UCE physics 2011 paper 2

1. (a) State the conditions for a body to be in
   (i) Stable equilibrium (01mark)
   The center of gravity should be low and the base wide
   (ii) Neutral equilibrium (01mark)
   When the center of gravity should remain unchanged when the body is slightly dissiplaced.

   (b) Explain why bus passengers' luggage is loaded in the boots rather than the rack on the top of the bus. (04marks)

   Loading on the rack would raise the centre of gravity of the bus making it unstable whereas loading in the boot lowers the centre of gravity making the bus stable

   (c) A block of wood floats on both fluid X and liquid Y, but with a greater portion inside liquid Y than in liquid X. Explain this observation. (04marks)

   It sinks deeper in liquid Y because Y is less dense than X because big volume of Y provide the same upthrust as a smaller volume of liquid X displaced.

   (d) If a block of volume 280cm^3 floats on water with ¾ of its volume immersed, find

   (i) mass of the wooden block. (03marks)

   Volume of water displaced = $\frac{3}{4}\ x\ 280 = 210g$

   Mass od block = mass of water displaced (law of flotation) = 120 x 1 = 210g

   (ii) fraction of the block that sinks when it is placed in cooking oil of density 0.84gcm^{-3}. (03marks)

   Mass of cooking oil displaced = 210g

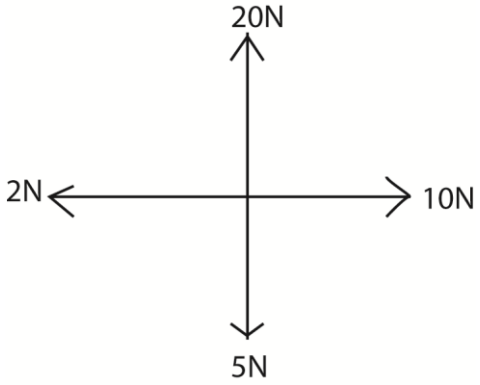
   Volume of cooking oil = $\frac{mass}{density} = \frac{210}{0.84} = 250cm^3$

   Fraction of block sunk = $\frac{250}{280} = \frac{25}{28}$

2. (a)(i) Distinguish between scalar and vector quantities. (01mark)
   A scalar quantity has only magnitude while a vector quantity has both magnitude and direction
   (ii) Give one example of each quantity. (01mark)
   Examples of scalar quantities: density, mass, time, speed, distance

Examples of vector quantities: velocity, force, acceleration, displacement, momentum

(b) Four forces of 2N, 5N, 10N and 20N act on a doll as shown in the figure below



Find the magnitude of the resultant force acting on the doll. (03mark)

Resultant vertical forces = 20 – 5 = 15N

Resultant horizontal forces = 10 – 2 = 8N

From Pythagoras theorem, resultant force = $\sqrt{(15^2 + 8^2)}$ =17N

(c) State Newton's Laws of motion. (03marks)

1st law: A body at rest remains at rest of if moving it continues moving in straight line unless an external force acts on it.

2nd law: the rate of change of momentum of a body is proportional to the applied force and takes place in the direction of the applied force.

3rd law: action and reaction are equal and opposite

(d) Explain why passengers in a vehicle need to fasten their belts. (03marks)

Because when the vehicle moving at high speed suddenly come to rest, the passengers jerk forward due to inertia. The seat belts protect the passengers from injury by holding them in their seats.

(e) A bullet of mass 0.006kg travelling at 120ms^{-1} penetrates deeply into a fixed target and brought to rest in 0.01s. Calculate the

(i) distance of penetration of the bullet. (02marks)

a = $\frac{v-u}{t} = \frac{0-120}{0.01}$ = - 12000ms-2

from $v^2 = u^2 - 2as$

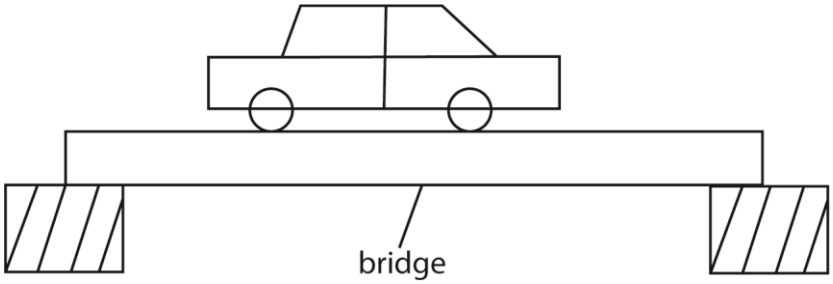
$0 = 120^2 - 2 \times -12000 \times s$

s = 0.6m

(ii) average retarding force on the bullet. (03marks)

