PHYSICS Date: 21/ 06 /2022 Period: 8:30 am-11:30 am	NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

END OF TERM III EXAMINATIONS

GRADE   S4
COMBINATIONS   ANP,PCB,MPC,MPG,PCM

DURATION: 3 HOURS

MARKS: ...... /100

INSTRUCTIONS

This paper has **two** sections: **A** and **B**

SECTION A: Attempt all 15 questions.   **(60 marks)**

SECTION B: Attempt all 5 questions.   **(40 marks)**

SECTION A: ATTEMPT ALL QUESTIONS (60 MARKS)

1) Complete the following statements using appropriate terms.

a) A ray of light that passes through the optical centre of a

lens emerges.............   **(1mark)**

b) When white light passes through a prism, it undergoes ....**(1mark)**

c) Image of pencil placed upright between F entre 2F in front of convex

lens where F is focal point is........................   **(1mark)**

2) a) List any one

(i) Inner planet.   **(1mark)**

(ii) Outer planet   **(1mark)**

b) Define the following terms used in Physics

(i)Right ascension   **(1 mark)**

(ii)Declination   **(1mark)**

3) State the types of equilibrium described below.

a) A state of equilibrium of a body (such as a pendulum hanging directly

downwards from its point of support) such that when the body is

slightly displaced it tends to return to its original position.   **(1mark)**

b) A state of equilibrium of a body which, when subjected to a slight

displacement ,it remains in its new position; e.g., a ball placed on a

horizontal surface or a cone supported on its side on a horizontal

surface.   **(1 mark)**

c) A state of equilibrium of a body which, when subjected to a slight

displacement, the centre of gravity is lowered and the body does not

return to its original position but moves further from it.   **(1mark)**

4) List any 4 sources of energy used in the Rwanda. **(4 marks)**

5) Identify the choice that best answers the question.

a) A body of mass m is projected at an angle θ from the ground with an initial velocity v. Acceleration due to gravity is g. What is the maximum horizontal range covered?

  (i) $R = v^2 (\sin 2\theta)/g$

  (ii) $R = v^2 (\sin \theta)/2g$

  (iii) $R = v^2 (\sin 2\theta)/2g$

  (iv) $R = v^2 (\sin \theta)/g$

(1 mark)

b) A particle is projected with velocity u at an inclined angle θ with the horizontal. The maximum height (H) attained is

  (i)$H=u^2 \sin^2\theta/g$

  (ii)$H=2u^2 \sin^2\theta/g$

  (iii)$H=u^2 \sin^2\theta/2g$

  (iv)$H=u^2 \sin 2\theta/g$

(1mark)

c) What is the time of flight of a projectile on a horizontal plane, where u is the initial velocity of projectile?

  (i)$t=2 u \sin \theta/g$

  (ii)$t=2u\cos\theta/g$

  (iii)$t=u \sin \theta/g$

  (iv)$t=u\cos\theta/g$

(1 mark)

d)The path followed by a projectile in the air is

  (i) circular

  (ii) parabola

  (iii)Elliptical

(iv)Straight line

(1 mark)

6) a)State any two Kepler's laws of planetary motion.   **(2 marks)**

b) State Newton's law of universal gravitation.   **(1mark)**

7) a)What do you understand by the term degradation of energy?

Explain it by taking one example of your daily life.   **(2 marks)**

b) How is the thermal energy converted into work by single cyclic

processes.   **(2 marks)**

8) Describe any three characteristics of electric force between electric

charges.   **(3 marks)**

9) Compare between electric potential energy and electric potential

(4 marks)

10) Explain any two types of thermodynamic processes.   **(4 marks)**

11) The distance between the centres of two metal spheres each of mass

90 kg is 40 cm.

a) Calculate the gravitational force between the two metal spheres.

Given G= 6.67×10^{-11} Nm^2/kg^2 **(2 marks)**

b) Will the gravitational force be different if the same metal spheres

are taken on the Moon, their separation remaining the same ?

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

12) A toy train travels around a circular track of radius 2.5 m in a time of

40 seconds.

a) Calculate the train's angular velocity ω .   **(2 marks)**

b) What is its linear speed?   **(2 marks)**

13) On a smooth surface, a soft 100 grams ball A at the velocity of 10

meters per second collides with another 700 grams ball B initially

at rest. After collision, the two balls stick together and keep moving

in the same direction as ball A.

