



**PAMIBIA UNIVERSITY**  
OF SCIENCE AND TECHNOLOGY

**FACULTY OF ENGINEERING**

**InSTEM**

<b>QUALIFICATION: INTRODUCTION TO SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS</b>	
<b>QUALIFICATION CODE: 04STEM</b>	<b>LEVEL: 4</b>
<b>COURSE CODE: IPH402S</b>	<b>COURSE NAME: INTRODUCTION TO PHYSICS B</b>
<b>SESSION: NOVEMBER 2019</b>	<b>PAPER: N/A</b>
<b>DURATION: 3 HOURS</b>	<b>MARKS: 100</b>

<b>FIRST OPPORTUNITY EXAMINATION QUESTION PAPER</b>	
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<p style="text-align: center;"><b>INSTRUCTIONS</b></p> <ol style="list-style-type: none"><li>1. Answer all questions.</li><li>2. Write all the answers in ink.</li><li>3. No books, notes, correction fluid (Tippex) or cell phones allowed.</li><li>4. Pocket calculators are allowed.</li><li>5. You are not allowed to borrow or lend any equipment or stationary.</li><li>6. All <b>FINAL ANSWERS</b> must be rounded off to <b>THREE DECIMAL PLACES</b>.</li><li>7. All <b>CONSTANT VALUES</b> and <b>FORMULAS</b> on page 7.</li><li>8. Periodic Table on page 8.</li></ol>
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**THIS QUESTION PAPER CONSISTS OF 8 PAGES (Excluding this front page)**

## SECTION A

This section consists of ten (10) questions. Choose the correct answer and clearly indicate your answer.

**Question 1** [2]

Water flows through a pipe of internal diameter 22 cm at the speed of 1m/s. What should the diameter of the nozzle be if the water is to emerge at the speed of 4 m/s?

- (a) 5.5 cm
- (b) 44 cm
- (c) 5 cm
- (d) 11 cm

**Question 2** [2]

The predominant frequency of a certain police car's siren is 1800 Hz when at rest. What frequency do you detect if you move towards the car with a speed of 60 km/h?

- (a) 1900 Hz
- (b) 1888 Hz
- (c) 2300 Hz
- (d) 1966 Hz

**Question 3** [2]

Aluminium wire has a diameter of 3 mm. How many meters of aluminium wire is needed to give a resistance of 1  $\Omega$ ?

- (a) 252.449 m
- (b) 168.299 m
- (c) 80.357 m
- (d) 13.195 m

**Question 4** [2]

What is the work function of sodium metal if the photoelectric threshold wavelength is 680 nm?

- (a) 10.625 eV
- (b) 2.583 eV
- (c) 1.827 eV
- (d) 1.224 eV

**Question 5****[4]**

An oscilloscope with a time-base set at 3 ms/div is used to display a wave from a pitchfork. 8 waves cover 6 divisions. What is the frequency of the wave?

- (a) 0.457 kHz
- (b) 1.320 kHz
- (c) 0.973 kHz
- (d) 0.444 kHz

**Question 6****[2]**

A source emits a sound of frequency 440 Hz. It moves in a straight line towards a stationary observer with a speed of 30 m/s. The observer hears a sound of frequency 484 Hz. What is the speed of sound in air?

- (a) 340 m/s
- (b) 343 m/s
- (c) 300 m/s
- (d) 330 m/s

**Question 7****[2]**

A multi-stage transformer has 120 primary coils. The secondary loop can be connected to have 120, 60, or 30 and 10 secondary coils. If voltage incoming is to be cut in half, how many secondary coils should be chosen?

- (a) 120
- (b) 60
- (c) 30
- (d) 10

**Question 8****[3]**

If the count rate from a radioactive source is 500 counts per minute and drops to 31.25 counts per minute in 30 minutes, what is the half-life of the source?

- (a) 900 s
- (b) 225 s
- (c) 450 s
- (d) 113 s

**Question 9****[4]**

How many electrons flow through a light bulb in 5 minutes if the current through the light bulb is 650 mA?

- (a)  $221.885 \times 10^{20}$
- (b)  $161.979 \times 10^{19}$
- (c)  $123.855 \times 10^{18}$
- (d)  $121.875 \times 10^{19}$

**Question 10****[4]**

A metal object has a mass of 610 g in air and 550 g in water. What is the density of the metal?

