THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. DEGREE PROGRAMME 2015/2016
FINAL EXAMINATION
PHU3152 / PHE5152/ PYU3165/ PYE5165 – BIO PHYSICS
DURATION: TWO HOURS (2 hrs)

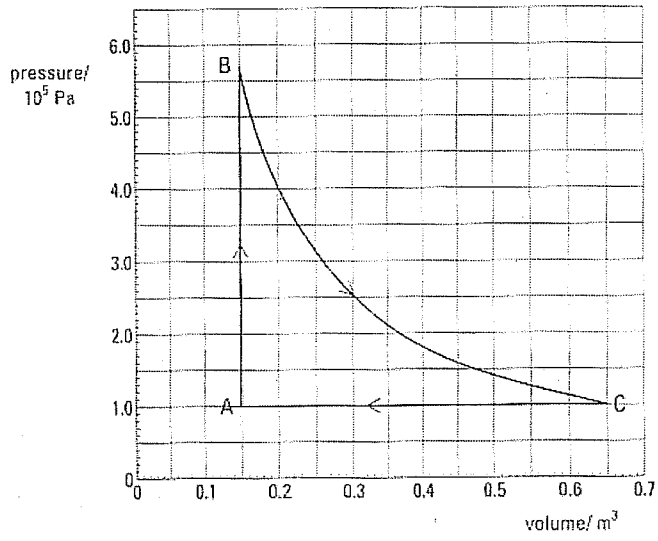
DATE: 05.07.2016 **TIME:09.30am- 11.30 am**

Answer four (4) questions only

1. **(a)** State briefly 1st and 2nd laws of thermodynamics with their differential forms.

(b) Explain following terms and draw *P-V* diagrams or each case.
(i) An isothermal expansion
(ii) An adiabatic expansion
(iii) An isobaric compression

(c) Figure shows the theoretical pressure-volume diagram of an engine in which fixed mass of air is heated, $(A \rightarrow B)$ allows expanding adiabatically from $(B \rightarrow C)$ and finally returned to its initial state $(C \rightarrow A)$ before repeating the same cycle.



(i) During the process $(A \rightarrow B)$ a heat source supplies 2 x 10^5 J of energy to the air, which is at an initial temperature of 20°C.
1. Calculate the number of moles of air which are taken through this process. The molar gas constant R = 8.3 J mol^{-1} K^1.
2. Show that the temperature of the air at B is approximately 1400°C.

(ii) During the process $(B \rightarrow C)$ the expanding gas does work on an external load. Using values taken from the diagram, show that the *net* output work done by the engine during one cycle is approximately 58 kJ.

2. (a) **(i)** Using labeled diagram, explain briefly how X-rays are produced and state briefly how you would control electrically **the intensity** and **the penetrating power of the emitted x-rays.**

(ii) The potential difference between the target and cathode of an X-ray tube is 50 kV and the current in the tube is 20 mA. What is the maximum frequency of the emitted radiation?
(The plank constant, h =6.6 x 10^{-34} J s, electron charge, e = -1.6 x 10^{-19} C)

(b) What are Miller indices? How are they determined?
Obtain the miller indices of a plane which intercepts at $a/3$, $-2b/3$ and $c/2$ in a simple cubic unit cell.

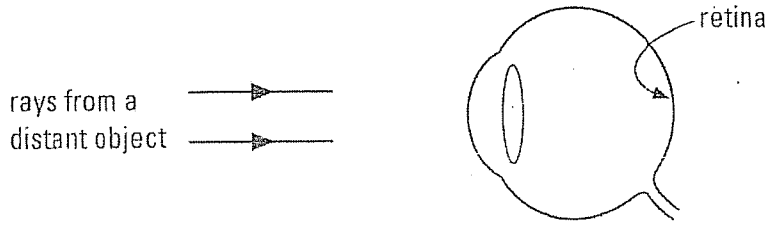
(c) **Draw** (111), (210) and (100) planes in a simple cubic cell individually.

3. (a) **(i)** What is meant by wave particle duality?
(ii) Can the electron be considered as a wave? Why?
(iii) Express the de Broglie wavelength in terms of energy.
(iv) An electron initially at rest is accelerated through a potential difference of 5000 kV. Compute (i) the momentum (ii) the de Broglie wave length.

