UACE Physics paper 1 set 9 Time 2½ marks

Instructions the candidates:

Answer **five** questions, including at least **one**, but **not more than two** from each sections **A, Band C**.

Any additional question(s) answered will not be marked.

Non programmable scientific calculators may be used.

Assume where necessary

Acceleration due to gravity, g	$9.81ms^{-2}$
Electron charge, e	$1.6 \times 10^{-19}C$
Electron mass	$9.11 \times 10^{-31}kg$
Mass of the earth	$5.97 \times 10^{24}kg$
Plank's constant, h	$6.6 \times 10^{-34}Js$
Stefan's-Boltzmann's constant, σ	$5.67 \times 10^{-8}Wm^{-2}K^{-1}$
Radius of the earth	6.4 x 106m
Radius of the sun	$7 \times 10^{8}m$
Radius of the earth's orbit about the sun	$1.5 \times 10^{11}m$
Speed of light in the vacuum, c	$3.0 \times 108ms^{-1}$
Thermal conductivity of copper	$390Wm^{-1}K^{-1}$
Thermal conductivity of aluminium	$210Wm^{-1}K^{-1}$
Specific heat capacity of water	$4.200Jkg^{-1}K^{-1}$
Universal gravitational constant	$6.67 \times 10^{-11}Nm^{2}Kg^{-2}$
Avogadro's number, N_A	$6.02 \times 10^{23}mol^{-1}$
Surface tension of water	$7.0 \times 10^{-2}Nm^{-1}$
Density of water	$1000kgm^{-3}$
Gas constant, R	$8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	$1.8 \times 10^{11}Ckg^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_0}$	$9.0 \times 10^{9}F^{-1}m$
Faraday's constant, F	$9.65 \times 10^{4}Cmol^{-1}$

SECTION A

1. (a) Define the following terms
   (i) Uniform acceleration (01mark)
   (ii) Angular velocity (01mark)

   (b) (i) What is meant by banking a track? (01mark)

   (ii) Derive an expression for the angle of banking θ for a car of mass, m, moving at speed, v, round a banked tract of radius, r. (04marks)

   (c) A bob of mass, m is tied to an inelastic thread of length, L, and whirled with constant speed in a vertical circle

   (i) With the aid of a sketch diagram, explain the variation of tension in the string along the circle. (05 marks)

   (ii) If the string breaks at one point along the circle, state the most likely position and explain the subsequent motion of the bob.

   (d) A body of mass 15kg is moved from earth's surface to a point 1.8×10^6m above the earth. If the radius of the earth is 6.4×10^6m and the mass of the earth is 6.0×10^{24}kg; calculate the work done in taking the body to that point (06marks)

2. (a) State Newton's laws of motion. (03marks)
   (b) Use Newton's laws of motion to show that when two bodies collide their momentum is conserved. (04marks)
   (c) Two balls P and Q travelling in the same line in opposite directions with speeds of $6ms^{-1}$ and $15ms^{-1}$ respectively make a perfect collision. If the masses of P and Q are 8kg and 5kg respectively, find the
   (i) final velocity of P, (04marks)
   (ii) change in kinetic energy. (04marks)
   (d) (i) What is an impulse of a force? (01marks)
   (ii) Explain why a long jumper should normally land on sand. (04marks)

3. (a) (i) What is meant by viscosity. (01mark)
   (ii) Explain the effect of temperature on viscosity of a liquid. (03marks)

   (b) Derive an expression for terminal velocity of a sphere of radius, a, falling in a liquid of viscosity, η. 904marks)

   (c) Explain why velocity of a liquid at a wide part of a tube is less than that at a narrow part. (02marks)

   (d) A solid weighs 237.5g in air and 12.5g when totally immersed in a fluid of density $9.0 \times 10^2 kgm^{-3}$. Calculate the density of the liquid in which the sold would float with one fifth of its volume exposed above the liquid surface.

   (e) Describe an experiment to measure the coefficient of static friction between a rectangular block of wood and a plane surface. (04marks)

4. (a) (i) What is meant by simple harmonic motion? (01mark)
   (ii) State two practical examples of simple harmonic motion. (01mark)

(iii) Using graphical illustrations, distinguish between under damped and critically damped oscillations (04marks)

(b) (i) Describe an experiment to measure acceleration due to gravity using a spiral spring (06marks)

(ii)State two limitations to the accuracy of the value obtained in (b)(i).

(c) A horizontal spring of force constant $200Nm^{-1}$ fixed at one end has a mass of 2kg attached to the free end and resting on a smooth horizontal surface. The mass is pulled through a distance of 40.0cm and released.

