

## [PS 4-1]

The screenshot shows the CLion IDE interface with the PS4.c file open in the editor. The code implements a physics simulation for a particle. It includes constants for gravity (g), mass (m), and other parameters. The user is prompted to enter time steps (dt) and the number of iterations (N). The program then calculates the position and velocity of the particle over time.

```
//PS4-1
int main(void)
{
    //double type constants declared
    double g, m, me, R, V;
    g = 6.67e-11;
    m = 2.0e30;
    me = 6.62e-24;
    R = 1.5e11;
    V = 3.0e4;

    //double type initialization var's
    double x, y, vx, vy, ax, ay, dt, E, t = 0.;

    int i, N;
    FILE *fileout;
    fileout = fopen( filename: "/Users/Austin/Desktop/PHY 40/Homework/4/PS4_1.txt", mode: "w" );

    //initial var's
    x = R;
    y = 0;
    vx = 0;
    vy = V;

    printf("\nEnter dt,\n");
    scanf("%lf %d", &dt, &N);

    //loop to calculate values
    for (i=1;i<N+1; i=i+1)
        {
            //These are changing variables that depend on each other and
            //are calculated in the loop
            x = x + vx*dt;
            y = y + vy*dt;
            vx = vx + ax*dt;
            vy = vy + ay*dt;
            E = 0.5*m*(vx*vx + vy*vy);
            t = t + dt;
            if (i%100 == 0)
                {
                    fileout = fopen( filename: "/Users/Austin/Desktop/PHY 40/Homework/4/PS4_1.txt", mode: "w" );
                    fprintf(fileout, "%lf %lf %lf %lf %lf %lf %lf %lf\n", x, y, vx, vy, ax, ay, dt, E );
                    fclose(fileout);
                }
        }
}

Process finished with exit code 0
```

## [PS4-3]

The screenshot shows the CLion IDE interface with the PS4.c file open in the editor. The code is identical to the one in PS4-1, implementing a physics simulation for a particle. The user is prompted to enter time steps (dt) and the number of iterations (N). The program then calculates the position and velocity of the particle over time.

```
//PS4-1
int main(void)
{
    //double type constants declared
    double g, m, me, R, V;
    g = 6.67e-11;
    m = 2.0e30;
    me = 6.62e-24;
    R = 1.5e11;
    V = 3.0e4;

    //double type initialization var's
    double x, y, vx, vy, ax, ay, dt, E, t = 0.;

    int i, N;
    FILE *fileout;
    fileout = fopen( filename: "/Users/Austin/Desktop/PHY 40/Homework/4/PS4_3.txt", mode: "w" ); //open write/rewrite .txt

    //initialized var's
    x = R;
    y = 0;
    vx = 0;
    vy = V;

    printf("\nEnter dt,\n");
    scanf("%lf %d", &dt, &N);

    //loop to calculate values
    for (i=1;i<N+1; i=i+1)
        {
            //These are changing variables that depend on each other and
            //are calculated in the loop
            x = x + vx*dt;
            y = y + vy*dt;
            vx = vx + ax*dt;
            vy = vy + ay*dt;
            E = 0.5*m*(vx*vx + vy*vy);
            t = t + dt;
            if (i%100 == 0)
                {
                    fileout = fopen( filename: "/Users/Austin/Desktop/PHY 40/Homework/4/PS4_3.txt", mode: "w" );
                    fprintf(fileout, "%lf %lf %lf %lf %lf %lf %lf %lf\n", x, y, vx, vy, ax, ay, dt, E );
                    fclose(fileout);
                }
        }
}

Process finished with exit code 0
```

## [PS4-7]

### First set of values

The screenshot shows the CLion IDE interface with the file `PS4.c` open. The code implements a function to calculate position and velocity at a specific time step based on initial values and a time step. The run output window shows the program's execution and the resulting values for position and velocity at step 785.

```

121 //open & write/rewrite text
122 fileout = fopen( Rename: "/Users/Austin/Desktop/PHY 40/Homework/4/PS4_7n2.txt", mode: "w");
123 for (i=0; i<N; i+=1) //for loop placing
124 {
125     //for x,r the new array element [i+1] is = to the previous index i * indicated values
126     //this goes on up until the i=N!
127     x[i+1]=x[i]+v[i]*dt;
128     a=kx*(i+1)/m;
129     v[i+1]=v[i]+a*dt;
130     t+=dt;
131     fprintf(fileout,"%12.6lf %12.6lf",x[i+1],v[i+1]);
132 }
133 //user input and printed indicated values.
134 printf("\nEnter a time step at which you want to know";
135 printf("\nthe position and velocity: \n");
136 scanf("%d",&i);
137 printf("\n\nThe position at step %d is %8.4lf",i,x[i]);
138 printf("\n\nThe velocity at step %d is %8.4lf\n",i,v[i]);
139 return 0;
140 }
141
142 /////////////////// Lab 8
143
144 /////////////////////////////////////////////////////////////////// PS4-7
145 //
146 //double myfunction();
147 //int main(void)
148 //{
149 //    double x,dx,A,B,C,secondderiv; //variable declaration
150 //    printf("Enter x and dx \n");
151 //    scanf("%lf,%lf",&x,&dx);
152 //    printf("Enter A,B,C,secondderiv \n");
153 //    scanf("%lf,%lf,%lf,%lf",&A,&B,&C,&secondderiv);
154 //    main();
155 //    return 0;
156 }

//user input and printed indicated values.
printf("\nEnter a time step at which you want to know";
printf("\nthe position and velocity: \n");
scanf("%d",&i);
printf("\n\nThe position at step %d is %8.4lf",i,x[i]);
printf("\n\nThe velocity at step %d is %8.4lf\n",i,v[i]);
return 0;
}

/////////////////// Lab 8

///////////////////////////////////////////////////////////////// PS4-7
//
//double myfunction();
//int main(void)
//{
//    double x,dx,A,B,C,secondderiv; //variable declaration
//    main();
//    return 0;
//}

Process finished with exit code 0

