PHYSICS

Date: 29 /June /2023

Period: 8:30 am-11:30 am

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

END OF TERM III EXAMINATIONS

GRADE : **S 2**

COMBINATION : **O'LEVEL**

DURATION: **3 HOURS**

MARKS: ..... /100

INSTRUCTIONS

This paper is composed of two Sections **A** and **B**

Section A: Attempt all 15 questions. **(70 marks)**

Section B: Attempt any three (3) out of 5 questions. **(30 marks)**

SECTION A: ATTEMPT ALL QUESTIONS (70 MARKS)

1) State any two causes of each of the following types of errors

a) random error. **(2 marks)**

b) systematic error. **(2 marks)**

2) Choose the correct answer

a) Which of the following equations of motion can be used to determine the distance or displacement travelled by a body directly?

The symbols have their usual meanings.

i) $s = vt + a$ ii) $v^2 + u^2 = 2as$ iii) $s = ut + \frac{1}{2}at^2$

iv) Both $v^2 + u^2 = 2as$ and $s = ut + \frac{1}{2}at^2$.

(1mark)

b) Horizontal line on a distance -time graph shows that

i)the object is not moving ii) the object is travelling at a constant speed

iii)the object is slowing down iv) the object is accelerating

(1mark)

c)A straight horizontal line on a speed -time graph means that

i)the object is slowing down ii) the object is not moving

iii)the object is travelling at a constant speed. iv)the object accelerating

(1mark)

d)The area below a velocity-time graph shows

i) the time taken ii) the acceleration of the moving body

iii)the velocity iv) the distance travelled

(1mark)

c) While a ball is in free fall, it undergoes an increase in

i) acceleration ii) speed iii) both of these iv) neither of these

(1mark)

3) Indicate whether each of the following statements is **true** or **false.**

a) The hydrostatic paradox in fluid dynamics concerns the liquid pressure at all sites at the same depth or horizontal level. **(1 mark)**

b) At every point and in every direction, the pressure exerted inside the liquid at rest is same. **(1 mark)**

c)The pressure at the bottom of the fluid at rest depends upon the depth only. **(1mark)**

d)When a liquid is poured into a communicating vessel, the liquid balances out to the same level in all of the containers regardless of the shape and volume of the containers. **(1mark)**

4) Match each of the following physical quantities **(column A)** with its meaning **(column B)**.

Column A	**Column B**
a) Energy	i) Energy that is stored in an object due to its position relative to some zero position.
b) Power	ii) Capacity to do work
c)Kinetic energy	iii) Rate at which work is done.
d)Potential energy	iv) Energy which a body possesses by virtue of being in motion.

(4 marks)

5) a) Matter is made of tiny particles called atoms and an atom is made of three

particles. List these particles. **(3 marks)**

b) Outline any one method of

i)demagnetization. **(1 mark)**

ii) magnetization. **(1 mark)**

6) a) State the rules to be followed while drawing ray diagrams for concave mirror. **(2 marks)**

b) Name the type of mirror used in each of the following situations.

i)Headlights of a car. **(1mark)**

ii)Rear-view mirror of vehicles. **(1 mark)**

c)What is meant by the term real image in Optics? **(1 mark)**

7) a) Give the names of the physical quantities whose dimensional formula are as follows:

i)$|LT^{-2}|$ **(1mark)**

ii) $|LMT^{-2}|$ **(1 mark)**

b) Which of the following mass measurements is most accurate?

Explain your answer.

i)5.00 kg

ii)5.004 kg

(2 marks)

c)Give an instrument you would use to measure accurately the thickness of a sheet of paper. **(1mark)**

8) The diagram below (figure 1) shows a vehicle supported by a hydraulic lift in a garage.

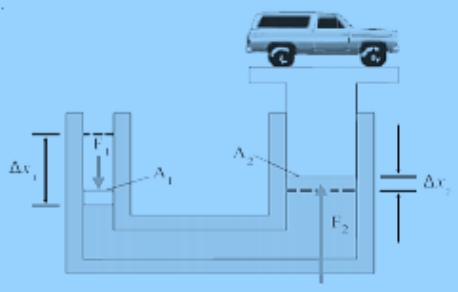


Figure 1

With the aid of the above diagram, explain how a small force F_1 exerted on the small piston(left) produces a great force F_2 on the larger piston(right).

