m}$ rising in a water of viscosity $10^{-3} \text{ N}\cdot\text{s}/\text{m}$ . Density of water is $10^3 \text{ kg}/\text{m}^3$ . [Neglect density of air in comparison to that of water].	10	3

8000  
+ 840  
   16  
   880  
   8400  
   8210  
   13  
   1487000  
   2487000