NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

InSTEM

QUALIFICATION: INTRODUCTION TO SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS	
QUALIFICATION CODE: 04STEM	**LEVEL:** 4
COURSE CODE: IPH401S	**COURSE NAME:** INTRODUCTION TO PHYSICS A
SESSION: NOVEMBER 2019	**PAPER:** N/A
DURATION: 3 HOURS	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**Ms Ilana Malan** **Ms Oksana Kachepa**
MODERATOR:	**Mr Anthony Apata**

INSTRUCTIONS
1. Answer all questions. 2. Write all the answers in ink. 3. No books, notes, correction fluid (Tippex) or cell phones allowed. 4. Pocket calculators are allowed. 5. You are not allowed to borrow or lend any equipment or stationary. 6. All **FINAL ANSWERS** must be rounded off to **THREE DECIMAL PLACES**. 7. All CONSTANT VALUES and FORMULAS on page 8.

THIS QUESTION PAPER CONSISTS OF 8 PAGES (Excluding this front page)

SECTION A

This section consists of nine (9) questions. Choose the correct answer and clearly indicate your answer.

Question 1 **[3]**

A student walks 8 km due south and then 12 km due west. What is the resultant displacement?

(a) 14.422 km @ 56^0
(b) 14.422 km @ 326^0
(c) 11.314 km @ 146^0
(d) 11.314 km @ 326^0

Question 2 **[3]**

A mass is launched at 30^0 to the horizontal with initial speed 25.0 m/s. What is the maximum height reached?

(a) 6.251 m
(b) 12.508 m
(c) 7.964 m
(d) 5.674 m

Question 3 **[3]**

A cannon of mass 900 kg fires a 20 kg shell at a velocity of 180 m s^{-1}. What is the recoil velocity of the cannon?

(a) 4 m/s
(b) 3 m/s
(c) 1 m/s
(d) 10 m/s

Question 4 **[3]**

A bullet of mass 30 g and travelling at a speed of 200 m s^{-1} embeds itself in a wooden block. The bullet penetrates a distance of 10 cm into the wood. What is the average resistive force acting on the bullet?

(a) 2000 N
(b) 4000 N
(c) 2500 N
(d) 6000 N

Question 5 **[4]**

A locomotive with a mass of 6 t and a tractive resistance of 0.5 N / kg travels at a constant speed of 36 km/h on a straight horizontal track. Determine the work done in 10 minutes.

(a) 176.580 MJ
(b) 153.441 MJ
(c) 839.562 MJ
(d) 993.473 MJ

Question 6 **[4]**

In an attempt to increase the volume of a cylinder, the gas is heated for 3 minutes at a rate of 25 kW and an efficiency of 80 %. At a certain temperature the gas pushes an adjustable piston 30 mm outwards. If the radius of the piston is 8 cm and pressure is 3 atm, determine the change in the internal energy of the gas.

(a) 3600183.353 J
(b) 4893064.483 J
(c) 9337402.721 J
(d) 3700750.738 J

Question 7 **[3]**

A sample of gas contains 3.0 X 10^{24} atoms. What volume is occupied by the gas at a temperature of 27^0 C and pressure of 120 kPa?

(a) 1.512 m^3
(b) 2.436 m^3
(c) 1.831 m^3
(d) 0.104 m^3

Question 8 **[3]**

When a certain gas is doubled in initial volume and pressure decreases by a third, what will the final temperature be in relation to the initial temperature?

(a) $T_2 = \frac{4}{3}T_1$

(b) $T_2 = \frac{2}{3}T_1$

(c) $T_2 = \frac{1}{3}T_1$

(d) $T_2 = \frac{3}{2}T_1$

Question 9 **[4]**

A 500 W kettle contains 500 g of water at 20^0C. What time is needed to raise the temperature of the water to boiling point?

(a) 4 min 23 s
(b) 5 min 2 s
(c) 5 min 36 s
(d) 3 min 4 s

SECTION B – TOTAL MARKS 70

This section consists of six (6) questions. Answer ALL the questions.

Question 10 **[16]**

10.1 Determine the magnitude and direction of the equilibrant force of the following three forces: (7)
70 N @ 40°
15 N @ 270°
85 N @ 120°

10.2 A non-uniform wooden bar of mass 220 g and length 1.6 m is pivoted at the centre. Three loads of masses 15 g, 30 g and 65 g are placed on the bar and keep it in horizontal equilibrium. 15 g is placed 18 cm from the right end of the rod, 30 g load is 42 cm from the left end and 65 g is placed 31 cm from the right end.

