PHYSICS

PHY 01

27/07/ 2022 8:30 AM - 11:30 AM

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

TTC NATIONAL EXAMINATIONS, 2021-2022

OPTION: SCIENCE AND MATHEMATICS EDUCATION (SME)

SUBJECT: PHYSICS

INSTRUCTIONS

1) Write your names and index number on the answer booklet as written on your registration form, and **DO NOT write** your names and index number on additional answer sheets if provided.
2) Do not open this question paper until you are told to do so.
3) This paper consists of three sections: **A, B** and **C**

SECTION A: Attempt **all** questions. **(55 marks)**

SECTION B: Attempt any **three** questions. **(30 marks)**

SECTION C: Compulsory question. **(15 marks)**

Useful constants

Planck's constant $h=6.63 \times 10^{-34} Js$

Speed of light in vacuum $C=3 \times 10^{8}$ m/s

Electric charge of electron $e=1.6 \times 10^{-19} C$

Universal gravitational constant $G=6.67 \times 10^{-11} Nm^2/kg^2$.

$1\ eV = 1.6 \times 10^{-19} J$

SECTION A: ATTEMPT ALL QUESTIONS (55 marks)

1) Choose the correct answer.

a) Which of the following physical quantities is a scalar quantity?

(i)Velocity (ii) Force (iii) Pressure (iv) Acceleration

(1 mark)

b) A measuring instrument used to measure thickness of a single sheet of paper is:

(i) Metre rule (ii) Thermometer (iii) Measuring tape

(iv) Micrometer screw gauge

(1 mark

c) Which pair of unit and symbol below is correct?

(i)Electric charge: A (ii) Weight: kg (iii) Speed: s (iv) Energy: J

(1 mark)

d) Which of the following is a fundamental physical quantity?

(i) Power (ii) Amount of substance (iii) volume (iv) voltage

(1 mark)

2) State whether each of the statements below is **true** or **false**.

a) Opening and closing of a door about the hinges is an example of torque in day-to-day life. **(1 mark)**

b) The principle of moments states that when a body is balanced, the total sum of the clockwise moments about a point equals the total sum of the anticlockwise moments about the same point. **(1 mark)**

c) The centre of gravity of a body is defined as a point where the entire mass of the body appears to be concentrated. **(1 mark)**

d) A body is said to be in unstable equilibrium if on being slightly displaced it remains in its new position. **(1 mark)**

3) Complete each of the following statements using the term from the box.

Optical receiver	Free space	Antenna
Total internal reflection		

a) .....is an electrical device connected (often through a transmission line) to the receiver or transmitter which converts electrical signals into radio waves, and vice versa. **(1 mark)**

b) The communication using optical fibres is based on the principle of ..... **(1 mark)**

c) .....is an example of communication channel. **(1 mark)**

d) .....uses a photocell to detect the light and convert light signals to proportional electrical signals and recover the data transmitted through the light wave system. **(1 mark)**

4) Match the elements from Column **A** with elements from column **B** **(4 marks)**

Column A	**Column B**
Bosons	Include particles of the class of leptons
Fermions	They are hadrons
Baryons	Their exchange particles are photons
Electromagnetic forces	Force carrier particles

5) a) Enumerate two properties of **X**-rays. **(2 marks)**
b) List any two dangers of **X**- rays. **(2 marks)**

6) a) Write in full the acronym LASER. **(1mark)**

b) State any two properties of LASER light. **(2 marks)**

7) a) Use Kepler's law of area to find the time taken by a planet to sweep an area of 2×10^6 km^2 if the time taken by the same planet to cover an area of 1×10^6 km^2 is 36 hours. **(2 marks)**

b) Calculate the gravitational force of attraction between the Earth and the Sun given that the mass $\mathbf{M_s}$ of Sun and the mass $\mathbf{M_e}$ of the Earth are respectively 2.00×10^{30} kg and 6×10^{24}kg.
The distance **d** from Earth to the Sun (centre to centre) is 150×10^6 km. **(2 marks)**

8) a) Draw an isobaric process on a P-T diagram below (***figure1***).

