CINEC CAMPUS (PVT) LTD
Faculty of Maritime Sciences
Department of Navigation
EDUCATION & TRAINING COURSE: FOUNDATION PROGRAMME
COURSE CODE: ND-0199 BATCH 23/26

FINAL EXAMINATION – QUESTION PAPER
PHYSICS

- Answer any 05 questions
- Total Marks: 100
- **Speed of sound in air 340 m/s**
- **Speed of light in air or vacuum 3 x 10 ^{8} m/s**
- $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2, $\mu_0 = 4\pi \times 10^{-7}$ H/m, $m_e = 9.11 \times 10^{-31}$ kg, $m_p = 1amu = 1.6726 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C

Date: 25.02.2023   Pass mark 50%   Time allocated: 03 Hours

1. A fire engine has a siren with a frequency of **1000 Hz**. The engine is hurtling down the street at **25 m/s** in the direction of a pedestrian standing on the curb. Assume that the speed of sound in air is **350 m/s**, and that there is no wind blowing

   a. What is the frequency of the siren heard by the pedestrian as the engine approaches?

      (5 marks)

   b. What is the frequency heard by the same pedestrian once the engine has passed by?

      (5 marks)

   c. If a listener is driving a car initially moving towards the fire engine with a speed of 15 m/s, find the frequencies heard by the driver before and after passing the fire engine.   (10 marks)

2. The equation for a particular standing wave on a string is

   $$y(x, t) = 2.5 . \text{Sin } 8x \text{Cos } 340 t \text{ m}$$

   Find the

   a. Amplitude of vibration at the anti-node,   (5 marks)
   b. Distance between nodes   (5 marks)
   c. Wavelength   (5 marks)
   d. Frequency and speed of the wave   (5 marks)

3. A sound-progressive wave in air is represented by the equation

$$P(x, t) = 6.8 \, Sin(512\pi t - 1.5058\pi x)$$

Where P is the pressure in Pascals, t is in seconds and x is the distance from a fixed origin O in meters (m). Determine

   a. The amplitude   (4 marks)

   b. The frequency of the wave   (4 marks)

   c. Its wave length   (4 marks)

   d. Its speed   (4 marks)

   e. The audible pressure of the wave when $x = 0.25 \, m$ and $t = 10 \, s$.   (4 marks)

4. A block whose mass m is 0.5 kg is vertically fastened to a spring whose spring constant k is 50 N/m. The block is pulled under gravity a distance x = 12 cm from its equilibrium position at x = 0 and released.

   a. What are the angular frequency, the frequency and the period of the resulting motion?   (5 marks)

   b. What is the amplitude of the oscillation?   (5 marks)

   c. What is the maximum speed of the oscillating block, and where is the block when it has this speed?   (5 marks)

   d. What is the magnitude of the maximum acceleration of the block? (5 marks)

5.

   a. Define frequency and explain the term harmonics. How harmonics determine the quality of musical note   (4 marks)

   b. Write expressions for the frequencies of fundamental and of the first two overtones produced in an open organ pipe   (4 marks)

   c. An organ pipe 1.2 m long is opened at both ends. If the velocity of sound is 340 m/s, what are the frequencies of the fundamental and of the first two overtones?

                                                                                                                 (6 marks)

   d. Two open pipes, one 1.05 m and 1.25 m in length, are sounded simultaneously. How many beats per second will be produced between the fundamental tones if the velocity of sound is 340 m/s?   (6 marks)

6.

    a. Define pitch, loudness, quality, shock wave   (8 marks)

    b. Write an expression for the sound level change using Intensity or power of source relative to the threshold of hearing   (2 marks)

    c. A certain loudspeaker has a circular opening with diameter of 10 cm. assume that the sound it emits is uniform and outward through this entire opening. If the sound intensity at the opening is 100 uW/m². Determine

        i. The power radiated as sound by loudspeaker   (3 marks)

        ii. The intensity of sound 10 m from the speaker   (3 marks)

        iii. Sound level change which can be heard by an observer 10 m away from the speaker.   (4 marks)

7. Light is incident from glass (n = 1.51) to air (n = 1).

    a. If the angle of incidence is 37 ^{0}, what are the angle of reflection and refraction?   (5 marks)

    b. If the angle of incidence is 85 ^{0}, is there a solution for the angle of refraction?   (5 marks)

    c. What is the largest angle of incidence for which a solution exists for the angle of refraction?   (5 marks)

    d. What is the largest angle of incidence if the light travels from glass to water (n = 1.33)?   (5 marks)

