Scottish Church College

Department of Physics

Model Question Paper

Total Marks: 50 **Time: 2 Hrs**

Name (in block letters): ______________________________

Application Number									

Invigilator's Signature:______________

FOR OFFICE USE ONLY

Group	+ve	−ve	Total	Grand Total	Examiner's signature
A					
B		______			
C		______			

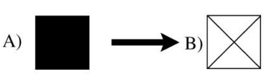
Instructions to the Candidate

1. Use only **BLUE or BLACK BALL PEN** for making entries and answers.

2. In Group A each question, carrying ***one*** marks, has **four** alternatives, out of which only one is correct. There is **negative marking of 0.5 for each wrong answer**. Choose the correct alternative and mark a cross (X) in the corresponding box on the answer sheet. For example,


3. Group-B has **four** alternatives in each question, but **one or more than one options** may be correct. You have to mark **ALL** correct alternatives and mark a cross **(X)** for each. For Group-B ***two*** marks will be awarded only when **ALL** options are correct. **There is no negative marking in this group.**

4. Suppose you have marked **(X)** and you want to change your option from, say, '*A*' to'*B*' . In that case, '*A*' must be blackened completely and then put **(X)** in '*B*', as



5. For Group-C, please write the answer in the **space provided**. Each correct answer carries 2.5 marks but **no** negative marks for wrong answer.

6. Please do not make any mark other than the cross (X) in the space provided.

7. Scientific calculator (non-programmable) is allowed.

8. No candidate should leave the examination hall before one hour.

1 GROUP-A: Only one option correct

1. A hollow metal sphere of radius $10\,cm$ is charged such that the potential on its surface is $10V$. The potential at the centre of the sphere will be

   (A) 0 V ☐
   (B) 10 V ☐
   (C) 1 V ☐
   (D) none of the above ☐

2. A conducting circular loop of radius R carries a constant current I. It is placed in a uniform magnetic field $\vec{B}_0$, perpendicular to the plane of the loop. The magnitude of the magnetic force acting on the loop is

   (A) IRB_0 ☐
   (B) $2\pi IRB_0$ ☐
   (C) πIRB_0 ☐
   (D) 0 ☐

3. The total mechanical energy of a spring-mass system in simple harmonic motion is $E = \frac{1}{2}m\omega^2 A^2$. Suppose the oscillating particle is replaced by another particle of double the mass while the amplitude A remains the same. The new mechanical energy will be

   (A) $2E$ ☐
   (B) $\frac{E}{2}$ ☐
   (C) $\sqrt{2}E$ ☐
   (D)E ☐

4. Consider two quantities $A = \frac{h}{mc}$, and $B = \frac{e^2}{\epsilon_0 hc}$, where the symbols have their usual meaning. The ratio of $\frac{A}{B}$ has the dimension of
   (A) L ☐
   (B) T ☐
   (C) M ☐
   (D) $dimensionless$ ☐

5. Two balls collide elastically in an inertial frame S. Consider another frame S' moving with uniform velocity v with respect to S. Which of the following option is correct?

(A) The linear momentum and the kinetic energy are conserved in S' frame ☐
(B) The linear momentum is not conserved but the kinetic energy is conserved in S' frame. ☐
(C) The linear momentum is conserved but the kinetic energy is not conserved in S' frame. ☐
(D) The linear momentum and the kinetic energy are conserved in S frame but not in S' frame. ☐

6. An insulated container containing 1 mole of ideal monatomic gas of molar mass m is moving with a velocity v_0. If the container is suddenly stopped, the change in temperature is

(A) $\frac{mv_0^2}{3R}$ ☐
(B) $\frac{mv_0^2}{R}$ ☐
(C) $\frac{mv_0^2}{2R}$ ☐
(D) none of the above. ☐

7. A continuous function has always

(A) a well defined first derivative ☐
(B) a well defined second derivative ☐
(C) a well defined first derivative but not necessarily a well defined second derivative ☐
(D) none of the above. ☐

8. The potential barrier at PN-junction is due to the charges on either side of the junction. These charges are
(A) minority carriers ☐
(B) majority carriers ☐
(C) both minority and majority carriers ☐
(D) fixed donar and acceptor ions ☐

9. A blackbody at 227^0C radiates heat at a rate of 7 $\frac{cal}{cm^2 sec}$. At a temperature of 727^0C the rate of heat radiated in the same unit will be
   (A) 112 ☐
   (B) 105 ☐
   (C) 201 ☐
   (D) 224 ☐

10. If an ideal gas is subjected to an isothermal process, then
   (A) total heat supplied to the body will be equal to the work done by the system. ☐
   (B) total heat supplied to the body will be equal to the change in internal energy. ☐
   (C) the heat supplied to the system is zero. ☐
   (D) total heat supplied to the body is always larger than the work done by the system. ☐

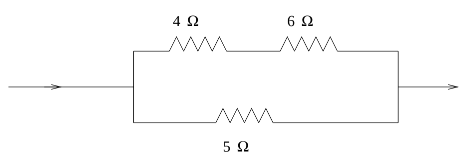
2 GROUP-B: More than one option may be correct

1. A particle is moving on $x - y$ plane. At any instant of time t, the position of the particle is given by $\vec{r}(t) = a(\hat{i}cos\omega t + \hat{j}sin\omega t)$, where a and ω are the constants. Identify the correct option(s) regarding the motion of the particle.

   (A) the trajectory of the particle is circular.
   (B) the angle between $\vec{r}$ and its instantaneous velocity is 90^0 .
   (C) the angle between $\vec{r}$ and its instantaneous acceleration is 180^0.
   (D) the angle between $\vec{r}$ and its instantaneous acceleration is 90^0.