What is the velocity of the two balls after collision? **(4 marks)**

14) An object of height h = 7 cm is placed at a distance p = 25 cm in front of a thin

converging lens of focal length f = 35 cm.

Find a) the position of image **(2 marks)**

b) the size of the image **(2 marks)**

15) Processes related to both energy generation and energy consumption

are associated with some negative and harmful environmental effects. In

four points, discuss this topic.

(8 marks)

SECTION B: ATTEMPT ALL QUESTIONS (40 MARKS)

16) Humans have changed their view of the world through lenses.

Discuss any three benefits of lenses in our daily life **(6 marks)**

17) a)Use free body diagram to show all forces acting on the following

diagram. **(2 marks)**

b) Show that the person shown above is in equilibrium or not.
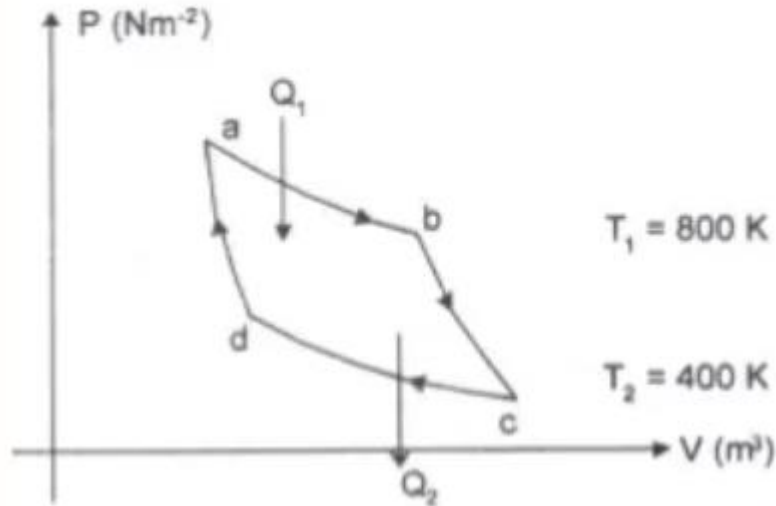
(4 marks)

18) a)Explain any four advantages of electricity /electrical energy in

general. **(8 marks)**

b) Which electrical circuit is better between parallel circuit and series

circuit ?Justify your answer. **(4 marks)**

19) Analyse the following figure related to Carnot engine

a) Find the efficiency of this Carnot engine. **(2 marks)**

b) If heat absorbed by the engine Q_1=10 000 J, what is the work done
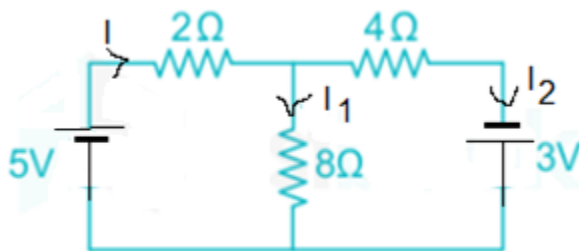by the Carnot engine? **(2 marks)**

c) Find the heat output Q_2 **(2 marks)**

20) a)State the Kirchhoff's current and voltages laws **(2 marks)**

Analyse the following electric circuit and answer the related questions

Use Kirchhoff's laws to determine the electric currents I, I_1, I_2 indicated
through the circuit above: **(8 marks)**

End.

PHYSICS PRACTICAL Date: 29 / 06 /2022 Period: 8:30 am-11:30 am

END OF TERM III EXAMINATIONS

GRADE   **S4**
COMBINATIONS   **ANP,PCB,MPC,MPG,PCM**

DURATION: **1H 30 MIN**

MARKS:

...... /40

INSTRUCTIONS

This paper is composed of ONE compulsory question

Non programmable calculator and mathematical instruments

 may be used.

Use only a blue or black pen.

Use pencil for drawing.

ATTEMPT ALL SUB QUESTIONS (40 MARKS)

In this experiment you will investigate a system in equilibrium due to several turning forces.