10.2.1 Determine the position of the center of mass of the bar. (4)

10.2.2 The pivot is moved 10 cm to its left. The position of the centre of mass and all three masses remain as in 10.2.1. The magnitude of the centre of mass, the 65 g and the 15 g masses remain as in 10.2.1. How should the 30 g mass change to maintain horizontal equilibrium? (5)

Question 11 **[9]**

11.1 State three requirements for simple harmonic motion. (4)

11.2 The graph of displacement x against time t for an object executing simple harmonic motion (s.h.m.) is shown in **Figure 1**.

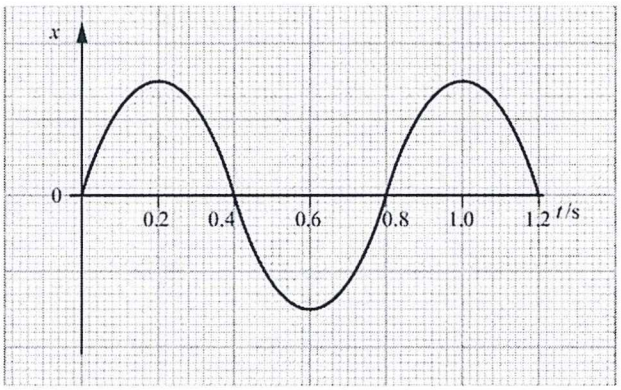

Figure 1

11.2.1 State a time at which the object has maximum speed. (1)

11.2.2 State a time at which the magnitude of the object's acceleration is a maximum. (1)

11.3 Three graphs of displacement x against time t (a), velocity v against time t (b) and acceleration a against time t (c) of an oscillating object are shown in **Figure 2** below.

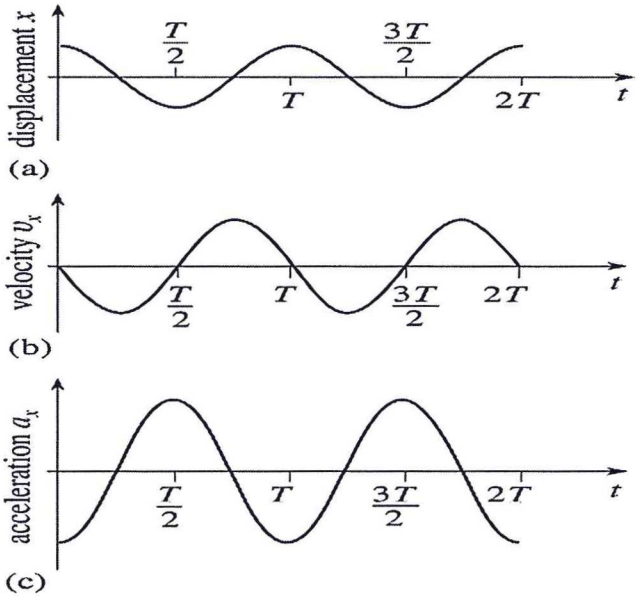

Figure 2

State the phase difference between:

11.3.1 displacement-time and velocity-time graphs (1)
11.3.2 velocity-time and acceleration-time graphs (1)
11.3.3 displacement-time and acceleration-time graphs (1)

Question 12 **[15]**

12.1 A ball is thrown at an angle of 35^0 to the horizontal and velocity of 4 m/s from the top of the building of height 10 m. Using the time symmetry and velocity symmetry principles determine:

12.1.1 Maximum height reached by the ball from the ground. (2)
12.1.2 Total time of flight. (5)
12.1.3 The range of the ball. (1)

12.2 A truck with a mass of 6 t drives down a slope of 1 in 8 at a constant speed of 10 km/h. The resistance to motion of the truck is 190N/kN of the weight of the truck.
12.2.1 Calculate the work done by the truck in a half hour. (6)
12.2.2 Determine the power required if the truck was driving on a horizontal surface. (1)

Question 13 **[9]**

13.1 State the principle of conservation momentum. (2)
13.2 A ball of mass 210 g moving at a speed of 23 m s^{-1} hits a wall at right angle and rebounds at a speed of 19 m/s. The ball is in contact with the wall for 0.31 s.
13.2.1 Calculate the change in momentum of the ball. (3)
13.2.2 Calculate the magnitude of the average force acting on the ball. (1)
13.2.3 Determine energy lost in collision. (3)

Question 14 **[11]**

14.1 Define the specific heat capacity of a substance. (2)

14.2 A small object of mass m = 250 g and unknown specific heat capacity c, initially at 100 °C, is placed into a body of liquid with a heat capacity of 1300 J K^{-1}, initially at 20 °C. The final equilibrium temperature is 27 °C. What is the value of c? Ignore any heat that may be absorbed by the vessel containing the liquid. (4)

14.3 154 g of crushed ice at -20^0 C is removed from a freezer and placed in a calorimeter. Thermal energy is supplied to the ice at a constant rate of 530 W. To ensure that all the ice is at the same temperature, it is continually stirred. The temperature of the contents of the calorimeter is recorded every 15 seconds. **Figure 3** below shows the variation with time t of the temperature ϑ of the contents of the calorimeter.

