In[ ]:=

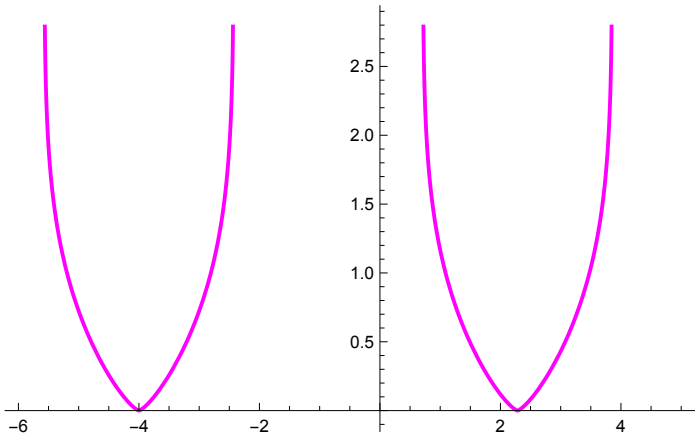
In[ ]:=
```
(*
ст.гр.221703
 Воложинец Архип
 Вариант 3
*)
```

In[ ]:=
```
(*Задание 1*)
```

In[ ]:=
```
f[x_] := ∛(Log[Cos[x + 4]]^2);
x0 = 1.82;
graph = Plot[f[x], {x, -6, 5}, PlotStyle → Magenta];
```
график функции стиль графика малиновый

In[ ]:=
```
Show[graph]
```
показать

Out[ ]=



In[ ]:=
```
(*1.a*)
```

In[ ]:=
```
d11 = D[f[x], x] /. x → x0
```
дифференциировать
```
d21 = D[f[x], {x, 2}] /. x → x0
```
дифференциировать

Out[ ]=
```
-0.692084
```

Out[ ]=
```
0.696623
```

In[ ]:=
```
(*1.б*)
FiniteDiff1[y_, y1_] := y1 - y;
FiniteDiff2[y_, y1_, y2_] := y2 - 2 y1 + y;
FiniteDiff3[y_, y1_, y2_, y3_] := y3 - 3 y2 + 3 y1 - y;
```

In[•]:=
```
(*Шаг h = 0.1*)
h = 0.1
```

Out[•]=
```
0.1
```

In[•]:=
```
y1 = 1/h (FiniteDiff1[f[x0], f[x0 + h]] - 1/2 * FiniteDiff2[f[x0], f[x0 + h], f[x0 + 2 h]] +
    1/3 * FiniteDiff3[f[x0], f[x0 + h], f[x0 + 2 h], f[x0 + 3 h]])
```

Out[•]=
```
-0.690232
```

In[•]:=
```
y2 = 1/h^2 (FiniteDiff2[f[x0], f[x0 + h], f[x0 + 2 h]] -
    FiniteDiff3[f[x0], f[x0 + h], f[x0 + 2 h], f[x0 + 3 h]])
```

Out[•]=
```
0.632285
```

In[•]:=
```
{Abs[d11 - y1], Abs[d21 - y2]}
```
абсолютное зна··· абсолютное значен

Out[•]=
```
{0.00185118, 0.0643387}
```

In[•]:=
```
(*Шаг h = 0.01*)
```

In[•]:=
```
h = 0.01
```

Out[•]=
```
0.01
```

In[•]:=
```
y1 = 1/h (FiniteDiff1[f[x0], f[x0 + h]] - 1/2 * FiniteDiff2[f[x0], f[x0 + h], f[x0 + 2 h]] +
    1/3 * FiniteDiff3[f[x0], f[x0 + h], f[x0 + 2 h], f[x0 + 3 h]])
y2 = 1/h^2 (FiniteDiff2[f[x0], f[x0 + h], f[x0 + 2 h]] -
    FiniteDiff3[f[x0], f[x0 + h], f[x0 + 2 h], f[x0 + 3 h]])
```

