080

THE OPEN UNIVERSITY OF SRI LANKA
ADVANCED CERTIFICATE IN SCIENCE
PHF 2525-PHYSICS – 3
FINAL EXAMINATION
DURATION – THREE HOURS

Date: 18.09.2022 **Time: 1.30 pm to 4.30 pm**

Part -A

- **The Question paper (Part A) consists of 25 multiple choice questions.**
- **Answer all the questions.**
- **Answers for the all Multiple Choice Questions, by underline the correct answer.**
- **At the end of the examination you should submit the question paper with answer sheet.**
- **Maximum marks for this part is 50%.**

- $\mathbf{g = 10\ ms^{-2}}$
- Latent Heat of Fusion $334 \times 10^3\ J\ kg^{-1}$
- Latent Heat of Vaporization $226 \times 10^4\ J\ kg^{-1}$
- $\varepsilon_0 = 8.86\times10^{-12}\ C^2\ N^{-1}\ m^{-2}$
- $\mu_0 = 4\pi\times10^{-7}\ N\ A^{-2}$
- e (Charge of Electron) $= 1.6\times10^{-19}\ C$
- R (Universal Gas Constant $= 8.3\ J\ mol^{-1}\ K^{-1}$

1. An aluminum piece and a wooden piece have been left in a room for a few hours. When you go and touch them the aluminum seems colder than wood. Select the correct option. Assume room temperature to be 25 °C.

   (1) Both have the same temperature greater than 25 °C
   (2) Aluminum has a greater temperature than wooden piece
   (3) Aluminum has a lower temperature than wooden piece
   (4) Both have the same temperature equal to 25 °C
   (5) None of above

2. The reverse process of vapor becoming liquid is

   (1) Vaporization (2). Freezing (3). Condensation (4). Sublimation (5). None of above

3. The amount of heat required to raise the temperature of 1 kg of a substance by one Kelvin is

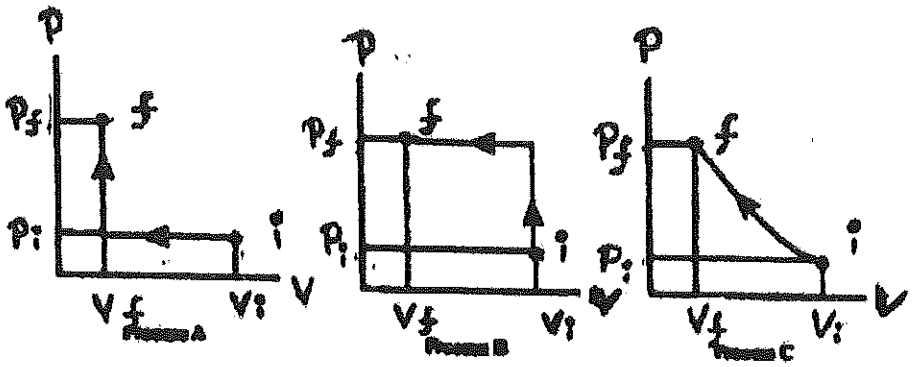
(1). Thermal conductivity (2). Specific heat capacity (3). Latent heat (4). Heat capacity

(5) None of the above

4. A perfect gas at 27 °C is heated at constant pressure so as to double its volume the temperature of the gas becomes

(1) 54 °C (2). 157 °C (3). 327 °C (4). 400 °C (5). 427 °C

5. An ideal gas is taken from state (Pi, Vi) to state (P_f , V_f) in three different ways. Identify the process in which the work done on the gas the most.



(1) Process A (2). Process B (3). Process C (4). Equal work is done in Process A, B &C
(5) None of above

6. A box contains 10^5 molecules. The average kinetic energy of each molecule is 0.5 x 10^{-6} J. With respect to an observer at rest the box, having a mass of 1 kg, is moving with a velocity of 2 m/s. What is the value of kinetic energy that will contribute to the internal energy?

(1). 0.05 J (2). 2.05 J (3) 0 J (4). 2 J (5) 1.5 J

7. What will be the gravitational potential (V) at distance **d** from the surface of the earth with radius **R** and Mass **M**?

