

Remarks on tutorial 3

Note that Q2(d) = Q3(a). Use the method of undetermined coefficients to solve Q2(b)

Q4 (A) Chain Rule $\frac{df(x)}{dy} = \frac{df(x)}{dx} \frac{dx}{dy}$

Apply Chain Rule to the right-hand side of the following equation

$$\frac{d^2 y}{dx^2} = \frac{d}{dy} \left[\frac{1}{2} (y')^2 (x) \right]$$

(B) Suppose that the earth were to stop moving. Then the earth would fall towards the sun according to

$$\ddot{r} = -\frac{GM}{r^2}$$

Use the first part result of Q4, we get

$$\frac{d}{dr}[(r')^2] = -\frac{GM}{r^2}$$

$$d[(r')^2] = -\frac{GM}{r^2} dr$$

Now Integrate both sides

$$\text{Remember } \int df(x) = \int f'(x)dx = f(x)$$

(C) From (B) , we have

$$(\dot{r})^2 = 2GM \left(\frac{1}{r} - \frac{1}{R} \right) \quad \dot{r} = -\sqrt{2GM \left(\frac{1}{r} - \frac{1}{R} \right)}$$

(D) Initial condition

$$t = 0, r = R, \dot{r} = 0$$

(E) Now find t when $r = \frac{2}{3}R$

i.e., reach the orbit of Venus

(F) We need to find the integral

$$\int \frac{1}{\sqrt{\frac{1}{r} - \frac{1}{R}}} dr$$

Let $x=r/R$ Then we need to find the integral

$$\int \frac{\sqrt{x}}{\sqrt{1-x}} dx$$

$$\int \frac{1}{\sqrt{\frac{1}{x}-1}} dx = \int \frac{\sqrt{x}}{\sqrt{1-x}} dx$$

$$= \sin^{-1}(\sqrt{x}) - \sqrt{x(1-x)}$$

From online integrator

or

$$\frac{1}{\sqrt{1-x}} = (1-x)^{-\frac{1}{2}}$$

$$= 1 + \frac{1}{2}x + \frac{1}{2} \frac{3}{4}x^2 + \frac{1}{2} \frac{3}{4} \frac{5}{6}x^3 + \dots$$

for $-1 < x < 1$

$$\int \frac{\sqrt{x}}{\sqrt{1-x}} dx = \int \left(\sqrt{x} + \frac{1}{2}x^{\frac{3}{2}} + \frac{1}{2} \frac{3}{4}x^{\frac{5}{2}} + \dots \right) dx$$

$$\approx \int \left(\sqrt{x} + \frac{1}{2}x^{\frac{3}{2}} + \frac{1}{2} \frac{3}{4}x^{\frac{5}{2}} \right) dx$$



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$$\int \frac{\sqrt{x}}{\sqrt{1-x}}$$

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Traditional Form	Input Form	Output Form
<p>1. Form Design</p> <p>Traditional forms are designed to be filled out by hand, often with a focus on maximizing space and minimizing the number of lines. They typically use a grid-like structure with clear sections for different types of information.</p> <p>2. Input Method</p> <p>Input is typically done by hand, using a pen or pencil. This can be slower and more prone to errors compared to digital input.</p> <p>3. Output Method</p> <p>Output is typically a physical document, such as a printed form or a scanned document. This can be cumbersome to handle and store.</p>	<p>1. Form Design</p> <p>Input forms are designed to be filled out on a computer screen. They often use a more structured, form-like layout with clear labels and input fields. They may also include validation rules to ensure data accuracy.</p> <p>2. Input Method</p> <p>Input is done digitally, typically using a mouse or touchpad. This is faster and more accurate than hand input.</p> <p>3. Output Method</p> <p>Output is typically a digital document, such as a PDF or a database record. This is easier to store, retrieve, and share.</p>	<p>1. Form Design</p> <p>Output forms are designed to be printed out and filled out by hand. They often use a more structured, form-like layout with clear labels and input fields. They may also include validation rules to ensure data accuracy.</p> <p>2. Input Method</p> <p>Input is typically done by hand, using a pen or pencil. This can be slower and more prone to errors compared to digital input.</p> <p>3. Output Method</p> <p>Output is typically a physical document, such as a printed form or a scanned document. This can be cumbersome to handle and store.</p>

$$\sin^{-1}(\sqrt{x}) = \sqrt{-(x-1)x}$$

Time to compute: 0.02 sec

$\text{ArcSin}[x]$: inverse sine [properties]

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