Out[•]=
```
-0.692083
```

Out[•]=
```
0.696211
```

In[•]:=
```
{Abs[d11 - y1], Abs[d21 - y2]}
```
абсолютное зна··· абсолютное значен

Out[•]=
```
{1.126 × 10^-6, 0.000411991}
```

In[•]:=
```
(*При уменьшении шага результат получается более точным*)
```

In[•]:=
```
(*Задание 2*)
```

In[ ]:=
```
(*2.a*)
f[x_] := Tan[1 + Cosh[1/(x + 2)]]^2
```

In[ ]:=
```
h = 0.2;
a = -1;
b = 3;
data = Table[{x, (f[x + h] - f[x - h])/(2 h)}, {x, a, b, h}];
```
таблица значений

```
TableForm[data, TableHeadings → {Table[i, {i, (b - a)/h + 1}], {"x_i", "y'_i"}}]
```
табличная форма · табличные заголовки · таблица значений

Out[ ]//TableForm=

	x_i	y'_i
1	−1.	2.21937
2	−0.8	2.42858
3	−0.6	2.29713
4	−0.4	2.04518
5	−0.2	1.7668
6	0.	1.50402
7	0.2	1.27258
8	0.4	1.07562
9	0.6	0.910864
10	0.8	0.774099
11	1.	0.660835
12	1.2	0.566951
13	1.4	0.488915
14	1.6	0.423798
15	1.8	0.369213
16	2.	0.323234
17	2.2	0.28431
18	2.4	0.251195
19	2.6	0.222881
20	2.8	0.198558
21	3.	0.177566

In[ ]:=
```
(*2.б*)
```

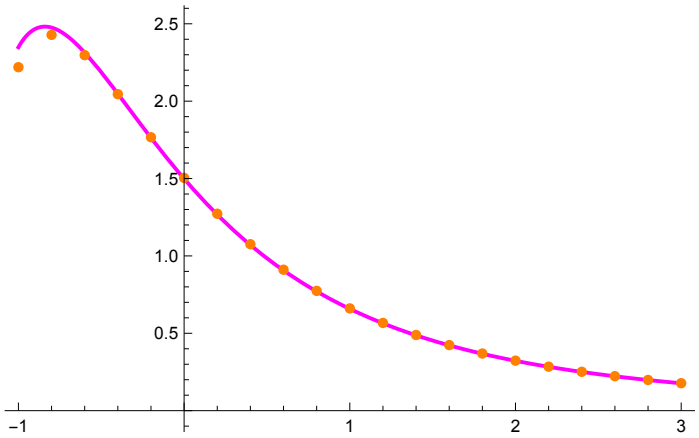
In[ ]:=
```
derivateOfFunc = D[f[x], x]
```
дифференции

Out[ ]=

$$-\frac{2\,\text{Sec}\left[1+\text{Cosh}\left[\frac{1}{2+x}\right]\right]^2\,\text{Sinh}\left[\frac{1}{2+x}\right]\,\text{Tan}\left[1+\text{Cosh}\left[\frac{1}{2+x}\right]\right]}{(2+x)^2}$$

In[ ]:=
```
graph = Plot[derivateOfFunc, {x, -1, 3}, PlotStyle → Magenta];
```
график функции стиль графика малиновый
```
dots = ListPlot[data, PlotStyle → {PointSize[0.015], Orange}];
```
диаграмма разбро… стиль графика размер точки оранжевый
```
Show[graph, dots]
```
показать

Out[ ]=



In[ ]:=
```
(*Задание 3*)
(*3.a*)
```

In[ ]:=
$$f[x\_] := \frac{2 + \sqrt[4]{3\,x + 1,\ 7}}{x + \sqrt{1.5\,x^2 + 1}};$$