F = ma = 0.006 x 12000 = 72N

3. (a) the diagram in the figure below shows a car crossing a bridge made of a beam



Explain the mechanical state of the beam. (04marks)

The weight of the car acts downwards on the bridge; the upper side of the bridge is under compression while the lower side is under tension. The middle part is neutral

(b) What would be effect on the beam in (a) above if a notch is made on the

(i) upper side (01mark)

The beam is compressed thus no effect

(ii) lower side (01mark)

The beam is under tension, the notch spreads and the beam may break

(c) (i) State Hooke's law. (01mark)

The extension produced in a material is proportional to the force applied provided elastic limit is not exceeded.

(ii) Describe an experiment to verify Hooke's law using a spring. (05 marks)

- -A spring with a pointer is clamped vertically and a ruler is placed by the side
- The initial position of the pointer is noted
- A known mass is suspended from the spring
- A new position of the pointer is noted and extension determined.
- The procedure is repeated for various masses
- A graph of extension against the load is a straight line showing that extension is proportional to the load.

(d)(i) What is meant by elasticity (01 mark)

It is the ability of a material to regain its original shape and size after deformation.

(ii) A spring produces an extension of 6mm when a load of 9N is hanged from its free end. What load would cause the same spring to stretch by 16mm? (03 marks)

F = ke

k = $\frac{9}{6} = \frac{F}{16}$

F = $\frac{9}{6}\ x\ 16$ = 24N

4. (a) What is meant by the following as applied to sound waves

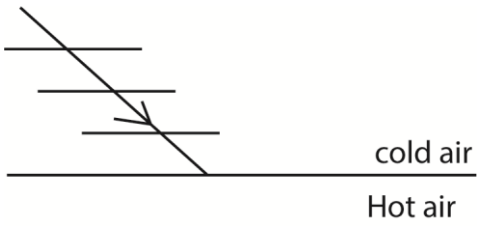
(i) Pitch (01mark)

It the highness or lowness of sound

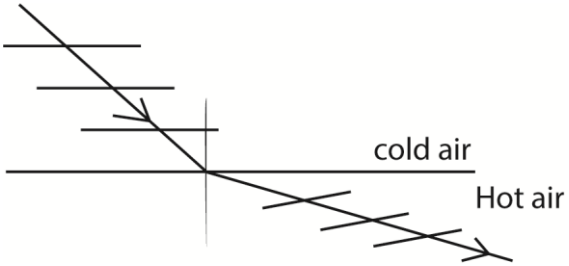
(ii) Audio-range (01mark)

Is the range of wave frequency a human hear can detect

(b) The figure below shows parallel sound wave travelling from a region of cold air to a region of hot air.



(i) Copy and draw the waves' pattern in the hot air, showing the direction of travel. (02 marks)



(ii) Name the wave phenomenon shown by the wave. (01mark)
refraction

(iii) Explain why the wave behaves the way you have drawn in the hot air.

Since the speed of sound waves increase with temperature, the wavelength of sound wave increases, hence the sound waves are refracted away from normal.

(c) A student observed the time interval between the lightning flash from a distant storm and accompanying thunder as 4 beats of his pulse. If his pulse rate is 72 beats per minute,

Determine

(i) Time in seconds taken for him to hear the thunder from the instant he sees the flash. (03marks)
1beat = $\frac{1}{72}\ x\ 60s$
4beats = $\frac{4}{72} x\ 60 = \frac{1}{18} x\ 60 = \frac{10}{3} s$

(ii) Distance of the storm from the observer. (03mark)
(Take the speed of sound in air = 330ms^{-1})
Distance = speed x time = $330\ x\ \frac{10}{3}$ = 1100m

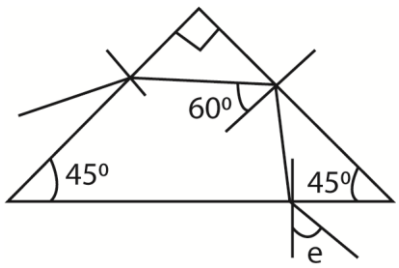
(d) Give any two applications of ultrasonic sounds. (02marks)

