P510/1

PHYSICS

PAPER 1

July/August 2018

2½ hours

MWALIMU EXAMINATIONS BUREAU

UACE RESOURCE MOCK EXAMINATIONS 2018

S.6 PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

- Attempt five questions including at least one **but not** more than **two** from each of the sections A, B, and C.
- Silent non-programmable scientific electronic calculators may be used.
- Where necessary assume:

Electronic charge, (e)	$= 1.6 \times 10^{-19} C$
Acceleration due to gravity, (g)	$= 9.81\ ms^{-2}$
Electron mass, (m_e)	$= 9.11 \times 10^{-31} kg$
Mass of the earth, (M_E)	$= 6.0 \times 10^{24} kg$
Plank's constant, (h)	$= 6.63 \times 10^{-34} Js$
Stefan's constant, (σ)	$= 5.7 \times 10^{-8} Wm^{-2} K^{-4}$
Radius of earth (R_e)	$= 6.4 \times 10^{6} m$
Radius of the sun (R_s)	$= 7.0 \times 10^{8}$ m
Speed of light in a vacuum (c)	$= 3.0 \times 10^{8} m/s$
Specific latent of fusion of ice (L_f)	$= 3.36 \times 10^{5} Jkg^{-1}$
Specific heat capacity of water (C)	$= 4200 Jkg^{-1} K^{-1}$
Universal Gravitation constant, (G)	$= 6.67 \times 10^{-11} Nm^2 kg^{-2}$
Avogadro's number (N_A)	$= 6.02 \times 10^{23} mol^{-1}$
Density of water (ρ)	$= 10^{3} kgm^{-3}$
Surface tension of water ( )	$= 7.2 \times 10^{-2} Nm^{-1}$
Charge to mass ratio (e/m)	$= 1.8 \times 10^{11} Ckg^{-1}$
Density of copper	$= 8.93 \times 10^{3} kgm^{-3}$
Specific heat capacity of copper	$= 3.70 \times 10^{2} Jkg^{-1} K^{-1}$

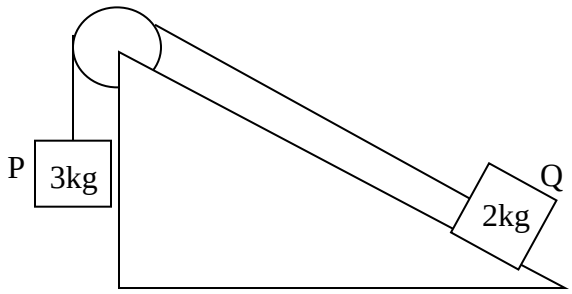
SECTION A

1. (a). A particle is projected vertically upwards from the top of a tree and attains the maximum height after **2s**. For the first **5s** sketch:
   (i) The displacement-time graph. (01 mark)
   (ii) The velocity-time graph. (01 mark)

   (b). The distance between two stations is 1800m. An electric train, which covers this journey in 3 minutes, starts from rest at one station with a uniform acceleration of $0.5ms^{-2}$. It comes to rest at the other station with a uniform retardation of $0.75ms^{-2}$ and the speed in the intermediate portion of its journey is constant. Find:
   (i) The time taken during acceleration. (05 marks)
   (ii) The maximum constant speed attained. (02 marks)

   (c). (i). State the principle of conservation of momentum. (01 mark)
   (ii). Show how Newton's laws of motion may be used to arrive at the principle of conservation of momentum. (05 marks)

   (d). The diagram below shows a block Q of mass of 2kg placed on a rough plane inclined at an angle of 30^o to the horizontal. A string, which is parallel to the plane and passes over a light smooth pulley, connects Q to another block P of mass 3kg.



   If the acceleration of the blocks is $5.0ms^{-2}$. Find the coefficient of friction between block Q and the inclined plane. (05 marks)

2. (a). (i). Define limiting frictional force. (01 mark)
   (ii). Explain using molecular theory the laws of kinetic friction. (04 marks)

   (b). (i). Define gravitational potential. (01 mark)
   (ii). If **r** is the radius of the earth and **g** the gravitational acceleration, show that the gravitational potential at the earth's surface is **–gr**. (03 marks)

   (c). (i) Define relative density of a body. (01 mark)
   (ii) Describe an experiment to determine the relative density of a liquid using Archimedes principle and principle of moments. (03 marks)

   (d) A simple hydrometer consisting of loaded glass system of a uniform cross section in water so that a certain **x** distance of its stem is 4.0 cm below the water surface. It sinks in a liquid of density 0.9 gcm^{-3} until **x** is 6.0cm below the surface. It is then placed in a liquid of density 1.1 gcm^{-3}. Calculate:

(i) the distance **x** from the bulb of the hydrometer. (04 marks)

(ii) the depth of mark **x** below the surface of the liquid of density $1.1gcm^{-3}$.