2. The motion of a particle is given by $\frac{dv}{dt} = 6 - 3v$, where v is the velocity (in ms^{-1}) at time t (in sec). The body is at rest at $t = 0$. Identify the correct option(s).
   (A) The velocity of the particle when its acceleration is zero, is $2ms^{-1}$
   (B) The velocity of the particle when its acceleration is half of its initial value is $1ms^{-1}$
   (C) The initial acceleration of the particle is $6ms^{-2}$
   (D) The particle has uniform velocity if $t \gg 0$.

3. The rate of heat produced in the 5Ω resistor is $20Js^{-1}$. Identify the correct option(s).



   (A) The current through the 6Ω resistor is $1A$.
   (B) The current through the 5Ω resistor is $2A$.
   (C) The rate of heat produced in 4Ω resistor is $4Js^{-1}$.
   (D) The potential drop across the 4Ω resistor is $4V$.

4. Two electric bulbs rated at 25 W 220V and 100 W, 220V are connected in series across a 220V voltage source. Identify the correct option(s).
   A) The power drawn by the $25W$ bulb is $16W$
   B) The power drawn by the $100W$ bulb is $16W$
   C) The power drawn by the $25W$ bulb is $4W$
   D) The power drawn by the $100W$ bulb is $4W$

5. The SI unit of inductance, the Henry, can be written as

   (A) Weber/ampere ☐
   (B)Volt second /ampere ☐
   (C)Joule ampere^2 ☐
   (D)Ohm second ☐

6. For which of the following option(s), does the function $x = Asin^2\omega t + Bcos^2\omega t + Csin\omega tcos\omega t$ represent a SHM?

   (A) $A = B = 0$ and any value of $C(\neq)0$ ☐
   (B) $A = B$, $C = 2B$ ☐
   (C) $A = -B$, $C = 2B$ ☐
   (D) $A = B$,$C = 0$ ☐

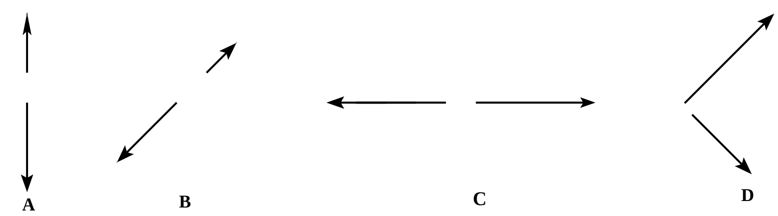
7. An ideal gas is taken from the state A (pressure P, Volume V) to state B (pressure $\frac{P}{2}$ volume $2V$) along a straight line path in the $P-V$ diagram. Select the correct statement(s) from the following:

   (A) The work done by the gas in the process A to B is $\frac{PV}{4}$ ☐
   (B) In the $T-V$ diagram, the path AB becomes a part of a parabola. ☐
   (C) In the $P-T$ diagram, the path AB becomes a part of a hyperbola. ☐
   (D) In the $P-T$ diagram, the path AB is also a straight line. ☐

8. A rectangular block of mass m and area of cross-section A is floating in a liquid of density ρ. If it is given a small vertical displacement from equilibrium, it undergoes oscillation with time period T. Which of the following option(s) is(are) **NOT** possible?

   (A) $T \propto \sqrt{m}$ ☐
   (B) $T \propto \sqrt{\rho}$ ☐
   (C) $T \propto \frac{1}{\sqrt{A}}$ ☐
   (A) $T \propto \frac{1}{\sqrt{g}}$ ☐

9. A mass m moving with a given speed collides (not necessarily head on) elastically with another identical mass which is initially at rest. Which of the following figure(s) shows possible outcome for the two velocities ?



(A) ☐
(B) ☐
(C) ☐
(D) ☐

10. In the photoelectric effect experiment if we increase the intensity of the incident beam, then

(A) the kinetic enrgy of the emitted electrons increases ☐
(B) the kinetic enrgy of the emitted electrons decreases, because the number of electrons emitted increases ☐
(C) the kinetic enrgy of the emitted electrons does not change, but the number of electrons emitted increases ☐
(D) the kinetic enrgy of the emitted electrons increases and also the number of electrons emitted increases ☐

3 GROUP-C:Fill in the blank

1. A simple harmonic motion is represented by $x = 4sin\omega t + 3cos\omega t$, where ω is constant. Its ampitude is

   ________________ unit.

2. A particle of mass m is moving on $x - y$ plane with constant velocity $\vec{v}$ along the line $y = b = constant$. The magnitude of the angular momentum about the origin is

   ________________.

3. Two wires of same dimensions but resistivities ρ_1 and ρ_2 are connected in series.The equivalent resistivity of the combination is

   ________________.

4. Vector $\vec{A}$ having a magnitude of 5 unit is lying on the $x - y$ plane and pointing in a direction 120^0 with respect to the $+ve$ $x-$axis. Vector $\vec{B}$ has a magnitude of 9 unit and points along the $z-$axis. The magnitude of the cross product $\vec{A} \times \vec{B}$ is

   ________________.

5. When an object is kept at a distance of 30 cm from a concave mirror, the image is formed at at a distance of 10cm. If the object is moved with a speed of $9m/s$, the speed with which the image moves, is

   ________________m/s

6. A charged particle of mass m and charge q is released from rest in an electric field of constant magnitude E. The kinetic energy of the particle after a time t is

    ________________.

7. A charge q is placed at the centre of two concentric spheres of inner and outer radius R_1 and R_2 respectively. The outward electric flux through the inner sphere is ϕ, while the flux through the outer sphere is 2ϕ. The charge inside the region between the concentric spheres is

    ________________.

8. A smooth sphere of radius R rests on a horizontal plane. A particle of mass m slides frictionlessly down the sphere, starting at the top. The velocity of the particle when it leaves the sphere is

    ________________.