UACE Physics paper 1 2008 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.

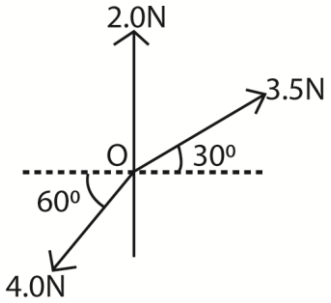
Non programmable scientific calculators may be used.

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) (i) Define the term velocity and displacement. (02marks)
   (ii) Sketch velocity against time for an object thrown vertically upwards. (02marks)
   (b)



   Three forces of 3.5N, 4.0N and 2.0N, act at O as shown in the figure above. Find the resultant force. (04marks)

   (c) (i) What is meant by saying that a body is moving with velocity relative to another? (01marks)

   (ii) A ship, A is travelling due north at 20kmh^{-1} and ship B is travelling due east at 15kmh^{-1}. Find the velocity of A relative to B. (03marks)

   (iii) If the ship B in (c)(ii) is 10km due west of A at noon. Fins the shortest distance apart and when it occurs. (05marks)

   (d) (i) What is meant by a couple in mechanics? (01mark)

   (ii) State the conditions for equilibrium of a system of coplanar forces

2. (a) (i) State the laws of friction between solid surfaces (03marks)
   (ii) Explain the origin of friction force between two solid surfaces in contact. (03marks)
   (iii) Describe an experiment to measure the coefficient of kinetic friction between two solid surfaces. (03marks)

   (b) (i) A car of mass 1000kg moves along a straight surface with speed 0f 20ms^{-1}. When brakes are applied steadily, the car comes to rest after travelling 50m. Calculate the coefficient of friction between the surface and the tyre. (04marks)

   (ii) State the energy changes which occur from the time brakes are applied to the time the car comes to rest. (02marks)

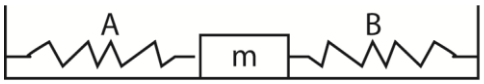
   (c) (i) State two disadvantages of friction (01mark)

   (ii) Give one method of reducing friction between solid surfaces. (01mark)

   (d) Explain what happens when a small steel ball is dropped centrally in a tall jar containing oil. (03marks)

3. (a) (i) Define simple harmonic motion. (01mark)
   (ii) A particle of mass m executes simple harmonic motion between two points A and B about equilibrium position O. sketch a graph of the restoring force acting on the particle as a function of distance, r, moved by the particle. (02marks)

(b)



Two springs A and B of spring constant K_A and K_B respectively are connected to mass m as shown in the figure above. The surface on which the mass slides is frictionless.

(i) Show that when the mass is displaced slightly, it oscillates with simple harmonic motion of frequency, f given by $f = \frac{1}{2\pi}\sqrt{\frac{K_A + K_B}{m}}$ (04marks)

(ii) If the two springs in the figure above are identical such that $K_A = K_B = 5.0 Nm^{-1}$ and mass m =50g, calculate the period of oscillation (03marks)

(c) (i) With the aid of a diagram, describe an experiment to determine the universal gravitational constant, G. (0marks)

(ii) If the moon moves round the earth in a circular orbit of radius = 4.0×10^8m and takes exactly 27.3 days to go round once, calculate the value of acceleration due to gravity, g, at the earth's surface. (04marks)

4. (a) State
   (i) Newton's laws of motion (03marks)
   (ii) The principle of conservation of momentum (01mark)

   (b) A bod A of mass m_1 moves with velocity u_1 and collides head on elastically with another body B of mass m_2 which is at rest. If the velocities of A and B are v_1 and v_2 respectively and given that X = $\frac{m_1}{m_2}$, show that

   (i) $\frac{u_1}{v_1} = \frac{X+1}{X-1}$ (04marks)

   (ii) $\frac{v_2}{v_1} = \frac{2X}{X-1}$(03marks)

   (c) Distinguish between conservative and non-conservative forces. (02marks)

   (d) A bullet of mass 40g is fired from a gun at $200ms^{-1}$ and hit a block of wood of mass 2kg which is suspended by a light vertical string 2m long. If the bullet gets embedded in the wooden block,

   (i) Calculate the maximum angle the string makes with the vertical. (06marks)

   (ii) State a factor on which the angle of swing depends. (01mark)

SECTION B

5. (a) Define the following terms
   (i) Specific latent heat of vaporization (01mark)
   (ii) Coefficient of thermal conductive

(b) With the aid of a labelled diagram, describe an experiment to measure the specific latent heat of vaporization of water by electrical method (07marks)

(c) An appliance rated 240V, 200W evaporates 20g of water in 5 minutes. Find the heat loss if specific latent heat of vaporization is 2.26 x 10^6Jkg^{-1}. (03marks)

