2021_2 EXAMINATIONS.

COURSE CODE: **PHY301**

COURSE TITLE: **CLASSICAL MECHANICS II**
CREDIT UNIT: **3**
TIME ALLOWED: **(2½ HRS)**

INSTRUCTION: *Answer question 1 and any other four questions*

## QUESTION 1

a. Distinguish between a particle and a rigid body as applied in classical mechanics.   4 marks

b. Consider a system of n particles and state the conditions for it to be classified as a rigid body   4 marks

c. i. Briefly explain what is meant by the "number of degrees of freedom" of a system   2 marks

ii. Give three examples on which the freedom of choice of how to specify the degrees of freedom might depend.   2 marks

d. i. The system shown in the figure consists of a spiral spring with force constant k suspended from a
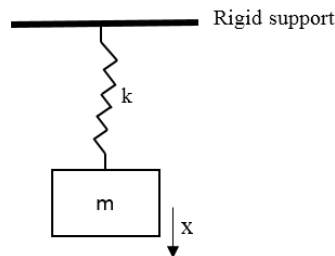
rigid support and loaded with an object of mass m. The system is stretched by a small displacement x and released. Use the Lagrangian method to obtain the Newtonian equation of motion of the system.7 marks

ii. Write down the Hamiltonian function for the system and comment on its physical significance. 3 marks
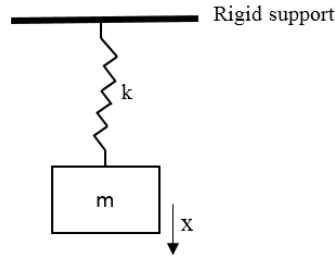
QUESTION 2
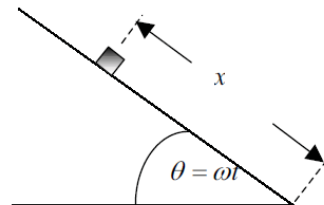
The figure shows a particle sliding on a smooth inclined plane whose inclination θ is increasing at a constant rate ω. If θ = 0, at time t = 0, at which time the particle starts from rest, use the Lagrangian method to show that the acceleration of the particle down the incline may be represented by:

$$\ddot{x} = \omega^2 x - g\sin\omega t$$ 12 marks

QUESTION 3

Obtain Hamilton's equations for a one-dimensional harmonic oscillator shown in the figure, hence obtain

obtain the Newtonian equivalent equation of motion.   12 marks

QUESTION 4

a. Titan, the largest moon of Saturn, has a mean orbital radius of 1.22×10^9 m. The orbital period of Titan is 15.95 days. Hyperion, another moon of Saturn, orbits at a mean radius of 1.48×10^9 m. Use Kepler's third law of planetary motion to predict the orbital period of Hyperion in days.   6marks

b. The planet Mercury travels around the Sun with a mean orbital radius of 5.8×10^{10} m. The mass of the Sun is 1.99×10^{30} kg. Use Newton's version of Kepler's third law to determine how long it takes Mercury to orbit the Sun. Give your answer in Earth days.   6marks

QUESTION 5

(a) (i) Distinguish between *inertial* and *non-inertial reference frames*?   2 marks

   (ii) Briefly explain phenomenon of the Coriolis force   4 marks

(b)Find the eastward drift of an object falling freely from a height of 100m with latitude of 45^0

6 marks

QUESTION 6

(a) Briefly explain the concepts of (i) virtual displacement (ii) virtual Force and virtual work and write down appropriate equations of them   6 marks

(b) Obtain the equation which relates virtual work with non-constraint forces   6 marks