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**P510/1**

**PHYSICS**

**Paper 1**

**AUGUST 2017**

**UGANDA ADVANCED CERTIFICATE OF EDUCATION**

**MOCK TWO EXAMINATIONS 2017**

**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****.*

*Non-programmable scientific electronic calculators may be used.*

Assume where necessary.

Permittivity of free space εo = 8.85  10-12 Fm-1

Acceleration due to gravity, g = 9.81 ms-2

Electronic charge, *e*  = 1.6 10-19 C

Mass of the earth = 5.97  1024 kg

Radius of the earth = 

Planck’s constant, *h*  = 6.6  10-34Js

Stefan’s Boltzmann’s constant, σ = 5.710-8 Wm-2 K-4

Wien’s displacement constant = 2.9 10-3 m K

Radius of Earth’s orbit about the sun = 1.5 1011m

Radius of the sun = 7.0 108 m

Specific heat capacity of water = 4.2 103J kg-1 K-1

Specific latent heat of fusion of water = 3.34 105 *J kg-1*

Specific heat capacity of copper = 400 *J kg-1 K*-1

Avogadro’s number NA = 6.02 1023 *mol*-1

Density of water = 1000 *kgm-3*

Gas constant, R = 8.31 *J mol-1K-1*

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| Questions attempted |  |  |  |  |  |
| Marks |  |  |  |  |  |

SECTION A

1. (a) (i) Define angular velocity and centripetal acceleration. (2 marks)

(ii) Derive the expression for the centripetal force on a mass *m*

moving with uniform speed *v* in a circular path of radius *r*.

(4 marks)

(b) Explain the variation of the tension in the sting for a particle of mass *m* attached to a string and whirled in a vertical circle of radius *r*.

(4 marks)

(c) A car travels round a bend banked at an angle of . If the radius of curvature of the bend is 60 m and the coefficient of friction between the tyres of the car and the road surface is 0.25, calculate the maximum speed at which the car can negotiate the bend without skidding. (4 marks)

(d) A satellite of mass 120 kg moves in a circular orbit around the earth at

a period of 1.9 x 108 s.

(i) Find its height above the earth. (3 marks)

(ii) Calculate the mechanical energy of the satellite. (3 marks)

2. (a) (i) State Archimedes’ principle. (1mark)

(ii) A solid weighs 2.45 N when totally immersed in water and 2.06 N in a liquid of density 1800 kgm-3. Find the mass of the solid.

(3 marks)

(b) (i) What is meant by simple harmonic motion? (1 mark)

(ii) Distinguish between damped and forced oscillations. (2marks)

(c) A cylinder of length h, cross-sectional area, A, and density σ floats in a liquid of density, ρ. The cylinder is pushed down slightly and released.

(i) Show that the cylinder performs simple harmonic motion.

(5marks)

(ii) Derive an expression for the period of the oscillation. (2marks)

(d) A mass of 0.1kg suspended from a spring of force constant 24.5 Nm-1 is pulled vertically downwards through a distance of 5.0 cm and released. Find the

(i) period of oscillation, (2marks)

(ii) position of the mass 0.4 seconds after release. (4marks)

3. (a) (i) Account for the existence of intermolecular forces. (2 marks)

(ii) Sketch a graph of potential energy against separation of two molecules in a substance and explain the main features of the graph. (3 marks)

(b) (i) Define surface tension in terms of surface energy. (1 mark)

(ii) Use the molecular theory to account for the surface tension of a liquid. (3 marks)

(iii) Show that the excess pressure, p, in an air bubble inside a liquid over outside pressure is given bywhere r is the radius of the bubble and γ its surface tension. (4 marks)

(c) A soap bubble of diameter 1 cm is formed at the top of a capillary tube of diameter 1 mm dipping into a beaker of water. If the surface tensions of water and soap solution are 7.010-2 and 3.010-2 Nm-1 respectively, calculate the height of the water in the capillary tube above the water and state any assumptions you have made. (5 marks)

(d) Explain why large mercury drops flatten out where as small ones assume spherical shapes. (2 marks)

4. (a) (i) What is meant by the **resultant** of a system of forces? (1mark)

(ii) Coplanar forces act on a particle of mass 2 kg as shown in figure 1.

4N

130o

15N

6N

5N

60o

Fig. 1

Find the distance moved by the particle in 3 seconds from rest.

(6 marks)

(b) (i) State two differences between solid friction and fluid friction.

(2 marks)

(ii) You are provided with a metre rule and a physics textbook placed on a flat wooden board on a table. Using only what is provided describe how you would determine the coefficient of static friction between the book and the board. (4 marks)

(c) A non-uniform beam AB of weight 30N and length 2m is hinged to a vertical wall at A and supported in a horizontal position by a string fixed at a point on it at a distance of 0.5m from B connected to the same vertical wall 1.5m above A. If the tension in the string is 40N when a weight of 10N is suspended from end B, find

(i) the position of the centre of gravity of the beam, (3 marks)

(ii) the magnitude and direction of the reaction at the wall.