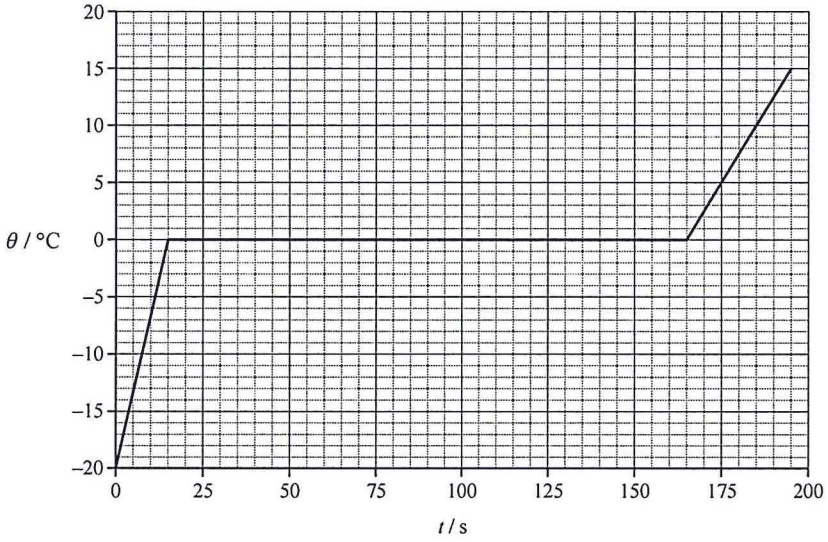

Figure 3

14.3.1 Determine the specific heat capacity of ice. (3)

14.3.2 Determine the specific latent heat of fusion of ice. (2)

Question 15 **[10]**

15.1 List four assumptions of the kinetic model of ideal gases. (4)

15.2 An ideal gas is kept in a cylinder by a piston that is free to move. The gas is heated such that its internal energy increases and the pressure remains constant. Use molecular model of ideal gases to explain the increase in internal energy. (2)

15.3 A cylinder contains 50 L of argon gas at 18.4 atm and 127 ^{0}C. How many moles of argon gas is in the cylinder? (2)

15.4 The volume of the cylinder is decreased by a half at a constant temperature, what is the new pressure of argon gas in atm and in Pa? (2)

THE END

Constants:

$g = 9.81\ m/s^2$
$0\ K = -273.15\ ^oC$
$1\ atm = 101325\ Pa$
$C_{water} = 4200\ J/kg^0C$

one year = 365.25 days
$R = 8.31\ J/mol\ K$
$1\ m^3 = 1000\ L$
$N_A = 6.02 \times 10^{23}\ mol^{-}$

Formulae:

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{average velocity} = \frac{\text{displacement}}{\text{time}}$$

$$\text{average velocity} = \frac{u + v}{2}$$

$$a = \frac{v - u}{t}$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$F = ma$$

$$\text{moment} = Fs$$

$$\text{work} = Fs$$

$$\text{pressure} = \frac{F}{A}$$

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$\eta = \frac{\text{output}}{\text{input}} \times 100\%$$

$$\text{power} = \frac{\text{work}}{t}$$

$$\text{power} = F \times \text{velocity}$$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$F = \frac{\Delta\text{momentum}}{\Delta t} = \frac{\Delta p}{\Delta t}$$

$$f = \frac{1}{T}$$

$$\Delta U = \Delta Q + \Delta\text{work}$$

$$E = mc\Delta T$$

$$E = mL$$

$$pV = nRT$$

$$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$$

$$\text{work} = pAs = p\Delta V$$

10^3	kilo	K	10^{-2}	centi	c
10^6	Mega	M	10^{-3}	milli	m
10^9	Giga	G	10^{-6}	micro	μ
10^{12}	Tera	T	10^{-9}	nano	n
10^{15}	Peta	P	10^{-12}	pico	p