Calculate the

(i) Angular speed

(ii) Maximum velocity attained by a vibrating body. (02marks)

(iii) Acceleration when the body is half way towards the centre from its initial position (02marks)

SECTION B

5. (a)(i) State Boyles law (01mark)

(ii) Describe an experiment to verify Boyles' law (06mark0

(iii) Explain why the pressure of a fixed mass of a gas rises if its temperature is increased. (02marks)

(b) (i) Define the term thermometric property and give four examples (03marks)

(ii) State two qualities of a good thermometric property. (01mark)

(c) (i) With reference to a liquid in glass thermometer, describe the step involved in setting up a Kelvin scale of temperature (03marks)

(ii) State one advantage and one disadvantage of the resistance thermometer. (01mark)

(d) A resistance thermometer has resistance of 21.42Ω at the ice point, 29.10Ω at steam point and 28.11Ω at some unknown temperature θ. Calculate θ on the scale of this thermometer. (03marks)

6. (a) Define specific heat capacity of a substance and state its units (02marks)

(b) (i) Describe how specific heat capacity of a liquid can be obtained by continuous flow method. (07marks)

(ii) State one disadvantage of this method. (01mark)

(c) 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 water is 20^0C, how long will the water take to boil? (04marks)

(d) (i) Distinguish between isothermal and adiabatic changes (02marks)

(ii) An ideal gas at 18^0C is compressed adiabatically until the volume is halved. Calculate the final temperature of the gas. [Assume specific heat capacities of the gas at constant pressure and volume are $2100Jkg^{-1}K^{-1}$ and $1500Jkg^{-1}K^{-1}$] respectively. (04marks)

7. (a) State Stefan's law of black body radiation. (01marks)

(b) Briefly describe how a thermopile can be used to detect thermal radiation. (05marks)

(c) Explain the temperature distribution along

(i) a perfectly lagged metal bar (02marks)

(ii) an unlagged metal bar. (02marks)

(d) The wall of a furnace is constructed with two layers. The inner layer is made of bricks of thickness 10.0cm and thermal conductivity 0.8 $Wm^{-1}K^{-1}$ and the outer layer is made of material of thickness 10.0 cm and thermal conductivity 1.6 $Wm^{-1}K^{-1}$.

The temperatures of the inner and outer surfaces ate 600^0C and 460^0C respectively.

(i) Explain why in steady state, the rate of thermal energy transfer must be the same in both layers. (01mark)

(ii) Calculate the rate of heat flow per square meter through the wall. (05marks)

(e) Explain the greenhouse effect and how it is related to global warming. (04marks)

SECTION C

8. (a) (i) Describe with the aid of a well labelled diagram, the structure and mode of operation of a C.R.O (06marks)

(ii) State the advantages of C.R.O over a moving coil voltmeter. (02marks)

(b) In the determination of the electron charge by Millikan's method, a potential difference of 1.5kV is applied between horizontal metal plates, 12mm apart. With the field switched off, a drop of oil of mass 1,0x 10^{-14} kg is observes to fall with constant velocity, 4 x $10^{-4}ms^{-1}$ between two metal plates. When a potential difference of 1.5kV is applied across the plates, the drop rises with constant velocity of 8.0 x $10^{-5}ms^{-1}$.

How many electron charges are there on the drop? (Assume air resistance is proportional to the velocity of the drop and neglect air buoyancy.

(c) Explain why

(i) the apparatus in Millikan's experiment is surrounded with a constant temperature enclosure, (03marks)

(ii) low vapor-pressure oil is used. (02marks)

(d) In Millikan's experiment, the radius, r, of the drop is calculated from

$$r = \sqrt{\frac{9\eta v}{2\rho g}}$$

where η is the viscosity of air and ρ is the density of oil.

Identify the symbol v and describe briefly how it is measured. (02mark)

9. (a) (i) Explain how X-rays are produced in an X-ray tube (04 marks)

(ii) Explain the emission of X-ray characteristic spectra. (03 marks)

(iii) Derive the Bragg X-ray diffraction equation (04marks)

(iv) Under what conditions does X-ray diffraction occurs? (02marks)

(b) With the aid of a labelled diagram, describe how a Bainbridge mass spectrometer is used to measure specific charge. (07marks)

10. (a) What is meant by unified atomic mass unit? (01mark)

(b) (i) Distinguish between nuclear fusion and nuclear fission (02marks)

(ii) State the conditions necessary for each of the nuclear reaction in (b) (i) to occur. (02marks)

(c) (i) With the aid of a labelled diagram, describe the operation of an ionization chamber. (06marks)

(ii) Sketch the curve of ionization current against applied p.d and explain its main features. (04marks)

(d) A typical nuclear reaction is given by:

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{95}_{42}Mo + {}^{139}_{57}La + 2{}^{1}_{0}n + {}^{0}_{-1}e$$

Calculate the total energy released by 1g of uranium. (05marks)

Mass of ${}^{1}_{0}n = 1.009\mu$

${}^{0}_{-1}e = 0.00055\mu$

${}^{95}_{42}Mo = 94.906\mu$

${}^{139}_{57}La = 138.906\mu$

${}^{235}_{92}U = 235.044\mu$

$1\mu = 1.66 \, x \, 10^{-27} kg$

Compiled by Dr. Bbosa Science