In[ ]:=
```
a = 0.3;
b = 0.9;
n1 = 8;
x0 = a;
```
$$step = \frac{(b - a)}{n1};$$

In[ ]:=
```
For[i = 1, i ≤ n1, i++, xi = step + xi-1;]
```
цикл ДЛЯ

In[ ]:=
$$averageRectangle1 = \frac{(b - a)}{n1} * \sum_{i=1}^{n1} f\left[x_{i-1} + \frac{(b - a)}{2 * n1}\right]$$

Out[ ]=
```
1.96522
```

In[ ]:=
```
n2 = 10;
```
$$step = \frac{(b - a)}{n2};$$
```
For[i = 1, i ≤ n2, i++, xi = step + xi-1;]
```
цикл ДЛЯ

In[ ]:=
$$averageRectangle2 = \frac{(b - a)}{n2} * \sum_{i=1}^{n2} f\left[x_{i-1} + \frac{(b - a)}{2 * n2}\right]$$

Out[ ]=
```
1.96518
```

In[ ]:=
```
(*по Ричардсону*)
```

In[ ]:=
```
k = 2;
Richardson = averageRectangle2 + n1^k / (n2^k - n1^k) (averageRectangle2 - averageRectangle1)
```

Out[ ]=
```
1.96511
```

In[ ]:=
```
(*3.б*)
```

In[ ]:=
```
n1 = 8;
x0 = a;
step = (b - a) / n1;
For[i = 1, i ≤ n1, i++,
 xi = step + xi-1;]
trapezoid1 = (b - a) / n1 * (Sum[f[xi], {i, 1, n1 - 1}] + f[x0] / 2 + f[xn1] / 2)
```

Out[ ]=
```
1.9649
```

In[ ]:=
```
n2 = 10;
x0 = a;
step = (b - a) / n2;
For[i = 1, i ≤ n2, i++,
 xi = step + xi-1;]
trapezoid2 = (b - a) / n2 * (Sum[f[xi], {i, 1, n2 - 1}] + f[x0] / 2 + f[xn2] / 2)
```

Out[ ]=
```
1.96498
```

In[ ]:=
```
(*По Ричардсону*)
```

In[ ]:=
```
Richardson = trapezoid2 + n1^k / (n2^k - n1^k) (trapezoid2 - trapezoid1)
```

Out[ ]=
```
1.96511
```

In[ ]:=
```
(*Задание 4*)
```

In[ ]:=
```
(*8 частей*)
```

In[ ]:=
$$\text{data} = \begin{pmatrix} -1 & 0.3499 \\ -0.9 & 0.3886 \\ -0.8 & 0.4317 \\ -0.7 & 0.4795 \\ -0.6 & 0.5325 \\ -0.5 & 0.5915 \\ -0.4 & 0.6570 \\ -0.3 & 0.7297 \\ -0.2 & 0.8105 \end{pmatrix};$$

In[ ]:=
```
a = -1;
b = -0.2;
n = 4;
h = (b - a) / (2 n)
```

Out[ ]=
```
0.1
```

In[ ]:=
```
For[i = 0, i ≤ 2 * n, i++, yᵢ = data⟦i + 1, 2⟧;]
```
цикл ДЛЯ

In[ ]:=
$$\text{SimpsonFormula} = \sum_{i=0}^{n-1} \frac{h}{3} * (y_{2\,i} + 4\,y_{2\,i+1} + y_{2\,i+2})$$

Out[ ]=
```
0.438667
```

In[ ]:=
```
(*16 частей*)
```

In[ ]:=
$$\text{data} = \begin{pmatrix} -1 & 0.3499 \\ -0.95 & 0.4055 \\ -0.9 & 0.3886 \\ -0.85 & 0.4459 \\ -0.8 & 0.4317 \\ -0.75 & 0.4904 \\ -0.7 & 0.4795 \\ -0.65 & 0.5392 \\ -0.6 & 0.5325 \\ -0.55 & 0.5930 \\ -0.5 & 0.5915 \\ -0.45 & 0.6521 \\ -0.4 & 0.6570 \\ -0.35 & 0.7171 \\ -0.3 & 0.7297 \\ -0.25 & 0.7885 \\ -0.2 & 0.8105 \end{pmatrix};$$