Apparatus required for each student:

      1Retort stand set (retort stand, base, clamp, boss head)

      1 metre rule

      2 pieces of string 20 cm long each

      1 mass M =100 g(you may use available slotted masses for example

        2 slotted masses of 50 g each)

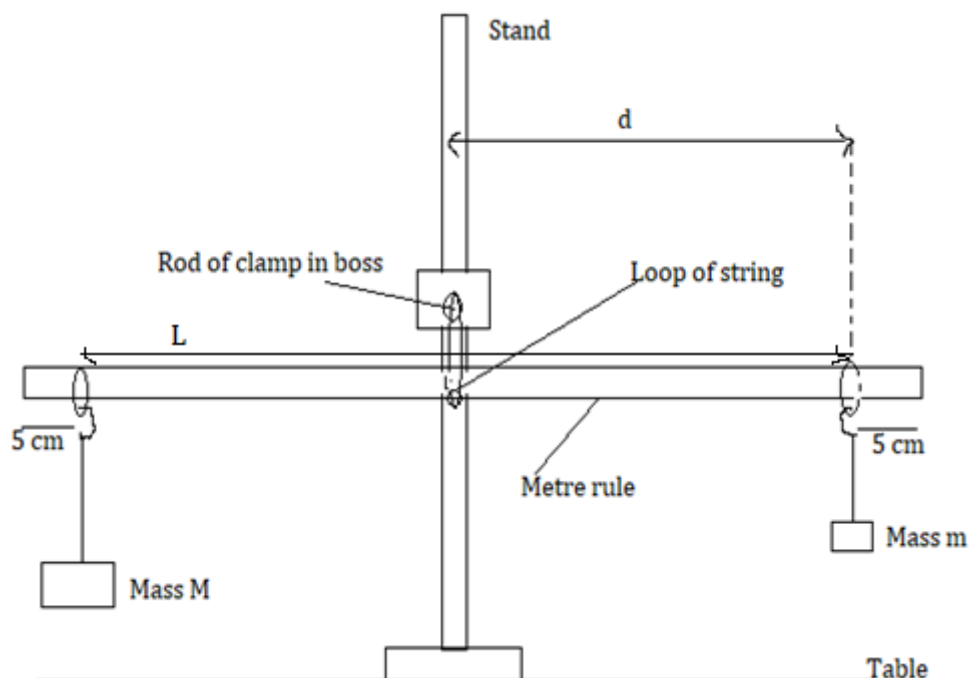   1 set of 9 slotted masses with mass hanger of 200 g each

a) (i)Set up the apparatus as shown in the following figure with masses

    m=0.040 kg and M=0.100 kg

   (ii)Record the distance L between the points of application of the two

     weights as shown below   **(1mark)**

b) Adjust the position of the metre rule until it balances.

   Measure and use SI unit to record the distance d as shown in the figure

c) Repeat the procedures (a) and (b) for m =0.060, 0.080, 0.100, 0.120 and 0.140 kg

d) Use suitable table to tabulate your results including m to three decimal places , d and 1/d to two decimal places **(15 marks)**

e) Plot a graph of 1/d on the y-axis against m on the x-axis.

Draw the straight line of best fit **(12 marks)**

f) Determine the gradient S and y-intercept y_0 of this line.

Give appropriate units. Indication of the slope is necessary

(7 marks)

g) The quantities d and m are related by equation

$$\frac{1}{d} = Pm + Q \quad \text{Where P and Q are constants}$$

Using your answers in f), write the equation governing this system of turning forces. **(1 mark)**

h) The constant P is related to L and M by $P = \dfrac{1}{kML}$ where k is a constant.

Calculate a value for k. **(2 marks)**

i) The mass of the metre rule is not negligible.

Why does it not appear in this investigation? **(2 marks)**

End.

END OF TERM III EXAMINATIONS 2021- 2022

S4 PHYSICS

MARKING SHEME

SECTION A

1) a)Without deviation **(1mark)** undeflected, undeviated

b) Dispersion (**1mark)** or refraction towards the base of prism

c) Real **(1mark)** magnified and inverted

2) a) (i) Venus **(1mark)** Earth ,Mars, Mercury

(ii)Jupiter **(1mark)** Saturn, Neptune, Uranus

b)(i)Right ascension is the equatorial coordinate specifying the angle,

measured eastwards along the celestial equator, from the vernal equinox

to the intersection of the hour circle that passes through an object in the

sky **(1mark)**

(ii) Declination is angular distance north or south from the celestial

equator measured along a great circle passing through the celestial

poles **(1mark)**

3) a)Stable equilibrium **(1mark)**

b) Neutral equilibrium **(1mark)**

c) Unstable equilibrium **(1mark)**

4) Sources of Energy used in the Rwanda are:

Solar energy **(1mark)**

Geothermal energy **(1mark)**

Electrical energy **(1mark)**

Biomass **(1mark)**

Charcoal

Fossil fuel such as natural gas, petroleum products,

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

6) There are three Kepler's laws of planetary motion:

The orbit of a planet is an ellipse with the Sun at one of the two foci.