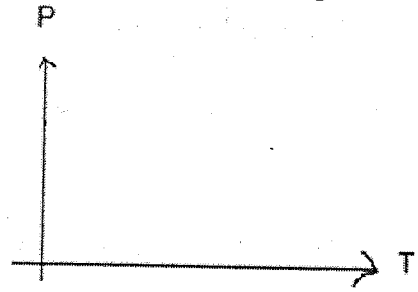

Figure 1

(1 mark)

b) A Carnot's engine whose low temperature reservoir is at 300 K has an efficiency of 40%.
What should be the temperature of a high temperature reservoir? **(2 marks)**

9) An object that moves in uniform circular motion has a centripetal acceleration of 13 m/s^2. The radius of the circular motion is 2 cm.

a) Convert 2 cm to m. **(1 mark)**

b) Find the linear velocity of the object. **(2 marks)**

10) a) Explain the term constellation as used in Physics. **(1mark)**
b) Differentiate between stars and planets. **(2 marks)**

11) a) (i) The relation for the Compton effect is $\lambda'-\lambda = (h/m_0c)(1-\cos\theta)$
Give the expression of the Compton wavelength of an electron. **(1 mark)**

(ii) Why is λ' greater than λ? **(1mark)**

b) How does increasing temperature of a black body affect the peak wavelength of emitted radiation from a black body?
Explain your answer. **(2 marks)**

12) A progressive wave is described by the equation $Y = 4\sin(\frac{2\pi}{0.02}t - \frac{2\pi}{100}x)$.

Where **Y** and **x** are in cm and **t** in **s**
Find a) Its amplitude. **(1 mark)**
b) Its wavelength. **(1 mark)**
c) Its frequency. **(1 mark)**

13) Differentiate between compound microscope and astronomical telescope. **(4 marks)**

14) Which is a more reliable system to be used in telecommunication, analog system or digital system? Justify your answer. **(4 marks)**

15) Relate the greenhouse effect to the climate change (15 lines maximum). **(4 marks)**

SECTION B: ATTEMPT ANY THREE QUESTIONS (30 marks)

16) a) (i) Construct a circuit element comprising two resistors connected in parallel. **(1 mark)**

(ii) Evaluate the advantages of parallel connection of electrical devices. **(3 marks)**

b) Consider the electrical circuit diagram depicted in ***figure 2***

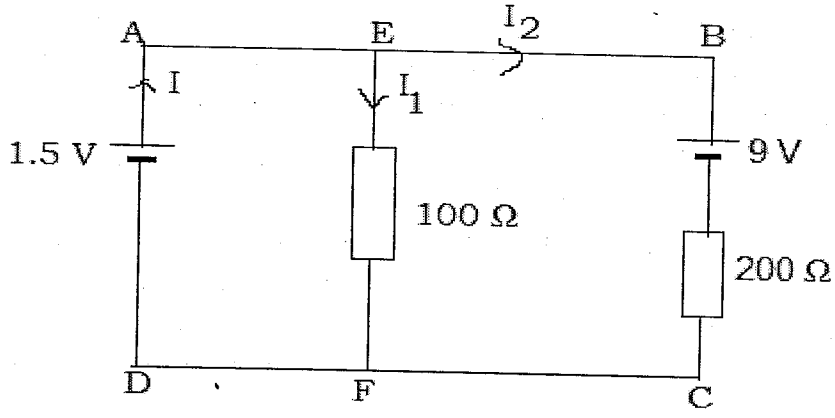

Figure 2

Analyze this electrical circuit to determine the electrical currents I, I_1 and I_2 to three decimal places. The electrical current may have a negative or positive sign depending on its direction indicated on the diagram. **(6 marks)**

17) Use essay form to discuss at least six imaging techniques used in medical imaging. **(10 marks)**

18) The graph below (***figure 3***) shows variation with time of the displacement **X** of a 0.32 kg object undergoing simple harmonic motion.

