THE OPEN UNIVERSITY OF SRI LANKA
B.SC. DEGREE PROGRAMME
FINAL EXAMINATION – 2012/2013
PHYSICS FOR BIOLOGY STUDENTS – PCU 1271/PSU 1244/PSE 1244

Duration : Three (3) Hours

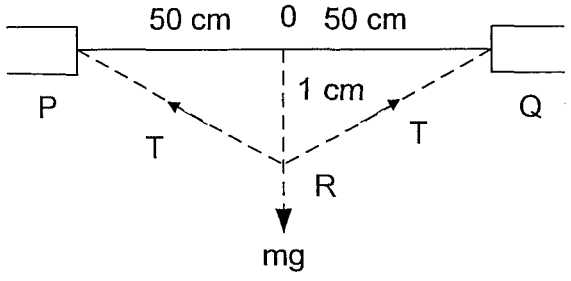
Date: 02/12/2013 **Time** : 1.30 pm – 4.30 pm

Answer Six questions only

(1) (a) (i) State Hooke's Law

(ii) Draw a labeled graph of tensile stress against tensile strain for a metal wire upto the breaking point. Show on your graph in which Hooke's law is valid.

(b) A steel wire of diameter *0.8 mm* and length *1 m* is clamped firmly at two points P and Q which are one metre apart and in the same horizontal plane. A body is hung from the middle point of the wire, such that the middle point sags *1 cm* lower from the original position as shown in figure. Calculate the mass of the body. Young's Modulus $(Y) = 2 \times 10^{11}\ Nm^{-2}$



(2) (a) State Kepler' laws of planetary motion. Assuming that the planets revolve in approximately circular orbits around the Sun, deduce Kepler's third law from Newton's law of gravitation.

(b) Use the following data to calculate

(i) the mass of the Sun

(ii) the acceleration due to gravity at the surface of the Sun. Mean radius of the Earth's orbit = $1.5 \times 10^{11} m$
Period of revolution of the Earth around the Sun = *365* days .
Radius of the Sun = $7 \times 10^{8} m$
Gravitational constant $G = 6.67 \times 10^{-11} m^3 s^2 kg^{-1}$

(3) (a) State the Faraday's laws of electromagnetic induction and the Lenz law.

(b) Two long straight parallel wires are separated by a distance *2a*. If the wires are carrying equal currents in opposite direction, what is the flux density in the plane of the wire at a point

(i) midway between them

(ii) at a distance "a" above the upper wire.

Find the force between two wires.

(c) A rectangular coil of dimension $0.3m \times 0.4m$, consisting of *200* turns rotates about an axis parallel to its long side, making *3000* revolutions per minute in a magnetic field of *0.08* tesla. What are the instantaneous values of induced e.m.f. when the plane of the coil makes on angle.

(i) 0^o (ii) 50^o (iii) 90^o with the field direction.

(4). (a) Explain the difference between reactance and impedance.

(b) Derive an expression for the impedance of a LR circuit connected to an a.c. Power supply. Obtain an expression for the phase relationship between the current and voltage.

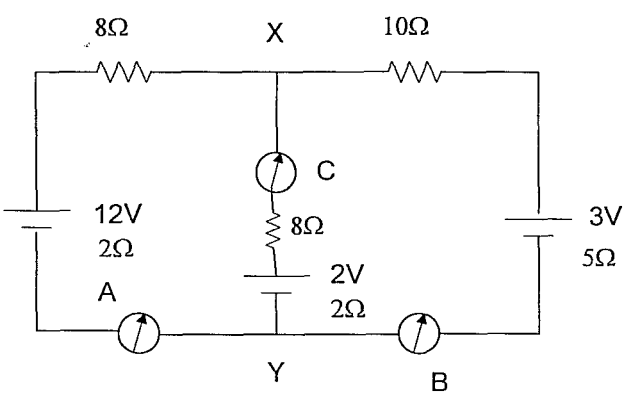
(c) A coil of negligible resistance and inductance 0.02 H is in series with a wire of zero inductance and resistance *12 Ω*. An e.m.f. of *130 V, 40 Hz* is applied across the above series circuit.

Calculate,
(i) the current in the circuit.
(ii) the potential difference across the resistor.
(iii) the potential difference across the inductor
(iv) the angle of lag. (Phase difference)

(5) (a) Explain clearly the difference between e.m.f and potential difference.

(b) State the Kirchchoff's network laws, and point out that each is essentially a statement of a conservation law.

(c)



Find for the above circuit,
(i) the readings on the ammeters *A, B* and *C* (of negligible resistance)
(ii) the potential difference between *X* and *Y*.
(iii) the power dissipated as heat in the circuit.
(iv) the power delivered by the *12V* cell.

(6) (a) Explain the terms half-life and activity in radioactivity.

(b) (i) Show that the activity A of a radioactive isotope at a given time t can be denoted by $A = A_0 e^{-\lambda t}$, where λ is the decay constant and A_0 is the activity at $t = 0$.

(ii) Hence, deduce the equation $t_{\frac{1}{2}} = \frac{ln2}{\lambda}$ for the half-life of a radioactive isotope.

(c) A freshly prepared sample of a radioactive isotope X contains 10^{20} atoms. The half-life of the isotope is 12 hours. Calculate,

(i) the initial activity of the radioactive isotope.
(ii) the number of radioactive atoms of X remaining after one hour.
(iii) the number of radioactive atoms of X remaining after 24 hours.

(7) (a) (i) Define linear momentum and state the law of conservation of momentum.

(ii) Explain what is meant by an elastic collision and inelastic collision.

(b) Two pendulum bobs, A and B hang side by side in contact with one another at rest, each supported by a thread of $2m$ long. A has mass $0.2\ kg$ and B has mass $0.08\ kg$. Bob A is then pulled to one side with its thread taut until it is $0.1\ m$ higher. Then it is released so it collides with B. After the collision, B gains $0.15\ m$ of height.

Calculate,
(i) the speed of A before impact
(ii) the speed of B just after impact
(iii) the speed of A just after impact
(iv) the height gained by A after impact
(v) the loss of kinetic energy as a result of the impact.

(8) (a) (i) State Bernoulli's Principle
(ii) Explain the phenomena's of streamline flow and turbulent flow.

(b) A tank of large area is filled with water to a depth of $0.3\ m$. A hole of $5\ cm^2$ cross-section in the bottom allows water to drain out in a continuous stream. What is the rate at which water flows out of the tank in $m^3 s^{-1}$?

(c) In a hurricane, the air (density $1.2\ kg\ m^{-3}$) is blowing over the roof of a house at a speed of $110\ km\ hr^{-1}$.

(i) What is the pressure difference between inside and outside that tends to lift the roof?
(ii) What would be the lifting force on a roof area of $10^2\ m$?

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