8. In a double-slit the slits are separated by distance, d = 0.36 mm, and the screen is 1.38 m (L) from the slits. Light of the wavelength, λ = 455 nm is incidents on the slits.

    a. Write an expression for the angle at which one gets constructive interference of light.   (4 marks)

    b. At what angle does the first maximum occur?   (4 marks)

    c. At what angle does the third maximum occur?   (4 marks)

    d. What is the spacing between adjacent fringes?   (8 marks)

9. A rope of length, $L = 0.6\ m$, and mass $m = 160\ g$ is under tension, $T = 200\ N$.
   Assume that both ends are nodes.

   a. Find the three longest resonant wavelengths ($\lambda_0, \lambda_1, \lambda_2$) for the rope. (5 marks)

   b. Find the fundamental frequency and first two overtones for resonant standing waves in the rope. (5 marks)

   c. How would the results to part (a) and (b) change if the tension in the rope were *800 N*? (5 marks)

   d. If the far end of the rope were looped to slide freely without friction on a vertical greased bar, what would the three longest resonant wavelengths ($\lambda_0, \lambda_1, \lambda_2$) be for the rope? (5 marks)

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COURSE CODE: ND-0199 BATCH 22/25

MID EXAMINATION – QUESTION PAPER
MATHEMATICS

- Answer any 04 questions only
- Total Marks – 100

Date: 24.02.2023   *Pass mark 50%*   *Time allocated: 2.5 Hours*

Question 1

1. Solve.

i.	$x^2 + 7x + 12 = 0$	(25 marks)
ii.	$x^2 - 15x + 100 = 0$	(25 marks)
iii.	$x^2 - 49 = 0$	(25 marks)
iv.	$6x^2 + 5x - 12 - 0$	(25 marks)

Question 2

2.1. A geometric sequence has first term 1/ 9 and common ratio 3.

     (i) Find the fifth term.

     (ii) Which is the first term of the sequence which exceeds 1000?

                                (50 marks)

2.2. There are 20 terms in an arithmetic progression. The first term is −5 and the last term is 90.

     (i) Find the common difference.

     (ii) Find the sum of the terms in the progression

     (50 marks)

Question 3

3.11. Find the 7th and 12th term in the geometric sequence 8, 24, 72, 216, ...
(50 marks)

3.1.2. The first 3 terms of an infinite geometric progression are 16, 12 and 9

   (a) Write down the common ratio.
      (25 marks)
   (b) Find the sum of the terms of the progression.
      (25 marks)

Question 4

4.1. Prove the identity

   i. $cos^2x - sin^2x = 2 cos^2x - 1$
   ii. $\frac{cot A + tan B}{cot B + tan A} = cot A \tan B$
   iii. $\frac{cos A}{1 + sin A} - \frac{cos A}{1 + sin A} = 2 \tan A$
         (60 marks)

4.2 Find the values of sine, cosine and tangent of the following angles.
         a) $8\pi/3$
         b) $31 \pi/6$

                                                    (40 marks)

Question 5

         i. Solve for x

              a. $\log_2 [(x-1)/(x+1)] = 4$

              b. $\log 5 + \log(5x + 1) = \log(x + 5) + 1$

                   (40 marks)

         ii. Solve the following System.

         a. $\log_x (y) = 2$
         b. $x y = 8$
                   (20 marks)
         iii. Solve for x,
              a. $3^{4x} = 3^{2x-2}$

              b. $\sqrt{x} + 4 = 8$

                                                    (40 marks)

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MID EXAMINATION – QUESTION PAPER
INDUSTRIAL CHEMISTRY

- *Answer any 05 questions*
- *Total Marks: 100*
- Formulae and all intermediate steps taken in reaching your answer should be clearly shown

Date: 23.09.2022   Pass mark 50%   Time allocated: 03 Hours

Avogadro Constant (N_A) – 6.022×10^{23} mol-1
H – 1.0, He – 4.0, Li – 6.9, Be – 9.0, B – 10.8, C – 12.0, N –14.0 , O – 16.0, F – 18.9, Ne – 20.2, Na – 23.0, Mg – 24.3, Al – 27.0, Si – 28.1, P – 31.0, S – 32.1, Cl – 35.5, Ar – 40.0, K – 39.1, Ca – 40.1, Ag- 108.0, Cu – 63.5, Fe – 56.0, Co – 58.9, Zn = 65.4, Ag = 107.9, Sn = 117.8, Ba -137.3