(4 marks)

9) Use the following table to compare Boyle's law and Charles' law.

The symbols have their usual meanings.

Basis for comparison	Charles' law	Pressure law
Qualitative definition		
Physical quantity kept constant		
Similarity		

(5 marks)

10) a) What are two main differences between Zener diode and ordinary diode?

(2 marks)

b) What is the function of the following electronic components in an electric circuit?

i)Resistor. **(1mark)**

ii)transistor. **(1mark)**

iii) capacitor. **(1mark)**

11) A rightward force is applied to a 10 kg object to move it across a rough surface at constant velocity. The coefficient of friction between the object and the surface is 0.2 as shown in figure 2 below. Neglect air resistance. Acceleration due to gravity g=9.81 m/s².

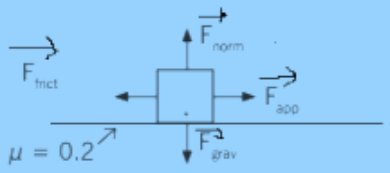


Figure 2

Use the diagram and the given data above-mentioned to determine

a) the gravitational force (weight of the object). **(2 marks)**

b) the normal force. **(1mark)**

c) the frictional force. **(2 marks)**

12) Consider the following electric circuit shown in figure 3.

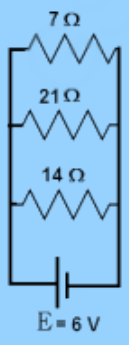


Figure 3

Find a) the total resistance of the electric circuit. **(2 marks)**

b) the electric current flowing through 14 Ω resistor. **(2 marks)**

c)The potential difference across 7 Ω resistor.

Explain your answer. **(2 marks)**

13) Draw an electric circuit comprising one battery, a switch, connecting wires, ammeter, a voltmeter and two resistors of 4 Ω and 2 Ω respectively so that the total resistance is greater than 4Ω. **(5 marks)**

14) a) A body floats in water with its one-third volume above the surface. The same body floats in a liquid with one-third volume immersed. Express the density of the liquid in term of the density of water. **(3 marks)**

b)The density of water is 1 g/cm^3 .The table below shows the densities of 4 different substances.

Substance	**Density/g cm^{-3}**
Substance 1	2
Substance 2	1.5
Substance 3	5
Substance 4	0.5

Which of the above substances will float on water? Explain. **(2 marks)**

15) What would happen if the acceleration due to gravity(g) on Earth increases to a very large value? **(3 marks)**

SECTION B: ATTEMPT ANY THREE QUESTIONS (30 MARKS)

16) a) A body of mass 5 kg weighs 30 N in a liquid.

i)Find the upthrust on the body due to liquid. Acceleration due to gravity g=9.81 m/s^2. **(3 marks)**

ii)Does this body float or sink into the liquid? Explain. **(2 marks)**

b) A metal block of density 7 800 kg/m³ weighs 117 N in air and 105 N in liquid when wholly immersed.

Find i) Volume of the metal block. **(2 marks)**

ii) the density of the liquid. **(3 marks)**

17) A 60 N constant force is exerted on a 10 kg object for 12 seconds. The initial velocity of the object is 6 m/s in the direction of the object that is the same as the direction of the force.

Find:

a) the acceleration of the object. **(1 mark)**

b) the speed of the object at t=12 s. **(2 marks)**

c)The distance travelled. **(2 marks)**

d) The work done by the force. **(2 marks)**

e) Power applied by this constant force. **(2 marks)**

f) Is the work done equal to the increase of kinetic energy? **(1mark)**

18)A 500 g cart travels along a frictionless roller coaster track/road. At point A, the cart is 10 m above the ground and travelling at 2 m/s as shown in figure 4. Air resistance is negligible.