(1mark)

A line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time. **(1mark)**

The square of the orbital period of a planet is proportional to the cube of the semi-major axis of its orbit. **(1mark)**

b) Newton's law of gravitation, statement that any particle of matter in the universe attracts any other with a force varying directly as the product of the masses and inversely as the square of the distance between them.**(1mark)**

7)a)Degradation of energy is explained as the situation where the transformation of energy into any form results in its less availability to do the said work, hence it is a gradual decrease of useful energy.

(1mark)

Example :

A large part of electrical energy is wasted in the form of heat energy when electrical appliances are run electricity **(1mark)**

A large part of heat energy from the fuel is given out when foot is cooked over fire .The liberated energy is of no use, instead cause pollution.

b) A device that converts heat energy into work in a cyclic process is heat engine. In each cycle, the heat engine absorbs heat Q_1 from the hot reservoir**(1mark)** ,converts it into useful work W and the remaining heat Q_2 is rejected to the cold reservoir**(1 mark).**From the first law of thermodynamics ,the net heat absorbed is equal to the work done W=Q_2-Q_1 or ΔQ=-W `

8) Characteristics of electric force between electric charges:

It is either attraction or repulsion force according to kind of electric charges **(1mark),**

It is a vector quantity **(1mark).**

It is a non-contact force **(1mark)**

It follows an inverse law

It is medium dependent. The permittivity of medium $\varepsilon = \varepsilon_0 \varepsilon_r$

It follows the principle of superposition

9)

Parameter of	Electric potential	Electric potential

comparison		energy
Definition	Electric Potential is the work done per unit charge in order to bring the electric charge from infinity to a point in electric field **(1mark)**	*Electric potential energy* is the energy an electric charge has due to its position relative to other electric charges **(1mark)**
Unit	Volt **(1mark)**	Joule **(1mark)**
Quantity type	Scalar quantity	Scalar quantity

10) There are 4 thermodynamic processes.

Isobaric process **(1mark**) is the thermodynamic process in which the pressure remains constant**(1mark)**

Isothermal process **(1mark)** is a thermodynamic process in which the temperature remains constant**(1 mark).**

Isochoric or Isovolumetric process is a thermodynamic process in which the volume remains constant.

Adiabatic process is a thermodynamic process that occurs without transferring heat or mass between the thermodynamic system and its environment

11) a) The gravitational force $F = G \, mm/r^2$ **(1mark)**

$$= 6.67 \times 90 \times 90/(40 \times 10^{-2})^2$$

$$= 3.377 \times 10^{-6} \text{ N } \textbf{(1mark)}$$

b)The gravitational force remains constant **(1mark)**

The mass of an object on the Moon remains the same as its mass on Earth and the G is universal gravitational constant **(1mark).**

It is not medium dependent.

12) a)One circuit of the track is equivalent to 2π radians. The rain travels around in 10 s. Therefore:

$\omega = \phi/t$**(1 mark)**where ϕ is angular displacement

$(2\pi /40)$ rad/s $= 0.157$ rad.s^{-1} **(1mark)**

b) Calculate the train's speed:

$v = \omega.r$ **(1mark)**

$= 0.157 \times 2.5 = 0.39$ m.s^{-1} **(1 mark)**

Hint: You could have arrived at the same answer by calculating the distance travelled (the circumference of the circle 2πr) and dividing by the time taken.

13) Let p1 be the linear momentum of the two balls before collision.

