UACE Physics paper 1 2007 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	$1.6 x10^{-19}C$
Electron mass	$9.11 x 10^{-31}kg$
Mass of the earth	$5.97 x 10^{24}kg$
Plank's constant, h	$6.6 x 10^{-34}Js$
Stefan's-Boltzmann's constant, σ	$5.67 x 10^{-8}Wm^{-2}K^{-1}$
Radius of the earth	6.4 x 106m
Radius of the sun	$7 x 10^{8}m$
Radius of the earth's orbit about the sun	$1.5 x 10^{11}m$
Speed of light in the vacuum, c	$3.0 x 108ms^{-1}$
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	$6.67 x 10^{-11}Nm^{2}Kg^{-2}$
Avogadro's number, N_A	$6.02 x 10^{23}mol^{-1}$
Surface tension of water	$7.0 x 10^{-2}Nm^{-1}$
Density of water	$1000kgm^{-3}$
Gas constant, R	$8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	$1.8 x 10^{11}Ckg^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_0}$	$9.0 x 10^{9}F^{-1}m$
Faraday's constant, F	$9.65 x 10^{4}Cmol^{-1}$

SECTION A

1. (a) Define simple harmonic motion (SHM). (01mark)
   (b) Sketch a graph of:
   (i) velocity against displacement for a body executing SHM. (03marks)
   (c) A glass U-tube containing a liquid is tilted slightly and then released.
   (i) Show that the liquid oscillates with simple harmonic motion. (04mark)
   (ii) Explain why the oscillations ultimately come to rest. (03marks)
   (d) Explain why maximum speed of a car on a banked road is higher than on an unbanked road. (04marks)
   (e) A small bob of mass 0.2kg is suspended by an inextensible string of length 0.8m. The bob is then rotated in a horizontal circle of radius 0.4m. Find
   (i) linear speed of the bob (03marks)
   (ii) tension in the string. (02marks)

2. (a) State Kepler's laws of planetary motion. (03marks)
   (b) (i) A satellite moves in a circular orbit of radius, R, about a planet of mass, M, with period T. Show that $R^3 = \frac{GMT^2}{4\pi^2}$, where G is the universal gravitational constant. (04marks)
   (ii) The period of the moon around the earth is 27.3 days. If the distance of the moon from the Earth is 3.83 x 105km, calculate the acceleration due to gravity at the surface of the Earth. (04marks)
   (i) Explain why any resistance to forward motion of an artificial satellite results into an increase in its speed. (04marks)

   (c) (i) What is meant by weightlessness? (02marks)

   (ii) Why does acceleration due to gravity vary with location on the surface of the earth? (03marks)

3. (a) (i) State the laws of solid friction. (03marks)
   (ii) Using molecular theory, explain the laws stated in (a)(i) (03marks)

   (b) Describe an experiment to determine the coefficient of static friction for an interface between a rectangular block of wood and plane surface. (04marks)

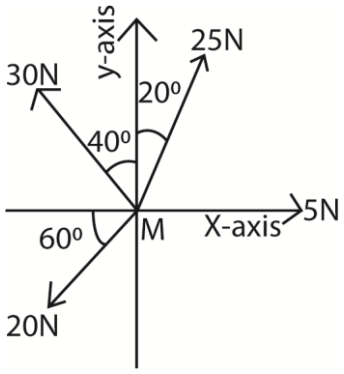
   (c) (i) State the difference between conservative and non-conservative forces, give one example each. (03marks)

   (ii) State the work-energy theorem. (01mark)

   (iii) A block of mass 6.0kg is projected with a velocity of $12ms^{-1}$ up a rough plane inclined at 45^0 to horizontal. If it travels 5.0m up the plane, find the friction force. (04marks)

   (d) Explain the effect of temperature on the viscosity of a liquid.

4. (a) (i) Define vector and scalar quantities and give one example of each. (03marks)
   (ii)



A body, M, of mass 6kg s acted on by forces of 5N, 20N, 25N and 30N as shown in the figure above. Find the acceleration of M (05marks)

(b) (i) What is meant by acceleration due to gravity? (01mark)

(ii) Describe how you would use a spiral spring, a retort stand with a clamp, a pointer, seven 50g masses, a meter rule and a stop clock to determine the acceleration due to gravity. (06marks)

(iii) State any two sources of error in the experiment in (b)(ii) above. (01marks)

(iv) A body of mass 1kg moving with simple harmonic motion has speeds of $5ms^{-1}$ and $3ms^{-1}$ when it is at distances of 0.10m and 0.2m respectively from equilibrium point. Find the amplitude of the motion. (04marks)