(03 marks)

3. (a). (i). Distinguish between ***kinetic energy*** and ***potential energy.*** (02 marks)

(ii). Show that a mass, **m** moving with a velocity, **v** has kinetic energy given by $\frac{1}{2}mv^2$. (03 marks)

(b).(i).What is meant by the term ***conservative force***? (01 marks)

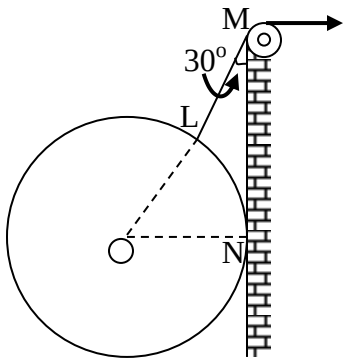
(ii).Show that for a particle moving in the gravitational field the total **mechanical energy** is **conserved**. (04 marks)

(c).(i).Define the ***moment of a force***. (01 mark)

(ii).The inner end of a concentrically coiled spring is fixed to the axle of a wheel of radius **0.5m**. When two tangential parallel forces, each of **6N** acting in opposite directions, are applied to the wheel to form a couple, the wheel turns through an angle of 120^o.

Find the energy stored in the spring. (03 marks)

(d)



The figure shows a uniform circular hoop with centre **O** and of radius **0.5m**. The hoop has a weight of **200N** and is being hauled up along a vertical wall ported by a string **LM** fixed at point **L** on the hoop. **LM** makes an angle of 30^o with the wall and the **angle** between radii **OL** and **ON** is 40^o. Find the:

(i) **Tension** in the string **LM**. (03 marks)

(ii) **Coefficient friction** between the hoop and the wall. (04 marks)

4. (a). (i). Define simple harmonic motion. (01 mark)

(ii).A particle performs simple harmonic motion with amplitude **a** and angular frequency,**ω.** Derive an expression relating the velocity of the particle and its displacement **x**, without the time. (03 marks)

(b).(i).Show that a small mass attached to the free end of a suspended inextensible string, executes simple harmonic motion when displaced through a small angle and then released. (04 marks)

(ii) Explain briefly how you can use the experimental arrangement in (b) (i) above to determine acceleration due to gravity. (05 marks)

(c). A particle of **mass 0.1kg** is executing simple harmonic motion of amplitude **3.6×10^{-2}m** between two points **A** and **B** about point **O** as the centre of oscillation. The maximum restoring force on the particle has a magnitude **3.52N**. Calculate

(i) The **period** of the motion (02 marks)

(ii) The **kinetic energy** of the particle at a point in the path of the motion a distance **4.5×10^{-2}m** from **A**. (03 marks)

(iii) The **total energy** of the particle (02 marks)

SECTION B

5. (a).(i).State any two factors that could be considered when choosing a thermometer to be used. (01 mark)

(ii).State four characteristics a physical property should exhibit in order to be used as a thermometric property. (02 marks)

(b).What is meant by:

(i) Fixed point in thermometry (01 mark)

(ii) Triple point of water (01 mark)

(c).(i).Describe the structure of a liquid in glass clinical thermometer. (04 marks)

(ii). State how the thermometer in (b) (i) can be made sensitive and quick acting. (02 marks)

(d).At a temperature of **90^{o}C** the resistance of a platinum wire is **2.000Ω**. What will the resistance be at the **triple point** of water? (03 marks)

(e).(i). What is meant by **pyrometry**? (01 mark)

(ii).With the aid of a diagram describes how an optical pyrometer may be used to measure the temperature of furnace. (05 marks)

6. (a). (i). Define ***specific latent heat of vaporisation***. (01 mark)

(ii).Explain why at the **boiling point of a liquid heat** is absorbed without change of temperature. (02 marks)

(iii).With the aid of a well labelled diagram, describe an **electrical method** of determining the **specific latent heat of vaporisation** of water. (07 marks)

(b).A **1.0 kW** electric heater is immersed in mass of **4kg** of water at **25^{o}C** contained in a copper vessel of mass **0.5kg**. Neglecting any loss of heat to the surroundings and the heat capacity of the heater, find:

(i) How **long** it will take to heat the water to its boiling point of **100^{o}C**. (03 marks)

(ii) How **long** it will take to boil off all the water, starting from **25^{o}C**? (02 marks)

(iii) How **much** it will cost to achieve b (ii) above if **1kWh** is Sh. **615.00**? (02 marks)

(c).Explain why a **smaller body cools faster than a bigger one** of the same shape. (03 marks)

7. (a).(i).Draw **sketch graphs** to show the **variation of relative intensity** of black body radiation with wavelength for three different temperatures. (02 marks)

(ii).Explain the appearance of a metal ball placed in a dark room when its temperature is progressively raised from room temperature to just below melting. (03 marks)