P2 be the linear momentum of the two balls after collision

$P1 = m_A V_A + m_B V_B$ **(1mark)**

$=0.100 \times 10$ kgm/s$=1$ kgm/s **(1mark)**

$P2=(0.100+0.700)v$ **(1mark)** Inelastic collision

Principle of conservation of linear momentum
$(0.100+0.700)v=1$

$V=1.25$ m/s**(1mark)**

14)a)Image position

Using thin lens equation: $\dfrac{1}{p} + \dfrac{1}{q} = \dfrac{1}{f}$ **(1mark)**

$$q = \frac{35x25}{25-35}cm = -87.5cm \textbf{(1mark)}$$

b) From magnification equation: $m = \dfrac{h'}{h} = -\dfrac{q}{p}$ **(1mark)**

h'=-(-87.5 x 7)/25 =24.5

The height h' of the image is 24.5 cm **(1mark)**

15). Energy generation and treatment (degradation) are associated to negative and harmful environmental effects such as:

- Deformation

-Deforestation

- Soil and land degradation,

- Water pollution,

- Air pollution,

- Global warming,

- Ozone layer depletion.

-Climate change

-Thermal pollution

-Solid waste disposal

NOTICE: Any four points **(4 marks)** with short explanation **(4 marks)**

No marks for introduction and conclusion

Example

Energy and environmental problems are closely related, since it is nearly impossible to produce, transport, or consume energy without significant environmental impact. The environmental problems directly related to energy production and consumption.

The emission of air pollutants from fossil fuel combustion is the major cause of urban air pollution.
Burning fossil fuels is also the main contributor to the emission of greenhouse gases.

Diverse water pollution problems are associated with energy usage. One problem is oil spills. In all petroleum-handling operations, there is a finite probability of spilling oil either on the earth or in a body of water.

Coal mining can also pollute water. Changes in groundwater flow produced by mining operations often bring otherwise unpolluted waters into contact with certain mineral materials which are leached from the soil and produce an acid mine drainage.

Solid waste is also a by-product of some forms of energy usage. Coal mining requires the removal of large quantities of earth as well as coal.

Agricultural crops such as oil palm, sugar cane, maize, rapeseed, soybeans and wheat, are being used to produce liquid biofuels, mainly to power vehicles. But the increased use of agricultural lands for growing energy crops may compete with food production, causing increased food prices and deforestation

SECTION B

16) No marks for introduction and conclusion

A lens is a transparent optical device limited with two spherical surfaces that affects the focus of a light beam through the refraction.

The lenses are used in designing some optical devices.

Camera **(1mark)**

A camera without a lens is useless to a photographer. The lens is what focuses light from what you see through the viewfinder into a tiny, (typically) 35mm spot on the back of a film. Camera has enabled people to capture images and share them with others around the world without having to be present at the scene.**(1mark)**

Telescope **(1mark)**

Telescopes which are used for formation enlarged images for the heavenly bodies. Telescope is a tool that allows people to see objects from far away, beyond human vision, this helps a lot in researching for scientists, especially for astronomers to discover new stars, planets and galaxies **(1mark)**

Microscope **(1mark)**

The lenses are used in Microscopes which are used for formation magnified images of the tiny bodies that cannot be seen with the naked eye such as microbes, cells etc.**(1mark)**

Eye glasses

Lenses are used in making of medical glasses to treat the vision defects

They also used to make
Projectors
Simple microscope etc

Brief, without lenses, no glasses, no camera, no microscopes, no telescopes .People would not able to see clearly, to observe microorganisms, to study universe or to enjoy entertainment through movies and televisions

17) a) Forces acting on the figure are:

A downwards Weight force acting in the centre of gravity and two

upward Reaction force acting on the two support.
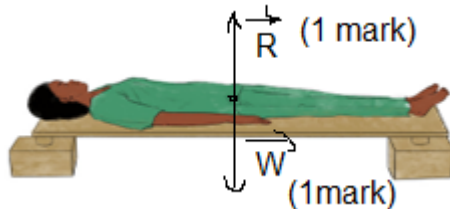
b) Conditions for equilibrium require that

The sum of all external forces acting on the body is zero **(1mark)** and

The sum of all external torques from external forces is zero **(1mark)**

With respect to the centre of gravity

$$\sum \tau = Wx0 + Rx0 = 0 \quad \textbf{(1mark)}$$

$$\sum F_{ext} = W + R = 0 \textbf{(1mark)}$$

18) a) Electricity is a form of energy that is used in many daily activities

for development different devices to:

➢ Produce light **(1mark)** where needed and during night **(1mark),**
➢ Facilitate communication **(1mark),** it is used to power
   telephone**(1mark)** and motorcycles ,cars et.
➢ It produces heat**(1mark)** used in cooking**(1mark),**
➢ Sources of energy **(1mark)** to power different engines and motor
   elevators, cars, Planes, machines **(1mark)**
   Etc.

b) Parallel circuit **(1mark)** All appliances in our houses are in parallel

connection

Each connected electrical device and appliance are independent from others **(1mark).** This way, switching ON / OFF a device won't affect the other appliances and their operation.