In[ ]:=
```
n = 8;
h = (b - a) / (2 n)
For[i = 0, i ≤ 2 * n, i++, yᵢ = data⟦i + 1, 2⟧;]
```
цикл ДЛЯ

Out[ ]=
```
0.05
```

In[ ]:=
$$\text{SimpsonFormula} = \sum_{i=0}^{n-1} \frac{h}{3} * (y_{2\,i} + 4\,y_{2\,i+1} + y_{2\,i+2})$$

Out[ ]=
0.455137

In[ ]:=
```
(*Задание 5*)
```

In[ ]:=
$$f[x\_] = \frac{\text{Cos}[5\,x + 2]}{x}$$

Out[ ]=
$$\frac{\text{Cos}[2 + 5\,x]}{x}$$

In[ ]:=
```
a = 0.8;
b = 2.1;
n = 7;
LegendreP[n, t]
```
LegendreP–функция Лежандра

Out[ ]=
$$\frac{1}{16}\left(-35\,t + 315\,t^3 - 693\,t^5 + 429\,t^7\right)$$

In[ ]:=
```
sl = NSolve[LegendreP[n, t] == 0, t]
```
числен… LegendreP–функция Лежандра первого р

Out[ ]=
$$\{\{t \to -0.949108\}, \{t \to -0.741531\}, \{t \to -0.405845\}, \{t \to 0.\}, \{t \to 0.405845\}, \{t \to 0.741531\}, \{t \to 0.949108\}\}$$

In[ ]:=
```
tt = t /. sl
```

Out[ ]=
$$\{-0.949108, -0.741531, -0.405845, 0., 0.405845, 0.741531, 0.949108\}$$

In[ ]:=
```
T = Table[If[i == 1, 1, (tt[[j]])^(i-1)], {i, n}, {j, n}]; MatrixForm[T]
```
табл… условный оператор матричная форма

Out[ ]//MatrixForm=
$$\begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ -0.949108 & -0.741531 & -0.405845 & 0. & 0.405845 & 0.741531 & 0.949108 \\ 0.900806 & 0.549868 & 0.16471 & 0. & 0.16471 & 0.549868 & 0.900806 \\ -0.854962 & -0.407745 & -0.0668469 & 0. & 0.0668469 & 0.407745 & 0.854962 \\ 0.811451 & 0.302355 & 0.0271295 & 0. & 0.0271295 & 0.302355 & 0.811451 \\ -0.770155 & -0.224206 & -0.0110104 & 0. & 0.0110104 & 0.224206 & 0.770155 \\ 0.73096 & 0.166256 & 0.0044685 & 0. & 0.0044685 & 0.166256 & 0.73096 \end{pmatrix}$$

In[ ]:=
```
B = Table[If[EvenQ[i] == True, 0, 2/i], {i, n}] // N
```
табл… у… чётное число? истина чи

Out[ ]=
$$\{2., 0., 0.666667, 0., 0.4, 0., 0.285714\}$$

In[ ]:=
```
A = LinearSolve[T, B]
```
решить линейные уравне

Out[ ]=
$$\{0.129485, 0.279705, 0.38183, 0.417959, 0.38183, 0.279705, 0.129485\}$$

In[ ]:=
$$\text{int} = \frac{(b-a)}{2} * \sum_{i=1}^{n} A[[i]] * f\left[\frac{b+a}{2} + \frac{b-a}{2} * tt[[i]]\right]$$

Out[ ]=
```
0.0969024
```

In[ ]:=
```
PaddedForm[int, {19, 18}]
```
форма числа с заполнением нулями

Out[ ]//PaddedForm=
```
 0.096902358500152500
```