THE OPEN UNIVERSITY OF SRI LANKA
ADVANCED CERTIFICATES IN SCIENCE
TAF2524-PHYSICS – 2
FINAL EXAMINATION
DURATION – THREE HOURS

Date : 20th December 2021 **Time : 0930-1230 Hrs**

Part -A

- **The Question paper(Part A) consists of 25 multiple choice questions**
- **Answer all the questions**
- **Answers for the Multiple Choice Questions, should be provided by placing X in the relevant cage indicating the most appropriate answer in the MCQ answer sheet provided**
- **At the end of the examination you should submit the question paper with answer sheet.**
- **Maximum marks for this part is 40%.**

$1/4\pi\varepsilon_0 = 9 \times 10^9\ NmC^{-2}$

Part I-MCQ

($g = 10\ m\ s^{-2}$)

01). SI unit of the amount of heat,

(1) °C (2) °F (3) K (4) J (5) A

02). Thermometric Property of a thermocouple,

(1) Expansion of a liquid.

(2) Expansion of a Glass.

(3) Expansion of a Gas.

(4) Thermoclectric effect.

(5) Resistance of a liquid.

03). Due to the anomalous expansion of water, it has the maximum density at,

(1) 273 K (2) 277 K (3) 300 K (4) 500 K (5) 1000 K

04). Approximate Celsius temperature corresponding to 1500 K will be,

00098

(1) 1227 °C (2) 927 °C (3) 1007 °C (4) 1773 °C (5) 807 °C

05). A thermometer indicates -70 °C. It may be:

1). Outdoors on a cold day in Sri Lanka.

2). Inside an air-conditioned room.

3). In a cold soft drink.

4). In a normal person's mouth.

5). Inside a medical freezer.

06). Resistances of a platinum wire at 0 °C and 100 °C are 3 Ohms and 7 Ohms respectively. What will be the temperature at a particular place when its resistance becomes 5 Ohms?

(1) 50 °C (2) 25 °C (3) 65 °C (4) 75 °C (5) 125 °C

07). What will be the most suitable thermometer to measure the temperature of a liquid drop accurately?

(1) Mercury-Glass thermometer.
(2) Alcohol-Glass thermometer.
(3) Platinum resistance thermometer.
(4) Constant volume gas thermometer.
(5) Thermocouple.

08). Length of a copper rod at 30 °C is 1000 mm. What will be its length at 1030 °C?

(linear expansivity of copper $17 \times 10^{-6}\ K^{-1}$)

(1) 1.0017 m (2) 1.017 m (3) 100.17 m (4) 1.0037 m (5) 10.23 m

09). A metal bar having linear expansivity $10 \times 10^{-6}\ K^{-1}$ and young's modulus (Y) 10^{10} Pa is just fixed between two non-expanding walls at 20 °C. The Compressive force generated in the rod at 120 °C will be, (Cross-sectional area of the rod is $2 \times 10^{-4}\ m^2$)

(1) 1080 N (2) 1000 N (3) 218 N (4) 2160 N (5) 2000 N

10). What will be the fractional increase $(\frac{\Delta A}{A})$ of the area of an aluminum plate, when its temperature is raised by 10 °C (Linear expansivity of aluminum $2 \times 10^{-5} K^{-1}$)

(1) 2×10^{-5} (2) 4×10^{-5} (3) 4×10^{-4} (4) 8×10^{-5} (5) 1×10^{-3}

11). What will be the apparent expansivity of a liquid having real expansivity $8 \times 10^{-5} K^{-1}$, If it is placed in a container having linear expansivity $1 \times 10^{-5} K^{-1}$?

(1) $1 \times 10^{-5} K^{-1}$ (2) $3 \times 10^{-5} K^{-1}$ (3) $7 \times 10^{-5} K^{-1}$ (4) $5 \times 10^{-5} K^{-1}$ (5) $6 \times 10^{-5} K^{-1}$

12). Density of a certain liquid at 20 °C is 800 kg m^{-3} . What will be its approximate density at 120°C? (Volume expansivity of the liquid $4 \times 10^{-4} K^{-1}$)

(1) 802 kg m^{-3} (2) 816 kg m^{-3} (3) 716 kg m^{-3} (4) 600 kg m^{-3} (5) 769 kg m^{-3}

13). 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

14). 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

15). A cylinder contains a mixture of dry air and water vapor at temperature at 300 K. If the partial pressure of dry air in the container is $1.5 \times 10^5\ Pa$ and the total pressure of the container is $3.5 \times 10^5\ Pa$. What would be the pressure of water vapor at 300 K.