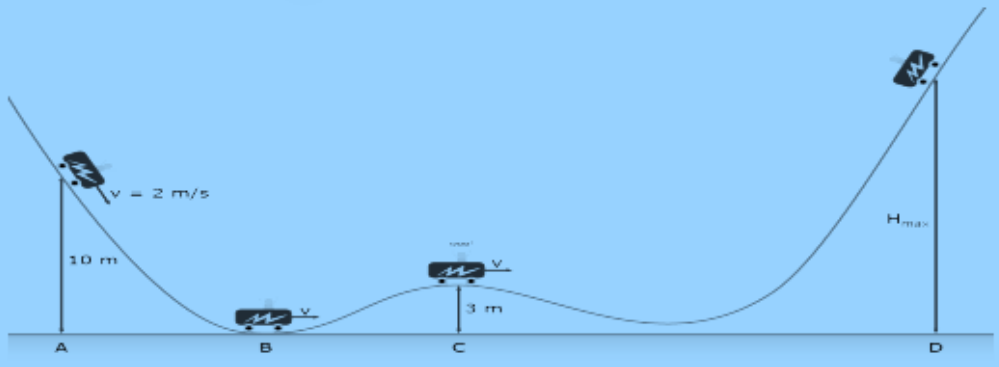


Figure 4

a) State the law of conservation of mechanical energy. **(1 mark)**

b) i) Calculate the total energy /the mechanical energy of the cart at A.

(2 marks)

ii)What is the velocity at point B where the cart reaches the ground?

(4 marks)

c)Will the cart reach the maximum height of 15 m? Justify your answer

(2 marks)

d)What would happen if the friction force is not negligible? **(1 mark)**

19) a) Analyze the following electric field lines (figure 5).

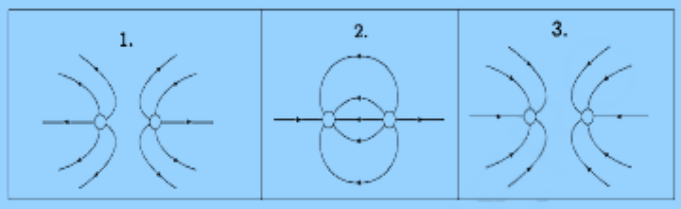


Figure 5

What does each of the above diagram of electric fields represent?

(3 marks)

b) During rain, it is not good to take shelter under tall tree.

Explain why. **(2 marks)**

c) Observe carefully the figure 6 below.

Figure 6

What does the above diagram represent? Explain. **(3 marks)**

d)Observe the following graph (figure 7).

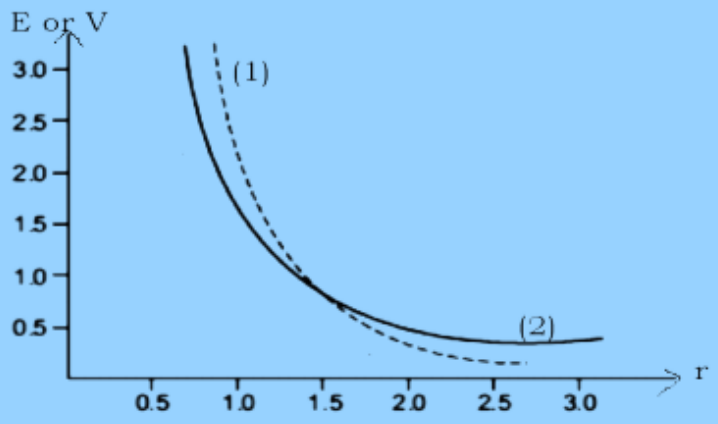


Figure 7

Which of the above graphs (1) and (2) represent the following?

i) The variation of the electric potential with distance r. **(1 mark)**

ii) The variation of electric field E with distance r. **(1mark)**

20)A 5-cm high object is placed in front of a concave mirror with a radius of curvature of 20 cm. The object distance is 5 cm.

a) Find the focal length of the mirror. **(2 marks)**

b) Determine

i) image distance. **(2 marks)**

ii)magnification of image. **(2 marks)**

iii)image height. **(1mark)**

c) Is the obtained image virtual and upright or real and inverted?