1)

   a) Write down the correct chemical formula

     i) Ethane
     ii) Carbon dioxide
     iii) Potassium permanganate
     iv) Ozone

                                                      (1×4= 04 marks)

   b) Name the three particles of the atom; and their respective charges.   (6 marks)

   c) Define the term

     i) Hydrate
     ii) Heterogeneous mixture
     iii) Ionic bond
     iv) Atomic number
   v) Covalent bond   (2×5= 10 marks)

2)

    a) How many moles of S are there in 348g of S?   (03 marks)

    b) Calcium carbonate is a chemical compound with the formula $CaCO_3$. It is a common substance found in rocks and is the main component of eggshells. How many moles of $CaCO_3$ are present in 97.5 g of $CaCO_3$?

                                                                     (05 marks)

    c) 1.534 grams of $BaCl_2 \cdot XH2O$ is heated to dryness. The mass of $BaCl_2(s)$ that remains is 1.308g.
       Find the chemical formula and the name of the hydrate.   (06 marks)

    d) Polymers are large molecules composed of simple units repeated many times. Thus, they often have relatively simple empirical formulas. Calculate the empirical formula of the polymer Orlon.

                Orlon – C -67.9%, H- 5.70%, N - 26.4%   (06 marks)

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3)

    e) Define p^H and p^{OH}. Express their equations.   (04 marks)

    f) Hydrofluoric acid (HF) is a solution of hydrogen fluoride in water. Solutions of HF are colourless, acidic and highly corrosive. Calculate the pH value of a 0.4 moldm^{-3} HF solution which is at 25 °C. At 25 °C, the Ka value of HF acid is 7.0×10^{-4}

                                                         (06 marks)

    g) Calculate the pH of each of these solutions which are at 25 °C:
       (a) 0.01M HCl,
       (b) 0.0.04 M KOH,

                                                   (04 marks)

    h) Write down the solubility product expression (K_{sp}) of the following
       i) $Ag_2SO_4(s)$
       ii) $Fe(OH)_2$

                                                   (04 marks)

    i) Calculate the solubility of PbF_2. $K_{sp} = 2.2 \times 10^{-20}$

                                                   (02 marks)

3)

The diagram below shows a galvanic cell involving the following half-cell reactions. (M & L are metals)

$$M^{2+} (aq) + 2e \rightarrow M (s) \quad (E^0 = -0.44)$$
$$L^{2+} (aq) + 2e \rightarrow L (s) \quad (E^0 = +0.34)$$
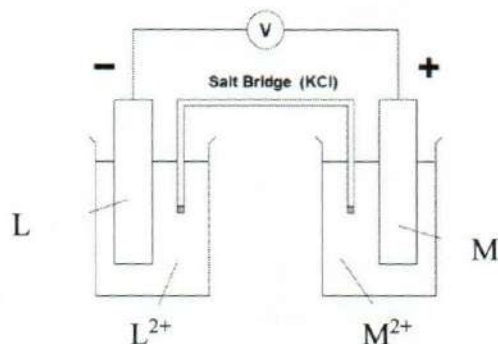
Using above Standard Reduction Potentials,

i) Give the anode and cathode half-reactions.   (06 marks)

ii) Write the overall equation for the chemical reaction.   (04 marks)

iii) Which metal would reduce?   (1.5 marks)

iv) Which metal acts as the anode?   (1.5. marks)

v) Represent the cell using standard notation.   (04 marks)

vi) Calculate the cell potential (e.m.f) of the electrochemical cell.   (03 marks)

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4)

a) Name and Draw the types of polymers which are categorized according to the structure

                                                                  (04 marks)

b) Explain the difference between cross linked and liner polymers based on the properties
                                                                  (04 marks)

c) Teflon is a useful polymer. (CF_2CF_2)

    i.   Write its monomer structure
    ii.   Polymer structure
    iii. Give two Uses and applications   (04 marks)

d) Explain the following
    i.   Thermoplastic polymers
    ii.   Thermosetting polymers   (04 marks)

e) What is meant by vulcanization of rubber   (04 marks)