(1) $5.5 \times 10^5\ Pa$ (2) $4.5 \times 10^5\ Pa$ (3) $2.5 \times 10^5\ Pa$ (4) $2 \times 10^5\ Pa$ (5) $1.5 \times 10^5\ Pa$

16). Consider the following statements regarding the electric charges,

(A) Electric Insulator can be charge by contact or by induction.

(B) Electric charges can feely travel in a conductor.

(C) Electric charges tend to collect at the sharp edges of a conductor.

True statement/s,

(1) Only A is correct. (2) Only B is correct. (3) Only C is correct. (4) Only B and C are correct.

(5) All A,B and C are correct.

17).+4 mC point charge is placed at the centre of a hollow conducting sphere contains -4 mC charge. What will be the charge of the inner and outer surfaces of the hollow conductor.

	Inner Surface	Outer Surface
(1)	+4 mC	-4 mC
(2)	+4 mC	0
(3)	-2 mC	-2 mC
(4)	+2 mC	+2 mC
(5)	-4 mC	0

(18). 5 μC charge is placed in an electric field with field intensity 200 N C^{-1}. The magnitude of the electrostatic force act on the charge will be,

(1) 1×10^{-3} N (2) 2×10^{-6} N (3) 1×10^{-4} N (4) 5×10^{-6} N (5) 4×10^{-6} N

19). Select the **incorrect** statement regarding the lines of force in an electric field.

(1) At any point in space, the electric field vector ($\vec{E}$) at that point is tangent to the electric field line through that point.

(2) They always form loops.

(3) Electric field lines never cross each other.

(4) Electric field lines are close together in regions where the magnitude of $\vec{E}$ is large, farther apart where it is small.

(5) Field lines point away from the positive charges and toward the negative charges.

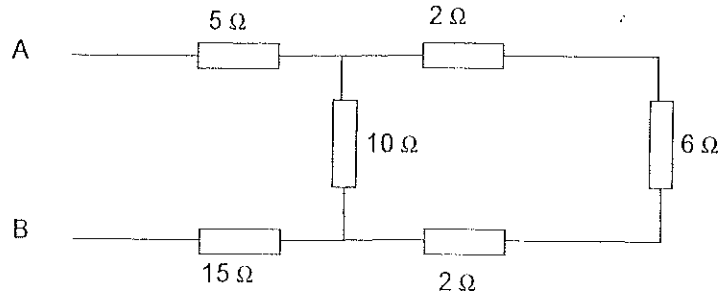
20). +20 mC charge is flows through a conductor within 100 ms, what will be the current flow through the conductor?

(1) 0.002 A (2) 0.02 A (3) 0.2 A (4) 2 A (4) 20 A

21). A cylindrical metal rod has a resistance R. If both its length and its diameter are tripled, its new resistance will be:

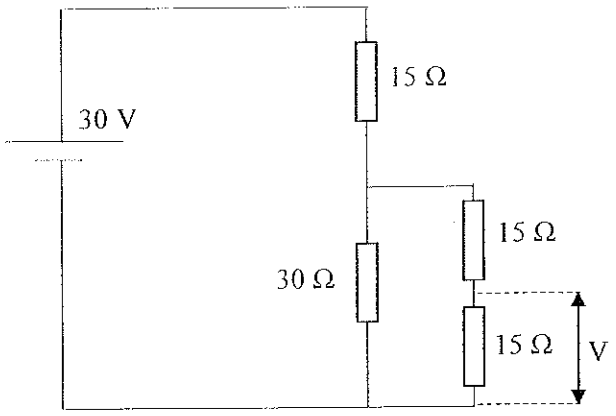
(1) R (2) 9R (3) R/3 (4) 3R (5) R/2

22). What will be the equivalent resistance between A and B of the following circuit.