(b) **(i)** State Stefan's law radiation and write down the corresponding mathematical equation.
(ii) A person with skin surface area 2 m^2 and the emissivity of the skin 0.9 is at rest, and has a skin temperature of 37°C in an environment with a uniform temperature of 20°C. Calculate the heat loss of this person per hour (Assume that the person is unclothed).

4. (a) Describe the optical system of the eye and explain the meaning of far point, near point and least distance of distinct vision using ray diagrams.

(b) A patient is able to see clearly text, which is nearby but finds that the same text appears blurred when moved further away.
(i) State the eye defect from which the patient is likely to be suffering.
(ii) Copy following figure and draw rays to show how the light from a distant object passes through the eye to the retina of this patient.



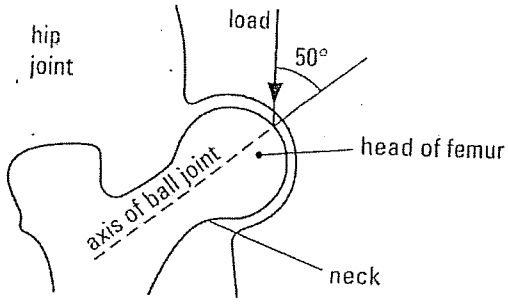
(iii) State the name of the corrective lens for the defect you have stated in section (i).

(iv) Describe a test which could be carried out to diagnose astigmatism defect of a patient.

(v) Explain how astigmatism can be corrected using an appropriate lens.

(c) A patient cannot see text clearly unless the text is held at least 100 cm from the eye. Calculate the minimum power of the lens required to see the text clearly when the text is placed 25 cm from the eye. State any assumption you make.

5.(a) When a person is standing upright and still, the load on the head of one femur (thigh bone) is vertical. The neck of the femur makes an angle of 50° to the vertical as shown in following figure.



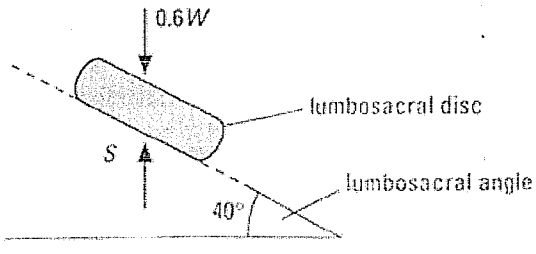
The weight, W, of the person is 700 N and the load on the head of one femur is 0.35 W. This load will produce a compressive force along the axis of the ball joint and a shear force normal to this axis.

(i) Copy this figure and indicate on it how the compressive and shear components of the load act on the head of the femur.

(ii) Calculate the values of these two components.

(b) Following figure shows the forces acting on the lumbosacral disc of the same person still standing upright. The vertical downwards load, 0.60 W and the upwards support force, S, are equal in magnitude but produce compressive and shear forces on the disc.

(i) If the effective area of the disc which supports the compressive load is 3.0×10^{-4} m^2, calculate the compressive pressure on the disc.



6. (a) A typical metabolic rate for a 20-year-old man of mass 60 kg is 66 W when he is asleep. This is called the basal metabolic rate. The metabolic rate might increase to 1200 W when the man is running although the mechanical power output he develops in running is only 350 W.

(i) State three uses for the 66 W of power when the man is asleep.
(ii) Calculate the efficiency of the man in converting energy input to the muscles into work done when running.
(iii) When the man is running, there is an 850 W difference between the mechanical power output and the metabolic rate. What is the effect on the body of this difference?
(iv) How does the body cope with the effect mentioned in (iii)?

(b) It has been suggested, for all animals, that r, the basal metabolic rate per unit mass, varies inversely with the fourth root of m, the mass of the animal, i.e.

$$r \propto \frac{1}{\sqrt[4]{m}}$$

(i) Calculate the basal metabolic rate per unit mass for the man in part (a).
(ii) Assuming the relation given above to be valid, show that the basal metabolic rate of a horse of mass 960 kg is about 530 W.

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