- (a)  $10166.667 \text{ kg/m}^3$
- (b)  $20166.653 \text{ kg/m}^3$
- (c)  $7166.254 \text{ kg/m}^3$
- (d)  $9166.167 \text{ kg/m}^3$

**Question 11****[3]**

Which of the following is NOT a use of UV light?

- (a) sterilize hospital equipment
- (b) assist body to produce vitamin D
- (c) identify counterfeit paper money
- (d) cause cancer

SECTION B – TOTAL MARKS 70

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

Question 12

[15]

12.1 State two Kirchoff's laws. (2)

12.2 Given that:  $\mathcal{E}_1=15\text{ V}$ ,  $\mathcal{E}_2= 9\text{ V}$ ,  $R_1=15\Omega$ ,  $R_2= 8\ \Omega$  and  $R_3= 5\ \Omega$ . Determine the currents  $i_1$ ,  $i_2$  and  $i_3$  in Figure 1. (6)

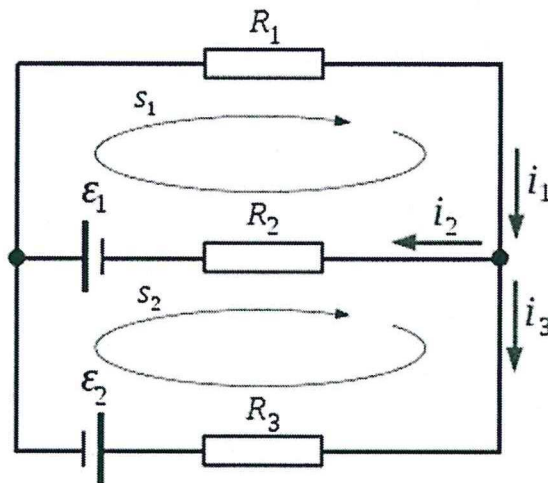


Figure 1

12.3 Define capacitance of a capacitor and its unit. (2)

12.4 Three capacitors of 8F, 12F and 6F are connected to a 15V battery as shown in Figure 2.

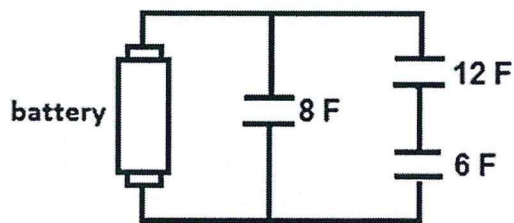


Figure 2

12.4.1 Determine the total capacitance. (2)

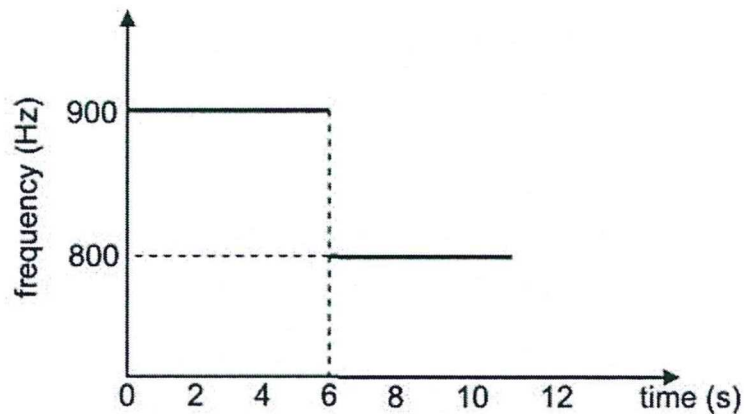
12.4.2 Determine the charges stored on each capacitor. (3)

**Question 13****[16]**

- 13.1 State Archimedes' Principle. (2)
- 13.2 A cubic block of oak of volume  $110 \text{ cm}^3$  is floating in olive oil. Determine the height of oak block that can be seen above the surface of oil. Give your answer in m. (5)
- 13.3 Describe an ideal fluid. (3)
- 13.4 A reservoir of dimensions  $14 \text{ m} \times 20 \text{ m}$  with a depth of  $2 \text{ m}$ , needs to be filled with water. A hose with a diameter of  $45 \text{ mm}$  is used while the water is pumped from a nearby supply.
- 13.4.1 If the reservoir is filled to two-thirds of the depth in 5 hours, determine the velocity with which the water flows out of the pipe. (4)
- 13.4.2 How long will it take for the reservoir to be filled to the same depth in 12.4.1 if there is an obstruction in the pipe and the area of the pipe is halved? Give a reason for your answer. (2)

**Question 14****[8]**

- 14.1 Explain the Doppler effect (2)
- 14.2 The siren of a stationary ambulance emits sound waves at a frequency. An observer, travelling in a car at a constant speed in a straight line, begins measuring the frequency of the sound waves emitted by the. The results obtained are shown in Figure 3.