(1). $V = -GMR$ (2). $V = -GMd$ (3) $V = -\frac{GM}{R}$

(4). $V = \frac{GM}{R+d}$ (5) $V = -\frac{GM}{d}$

8. If 315 J of heat is applied to the system, and the system does 20 J of work, find the change in an internal energy.

(1). 295 J (2). 335 J (3) 0 J (4). 340 J (5) 205 J

9. A steel and a copper bar are joined end to end. The area of the steel bar is half the area of the copper bar. Their lengths are equal to 10 cm each. Temperature of free ends of steel & copper rod are 0 °C & 100 °C respectively. Thermal conductivity of steel (KS) = 50 J/ s mK & Thermal conductivity of copper (Kc) =384 J/s mK. Calculate equivalent thermal conductivity of the combined bar.

(1). 63 °C (2). 63 K (3) 336 °C (4). 36 K (5) 36 °C

10. Two point charges 10 μC and 2 μC are 3 cm apart. What would be the force between them?

(1). 250 N (2). 200 N (3) 500 N (4). 2.5×10^{-6}N (5) 9.0×10^{-6} N

11. The force per unit charge is known as

(1). Electric current (2). Electric potential (3) Electric field Intensity (4). Electric space
(5) None of above

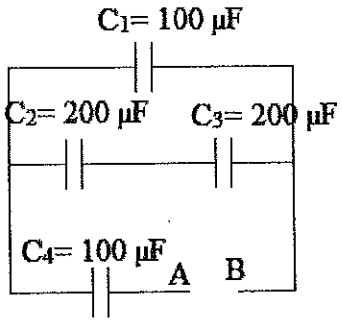
12. Two 1 Coulomb charges are kept at 1 m distance in air medium. Force of attraction or repulsion between them will be

(1). 9×10^9N (2). 10 N (3) 1 N (4). 3×10^3N (5) 2×10^3N

13. Four charges are kept at the corner points of a square. The net force on a charge kept at the center of the square is

(1). A long diagonal (2). Zero (3) Along one side
(4). Depends on the nature of the charges (5) None of above

14 What is the equivalent capacitance between A and B of the given circuit in the following Figure?



(1). 200 µF (2). 100 µF (3) 200/3 µF (4). 50 µF (5) 75 µF

15. Two plates are oppositely charged uniformly and kept parallel to each other at a certain distance. What will be the nature of electric field lines in between them?

(1). Circular

(2). Parallel to each other throughout the cross section

(3) Not uniformly distributed

(4). Parallel and uniform in central part but fringes out at the extreme ends

(5) None of above

16. What can be the nature of charges q_1 and q_2?

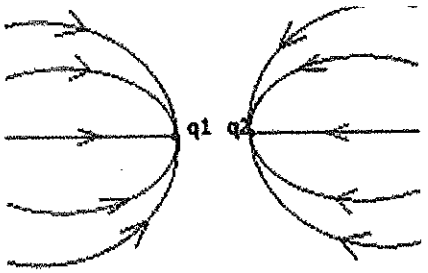
(1). q_1 is positive, q_2 is negative

(2). q_1 is negative, q_2 is negative

(3) q_1 is negative, q_2 is positive

(4). q_1 is positive, q_2 is positive

(5) None of above



17. The weight of an object on the earth's surface is 600 N. What is the weight of the object when it is at a height equal to the radius of the earth?

(1). 150 N (2). 240 N (3) 300 N (4). 600 N (5) 2400 N

18. An electron moving with a velocity of 15 ms^{-1}enters a uniform magnetic field of 0.2 T, along a direction parallel to the field. What would be its trajectory in this field?
(1). Elliptical (2). Straight path (3) Helical (4). Circular (5) None of above

19. A lead bullet is fired at a speed of 200 ms^{-1} into a tree in which it stops. Assuming that two third of the heat produced goes to the bullet, what would be the increased temperature in the bullet? (Specific Heat Capacity of lead is 130 J $kg^{-1}K^{-1}$)

(1)103^{0}C (2) 140^{0}C (3) 180^{0}C (4) 200^{0}C (5) 206^{0}C

20. A proton enters a magnetic field of flux density 5 T with a velocity of 5×10^7 ms^{-1}at an angle of 30° with the field. Find the force on the proton.
(1). 0.2×10^{-11} N (2). 2×10^{-11} N (3) 20×10^{-11} N (4). 200×10^{-11} N
(5) 0.002×10^{-11} N

21. When a charged particle moves at right angles to the magnetic field, the variable quantity is?
(1). Momentum (2). Speed (3) Energy (4). Moment of inertia (5) None of above