(4 marks)

SECTION B

5. (a) (i) Draw sketch graphs to show the variation of relative intensity

of black body radiation with wavelength for three different temperatures. (2 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. (3 marks)

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

fire. (3 marks)

(b) (i) State Wien’s and Stefan’s laws of black body radiation.

(2 marks)

(ii) The intensity of radiant energy from a black body is a

maximum at a wavelength of 1.5 x 10-6 m. Calculate the temperature of the black body. (2 marks)

(iii) Describe an experiment to compare surfaces as absorbers of

radiation. (4 marks)

(c) The energy intensity received by a spherical planet from a star is

1.4 x 103 Wm-2. The star is of radius 7.0 x 105 km and is 1.4 x 108 km from the planet from the planet.

(i) Calculate the surface temperature of the star. (4marks)

(ii) State any assumptions you have made in (b) (i) above. (1 mark)

6. (a) (i) Explain the fact that the heat required to raise the temperature

of a fixed mass of gas by 1K at constant volume is different from that required when the pressure is kept constant. (2 marks)

(ii) Describe an experiment to verity Boyle’s law. (4 marks)

(b) (i) State the conditions necessary for a reversible isothermal

process. (2 marks)

(ii) A fixed mass of gas at a pressure P1 and volume V1 expands isothermally to a pressure P2 and volume V2. Derive an expression for the work done by the gas. (4 marks)

(c) A gas of volume 2 litres at a temperature of 27oC and pressure of Pa is heated at constant pressure until its volume doubles. It is then cooled at constant volume back to its original temperature before finally being compressed isothermally to its original volume.

Draw a p-V diagram of the whole cycle and find the net work done by the gas. (5 marks)

(d) The pressure P of an ideal gas of density is given by

where is the mean-square speed of its molecules.

Using this expression, show Avogadro’s hypothesis. (3 marks)

7. (a) (i) Define the term specific latent heat of vapourisation. (1 mark)

(ii) Explain briefly why temperature is constant when a solid is

changing into a liquid. (2 marks)

(b) Describe with the aid of a labelled diagram, an electrical method for determination of specific latent heat of vaporization of a liquid.

(7 marks)

(c) (i) Define the term specific heat capacity of a substance. (1mark)

(ii) An electrical heater rated 500W is immersed in a liquid of mass 2.0kg contained in a large thermos flask of heat capacity 840 at 28oC. Electrical power is supplied to the heater for 10 minutes. If the specific heat capacity of the liquid is 2.5 103 Jkg-1K-1, its specific latent heat of vaporization is 8.54 103 and its boiling point is 78oC, estimate the amount of liquid which boils off stating any assumptions made. (6 marks)

(d) (i) What is boiling point of a liquid? (1 mark)

(ii) Explain why extra pressure increases the boiling point of a

liquid. (2 marks)

SECTION C

8. (a) (i) What is the significance of Millikan’s oil drop experiment?

(1 mark)

(ii) Explain why a constant temperature bath is used in Millikan’s

oil drop experiment. (2 marks)

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

(i) **work function.** (1 mark)

(ii) **stopping potential.**  (1 mark)

(c) (i) Describe a laboratory experiment to determine Planck’s

constant. (5 marks)

1. (ii) Electromagnetic radiation of frequency 8.8  1014 Hz fall onto

a metal surface whose work function is 2.5eV. Calculate the velocity with which photoelectrons are released from the surface. (4 marks)

(d)

Q

P

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 1.0  106 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. (6 marks)

9. (a) (i) Outline the processes involved in the production of X-rays in a

modern X-ray tube. (4 marks)

(ii) How do X-rays differ from positive rays? (2 marks)

(iii) Distinguish between X-ray production and the photoelectric

effect. (2 marks)

(b) In an x-ray tube operated at 1.5  105V, the target is made of material of specific heat capacity 2.5  102 J kg-1 K-1 and has a mass of 0.25kg. Given that one percent of the electric power supplied is converted into x –rays and the rest dissipated as heat in the target.

If the temperature of the target rises by 8Ks-1, Find:

1. the number of electrons which strike the target every second.

(4 marks)

(ii) the shortest wavelength of x- rays produced. (2 marks)

(c) (i) Define the term specific charge of an electron. (1 mark)

(ii) Describe a laboratory experiment to determine the specific charge (e/m) of an electron. (5 marks)

10. (a) (i) Distinguish between radioactivity and nuclear fission. (2 marks)

(ii) Why are neutrons preferred to charged particles for inducing

nuclear reactions? (2 marks)

(b) With aid of a labeled diagram, describe the principle of action of an ionization chamber. (6 marks)

(c) 1.2g of a substance form a point source of γ-rays. Only 1 in 1012 of its atoms are radioactive and the half-life is 100 days. A Geiger-Muller tube facing the source at a distance of 10 cm gives a count rate of 11 . Given that the window of the tube has an area of 7 cm2, find:

(i) the number of radioactive atoms present. (5 marks)

(ii) the mass number of the substance. (2 marks)

(d) Determine whether the nucleus  is stable or it may undergo

disintegration to produce  and an α-particle.

Mass of 210Po = 209.937u

Mass of 206Pb = 205.929u

Mass of  4He = 4.002u

(3 marks)

END