**Figure 3**

- 14.2.1 Calculate the speed of the car. (4)
- 14.2.2 Calculate the frequency of the siren. (2)



**Question 15** [9]

- 15.1 Define the following concepts:
- 15.1.1 threshold frequency (1)
  - 15.1.2 work function (1)
  - 15.1.3 electronvolt (2)
- 15.2 The velocity of an electron ejected from magnesium with a work function of 3.7 eV, is calculated to be  $1.481 \times 10^6$  m/s.
- 15.2.1 Determine the frequency of the incident light. (4)
  - 15.2.2 Determine  $f_0$ . (1)

**Question 16** [13]

- 16.1 Explain what is meant by:
- 16.1.1 random decay (1)
  - 16.1.2 spontaneous decay (1)
  - 16.1.3 half-life (1)
- 16.2 A sample of a radioactive element has 9100 active nuclei. It takes 371 days for 9028.90625 of the active nuclei to decay. Determine the half-life of this element using a decay table. (5)
- 16.3 Radon ( ${}^{222}_{86}\text{Rn}$ ) decays and emits four  $\alpha$ -particles and three  $\beta$ -particles.
- 16.3.1 State a new element produced in this decay. (2)
  - 16.3.2 Write the balanced equation of this decay. (3)

**Question 17** [9]

- 17.1 Explain how the current can be induced in the coil. (2)
- 17.2 Give three ways in which induced current can be increased. (3)
- 17.3 A step-down transformer has a turns ratio of 10:3. When alternating voltage of 0.4 kV is applied to the primary coil, a current of 35 mA flows in it. Determine the current in the secondary coil if the transformer is 90 % efficient. State your answer in mA. (4)

**THE END**

### Constant values:

density of fresh water =  $1000 \text{ kg/m}^3$   
density of oak =  $710 \text{ kg/m}^3$   
density of olive oil =  $920 \text{ kg/m}^3$   
speed of light in a vacuum =  $3 \times 10^8 \text{ m/s}$   
Planck's constant =  $6.626 \times 10^{-34} \text{ Js}$   
mass of an electron =  $9.1 \times 10^{-31} \text{ kg}$   
elementary charge =  $1.6 \times 10^{-19} \text{ C}$   
mass of a proton =  $1.67 \times 10^{-27} \text{ kg}$   
speed of sound in air =  $340 \text{ m/s}$   
 $g = 9.81 \text{ m/s}^2$   
resistivity of aluminium =  $2.8 \times 10^{-8} \Omega\text{m}$

### List of equations

$v = f\lambda$	$P = \frac{F}{A}$	$P = \rho gh$
$F_B = W_f$	$\rho = \frac{m}{V}$	flow rate = $\frac{V}{t} = Av$
$A_1v_1 = A_2v_2$	$Q = \frac{I}{t}$	power = $VI$
$f_o = f \left( \frac{v \pm u}{v} \right)$	$f_o = f \left( \frac{v}{v \pm u} \right)$	$emf = (I_T R_T) + (I_T r_T)$
$R = \rho \frac{L}{A}$	$C = \frac{Q}{V}$	$power_p = power_s$
$E = hf = \phi + KE$	$N_p : N_s = V_p : V_s$	



# Periodic Table of the Elements

Period	1
1	H

**KEY**

Atomic Mass → 12.011

Symbol → C

Relative Oxidation States → +4, +2, -4

Electron Configuration → 2-4

Note: Mass numbers in parentheses are mass numbers of the most stable or common isotope.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18							
1	Li	Na	K	Rb	Cs	Fr	He	Ne	Ar	Kr	Xe	Rn												
2	Be	Mg	Ca	Sr	Ba	Ra	Li	Be	B	C	N	O	F	Ne										
3							Na	Mg	Al	Si	P	S	Cl	Ar										
4							K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5							Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6							Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7							Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub						

\*Denotes the presence of (2s-1) for elements 72 and above

\*The systematic names and symbols for elements of atomic numbers above 109 will be used until the approval of trivial names by IUPAC.

8	9	10	11	12	13	14	15	16	17	18			
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	ES	Fm	Md	No	Lr
90	91	92	93	94	95	96	97	98	99	100	101	102	103