(1) 2 Ω (2) 10 Ω (3) 20 Ω (4) 25 Ω (5) 40 Ω

23). What will be the potential difference V in the following resistor network under supply voltage 30 V.

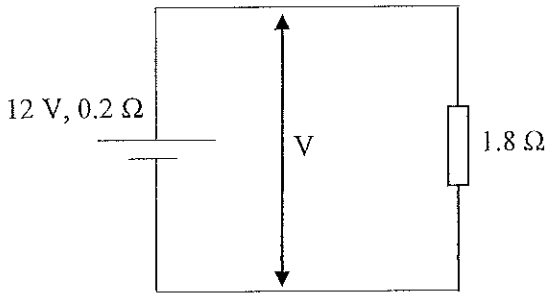


(1) 1.5 V
(2) 5.5 V
(3) 7.5 V
(4) 12.5 V
(5) 20.5 V

24). 40 W bulb is used in a house 8 hours per day. Find the expense for a month (30 days) for using it at Rs. 10 per unit (1 kW h)

(1) Rs.200 (2) Rs.120 (3) Rs.50 (4) Rs.96 (5) Rs.20

25). What will be the potential difference across the cell terminals in the following circuit? (The e.m.f of the battery is 12 V and it has an internal resistance of 0.2 Ω)



(1) 11.5 V (2) 10.8 V (3) 12 V (4) 12.5 V (4) 12.8 V

End of Part I

Part - B

- **Answer any four (04) questions only.**
- **If more than (04) question are answered only the first four will be marked.**
- **Each question earns fifteen (15) marks, amounting to total of 60% marks.**
- **You have to show the steps involved in solving problems. No marks are awarded for the mere final answer without proper steps.**

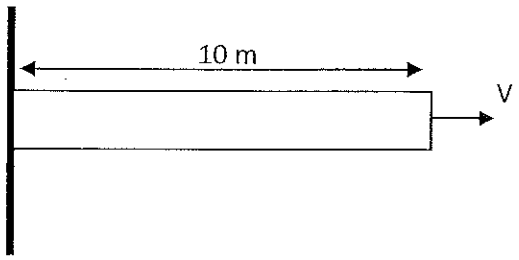
01). (a) A Particular resistance thermometer has a resistance of 30 Ω at the ice point, 40.5 Ω at the steam point and 34.5 Ω when immersed in a boiling liquid. A constant-volume gas thermometer gives readings of 1.3 x 10^5 Pa, 1.8 x 10^5 Pa and 1.5 x 10^5 Pa at the same three temperatures. Calculate the temperature at which the liquid is boiling:

(i) On the scale of the gas thermometer, (03 Marks)

(ii). On the scale of the resistance thermometer. (03 Marks)

(b) A particular constant-volume gas thermometer indicates a pressure of 2 x 10^4 Pa at the triple point of water and 2.5 x 10^4 Pa at the boiling point of a liquid. What is the boiling point of the liquid **in Celsius** according to the thermometer? (03 Marks)

(c). An Aluminum rod of length 10 m is clamped to a rigid wall as shown in the figure, Find its free end's velocity (V) if the Temperature of the system is increasing with 5°C s^{-1}. ($\alpha_{Aluminum} = 2.5 \times 10^{-5}\ K^{-1}$) (06 Marks)



02).(a) A cylindrical tank has a tight-fitting piston that allows the volume of the tank to be changed. The tank originally contains 0.12 m^3 of air at a pressure of 3.0 atm. The piston is slowly pushed in until the volume of the gas is decreased to 0.05 m^3 If the temperature remains constant, what is the final value of the pressure? (03 Marks)

(b) At an altitude of 11,000 m (a typical cruising altitude for a jet airliner), the air temperature is -56 °C and the air density is 0.4 kg m^{-3} What is the pressure of the atmosphere at that altitude? The molar mass of air is 28 g mol^{-1}.(Take R=8.31 $J\ mol^{-1}\ K^{-1}$)

(06 Marks)

(c) According to the kinetic theory of gases a pressure exerted by a gas is given by the expression, $P = \frac{d\overline{C^2}}{3}$ here, d is the density of the gas and $\overline{C^2}$ is the mean square speed of the gas. Assuming the air described in part (b) behave as an ideal gas, Find the root mean square speed (V_{rms}) of the air.