22. Root mean square (rms) speed of a certain gas at 300 K is V. At what temperature the rms speed becomes 2V.

(1) 600 K (2) 1200 K (3) 1000 K (4) 150 K (5) 2000 K

23. Calculate the speed of an electron if it travels in a circular path of radius 50 cm in a magnetic field of 5×10^{-3} T.
(1). 440×10^7 m/s (2). 4×10^7 m/s (3) 44×10^7 m/s (4). 0.4×10^7 m/s
(5) None of above

24. What would be the pressure of 2 moles of an Ideal gas kept inside a container with volume 200 cm^3 at 300 K. (Take R=8.3 J K^{-1} mol^{-1})

(1) 2.49×10^7Pa (2) 3.00×10^6Pa (3) 4.30×10^7Pa (4) 8.30×10^6Pa (5) 2×10^7Pa

25 A satellite of mass m is revolving around the earth at a height R above the surface of the earth. If the g is the gravitational field strength at the surface of the earth and R is the radius of the earth, the Kinetic energy of the satellite will be

(1). mgR/4 (2). mgR/2 (3) mgR (4). 2mgR (5) 4mgR

(4 x 25 = 100 Marks)

Part – B (Essay)

- **Answer any four (04) questions only.**
- **If more than (04) question are answered only the first four will be marked.**
- **Each question earns twenty five (25) marks, amounting to total of 50% marks.**

1 Answer for both Part A and B

A. (i) Expression related to linear expansion is given as $l_\theta = l_o(1 + \alpha\theta)$. Name the parameters in the expression. **(3 Marks)**

(ii) Drive a relationship between the coefficient of linear expansion and coefficient of area expansion. **(2 Marks)**

(iii) A circular section of radius 5 cm is removed from a square steel plate of length 8 cm at 10 °C. Find the new area of the plate at a temperature of 60 °C. The coefficient of linear expansion of steel (α) =11x10^{-6} °C^{-1}. **(5 Marks)**

B. State the **Boyle's law** **(2Marks)**

(i) Draw the variation of Pressure (P) with 1/ Volume (1/V) of ideal gases at the different temperatures T_1, T_2 and T_3 where $T_1>T_2>T_3$ **(3 Marks)**

(ii) Using the Boyle's law and Charles's law, Derive an equation of PV = n RT symbols have their usual meaning. State any assumptions that you used in deriving the expression. **(4 Marks)**

Air molecules are trapped in 25.0 m^3 at a temperature of 27 °C and 1 atm pressure. (R = 8.31 Jmol^{-1}K^{-1} Avogadro no. A = 6.023x10^{23})

(iii) Write down the relationship between the universal gas constant (R) and Boltzmann constant (k). **(2 Marks)**

(iv) Calculate the number of air molecules trapped in the given volume. **(4 Marks)**

2 A Define the **latent heat of fusion** and write down the unit of it. **(2 Marks)**

(i) Consider the 1 kg of ice cube at -20 °C, calculate amount of heat energy needed to increase 100 °C of water. **(2 Marks)**

(ii) If energy is supplied through 500 W heater, find the time taken to reach 100 °C of water. **(2 Marks)**

(iii) Now the 1 kg of ice cube at -20 °C is added to the 2 kg of steam at 100 °C. Calculate the final temperature of the mixture. **(4 Marks)**

B. Figure 01 shows that a steam chamber and copper cube are connected to an AB metal rod. The temperature (θ) of the copper cube is measured with time (t). After a few minutes temperature of the copper cube is achieved at the steady state of 50 °C.

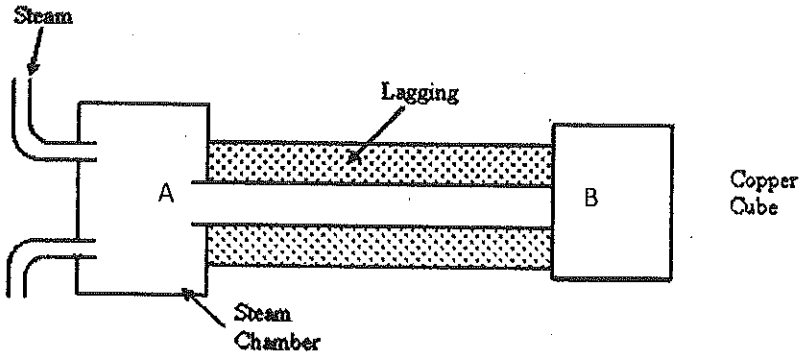


Figure 1.