In case of break in the cable or removal of any lamp will not break the all circuits and connected loads **(1mark),** in other words, other lights/lamps and electrical appliances will still work smoothly.

If more lamps are added in the parallel lighting circuits, they will not be reduced in brightness (as it happens only in series lightning circuits)because voltage is same at each point in a parallel circuit**(1mark).** In short, they get the same voltage as the source voltage.

It is possible to add more light fixture and load points in parallel circuits according to future need as far as the circuit is not overloaded.

Adding additional devices and components wont increase the resistance but will decrease the overall resistance of the circuit especially when high current rating devices are used such as air conditioner and electric heaters.

Parallel wiring is more reliable, safe and simple to use

19) a)Efficiency of the Carnot engine $e = \dfrac{T_H - T_C}{T_H}$ **(1mark)**

$$e = \frac{800 - 400}{400} = 0.5 \textbf{(1mark)}$$

b) Work done by the Carnot W = e Q1   **(1mark)**

W = (1/2)(10,000) = 5000 J**(1mark)**

c) Heat output $Q_2 = Q_1 - W$ **(1mark)** =10 000 J- 5 000 J=5 000 J**(1mark)**

20) a) **Kirchhoff's current law** (1st Law) states that the current flowing into a node (or a junction) must be equal to the current flowing out of it**(1mark).** This is a consequence of charge conservation.

Kirchhoff's voltage law (2nd Law) states that in any complete loop within a circuit, the sum of all voltages across components which supply electrical energy (such as cells or generators) must equal the sum of all voltages across the other components in the same loop**(1mark).** This law is a consequence of both charge conservation and the conservation of energy
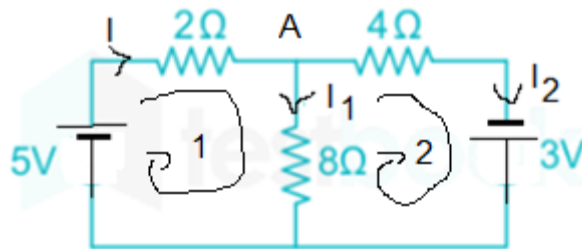
Junction A: $I=I_1+I_2$ **(1mark)** Eq 1

Loop 1: $5-2I-8I_1=0$ **(1 mark)** Eq 2

Loop 2: $3+8I_1-4I_2=0$ **(1 mark)** Eq 3

  Eq 1 in Eq (2) $5-2(I_1+I_2)-8I_1=0$

                  $5-10I_1-2\ I2=0$ Eq 4 **(1mark)**

              Eq (3) and Eq 4 give us

             $-7+28\ I_1=0$ **(1 mark)**

             $I_1=0.25$ A **(1mark)**

      I_1 in Eq 3 helps us to find I_2

    $3+8\ x0.25\ -4I_2=0$

           $I_2=1.25$ A **(1 mark)**

   $I=1.25$ a$+0.25$ A$=1.5$ A**(1mark)**

END OF TERM III EXAMINATIONS 2021-2022

S4 PHYSICS PRACTICAL(40 MARKS)

MARKING SCHEME

After exam, S4 Physics teacher will carry out the experiment

The results obtained may be used as marking scheme of S4 physics practical exam

The following marking scheme is a guide

Procedure a(iii) L=90 cm **(1mark)**

$\qquad$ = 0.90 m

Question d)