(iii).Explain why cavities in a fire look brighter than the rest of the fire. (03 marks)

(b).(i).State Wien's and Stefan's laws of black body radiation. (01 mark)

(ii).The intensity of radiant energy from a black body is a maximum at a wavelength of $\mathbf{1.5 \times 10^{-6}m}$. Calculate the **temperature** of the black body. (02 marks)

(iii).Describe an experiment to compare surfaces as absorbers of radiation. (04 marks)

(c).The energy intensity received by a spherical planet from a star is $\mathbf{1.4 \times 10^{3}Wm^{-2}}$. The star is of radius $\mathbf{7.0 \times 10^{5}km}$ and is $\mathbf{1.4 \times 10^{8}km}$ from the planet from the planet.

(i) Calculate the surface temperature of the star. (04 marks)

(ii) State any assumptions you have made in (b) (i) above. (01 mark)

SECTION C

8. (a).Draw a set-up of the apparatus used in the famous Millikan's oil drop experiment and answer the following questions:

(i) Why should a constant temperature bath be necessary? (02 marks)

(ii) State the important measurements that must be carried out in the experiment. (02 marks)

(b).(i).What was the significance of Millikan's oil-drop experiment? (01 mark)

(ii).In modern production of cathode rays thermionic emission is employed. Give two reasons why the older discharge tube method is considered unsuitable and risky. (02 marks)

(c).(i).Sketch the I-V characteristic for gaseous conduction. (01 mark)

(ii).Explain the main feature of the curve. (04 marks)

(d).Oil droplets are introduced into the space between two flat horizontal plates, set **5.0mm** apart. The plate voltage is the adjusted to exactly **780V** so that one of the droplets is held stationary. Then the voltage is switched off and the selected droplet is observed to fall a measured distance of **1.5mm** in **11.2s**.

Given the density of oil used is $\mathbf{900kgm^{-3}}$ and the viscosity of air is $\mathbf{1.8 \times 10^{-5}Nsm^{-2}}$, calculate the charge of the droplet.

(Assume buoyance effects are negligible) (06 marks)

9. (a).(i).What is the significance of Millikan's oil drop experiment? (01 mark)

(ii).Distinguish between **photoelectric emission** and **thermionic emission**. (02 marks)

(b).Define the following terms as used in photo electricity.

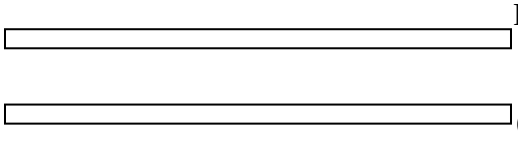
(i) **Work function.** (01 mark)

(ii) **Stopping potential** (01 mark)

(c).(i).Describe a laboratory experiment to determine Planck's constant. (03 mark)

(ii). Electromagnetic radiation of frequency $\mathbf{8.8 \times 10^{14}Hz}$ falls onto a surface whose work function is **2.5eV**. Calculate the **velocity** with which photoelectrons are released from the surface. (04 marks)

(d).



The diagram above shows two parallel metal plates **P** and **Q** each of length **4.0cm** and separated by a distance of **4.0cm**. A p.d. of 12V is applied between **P** and **Q** and the space between **P** and **Q** is a vacuum. A beam of electrons of speed $\mathbf{1.0 \times 10^{6}ms^{-1}}$ is directed midway between **P** and **Q**. Find the **angle** with which the beam emerges from the space between **P** and **Q** to the initial direction of the beam. (06 marks)

10. (a).State Bohr's postulates of the hydrogen atom. (02 Marks)

(b).The diagram below shows possible electron orbits in the Bohr atom for hydrogen. Assuming the orbits are circular and that the total energy of the atom is:

$$E_n = -\frac{me^4}{8\varepsilon_0^{\,2} n^2 h},$$

Where:

M = mass of an electron e = charge of an electron

n= principle quantum number h =Planck's constant

ε_o =permittivity of free space.

Calculate the **wavelength** of the radiation that will be emitted when the electron makes a Transition from: n= 3 to n =2. (07 marks)

(c).The energy levels in a mercury atom are:

$^{-}$10.4eV, $^{-}$5.5eV, $^{-}$3.7eV and $^{-}$1.6eV.

(i) Find the ionization energy of mercury in joules. (02 marks)

(ii) What is likely to happen if a mercury atom in unexcited state is bombarded with an electron of energy 4.0eV, 11.0eV? (03 marks)

(d).Show that when the $\alpha-$ particles collide head on with an atom of atomic number Z, the closest distance of approach to the nucleus x is given by:

$$x = \frac{Ze^2}{\pi\varepsilon_0 mv^2}$$

Where: e = electronic charge m = the mass of an electron

v = the velocity of $\alpha-$ particles. (03 marks)

(e).Explain the observation of absorption line spectra nature. (03 Marks)

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