SECTION B

5. (a) (i) Define a thermometric property and give two examples (02marks)
   (ii) When is the temperature of 0K attained? (02marks)
   (b)(i) With reference to constant-volume gas thermometer, define temperature on the Celsius scale (02marks)
   (ii) State two advantages and two disadvantages of the constant-volume gas thermometer. (02marks)
   (c) (i) Define triple point of water (01mark)
   (ii) Describe how you would measure the temperature of a body on the thermodynamic scale using a thermocouple. (03marks)
   (d) The resistance, R_θ of platinum varies with the temperature 0^0C as measured by the constant-volume gas thermometer according to the equation
   $R\theta = 50.0 + 0.17\theta + 3.0 \times 10^{-4}\theta^2$
   (i) Calculate the temperature on the platinum scale corresponding to 60^0C on the gas scale. (06marks)
   (ii) Account for the difference between the two values and state the temperatures at which they agree. (02marks)
6. (a) (i) Define latent heat (01mark)
   (ii) Explain the significance of latent heat in regulation of body temperature (03marks)

   (b) (i) using kinetic theory, explain boiling of a liquid (03mark)

   (ii) Describe how you would determine the specific latent heat of vaporization of water by the method of the mixtures (05marks)

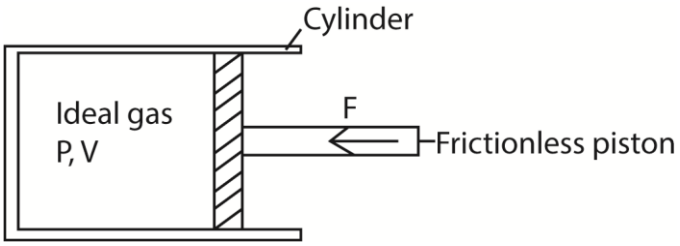
(iii) Explain why latent heat of vaporization is always greater than that of fusion. (02marks)

(c) In an experiment to determine the specific latent heat of vaporization of a liquid using the continuous flow calorimeter, the following results were obtained.

Voltage, V/V	Current, I/A	Mass collected in 300s/g
7.4	2.6	5.8
10.0	3.6	11.3

Calculate the power of the heater required to evaporate 3.0g of water in 2 minutes (06marks)

7. (a)



A fixed mass of an ideal gas is confined in a cylinder by frictionless piston of cross section area A. the piston is in equilibrium under the action of force, F as shown in the figure above. Show that the work done, W, by the gas when it expands from V_1 to V_2 is given by

$W = \int_{V_1}^{V_2} PdV$ (03marks)

(b) State the first law of thermodynamics and use it to distinguish between Isothermal and adiabatic changes in a gas. (05marks)

(c) The temperature of 1mole of helium gas at a pressure of 1.0 x 10^5Pa increases from 20^0C to 100^0C when the gas is compressed adiabatically.
Find the final pressure of the gas. (Take γ =1.67) (04 marks)

(d) With the aid of a P-V diagram, explain what happens when a real gas is compressed at different temperatures. (04marks)

(e) The root-mean square speed of the molecules of a gas is 44.72ms^{-1}. Find the temperature of the gas if its density is 9.0 x 10^{-2}kgm^{-3} and the volume is 42.0m^3. (04marks)

SECTION C

8. (a) Describe briefly the mechanism of thermionic emission (03marks)

(b) (i) Draw a labelled circuit to show a triode being used as a single-stage voltage amplifier. (03maks)

(ii) With the aid of an equivalent circuit of a triode as an amplifier, obtain an expression for voltage gain (04marks)

(iii) A triode with mutual conductance of 3.0 x 10^{-3} AV^{-1} and anode resistance of 1 x 104Ω, is used as a single-stage amplifier. If the load resistance is 3 x 10^4Ω, calculate the voltage gain of the amplifier. (05marks)

(c) (i) Describe the structure of a junction transistor. (02marks)

(ii) sketch and describe the collector-current against collector-emitter voltage characteristic of a junction transistor. (03marks)

9. (a) What are isotopes? (01mark)

(b) With the aid of a diagram, describe the operation of Bainbridge spectrometer in determining the specific charge of ions. (06marks)

(c) Explain the purpose of each of the following in a Geiger-Muller tube

(i) a thin mica window

(ii) Argon gas at low pressure

(iii) Halogen gas mixed with argon gas

(iv) An anode in the form of a wire (04marks)

(d) (i) What is meant by binding energy per nucleon of a nucleus? (01mark)

(ii) Sketch a graph of binding energy per nucleon against mass number for naturally occurring nuclides (01marks)

(iii) State one similarity between nuclear fusion and nuclear fission. (01mark)

(e) (i) At a certain time, an α-particle detector registers a count rate of $32s^{-1}$. Exactly 10days later, the count rate dropped to $8s^{-1}$. Find the decay constant. (04marks)

(ii) State two industrial uses and two health hazards of radioactivity. (04marks)

10. (a) (i) Describe, with aid of a diagram, the production of cathode rays

(ii) state and justify two properties of cathode rays (02marks)y

(b) Explain each of the following terms as applied to photoelectric emission:

(i) stopping potential (01marks)

(ii) threshold frequency (01mark)

(c) Explain X- ray diffraction by crystals and derive Bragg's law (06marks)

(d) The potential difference between the cathode and anode of an X-ray tube is 5.0×10^{-4}V. If only 0.4% of the kinetic energy of the electrons is converted into X-rays and the rest is dissipated as heat in the target at a rate of 600W, find the

(i) current that flows (03marks)

(ii) speed of the electrons striking the target. (03marks)

Compiled by Dr. Bbosa Science