Homework 1

Moodle Submission Deadline: 2024/3/11 23:59

Problem 1: Python Basics （ hw1_p1.docx ）

Problem 1 三個小題的答案(包含 Problem1-3 修改後的程式碼)，
請都寫在 word 檔裡面，檔名為 hw1_p1.docx，裡面使用英文或中文皆可。

Problem 1-1. Show the result of evaluating each expression. Be sure that the value is in the proper form to indicate its type (int, or float). If the expression is illegal, explain why.

(a) `4.0 / 10.0 + 3.5 * 2`
(b) `10 % 4 + 6 / 2`
(c) `(6.5 - 5.0) ** (0.5) + 7 * 3`
(d) `3 * 10 / 3 + 10 % 3`
(e) `5 / (1 // 2)`

Problem 1-2. What is the exact result of each of the following when evaluated?

(a) `12 / 6.0`
(b) `21 // 10`
(c) `25 // 10.0`
(d) `12 / 6`

Problem 1-3. Given a quadratic equation, $ax^2 + bx + c = 0$, the two roots are:

$$x_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a}, \quad x_2 = \frac{-b - \sqrt{b^2 - 4ac}}{2a} .$$

What are the problems with the following program?

```
a = 2
b = 5
c = 2
q = b*b - 4*a*c
q_sr = q ** (1//2)
x1 = (-b + q_sr)/2*a
x2 = (-b - q_sr)/2*a
print("x1,' x1, "x2=" x2)
```

Modify the program so that it can output the correct x1 and x2 by solving the given equation.

Problem 2: When Newton meets Einstein （ hw1_p2.py ）

Newton's law of universal gravitation states that every particle attracts every other particle in the universe with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers. The equation for universal gravitation thus takes the form:

$$F = G\frac{m_1 m_2}{r^2}$$

where F is the gravitational force acting between two objects, m_1 and m_2 are the masses of the objects, r is the distance between the centers of their masses, and the gravitational constant $G = 6.67 \times 10^{-11}$.

Another famous formula: *Mass-energy equivalence* is proposed by Albert Einstein:

$$E = mc^2$$

This formula states that the equivalent energy (E) can be calculated as the mass (m) multiplied by the speed of light (c = 299,792,458 m/s) squared.

Now, you need to develop a program which will ask the user to input the force F, mass of the object 1 m_1, and distance r. and output a float number that represents the energy E of the object 2 after you calculate m_2.

Note that in your program (hw1_p2.py), you need to write some comments to describe the meaning of each part.

Sample Input/Output **(以下特殊字型的部分是你的程式在執行後所必須列印出來的東西)**

```
Input the force: 5000
Input the mass of m1: 500
Input the distance: 50
The mass of m2 = 374812593703148.44
The energy of m2 = 3.36864759646483337e+31
```

需要可以用 python hw1_p2.py 來執行你的程式，你的程式在被執行後，必須先跳出 Input the force:可以輸入數字；接著跳出 Input the mass of m1:再次輸入數字；最後跳出 Input the distance:輸入最後的數字。譬如以下截圖中第一次執行時，在 force 輸入 5000 與在 mass 輸入 500 以及在 distance 輸入 50。接著才會根據輸入的 force 與 mass 以及 distance，列印出後面 mass 與 energy 之結果。(繳交作業是交 hw1_p2.py 檔，不是交截圖)

```
C:\Python37\workspace>python hw1_p2.py
Input the force: 5000
Input the mass of m1: 500
Input the distance: 50
The mass of m2 =  374812593703148.44
The energy of m2 =  3.36864759646483 37e+31
```

Problem 3: Time Travel (hw1_p3.py)

This problem aims at letting you practice using print and input functions, along with simple *mathematics* for conversion. You are asked to write a program that estimate the length of time that passes for astronauts as they travel at near light speeds. You may know that time passes more slowly for the astronauts on ship than those on earth as the ship approaches the speed of light. We can refer to Einstein's equation, as shown in the following, which provides a factor indicating the change in time based on speed:

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

where v is the velocity of the ship and c is the velocity of the speed of light, which is approximately 299,792,458 meters/second. The factor calculated is how much time is reduced by. For example, at 149,896,229 meters/second (half the speed of light), the factor is 1.1547005383792517. Time's passage is reduced by the factor γ. Specifically, let Δt_p be the travel time of a person in the ship, and let Δt_d be the time of light to the destination. We can calculate Δt_p based on Einstein's equation:

$$\Delta t_p = \frac{\Delta t_d}{\gamma}$$

Your program will first ask the user to input the velocity v, and output a float number that represents the percentage of the speed of light your ship will travel. Then your program will print out the time Δt_p that the astronauts experience for trips to:

- Alpha Centauri: 4.3 Light Years
- Barnard's Star: 6.0 Light Years
- Betelgeuse (in the Milky Way): 309 Light Years
- Andromeda Galaxy (closest galaxy): 2000000 Light Years

Note that in your program (hw1_p3.py), you need to write the comments to describe the meaning of each part.

Sample Output (以下特殊字型的部分是你的程式在執行後所必須列印出來的東西)

```
Input velocity: 149896229
Percentage of light speed = 0.5
Travel time to Alpha Centauri = 3.723909
Travel time to Barnard's Star = 5.196152
Travel time to Betelgeuse (in the Milky Way) = 267.601850
Travel time to Andromeda Galaxy (closest galaxy) = 1732050.807569
```

要可以用 python hw1_p2.py 來執行你的程式，你的程式在被執行後，必須先跳出 Input velocity:可以輸入數字，譬如以下截圖表示輸入 149896229。接著才會根據輸入的 velocity，列印出後面五行結果。(繳交作業是交 hw1_p3.py 檔，不是交截圖)

```
c:\Python35-32\workspace>python hw1_p2.py
Input velocity: 149896229
Percentage of light speed = 0.500000
Travel time to Alpha Centauri = 3.723909
Travel time to Barnard's Star = 5.196152
Travel time to Betelgeuse (in the Milky Way) = 267.601850
Travel time to Andromeda Galaxy (closest galaxy) = 1732050.807569
```

Problem 4: Slide and Collide (hw1_p4.py)

In the world of physics, some scholars strive to explore the world from the aspects of energy flows. Energy has many different forms, and they are discovered by humans in various ways. For example, heat is a kind of energy that makes us feel warm. In this problem, your task is to implement the *law of conservation of mechanical energy*.

In the *law of conservation of mechanical energy*, we only discuss the two main categories: Potential Energy (U), and Kinetic Energy (E_k). Below are some formulas describing the calculation for the two energy forms discussed previously.

To calculate the amount of Potential Energy, we have to take the following parameters into account: the mass of the object (m), the force that the gravity provides ($g = 9.8\ m/s$), and the current height of the object (h). With these parameters, we can combine them with the formula:

$$U = m \cdot g \cdot h$$

To calculate the amount of Kinetic Energy, we have to consider: the mass of the object (m), and the current speed of the object (v). We can combine these parameters with the formula:

$$E_k = \frac{1}{2} \cdot m \cdot v^2$$

The law is briefly expressed as follow:

$$E_{mechanical} = U + E_k$$

From the law we know that: without any participation of *non-conservative forces*, the Mechanical Energy remains constant. Which means: if no non-conservative forces (such as friction) is considered, then the total amount of Mechanical Energy stays the same.

First, we aim to discuss about the *law of conservation of mechanical energy*, now we discuss the phenomenon of Elastic Collision. According to the physicists, elastic collision describes the encounter of two objects, in which the total amount of Kinetic Energy remains the same.