- determine sea depth
- ultrasound drilling
- medical scan

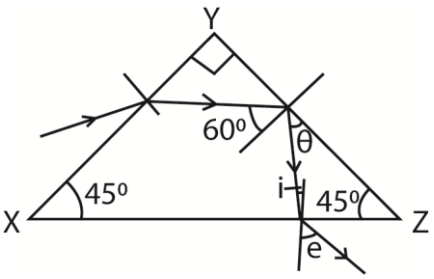
5. (a) What is meant by refraction of light? (01marks)
It s the change in the speed of light from one medium to another.
(b) When does total internal reflection occur? (02marks)

- when light is travelling from a denser optical to less dense optical medium
- when the angle of incidence is greater than the critical angle.

(c) Figure below shows a light ray through a right angled isosceles prism of refractive index 1.5.



If the ray is incident on face YZ at an angle of 60^0, find the angle of emergence, e. (05marks)



Angle θ = 90 – 60 = 30

Angle i = 180 – (90 + 45 + 30) = 15^0

n = $\frac{\sin e}{\sin i}$

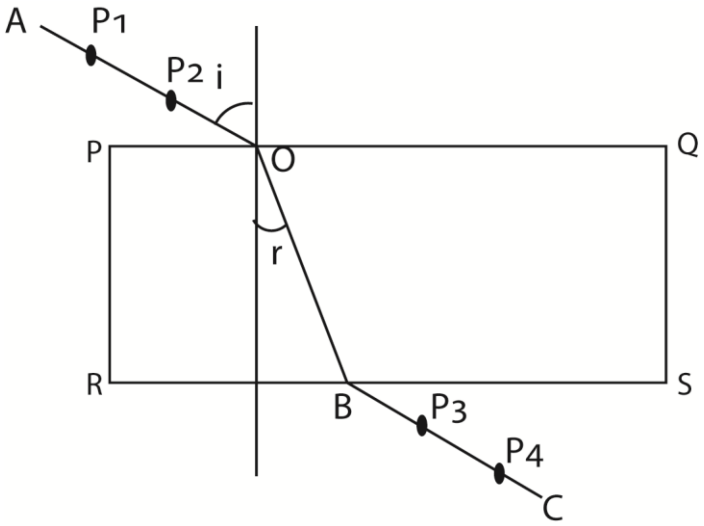
e = $\sin^{-1}$ (nsin i) = $\sin^{-1}$(1.5sin 15) =22.8^0

(ii) State two reasons why reflecting prism are better reflector than plane mirrors.

do not form multiple images
- produce clearer images
- do not tarnish like plane mirror

(d) Describe an experiment to determine the refractive index of the material of glass block. (06marks)

Experiment to determine the refractive index of the material of glass

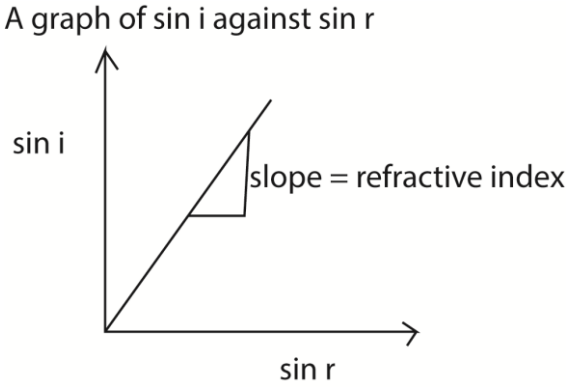


(i) Fix a glass block on a plane sheet of paper on soft board.
(ii) Trace outline PQRS
(iii) Draw a normal at O
(iv) Draw a line AO making an angle I = 10^0 with the normal at O
(v) Fix pins P_1 and P_2 vertically along AO and replace a glass block
(vi) From side RS fix pins P_3 and P_4 so as to appear to be in line with the images of pins of P_1 and P_2.
(vii) Remove P_3 and P_4 and draw a line to join holes of P_3 and P_4 to the block at B
(viii) Join B to O and measure angle r.
(ix) Repeat d) to h) for values of i = 25, 30, 35, and 40^0.

(x) Tabulate results including values of sine I and sine r.