Justify your answer. **(3 marks)**

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

END OF TERM III EXAMINATIONS

MARKING SCHEME OF S2 PHYSICS THEORY EXAM 2023

SECTION A: 70 MARKS

1)a) Parallax error if you view the dial from a random angle each time **(1mark)**, natural variations in real world or experimental contexts **(1mark)** reaction time, measurement error from insufficient precision, imprecise or unreliable measurement instruments, poorly controlled experimental procedures.

b) Causes of systematic error include poor instrument calibration**(1mark),** scale error **(1mark),** zero error, environmental influence, and imperfect measurement technique. Parallax error if always you view the dial from the same angle

2) a) iii) **(1mark)***or* $s = ut + \frac{1}{2}at^2$ b) i) **(1mark)** the object is not moving

c)iii) **(1mark)** the object is travelling at a constant speed

d)iv) **(1mark)** the distance travelled e) ii) **(1mark)** speed

3) a) True **(1mark)** b) true**(1mark)** c) False **(1mark)** d) True **(1mark)**

4)a) ii) **(1mark)** b) iii) **(1mark)** c) iv) **(1mark) d) i) (1mark)**

5) a) Electron **(1mark)**, Proton **(1mark)** and Neutron **(1mark)**.

b) i) Heating **(1mark)** Hammering**,** Alternating current

ii) magnetization by induction **(1 mark),** contact /stroking,

Alternating current

6) a) A ray of light running parallel to the principal axis passes through the principal focus F of a concave mirror after reflection**(1mark)**

A ray of light passing through the centre of curvature in a concave mirror is reflected back along the same path**. (1mark)**

A ray of light passing through the principal focus of a concave mirror becomes parallel to the principal axis after reflection.

b) i) Concave mirror **(1mark)**

ii)Convex mirror **(1mark)**

c) A real image is defined as one that is formed when rays of light actually meet at a point after getting reflected from a mirror **(1mark)** or A real image can be projected or seen on a screen.

7) a) i) Acceleration **(1 mark)** gravitational field strength

ii)Force **(1 mark)** weight, upthrust, gravitational force etc.

b)5.004 kg shows the most accurate mass **(1mark)** because it shows exact value till 3 decimal places of measurement**(1mark)** or it has more decimal places.

c)Micrometer screw gauge **(1mark)** or vernier caliper

8) Pascal's principle states that, in a fluid at rest in a closed container, a pressure change in one part is transmitted without loss to every portion of the fluid and to the walls of the container**(1mark)**.

When a small force F_1 is applied to a small area A_1 of a movable piston it

creates a pressure $p = \frac{F_1}{A_1}$. **(1mark)** This pressure $P=\frac{F_1}{A_1}$ is transmitted without loss to a larger movable piston of area A_2 and produces a force F_2 so that $P=\frac{F_2}{A_2}$ **(1mark)** since $\frac{F_2}{A_2} = \frac{F_1}{A_1}$ this gives us $F_2 = F_1 \frac{A_2}{A_1}$ where $A_2 > A_1$ therefore $F_2 > F_1$ **(1mark)** So a small force can be used to lift a car.

9)

Basis for comparison	Charles' law	Pressure law
Qualitative definition	It states that, at constant pressure, the volume of a given amount of ideal gas is directly proportional to the absolute temperature**(1mark)**. Or $\frac{V}{T}$ =constant	It states that, for a given mass and constant volume of an ideal gas, the pressure of an ideal gas is directly proportional to its absolute**(1mark)** or $\frac{P}{T}$ =constant
Physical quantity kept constant	Pressure **(1mark)** or mass of the gas	Volume **(1mark)** or mass of the gas
Similarity	They both deal with the temperature, pressure, and volume of a gas. **(1mark)** or They deal with the ideal gas laws **or** For both laws, the mass of the gas is kept constant	

10)a) An ordinary diode is a semiconductor device which conducts in one direction only**(1mark).** A Zener diode is a semiconductor device which conducts in forward biased as well as reversed biased **(1mark).** A normal diode if operated in reversed biased will get destroyed.

b) i)A resistor is an electrical component that limits or regulates the flow of

electrical current in an electronic circuit **(1mark).** Resistors can also be used to provide a specific voltage for an active device such as a transistor.

ii)The main use of transistor is amplification of electric currents **(1mark)**

iii)The primary function of a capacitor is to store electrostatic energy in an electric field and hence supply this energy whenever possible to the circuit. **(1mark)**