```

### Second set of values

The screenshot shows the CLion IDE interface with the file `PS4.c` open. The code is identical to the first set, but the run output window shows the program's execution and the resulting values for position and velocity at step 11.

```

121 //open & write/rewrite text
122 fileout = fopen( Rename: "/Users/Austin/Desktop/PHY 40/Homework/4/PS4_7n2.txt", mode: "w");
123 for (i=0; i<N; i+=1) //for loop placing
124 {
125     //for x,r the new array element [i+1] is = to the previous index i * indicated values
126     //this goes on up until the i=N!
127     x[i+1]=x[i]+v[i]*dt;
128     a=kx*(i+1)/m;
129     v[i+1]=v[i]+a*dt;
130     t+=dt;
131     fprintf(fileout,"%12.6lf %12.6lf",x[i+1],v[i+1]);
132 }
133 //user input and printed indicated values.
134 printf("\nEnter a time step at which you want to know";
135 printf("\nthe position and velocity: \n");
136 scanf("%d",&i);
137 printf("\n\nThe position at step %d is %8.4lf",i,x[i]);
138 printf("\n\nThe velocity at step %d is %8.4lf\n",i,v[i]);
139 return 0;
140 }
141
142 /////////////////// Lab 8
143
144 /////////////////////////////////////////////////////////////////// PS4-7
145 //
146 //double myfunction();
147 //int main(void)
148 //{
149 //    double x,dx,A,B,C,secondderiv; //variable declaration
150 //    printf("Enter x and dx \n");
151 //    scanf("%lf,%lf",&x,&dx);
152 //    printf("Enter A,B,C,secondderiv \n");
153 //    scanf("%lf,%lf,%lf,%lf",&A,&B,&C,&secondderiv);
154 //    main();
155 //    return 0;
156 }

//user input and printed indicated values.
printf("\nEnter a time step at which you want to know";
printf("\nthe position and velocity: \n");
scanf("%d",&i);
printf("\n\nThe position at step %d is %8.4lf",i,x[i]);
printf("\n\nThe velocity at step %d is %8.4lf\n",i,v[i]);
return 0;
}

/////////////////// Lab 8

///////////////////////////////////////////////////////////////// PS4-7
//
//double myfunction();
//int main(void)
//{
//    double x,dx,A,B,C,secondderiv; //variable declaration
//    main();
//    return 0;
//}

Process finished with exit code 11

```

## Lab 8

### [PS4-6]

First set of values

The screenshot shows the CLion IDE interface. The top menu bar includes File, Edit, View, Navigate, Code, Refactor, Build, Run, Tools, VCS, Window, and Help. The title bar indicates the project is named PS4.c and the current file is PS4.c. The code editor displays the PS4.c file with the following content:

```
141 // return 0;
142 ////////////////////////////////////////////////////////////////// Lab 8
143 ////////////////////////////////////////////////////////////////// [PS4-6]
144 //////////////////////////////////////////////////////////////////
145 double myfunction();
146 int main(void)
147 {
148     double x, dx, A, B, C, seconderiv; //variable declaration
149     printf("Enter x and dx\n");
150     scanf("%lf %f", &x, &dx);
151     A=myfunction(x); //
152     B=myfunction(x-dx);
153     C=myfunction(x-dx);
154     seconderiv=(B-C-4A)/(dx*dx);
155     printf("d^2f/dx^2= %lf \n", seconderiv);
156     return 0;
157 }
158 double myfunction(double x) {
159     double f0fx;
160     f0fx = pow(x, 4);
161     return f0fx;
162 }
```

The terminal window at the bottom shows the command run and its output:

```
"/Users/Austin/Desktop/PHY 40/Homework/4/cmake-build-debug/4"
Enter x and dx
d^2f/dx^2= 3.020000
Process finished with exit code 0
```