(d) Explain why at a given external pressure a liquid boils at constant temperature. (04marks)

(e) With the aid of a suitable sketch graphs, explain the temperature distribution along lagged and unlagged metal rods, heated at one end. (04marks)

6. (a) Describe an experiment to verify Newton's law of cooling. (05marks)
(b) (i) Distinguish between a real and an ideal gas. (03marks)
(ii) Derive the expression
$P = \frac{1}{3}\rho\overline{c^2}$ for the pressure of an ideal gas of density, ρ, and mean square speed $\overline{c^2}$
(c) (i) Explain why the pressure of a fixed mass of a gas in a closed container increases when the temperature of the container is raised. (02marks)
(ii) Nitrogen gas is trapped in a container by a movable piston. If the temperature of the gas is raised from 0^0C to 50^0C at constant pressure of 4.0 x 10^5Pa and the total heat added is 3.0 x 10^4J, calculate the work done by the gas. [The molar heat capacity of nitrogen at constant pressure is 29.1Jmol^{-1}K^{-1}, C_p/C_v= 1.4]

7. (a) (i) State the laws of black body radiation (02marks)
(ii) Sketch the variation of intensity with wavelength in a black for different temperatures. (03marks)
(b) (i) What is a perfectly black body? (01marks)
(ii) How can a perfectly black body be approximated in reality? (04marks)
(c)(i) The energy intensity received by a spherical planet from a star is 1.4 x 10^3Wm^{-2}. The star is of radius 7.0 x 10^5km and is 14.0 x 10^7km from the planet.
(i) Calculate the surface temperature of the star. (04marks)
(ii) State any assumptions you have made in (c)(i) above (01marks)
(d) (i) What is convection? (01mark)

(ii) Explain the occurrence of land and sea breeze. (04marks)

SECTION C

8. (a) What is meant by a line spectrum? (02marks)

(b) Explain how line spectrum accounts for existence of discrete energy levels in an atom. (04marks)

(c) The energy levels in mercury atom are -10.4eV, -5.5eV, -3.7eV and -1.6eV.

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

(ii) What is likely to happen if mercury atom in unexcited state is bombarded with an electron of energy 4.0eV, 6.7eV or 11.0eV? (03marks)

(d) Describe with the aid of a diagram, the action of an X-ray tube. (05marks)

(e) An X-ray tube is operated at 20kVwith electron current 16mA in the tube. Estimate the:

(i) the number of electrons hitting the target per second. (02marks)

(ii) rate of production of heat, assuming 99.5% of the kinetic energy of electron is converted to heat. (e = 1.6 x 10^{-19}C)

9. (a) (i) Define the term binding energy (01marks)

(ii) Sketch a graph showing the variation of binding energy per nucleon with mass number (02marks)

(iii) Use the sketch graph you have drawn in (a)(ii) to explain how energy is released during fission and fusion. (03marks)

(b) Explain why a high temperature is required during fusion of nuclides. (01mark)

(c) The isotope $^{238}_{92}U$ emits an alpha particle and forms an isotope of thorium (Th), while the isotope $^{235}_{92}U$ when bombarded by a neutron, forms $^{144}_{56}Ba$, $^{90}_{36}Kr$ and neutrons.

(i) Write the nuclear equation for the reaction of $^{238}_{92}U$ and $^{235}_{92}U$. (02marks)

(ii) How does the reaction of $^{235}_{92}U$ differ from that of $^{238}_{92}U$ (03marks)

(d) A steel piston ring contains 15g of radioactive iron, $^{54}_{26}Fe$. The activity of $^{54}_{26}Fe$ is 3.7 x 10^5 disintegration per second.

After 100 days of continuous use, the crankcase oil was found to have a total activity of 1.23 x 10^3 disintegrations per second. Find the

(i) Half-life of $^{54}_{26}Fe$ (05marks)
(ii) Average mass of iron worn off the ring per day, assuming that all the metal from the ring accumulates in the oil. (03marks)

10. (a) Describe the mechanism of thermionic emission (03marks)
(b) Explain the following terms as applied to a vacuum diode
(i) space charge limitation (03marks)
(ii) Saturation (01 mark)
(iii) Rectification (02marks)

(c) Sketch the current potential difference characteristics of a thermionic diode for two different operating temperatures and explain their main features (05marks)

(d) (i) A triode valve with an anode resistance of 3.0 x $10^3\Omega$is used as an amplifier. A sinusoidal alternating signal of amplitude 0.5Vis applied to the grid of the valve. Find the r.m.s value of the output voltage if the amplification factor is 15 and anode load is 50kΩ.

(ii) Draw an equivalent circuit of a triode as a single-stage amplifier. (01marks)

Compiled by Dr. Bbosa Science