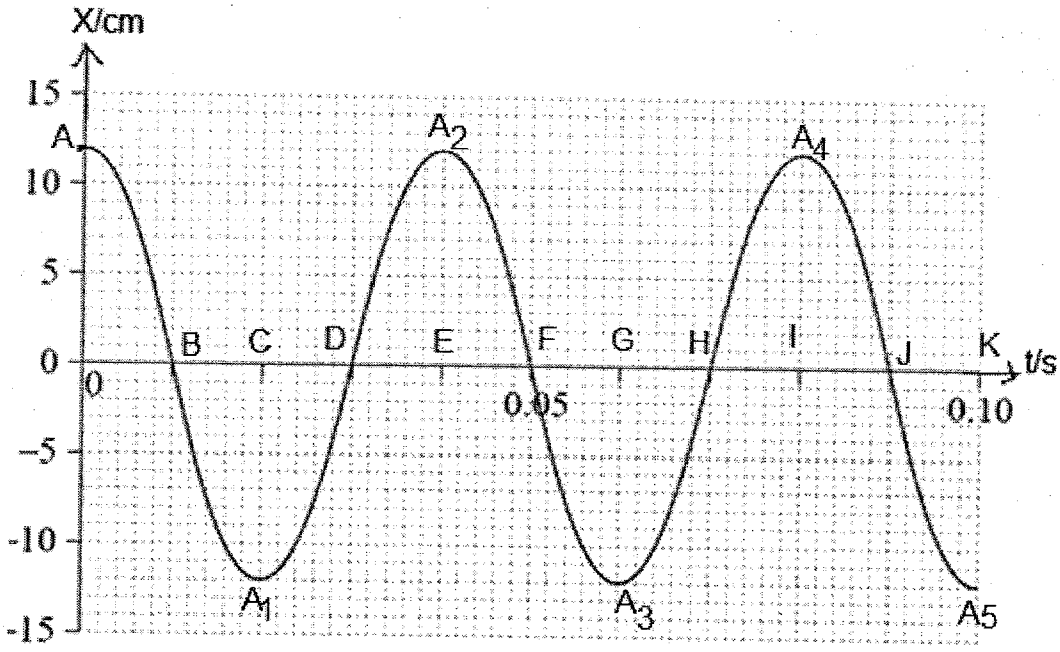

Figure 3

a) From the graph, find

(i) The value **A** of the displacement. **(1mark)**

(ii) The period **T** of oscillations. **(1mark)**

b) From the graph, identify a point where the magnitude of each of the following physical quantities is maximum.

(i) Acceleration of the object. **(1mark)**

(ii) Velocity of the object. **(1mark)**

c) Determine the angular velocity of the object. **(2 marks)**

d) Find the maximum kinetic energy of the object. **(2 marks)**

e) Use the data from the graph and the obtained results to draw the graph of kinetic energy(y-axis) against displacement X (x-axis). **(2 marks)**

19) The apparatus shown below (***figure 4***) is used to investigate photoelectric emission from a metal surface when electromagnetic radiation is incident on it.

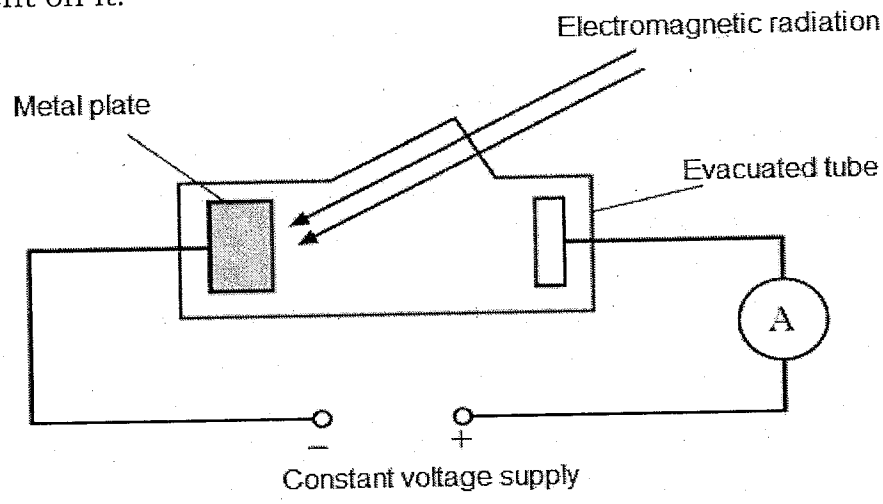

Figure 4

a) When light of wavelength 605 nm is incident on the metal plate, electrons are released with zero kinetic energy.

(i) Use power of ten (scientific notation) to express 605 nm in m. **(1 mark)**

(ii) Demonstrate that the work function of this metal is 3.29×10^{-19}J. **(2 marks)**

(iii) Convert 3.29×10^{-19}J into electron volts (eV). **(2 marks)**

b) The wavelength of the incident radiation is now altered. Photons of energy 5.12×10^{-19}J are incident on the metal plate. Calculate the maximum kinetic energy of electrons just as they leave the metal plate. **(2 marks)**

c) The intensity of incident radiation on the metal plate is now decreased. State the effect this has on the ammeter reading. Justify your answer. **(2 marks)**

d) Provide one real life application of photoelectric effect. **(1 mark)**

20) a) (i) Differentiate between longitudinal wave and transverse wave **(2 marks)**

(ii) Give an example of longitudinal wave. **(1 mark)**

(iii) Provide an example of transverse wave. **(1 mark)**

b) What do you understand by the following terms?
(i) Interference of sound waves. **(1mark)**
(ii) Diffraction of sound waves. **(1mark)**

c) ***Figure 5*** shows an electric bell ringing in a sealed glass chamber containing air. A student hears the bell ringing.