5)

    a) How does Petroleum form?

    b) What is the composition of crude oil?

    c) Write four functions of lubricants.

    d) What are the three types of lubricants?

    e) Write a short note about thin film lubrication.

$$(5 \times 4 = 20 \text{ marks})$$

6)

    a) Explain the meaning of corrosion with examples.   (04 marks)

    b) Explain why rusting occurs so rapidly in salt water?   (04 marks)

    c) Write three corrosion control methods and explain one method.   (04 marks)

    d) What are the ways of extraction of metals   (04 marks)

    e) What are the Raw materials of extraction of Iron?   (04 marks)

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MID EXAMINATION – QUESTION PAPER
APPLIED MECHANICS

- Answer any 04 questions only
- Total Marks – 100
- $g = 9.8\ ms^{-2}$

Date: 20.02.2023   Pass mark 50%   Time allocated: 2.5 Hours

1)

   i.   Define **velocity** and **acceleration**   (2× 3= 6 marks)

   ii.   The engine of a model rocket accelerates the rocket vertically upward for 2.0 s as follows: At t = 0, the rocket's speed is zero; at t =1.0 s, its speed is 5.0 m/s; and at t = 2.0 s, its speed is 16 m/s. Plot a velocity vs. time graph for this motion, and use the graph to determine (a) the rocket's average acceleration during the 2.0 s interval and (b) the instantaneous acceleration of the rocket at t = 1.5   (10 marks)

   iii.   It is possible to shoot an arrow at a speed as high as 1.00 m/s. (a) If friction is neglected, how high would an arrow launched at this speed rise if shot straight up? (b) How long would the arrow be in the air?   (9 marks)

2)

   i.   Man through a ball at **u** ms^{-1} at angle θ to horizontal .(gravitational acceleration as **g** ms^{-2}).show that horizontal range of projectile (R) is

$$R = \frac{u^2 \sin 2\theta}{g}$$

(Show your work out)   (5 marks)

ii.   A stone is thrown upward from the top of a building at an angle of 30^0 to the horizontal and with an initial speed of 20.0 m/s. The point of release is 45.0 m above the ground.
   (a) How long does it take for the stone to hit the ground?
   (b) Find the stone's speed at impact.
   (c) Find the horizontal range of the stone.

(20 marks)

3)

i.   State Newton's laws of motion   (3 ×4 =12 marks)

ii.   A light string passes over a smooth pulley, and carries particles of masses 6 kg and 11 kg at each end.
   a) Mark all the force acting on the system   (5 marks)
   If the system moves freely find;
   b) find the acceleration of masses and tension of the string

(8 marks)

4)

i.   Draw a graph to illustrate the variation of frictional force (F) with applied force. Mention limiting frictional force, Static region and Kinetic region on the graph.   (7 marks)

ii.   Suppose a block with a mass of 2.50 kg is resting on a ramp. If the coefficient of static friction between the block and ramp is 0.350, what maximum angle can the ramp make with the horizontal before the block starts to slip down?   (9 marks)

iii.   A dockworker loading crates on a ship finds that a 20-kg crate, initially at rest on a horizontal surface, requires a 75-N horizontal force to set it in motion. However, after the crate is in motion, a horizontal force of 60 N is required to keep it moving with a constant speed. Find the coefficients of static and kinetic friction between crate and floor.

(9 marks)

5)

i. Write 3 examples for circular motion

(6 marks)

ii. A freight train is being assembled in a switching yard, and Figure shows two boxcars. Car 1 has a mass of $m_1 = 65\times10^3$ kg and moves at a velocity of $v_{01} = +0.80$ m/s. Car 2, with a mass of $m_2 = 92\times10^3$ kg and a velocity of $v_{02} = +1.3$ m/s, overtakes car 1 and couples to it. Neglecting friction, find the common velocity v_f of the cars after they become coupled.

(a) Before   (b) After

(8 marks)

iii. A 5 Kg Cart is pushed by a 30 N force against friction for a distance of 10m in 5 seconds. Determine the Power needed to move the cart.

(5 marks)

iv. A wheel starting from rest and using a Torque angular velocity increases to 3.2 rad /s. After 10 s, Find the angular acceleration and the angular displacement.

(6 marks)