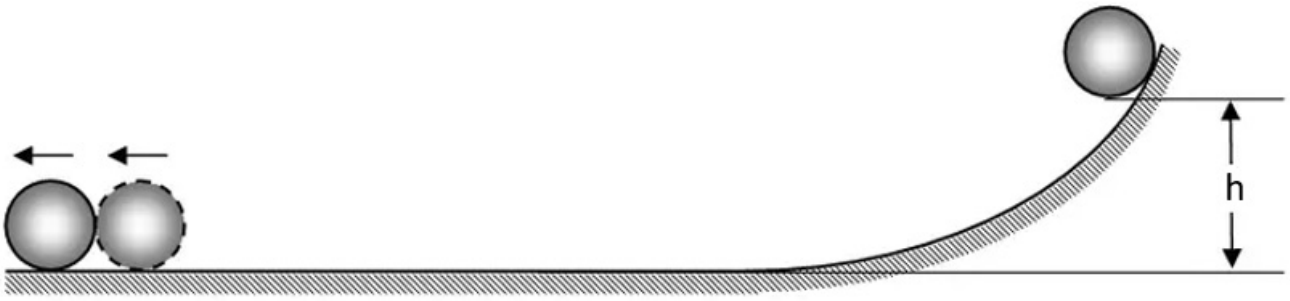
If we wish to inspect the changes before and after an elastic collision, we can apply the tip: when the elastic collision occurs, the total amount of kinetic energy remains unchanged. We assume the physical parameters of a collision system between two objects are listed as the form below:

Object	Mass: m	Velocity (before): u	Velocity (after): v
1st	m_1	u_1	v_1
2nd	m_2	u_2	v_2

Therefore, we can derive the formula as follow:

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

After introducing the two physic laws, we describe the scenario of the problem: two balls are on the same track, there are no friction between the balls and the track. First, the 1st ball sets off from the top of the track (on the upper-right-side of the picture), and rolls down to the level. Then, the first ball encounters the 2nd ball on the track and causes the elastic collision (on the lower-left-side of the picture).



Now, you need to develop a program which will ask the user to input the initial height of the 1st ball (h), the mass of the 1st ball (m_1), the mass of the 2nd ball (m_2). Then, the program will calculate the

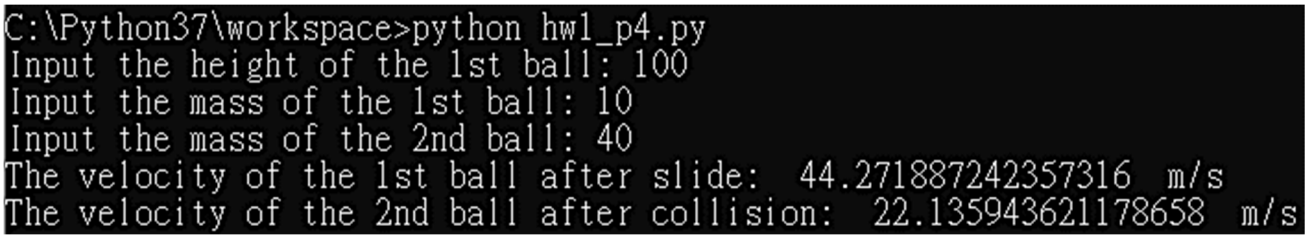
velocity of the 1st ball when it slides to level (v_1), and also the velocity of the second ball (v_2) after the elastic collision of two balls.

Note that in your program (hw1_p3.py), you need to write the comments to describe the meaning of each part.

Sample Output **(以下特殊字型的部分是你的程式在執行後所必須列印出來的東西)**

```
Input the height of the 1st ball: 100
Input the mass of the 1st ball: 10
Input the mass of the 2nd ball: 40
The velocity of the 1st ball after slide:  44.271887242357316  m/s
The velocity of the 2nd ball after collision: 17.708754896942924 m/s 或
The velocity of the 2nd ball after collision: 22.135943621178568 m/s
```

要可以用 python hw1_p4.py 來執行你的程式，你的程式在被執行後，必須先跳出 Input the height of the 1st ball:可以輸入數字；接著跳出 Input the mass of the 1st ball:以輸入數字；最後跳出 Input the height of the 2nd ball:可以輸入數字。譬如以下截圖表示依序輸入 100, 10, 40。接著才會根據輸入的值，列印出後面五行結果。(繳交作業是交 hw1_p4.py 檔，不是交截圖)



Note

This is a homework for each **individual**. 必須於程式檔內註解註明系及姓名學號。

How to Submit Your Homework?