(06 Marks)

03). (a) By considering the equations PV= n R T and $PV = \frac{1}{3}$ mN $\overline{c^2}$, show that $\sqrt{\overline{c^2}} = \sqrt{\frac{3RT}{M}}$. (03 Marks)

(b) Helium gas occupies a Volume of 0.04 m^3 at a pressure of 2×10^5N m^{-2} and temperature 300 K. Calculate the mass of Helium and R.M.S. speed of its molecules (M_{He}= 4 g mol^{-1}) (03 Marks)

(c) A cylinder contains 19 kg of compressed air at a pressure 9.5 times that of the atmosphere is kept in a store at 7 °C . When it is moved to a workshop where the temperature is 27 °C a safety valve on the cylinder operates, releasing some of the air. If the valve allows air to escape when its pressure exceeds 10 times that of the atmosphere, calculate the mass of air that escapes. (09 Marks)

04). (a) Draw the lines of force (electric field lines) around the charges in the following situations.

(i) Around two positive point charges kept close to each other.
(02 Marks)

(ii) Around two oppositely charged point charges kept close to each other. (02 Marks)

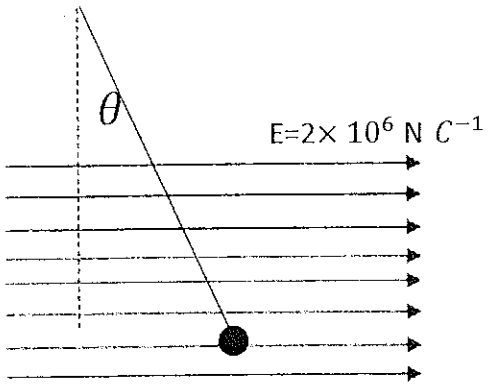


Figure 1

(b) A point object having mass $2\sqrt{3}$ kg and charge with magnitude |10 μC| is connected to a light inextensible rope and kept in a uniform electric field with field intensity 2×10^6 N C^{-1} to the direction as shown in figure 1,

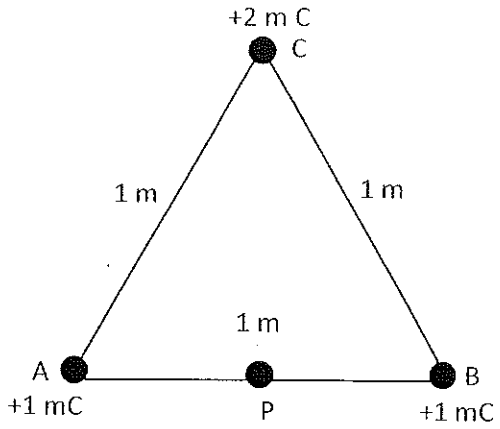
i). What would be the type of Charge ?

(01 Marks)

ii). The angle θ (05 Marks)

iii). The tension in the rope. (05 Marks)

05). (a) Find the direction and magnitude of the electric field intensity at point P, which is the midpoint of AB line. Assume that the system is kept in free space. ($\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}) (06 Marks)



(b) Two particles having charges of + 5 mC and + 8 mC are separated by a distance of 12 cm are kept in an isolated environment without the effect of any other electric fields.

(i) Find the distance from +5 mC charge to the point where the electric field intensity is zero. (06 Marks)

(ii) Draw the variation of the lines of force (electric field lines) for the above system. (03 Marks)

6). (a) A current of 10 A flows through a copper wire of cross-section 2 mm^2 which 10^{28} charge carriers (electrons) per cubic meter of copper and the charge of an electron is 1.6×10^{-19} C.

(i) Calculate the drift velocity of the electrons through the copper wire. (05 Marks)

(b) A kettle used in America has following details on its label 2200 W, 110 V

(i) Find the electrical resistance of the heating element of the kettle and maximum rated current (I_{max}).

(05 Marks)

(ii) what will happen, If you plug above kettle to a voltage supply with 220 V output. (explain your answer after finding the current flow through the heating element under 220 V supply voltage)

(05 Marks)

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