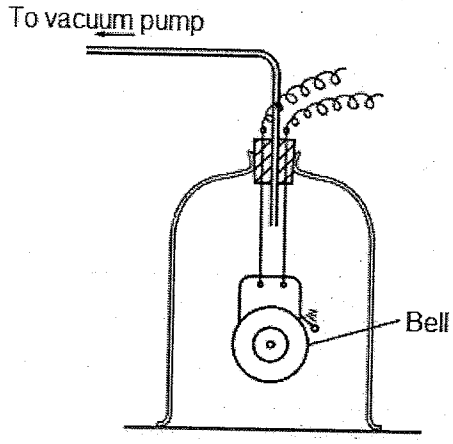

Figure 5

The air is then removed from the chamber.
(i) State any change in the sound heard by the student. **(1 mark)**
(ii) Explain your answer in (i) above. **(1 mark)**

d) A device at the bottom of the sea emits a sound wave of frequency 200 Hz. The speed of sound in sea-water is 1500 m/s.
The sound wave passes from the sea-water into the air and therefore it undergoes refraction.
What happens to the following?
(i) The frequency of this sound wave. **(1 mark)**
(ii) The speed of this sound wave. **(1 mark)**

SECTION C: COMPULSORY QUESTION (15 marks)

21) A student is investigating the focal length of a lens.
The apparatus is shown, not to scale, in ***figure 6***

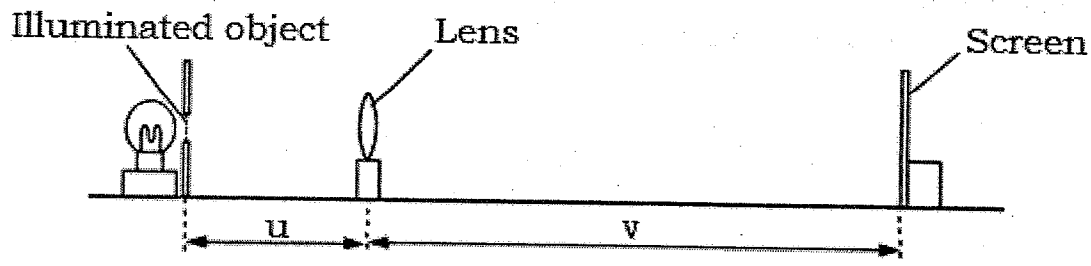

Figure 6

Procedures

The student places a lens at a distance u = 20.0 cm from an illuminated object.

He/ she moves the screen until a sharply focused image of the object is seen on the screen.

He/ she measures the distance v between the centre of the lens and the Screen.

He/ she calculates 1/u and 1/v to two decimal places.

He/ she repeats the procedure using a range of values of u and recorded The results in a suitable table using SI unit.

Table of results

u/m	v/m	$\frac{1}{u}/\frac{1}{m}$	$\frac{1}{v}/\frac{1}{m}$
0.200	0.600	5.00	
0.250	0.392	4.00	
0.300	0.305	3.33	
0.350	0.260	2.86	
0.450	0.222	2.22	
0.600	0.196	1.67	

Questions

a) Calculate the value of 1/v for each reading of v to two decimal places and enter the values in the table including only 1/v. **(3 marks)**

b) Use a graph paper to plot a graph of **1/v** (y-axis) against **1/u** (x-axis). Begin both axes at the origin (0, 0) 2 cm from the left side of the graph paper. The scale must allow the best-fit line when extended beyond the range of the data, to cross both axes. **(6 marks)**

c) (i) From the graph, determine the value p of **1/u** when **1/v** is zero (the x-intercept). **(1 mark)**

(ii) From the graph, determine the value q of **1/v** when **1/u** is zero (the y-intercept). **(1 mark)**

d) The student suggests that the focal length **f** of the lens $f=2/(p+q)$. Calculate **f**. **(1 mark)**

e) State whether the result support this suggestion. Justify your answer. **(2 marks)**

f) Suggest any one precaution that you would use in this investigation in order to obtain reliable results. **(1 mark)**

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