Submission in NCKU Moodle

Before submitting your homework, please zip the files (**hw1_p1.docx**, **hw1_p2.py**, **hw1_p3.py**, and **hw1_p4.py**) in a zip file, and name the file as "學號 1_學號 2_hw1.zip". For example, if your 學號 is H12345678, then your file name is:

"H12345678_hw**1**.zip" or "H12345678_hw**1**.rar"

When you zip your files, please follow the instructions provided by TA's slides to submit your file using NCKU Moodle platform http://moodle.ncku.edu.tw .

Have Questions about This Homework?

Please feel free to visit TAs, and ask/discuss any questions in their office hours. We will be more than happy to help you.

Homework 1 補充說明

問題 1 的三個小題都是寫在 word 檔裡面，檔名為 hw1_p1.docx，並繳交這個 word 檔。
問題 1-1，在 word 檔裡面，詳細列出每一個小題是否有語法上錯誤的地方，若有錯誤則更正它。
問題 1-2，在 word 檔裡面，詳細列出每一個小題在 python 直譯器中，會列印出什麼東西。
問題 1-3，在 word 檔裡面，詳細敘述這段程式錯誤的地方在哪裡，並且更正每一個錯誤的地方，使得程式最終能順利列印出正確的 x1 與 x2 的值。

問題 2，主要是寫一支程式並繳交它，檔名為 hw1_p2.py，這個程式主要是讓使用者分別輸入兩物體的作用力(F)、兩物體間的距離(r)以及其中一個物體的質量(m_1)，然後利用牛頓的萬有引力公式求得另一物體之質量(m_2)，再利用愛因斯坦的質能守恆公式，將 m_2 的能量 E 算出來。該程式在命令提示字元下執行 python hw1_p2.py 時，會停留在 Input the force: 讓使用者輸入作用力；接著會停留在第二行 Input the mass of m1: 讓使用者輸入第一個物體的質量；最後會停留在第三行 Input the distance: 讓使用者輸入兩物體間的距離。例如問題 2 的截圖表示分別在這三行輸入 5000、500、50 三個值。接著程式才會根據上面輸入的數值，分別計算出另一物體的質量與能量，並列印出最後兩行結果。 (最後你需要繳交的是 hw1_p2.py 檔，而非截圖)

問題 3，主要是寫一隻程式並且繳交它，檔名為 hw1_p3.py，這個程式做的事情主要是讓使用者輸入一個太空船行進的速度數值，接著根據公式，計算在太空船內的人在旅行到不同的星球，實際上經過了多少光年的時間。該程式在命令提示字元下執行 python hw1_p3.py 時，會停留在第一行 Input velocity:，讓使用者輸入速度，等使用者輸入速度的數值後，接著才根據這個數值，並根據公式來計算並列印出下面五行，分別是這個速度是幾倍光速、以光速旅行到達四個星球坐在太空船內的人會經過多少光年的時間。要可以用 python hw1_p3.py 來執行你所繳交的程式，你的程式在被執行後，必須先跳出 Input velocity: 可以輸入數字，譬如問題 3 的截圖表示輸入 149896229。接著才會根據輸入的 velocity，列印出後面五行結果。 (最後你需要繳交的是 hw1_p3.py 檔，而非截圖)

問題 4，主要是寫一隻程式並且繳交它，檔名為 hw1_p4.py，這個程式做的事情主要是讓使用者分別輸入第一顆球所在的起始高度以及它的質量，還有第二顆球的質量。接著根據公式，計算第一顆球在平滑軌道上(不考慮摩擦力)由該高度滑落至水平面時的速度值。接著使用前方得到的速度值，根據公式計算第二顆球在兩顆球進行完全彈性碰撞後的速度值。該程式在命令提示字元下執行 python hw1_p4.py 時，會停留在第一行 Input the height of the 1st ball: 讓使用者輸入第一顆球的初始高度；接著會停留在第二行 Input the mass of the 1st ball: 讓使用者輸入第一顆球的質量；接著再停留在第三行 Input the mass of the 2nd ball: 讓使用者輸入第二顆球的質量。例如問題 4 的截圖表示分別在上述三行的位置輸入：100、10、40 三個值。接著程式才會根據上面輸入的數值，分別計算出兩顆球各別在不同階段下的速度，並列印出最後兩行結果。(你需繳交的是 hw1_p4.py 檔，非截圖)