(i) Draw the possible variation of temperature (θ) of the copper cube with time (t). **(3 Marks)**

(ii) Cooling rates (R) of the Copper cube at is given by $R = 0.24\,(\theta - \theta_R)$. What is the unit of R.? **(2 Marks)**

(iii) Calculate R at the steady state temperature ($\theta_R = 30$ °C) **(5 Marks)**

(iv) The cross-sectional area of the rod = 1.2×10^{-4} m^2 and length of the rod = 0.4 m then calculate the thermal conductivity of the metal rod. **(5 Marks)**

3. Define the **Gravitational potential energy** **(2 Marks)**

(i) Write down an expression of the gravitational potential at the point with distance of R from the earth surface of radius R. **(2 Marks)**

(ii) Draw the variation of the gravitational potential of a point with the distance from the center of the earth. **(2 Marks)**

Two particles of mass m and M are initially at rest at an infinite distance apart and they are moving toward each other with two different velocities. When the separation becomes d at an instant, determine the following in the given questions

(iii) Using the conservation of momentum writes down the ratio of the velocities **(4 Marks)**

(iv) Write down an expression using conservation of energy **(4 Marks)**

(v) Find the velocities of M and m when the distance apart is d. **(5 Marks)**

(vi) Hence show that the velocity of the approach is given as $\sqrt{\frac{2G(M+m)}{d}}$. Where G is the universal Gravitational constant. **(6 Marks)**

4. State the Gauss's law of Electro-statistics. **(4 Marks)**

(i) Write down the equation for the capacitance (C) of the parallel plate capacitor.

(3 Marks)

A and B are two identical parallel plate capacitors with 100 cm^2 and separation 4.0 mm are connected to a potential of 100 V.

(ii) Find the capacitance and charge stored in the two capacitors **(6 Marks)**

(iii) Now 100 V potential difference is removed and separation of the capacitor A is reduced to 2 mm and separation of the capacitor B is increased by 8 mm. Calculate the new capacitance and potential difference across the capacitor. **(6 Marks)**

(iv) If the two capacitors are connected in parallel with the same polarities together. Determine the common potential difference across the combination. **(6 Marks)**

5. State **Fleming's left-hand rule** **(5Marks)**

(i) Write down an expression for the **force** on a charge moving in a magnetic field.

(2 Marks)

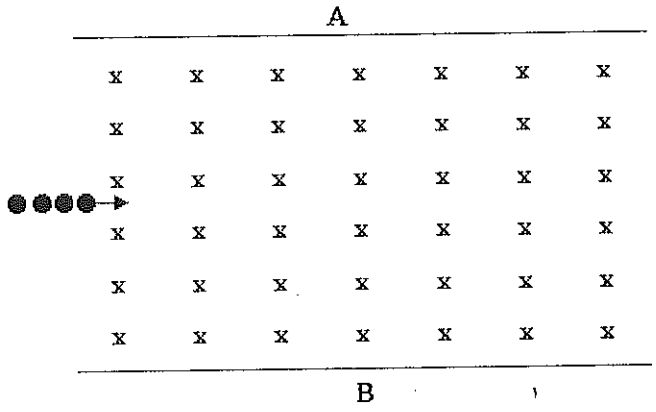


Figure 02

(ii) Figure 02 shows that the electron beam is entering to a magnetic field of 2.0×10^{-3} T into the paper covered with A and B plate. Draw the path of the electron beam that tend to move.

(3 Marks)

(iii) The electric field of 3.4×10^{4} NC^{-1} is applied from A to B to move the electron beam without any deviation. Draw the correct direction of the Electric Field. **(3 Marks)**

(iv) Calculate the speed of the electrons moving without any deviation. **(5 Marks)**

(v) Now the electric field is removed show that the path of the electron beam is circular. Calculate the radius of the circular path. **(7 Marks)**

(06) Draw a labelled diagram showing the essential features of a ***moving coil galvanometer.***

(5 Marks)

(i) A moving coil galvanometer consists of a rectangular coil of **N** turns each of area **A** suspended in a radial magnetic field of flux density ***B***. Derive an expression for the torque on the coil when current **I** passes through it. **(5 Marks)**

(ii) If the coil is suspended by a torsion wire for which the couple per unit twist is K, show that the instrument have a linear scale. **(3 Marks)**

(iii) Derive an expression for the sensitivity of the galvanometer. **(4 Marks)**

(iv) Two galvanometers, which are otherwise identical, are fitted with different coils. One has a coil of 50 turns and resistance 10Ω, while the other has 500 turns and resistance 600Ω.

What is the ratio of the deflections when each is connected in turn to a cell of emf 2.5 V and internal resistance 50 Ω? **(8 Marks)**

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