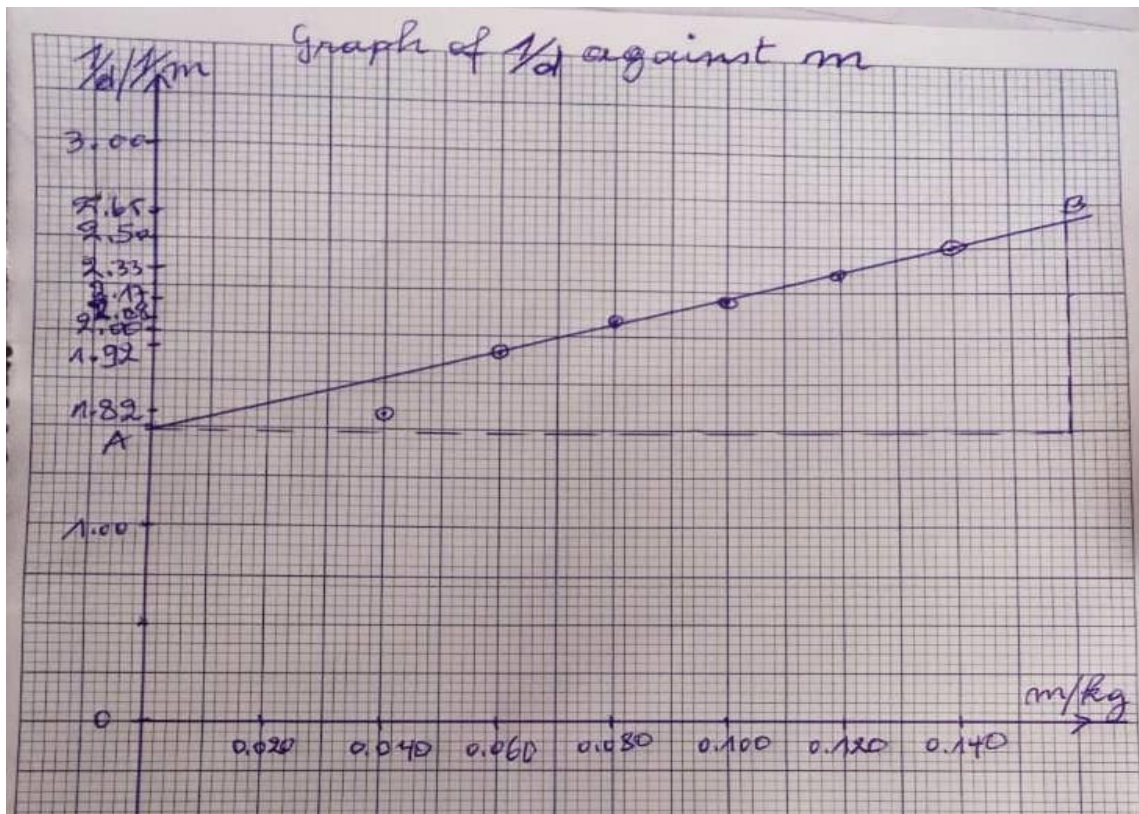| m/kg **(1mark)**	d/m**(1mark)**	$\dfrac{1}{d}/\dfrac{1}{m}$**(1mark)**
0.040	0.55**(1mark)**	1.82**(1mark)**
0.060	0.52**(1mark)**	1.92**(1mark)**
0.080	0.48**(1mark)**	2.08**(1mark)**
0.100	0.46**(1mark)**	2.17**(1mark)**
0.120	0.43**(1mark)**	2.33**(1mark)**
0.140	0.40**(1mark)**	2.50**(1mark)**

Question e)

Title of the graph **(1mark)**

Labelled axes 1 markx2 **=2 marks**

 Uniform scales 1markx2=**2 marks**

Six plotted points 1markx6=**6 marks**

Best fit straight line **1 mark**

Graph of 1/d against m

Procedure f) Indication of the slope **(1mark)**

Coordinates of point A (0, 1.48) **1 mark**

Coordinates of point B(0.160,2.65) **1 mark**

Slope of the graph S =(2.65-1.48)/(0.160-0) **(1mark)**

=7.31/kgm**(1mark)**

Y-intercept y_0=1.48 /m value **1mark**, unit (**1mark**)

Question g) $\dfrac{1}{d} = 7.31m + 1.48$ in m^{-1} **(1mark)**

Question h)

The constant $k = \dfrac{1}{pML}$ **(1 mark)**

$$k = \dfrac{1}{7.31x0.100x0.90} = 1.51 \textbf{(1mark)}$$

k is between 1.00 and 2.00

Question i) The metre rule is in static equilibrium for each value of d

(1mark)

This means that the sum of torques is zero with respect to the point where the metre rule is attached. This point is the point of application of the weight of the metre rule. Its torque is zero for each reading of d **(1mark)** Thus it cannot turn the system .