11)a) The gravitational force $F_{grav} = Weight(W) = m \times g$ **(1mark)**

$= 10 \times 9.81\ N = 98.1\ N$ **(1mark)**

b) Normal force(R)= $Weight = 98.1\ N$ **(1mark)**

They are equal in magnitude but opposite in direction

c)Frictional force $F_f = R \times \mu$ **(1 mark)**

$= 0.2 \times 98.1 = 19.62\ N$ **(1mark)**

12) a) The total resistance $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$**(1mark)**

$$\frac{1}{R} = \frac{1}{7} + \frac{1}{14} + \frac{1}{21}\ ,\frac{1}{R} = \frac{6+3+2}{42} = \frac{11}{42}$$

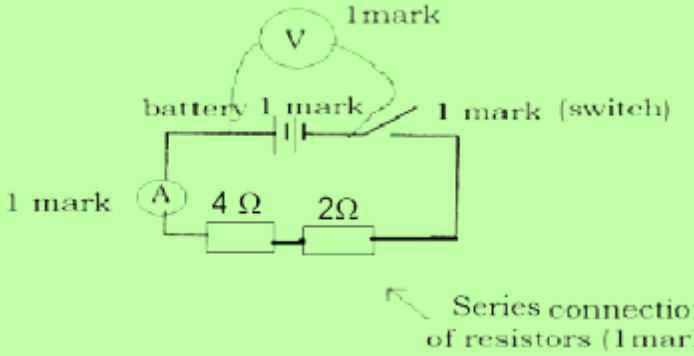
R=3.8 Ω **(1mark)**

b) Electric current I=E/R **(1mark)**

= (6/ 14) A=0.42 A **(1mark)**

c) V=6 **(1 mark)** Resistors are in parallel when each resistor is connected directly to the voltage source by connecting wires having negligible resistance. Each resistor thus has the full voltage of the source applied to it. **(1mark)**

13) Ammeter may be connected anywhere so that the current passes through it.Voltmeter can be connected across one of the resistors or across of the the two resistors connected in series.



14) a) According to the law of floatation the weight of the body is equal to the upthrust due to water.

$$W = \rho_w \left(\frac{2V}{3}\right) g$$ **(1mark)**

Apply the same for the liquid

$$W = \rho_l \left(\frac{1V}{3}\right) g$$ **(1mark)**

$$\rho_w \left(\frac{2V}{3}\right) g = \rho_l \left(\frac{1V}{3}\right) g$$

$$2\,\rho_w = \rho_l$$ **(1mark)**

The density of the liquid is 2 times more than that of the water

b) Substance 4 will float on water **(1mark)** because its density is less than that of water. **(1mark)**

15) The weight of any object will increase. **(1mark)**

All object will speed up when falling down **(1mark)**

Buildings would be slightly weaker and fall more easily **(1mark).**

Trips and falls would become more dangerous.

Our blood pressure would have to increase to overcome the increased gravity.

Mass of the Earth would increase

Bridges will no longer support the weight they supported before. They will collapse.

More force or energy would be needed to get a plane to reach the speed needed to take off

SECTION B: 30 MARKS

17)i) Weight of the body in air W=mg **(1mark)**

= 5x9.81 N=49.05 N**(1mark)**

The upthrust F=49.05 N- 30 N=19.05 N **(1mark)**

ii)It sinks **(1mark)** because the weight of the body is greater than the upthrust **(1 mark)**