Second set of Values

The screenshot shows the CLion IDE interface, identical to the previous one but with different terminal output. The terminal window at the bottom shows the command run and its output:

```
"/Users/Austin/Desktop/PHY 40/Homework/4/cmake-build-debug/4"
Enter x and dx
d^2f/dx^2= 3.000200
Process finished with exit code 0
```

### Third set of values

The screenshot shows the CLion IDE interface with the PS4.c file open. The code defines a function `myfunction` that calculates the derivative of  $f(x) = x^4$ . The run output shows the program prompts for input, calculates the derivative, and prints the result.

```
// PS4-6
double myfunction();
int main(void)
{
    double x, dx, A, B, C, seconderiv; //variable declaration
    printf("Enter x and dx \n");
    scanf("%lf %lf", &x, &dx);
    A=myfunction(x); //
    B=myfunction(x+dx);
    C=myfunction(x-dx);
    seconderiv=(B+C-2*A)/(dx*dx);
    printf("d^2f/dx^2= %lf \n", seconderiv);
    return 0;
}
double myfunction(double x) {
    double fofx;
    fofx = pow(x,4);
    return fofx;
}
```

Run: 4  
"/Users/Austin/Desktop/PHY 40/Homework/4/cmake-build-debug/4"  
Enter x and dx  
3  
d^2f/dx^2= 3.000002  
Process finished with exit code 0

### [PS4-7]

#### 1<sup>st</sup> set of values

The screenshot shows the CLion IDE interface with the PS4.c file open. The code defines a function `myfunction` that calculates the derivative of  $f(x) = e^{x/2}$ . The run output shows the program prompts for input, calculates the derivative, and prints the result.

```
// PS4-7
double myfunction();
int main(void)
{
    double x, dx, A, B, C, seconderiv; //variable declaration
    printf("Enter x and dx \n");
    scanf("%lf %lf", &x, &dx);
    A=myfunction(x); //
    B=myfunction(x+dx);
    C=myfunction(x-dx);
    seconderiv=(B+C-2*A)/(dx*dx);
    printf("d^2f/dx^2= %lf \n", seconderiv);
    return 0;
}
double myfunction(double x) {
    double fofx;
    fofx = exp(x) + x/2;
    return fofx;
}
```

Run: 4  
"/Users/Austin/Desktop/PHY 40/Homework/4/cmake-build-debug/4"  
Enter x and dx  
2  
d^2f/dx^2= 2.720548  
Process finished with exit code 0

## 2<sup>nd</sup> set of values

The screenshot shows the CLion IDE interface with the PS4.c file open. The code defines a function `myfunction` that calculates the second derivative of  $f(x) = e^x + x/2$ . The run output shows the result  $d^2f/dx^2 = 2.71838$ .

```
162 // double fofx;
163 // fofx = pow(x,4);
164 // return fofx;
165 //
166 //[[PS4-7]
167
168 double myfunction();
169 > int main(void)
170 {
171     double x,dx,A,B,C,secondderiv; //variable declaration
172     printf("Enter x and dx \n");
173     scanf("%lf %lf",&x,&dx);
174     B=myfunction(x); //
175     C=myfunction(x-dx);
176     C=myfunction(x-dx);
177     secondderiv=(B-C-2*A)/(dx*dx);
178     printf(" d^2f/dx^2= %lf \n",secondderiv);
179     return 0;
180 }
181
182 double myfunction(double x) {
183     double fofx;
184     fofx = exp(x) + x/2;
185     return fofx;
186 }
```

Run: 4 x  
"/Users/Austin/Desktop/PHY 40/Homework/4/cmake-build-debug/4"  
Enter x and dx  
2.71838  
d^2f/dx^2= 2.71838  
Process finished with exit code 0

## 3<sup>rd</sup> set of values

The screenshot shows the CLion IDE interface with the PS4.c file open. The code defines a function `myfunction` that calculates the second derivative of  $f(x) = e^x + x/2$ . The run output shows the result  $d^2f/dx^2 = 2.718282$ .

```
162 // double fofx;
163 // fofx = pow(x,4);
164 // return fofx;
165 //
166 //[[PS4-7]
167
168 double myfunction();
169 > int main(void)
170 {
171     double x,dx,A,B,C,secondderiv; //variable declaration
172     printf("Enter x and dx \n");
173     scanf("%lf %lf",&x,&dx);
174     B=myfunction(x); //
175     C=myfunction(x-dx);
176     C=myfunction(x-dx);
177     secondderiv=(B-C-2*A)/(dx*dx);
178     printf(" d^2f/dx^2= %lf \n",secondderiv);
179     return 0;
180 }
181
182 double myfunction(double x) {
183     double fofx;
184     fofx = exp(x) + x/2;
185     return fofx;
186 }
```

Run: 4 x  
"/Users/Austin/Desktop/PHY 40/Homework/4/cmake-build-debug/4"  
Enter x and dx  
2.718282  
d^2f/dx^2 = 2.718282  
Process finished with exit code 0