



ERETA EDUCATION CONSULTS LTD
JOINT MOCK EXAMINATIONS 2024
Uganda Advanced Certificate of Education

PHYSICS

Paper 1

Time: 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**.

Where necessary, assume the following:

- | | | |
|---|---|--|
| ✓ Acceleration due to gravity, g | = | 9.81m/s^{-2} |
| ✓ Electron charge, e | = | $1.6 \times 10^{-19}\text{C}$ |
| ✓ Electron mass | = | $9.11 \times 10^{-31}\text{kg}$ |
| ✓ Mass of earth | = | $5.97 \times 10^{24}\text{kg}$ |
| ✓ Plank's constant, h | = | $6.6 \times 10^{-34}\text{Js}$ |
| ✓ Stefan's constant, σ | = | $5.67 \times 10^{-8}\text{Wm}^{-2}\text{K}^{-4}$ |
| ✓ Density of water | = | 1000kgm^{-3} |
| ✓ Specific heat capacity of water | = | $4200\text{J/kg}^{-1}\text{k}^{-1}$ |
| ✓ Avogadro's number N_A | = | $6.02 \times 10^{23}\text{mol}^{-1}$ |
| ✓ Gas constant, R | = | $8.31\text{Jmol}^{-1}\text{k}^{-1}$ |
| ✓ Charge to mass ratio, e/m | = | $1.8 \times 10^{11}\text{Ckg}^{-1}$ |
| ✓ The constant $\frac{1}{4\pi\epsilon_0}$ | = | $9.0 \times 10^9\text{F}^{-1}\text{m}$ |
| ✓ Specific heat capacity of copper | = | $400\text{Jkg}^{-1}\text{k}^{-1}$ |

Turn Over

SECTION A:

1. (a) (i) What is meant by a **parking orbit** as applied to satellite motion? (2 marks)
- (ii) A football match played at a field in England is required to be broadcasted worldwide. Briefly describe how this can be done by means of satellites. (4 marks)
- (b) (i) State **Newton's law of gravitation** (1 mark).
- (ii) Use Newton's law of gravitation to verify Kepler's law and hence state the law. (4 marks)
- (c) A satellite revolves in a circular orbit at a height of 600km above the earth's surface. Calculate
- (i) Speed of the satellite. (3marks)
- (ii) Periodic time of the satellite. (2marks)
- (d) Explain what happens to a satellite when it encounters resistance. (4 marks)
2. (a) (i) Distinguish between **elastic** and **inelastic collisions**. (2 marks)
- (ii) State the **law of conservation of linear momentum**. (1 mark)
- (iii) Use Newton's laws to derive the law (a)(ii) above. (3marks)
- (iv) Explain why when catching a fast moving ball the hands are drawn backwards while the ball is being brought to rest. (2marks)
- (b) (i) A golf ball is projected from the ground at a velocity $v \text{ ms}^{-1}$ at an angle of β . The ball first strikes the ground at a horizontal distance a metres. Show that $v^2 = \frac{ag}{\sin 2\beta}$ (4 marks)
- (ii) Sketch a graph of kinetic energy against time for the ball in (b) (i) above. (2 marks)
- (c) A water pump draws water from a well at depth of 4m and delivers it into a tank at a height of 6m and the water is ejected at a velocity of 20 ms^{-1} . If 0.5 m^3 of water are delivered per second,
- (i) Calculate the power output of the pump. (3 marks)
- (ii) If the pump is 75% efficient, find the energy wasted in 30 minutes. (3 marks)
3. (a) (i) State the **laws of friction** between solid surfaces. (3 marks)
- (ii) Explain the origin of frictional force between two solid surfaces in contact. (3marks)
- (iii) Describe an experiment to measure the coefficient of kinetic friction between two solid surfaces. (4marks)

- (b) Describe an experiment to determine limiting friction between a block and a plane surface. (4 marks)
- (c) A uniform beam PQ of length 4m and weight 50N is freely hinged at P to a vertical wall and it is held horizontal in equilibrium by a string which has one end attached to Q and the other end attached to a point on the wall 4m above P. Calculate the reaction at P. (6 marks)
4. (a) (i) What is meant by **velocity gradient** as applied to fluid flow. (1 mark)
- (ii) Explain how increase in temperature affects surface tension of water. (3 marks)
- (b) (i) Explain **laminar flow** and **turbulent flow**. (3marks)
- (ii) Describe an experiment to measure the coefficient of viscosity of water using **Poiseulle's formula**. (7marks)
- (d) An aero plane on a runway moves such that air flows over the upper surface of its wings at 120ms^{-1} . The total mass aero plane is 5tonnes and the effective wing area is 30m^2 . Determine the velocity of the air flowing past the lower surface of the wings which just lifts the plane. (density of air = 1.3kgm^{-3}) (4 marks)
- (e) Explain why a small water drop forms a spherical shape. (2 marks)

SECTION B:

5. (a) (i) State **Dalton's law of partial pressures** (1 mark)
- (ii) Use the kinetic theory of gases to verify the law above. (6 marks)
- (b) Define **molar heat capacity** at constant pressure. (1 mark)
- (c) An ideal gas is trapped in a cylinder by a movable piston. Initially, its volume is $8 \times 10^{-3}\text{m}^3$ and exerts a pressure of 108kPa. The gas undergoes an isothermal expansion until its volume is $27 \times 10^{-3}\text{m}^3$, followed by an adiabatic compression to its original volume.
- (i) calculate the final pressure of the gas (Ratio of $C_p:C_v = 5:3$) (6 marks)
- (ii) Sketch and label the two stages on a P-V diagram. (2 marks)
- (d) Differentiate between a **real gas** and an **ideal gas** (4 marks)

6. (a) (i) Explain what is meant by a **thermometric property** (2 marks)

(ii) Mention **any two** electrical thermometric properties (2 marks)

(b) A thermometric property, X varies with temperature T in Kelvins according to the approximate law $X = X_0[1 + 5 \times 10^{-3}(T - T_0)]$. The value of X is 101.6 at the triple point of water and 165.5 at 600.5K. What is the temperature when X is 123.4? (5 marks)

(c) Define **specific heat capacity** of a substance (1 mark)

(d) With the aid of a labelled diagram, describe how specific latent heat of vaporization of water can be determined using the electrical method. (6 marks)

(e) An electric kettle rated 1000W, 240V is used on 220V mains to boil 0.52kg of water. If the heat capacity of the kettle is 400JK⁻¹, and the initial temperature of the water is 20°C, how long will the water take to boil? (4 marks)

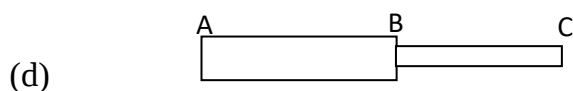
7. (a) (i) State the **laws of black body radiation** (2 marks)

(ii) Sketch spectral curves to show how intensity of black body radiation varies with wavelength at three different temperatures. (2 marks)

(b) The average distance of planet Y from the sun is about 40 times that of the earth from the sun. If the sun radiates as a black body at 6000K and is 1.5×10^{11} m from the Earth, Calculate the surface temperature of planet Y. (5 marks)

(c) (i) Define **thermal conductivity** (1 mark)

(ii) Describe an experiment to determine thermal conductivity of a good conductor. (5 marks)



A steel rod AB of length 10 cm and cross sectional area 200cm² is welded to a silver rod BC of length 20cm and cross sectional area 100 cm² as shown in the diagram above. The ends A and C are maintained at 300°C and 0°C respectively. The composite rod is covered with an insulating material. Find the rate of heat flow through the composite rod. (Thermal conductivity of steel = 50Wm⁻¹K⁻¹ and Silver = 400Wm⁻¹K⁻¹) (5 marks)

SECTION C:

- 8.(a) (i) State the **laws of photo electric emission**. (4 marks)
- (ii) Define **stopping potential** and **threshold frequency**. (2 marks)
- (b) With the aid of a labelled diagram, describe Millikan's experiment to verify Einstein's equation of photoelectric emission. (7 marks)
- (c) Light of wavelength 500nm falls on a certain metal surface whose work function is 2.3eV. Calculate
- (i) the threshold frequency (3 marks)
- (ii) the maximum velocity of the electrons emitted. (4 marks)
9. (a) Define **binding energy** of a nuclide. (1 mark)
- (b) Sketch a graph to show how binding energy per nucleon varies with mass number and explain its main features. (3marks)
- (c) $^{220}_{86}\text{Rn}$ nucleus decays into $^{216}_{84}\text{Po}$ releasing an alpha particle and energy. Calculate the energy released. ($^{220}_{86}\text{Rn} = 219.964176\text{u}$, $^{216}_{84}\text{Po} = 215.955794\text{u}$, $^4_2\text{He} = 4.001566\text{u}$, $1\text{u} = 931\text{MeV}$). (4 marks)
- (d) Using a labelled diagram, explain how a Bainbridge mass spectrometer can be used to distinguish between isotopes. (7 marks)
- (e) (i) State **Bragg's law** of X-ray diffraction (1 mark)
- (ii) X-rays of wavelength 0.155nm are incident on a copper crystal of atomic spacing 0.45 nm. Calculate the smallest glancing angle at which the radiation will be reflected. (3 marks)
- (iii) State **one** industrial use of X-rays (1 mark)

10. (a) (i) Define **thermionic emission** (1 mark)
- (ii) With the aid of a labelled diagram, describe the main features of a cathode ray Oscilloscope and their uses (8 marks)
- (iii) State **any two** uses of a CRO (2 marks)
- (b) An electron beam is accelerated through a high potential difference of 2000V and enters midway between two parallel horizontal plates. The plates are 5.0cm long and separated by 2.0cm. If the potential difference across the plates is 80V,
- (i) Calculate the speed of the electrons as they enter the region between the plates. (3 marks)
- (ii) Find the speed of the electrons as they emerge from the region between the plates (4 marks)
- (iii) Explain the motion of the electrons between the plates. (2 marks)

End