b) i) Volume of solid V=W/gρ **(1mark)** =117/7800 x9.81 =0.0015 m^3**(1 mark)**

ii)Apparent loss of weight in liquid U =117-105 =12 N **(1 mark)**

$U = \rho_{liq} gV$ **(1mark)** $12 = \rho_{liq} \times 9.81 \times 0.0015$

$\rho_{liq} = 815\ kg/m^3$ **(1mark)**

17) a) The acceleration a= F/m

= 60 N/ 10 kg = 6 m/s^2 **(1mark)**

b) The speed $V=V_0+at$**(1mark)**

= 6 m/s+ 6 x12 m/s = 78 m/s **(1mark)**

c)Travelled distance $x=at^2/2 +v_0t$ **(1mark)**

=(6x144/2) m+ 6 x12 m=504 m**(1mark)**

Or $x = \frac{(v_2+v_1)t}{2}$

= (6+78) m x12/2=504 m

d) Work done W=Fx **(1mark)**

=60 x504 J=30 340 J**(1 mark)**

e) Power P=W/t **(1mark)**

=30240 J / 12s= 2 520 W **(1mark)**

f) The increase in the kinetic energy $\Delta KE = \frac{m}{2}(v_f^2 - v_0^2)$

$$\Delta KE = \frac{10}{2}(78^2 - 6^2)J = 30\ 240\ J$$

They are equal. **(1mark)**

18)a) The law of conservation of mechanical energy states that the energy can neither be created nor be destroyed; it can only be internally converted from one form to another **(1mark)** or the principle of the conservation of mechanical energy states that the total mechanical energy in a system (i.e., the sum of the potential plus kinetic energies) remains constant as long as the only forces acting are conservative forces.

b) i) Mechanical energy $E = mgh + \frac{m}{2}v^2$ **(1mark)**

$$= 0.5\,x9.81x10J + \frac{0.5}{2}x2^2\,J = 50.05\,J$$ **(1mark)**

ii)The speed of the cart at B

Potential energy PE=0 J**(1mark)**

Kinetic energy KE= E-Ep= 50.05 J **(1mark)**

$KE = \frac{m}{2}v^2$ **(1 mark)**

$v = \sqrt{\frac{2x50.05}{0.5}}$ m/s=14.1 m/s **(1mark)**

c) The maximum height that the cart can reach

mgh_{max} = 50.05 J

h_{max}=50.05 m/0.5 x9.81=10.2 m **(1mark)**

It will not reach 15 m because the maximum height 10.2 m it reaches is less than 15 m. **(1mark)**

d) Students from S2 will not be able to solve this problem because work energy theorem should be used to determine the physical quantities. (Not studied in S2) **(1mark) or**

The cart will not reach the maximum height of 10.2 m due to friction forces that oppose the motion.

19) a) Graph 1 shows us the repulsion of 2 positive electric charges. **(1 mark)**

Graph 2 represents the attraction of unlike electric charges **(1mark)**

Graph 3 represents the repulsion between negative electric charges **(1mark)**

b) We can have an accident caused by thunder (lightening) **(1 mark)**.

And the lightning strikes the high-rise building, tree due to the shorter distance between clouds and the high rising building **(1 mark)** Or

The cloud charged negatively will be connected with Earth which is charged positively using that tall tree; this connection causes the ionization of air molecules near to the tall tree which makes thunder when you are near that tree we can have an accident caused by thunder.

c)The figure shows us how the lighning arrester works **(1mark)**

It consists of a long thick copper rod passing through the building to ground. When a negatively charged cloud passes over the building, positive charge will be induced on the pointed conductor. **(1mark)** The negative charges that are attracted to the conductor, travels down to the Earth positively charged. Thereby preventing the lightning strike from the damage of the building**(1mark).**

d) (1) represents the variation of E with distance **(1mark)** because $E \sim \frac{1}{r^2}$ it decreases rapidly with r compared to $V \sim \frac{1}{r}$

(2) represent the variation of V with distance r **(1mark)**

20) a) Focal length $f = \frac{R}{2}$ **(1mark)**

$$f = \frac{20\ cm}{2} = 10\ cm \quad \textbf{(1mark)}$$

b) i) Position of the image $\frac{1}{f} = \frac{1}{p} + \frac{1}{p'}$ **(1mark)**

$$\frac{1}{10} - \frac{1}{5} = \frac{1}{p'}$$

P'= -10 cm **(1mark)**

ii) Image magnification $m = -\frac{p'}{p} = \frac{h_i}{h_o}$ **(1mark)**

$$m = -(\frac{-10)}{5} = 2 \quad \textbf{(1mark)}$$

iii)Image size hi= 2x5 cm =10 cm **(1mark)**

c) Image is virtual and upright **(1mark)**

Use of sign convention

Image position is p'=-10 cm. The minus sign indicates that the image is virtual **(1mark).** Image size hi= +10 cm or image magnification m=+2 the plus sign indicates that the image is upright **(1mark)**