Mathematics for Chemistry: Assignment 8

June 16, 2017

1. The Frobenius method can be applied about the point $x = 0$ for the differential equation

   (a)
   $$y'' + y'/x^2 + y/x^2 = 0$$

   (b)
   $$y'' + y'/x + y/x^3 = 0$$

   (c)
   $$y'' + y'/x + y/x^2 = 0$$

   (d) None of the above

   Answer (c)

2. The indicial equation for the differential equation
   $$x^2y'' + xy' + x^2y = 0$$
   solved using the Frobenius method with a trial solution $y = \sum_{n=0}^{\infty} c_n x^{n+r}$ is
   (a) $r^2 = 0$ (b) $r^2 - 1 = 0$ (c) $r^2 - r - 1 = 0$
   (d) None of the above
   Answer (a)

3. The correct statement regarding solution of the ODE
   $$(1 - x^2)y'' - 4xy' + 4y = 0$$
   using the Frobenius method about $x = 1$ is

   (a) The equation can be solved using the Frobenius method with $r = 0$ about $x = 1$.
   (b) The equation can be solved using the Frobenius method about $x = 1$ but r is not equal to 0.
   (c) The equation cannot be solved using the Frobenius method about $x = 1$.
   (d) There is not enough information to decide whether the equation can be solved using the Frobenius method about $x = 1$.

   Answer (b)

4. The indicial equation for the differential equation
   $$x^2y'' + xy' + x^2y - 9y/4 = 0$$
   solved using the Frobenius method with the usual notation is
   (a) $r^2 - 1 = 0$ (b) $r^2 - r = 0$ (c) $r^2 - 9/4 = 0$
   (d) None of the above
   Answer (c)

5. THe correct statement regarding solution of the ODE
   $$x^2y'' - 2xy' + 2y = 0$$
   about the point $x = 1$ is

(a) The equation can be solved using the Frobenius method with $r = 0$ about $x = 1$.

(b) The equation cannot be solved using the Frobenius method about the point $x = 1$.

(c) The equation can be solved using the Frobenius method about $x = 1$ but r is not equal to 0.

(d) There is not enough information to decide whether the equation can be solved using the Frobenius method about $x = 1$.

Answer (a)

6. One of the solutions of the differential equation

$$x^2y'' + xy' + x^2y - 16y = 0$$

involves
(a) $J_0(x)$ (b) $J_2(x)$ (c) $J_4(x)$
(d) None of the above
Answer (c)

7. In the solution for the radial part of the Hydrogen atom for $n = 3, l = 0$, the solution contains a polynomial multiplying an exponential function. The degree of the polynomial is
(a) 0 (b) 1 (c) 2 (d) 3
Answer (c)

8. The recursion relation for the differential equation

$$x^2y'' + xy' + x^2y - 4y = 0$$

can take the form

(a)
$$a_{2n} = \frac{(-1)^n a_0}{2^{2n} n! 2}$$

(b)
$$a_{2n} = \frac{(-1)^n 2a_0}{2^{2n} (n!)^2}$$

(c)
$$a_{2n} = \frac{-a_0}{2^n n! 2}$$

(d) None of the above

Answer (b)

9. Writing the 2-dimensional partial differential equation

$$\nabla^2 u(x, y) + 4u(x, y) = 0$$

in plane polar coordinates and looking at the solution that is independent of the angular coordinate, we get a differential equation for the radial coordinate r. One solution of this differential equation involves
(a) $J_0(2r)$ (b) $J_2(2r)$ (c) $J_4(r)$
(d) None of the above
Answer (d)

10. The solution of the radial part of the hydrogen atom for a certain orbital is proportional to $r^2 P_2(r) e^{-r/4a_0}$. The values of the quantum numbers n and l are
(a) $n = 2, l = 1$ (b) $n = 3, l = 1$ (c) $n = 4, l = 2$
(d) None of the above
Answer (d)