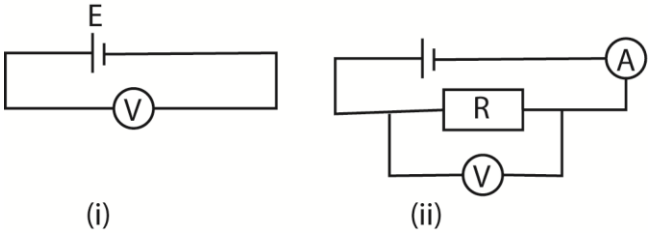
i (^{0})	Sin i	r(^{0})	Sin r

(xi) Plot the graph sine I and sine r.



(xii) The slope of the graph is equal to refractive index of glass.

6. (a) Distinguish between primary and secondary cells and give example each.(03marks)
Primary cells are not rechargeable when used up e.g. dry cells while secondary cells are rechargeable when used up e.g. lead acid cells.
(b) State two precautions one has to undertake to prolong the life of a lead-acid accumulator. (02marks)
- when not in use give it a top up charge at least once a month
- regularly top it up with distilled water
- regularly clean its terminals
- avoid short circuit.
(c) Define potential difference across a resistor in a circuit. (01mark)
It is the work done per coulomb of charge to pass through a resistor.
(d) With the aid of a circuit diagram, describe how you can determine the internal resistance of a cell. (05marks)
Experiment to determine internal resistance of a cell

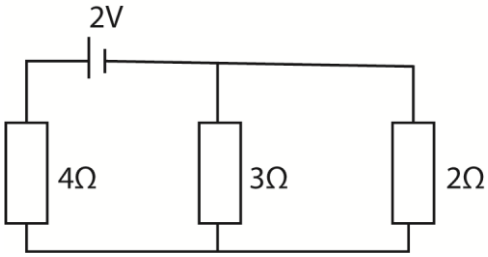


- A voltmeter is connected directly across the terminals of the cell and its reading E s recorded.
- the cell is then connected in series with the ammeter and a resistor of known resistance, R

The voltmeter V is connected across the resistor and readings I and V from the ammeter and voltmeter respectively are recorded.

- internal resistance, r = $\frac{E-V}{I}$

(e) Resistors of 4Ω, 3Ω and 2Ωare connected as shown in the figure below



Calculate the current through the 4Ωresistor. (05mark)

Resultant resistance in parallel = $4 + \frac{3\ x\ 2}{(3+2)}$ = 5.2Ω

Current, I = $\frac{2}{5.2}$ = 0.38Ω

7. (a) Define energy and state it SI unit (02mark)

Energy is the capacity/ability to do work. Units are joules (J)

(b) Give two examples of primary sources of

(i) renewable energy. (01mark)

- sunlight, wind flowing water, geothermal

(ii) non-renewable energy, (01mark)

Petroleum, coal, uranium (nuclear energy)

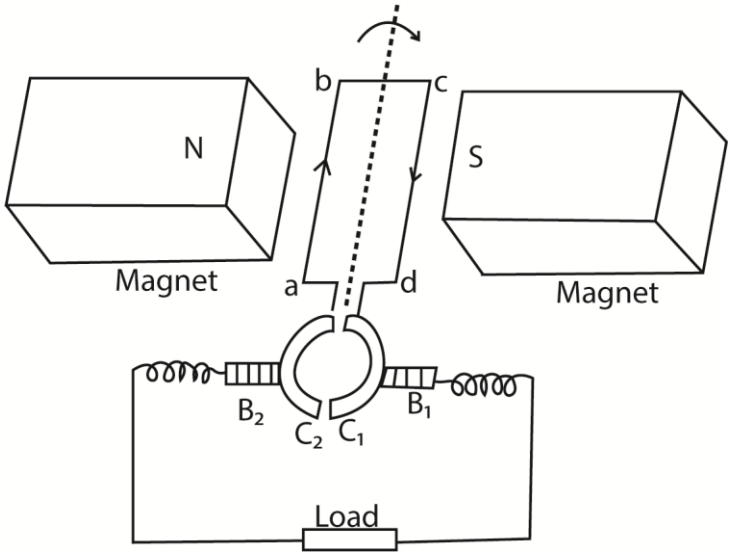
(c) Describe the energy changes that occur when a filament bulb connected to a battery lights.

Chemical energy from battery is converted to electrical energy which converted to heat and light.

(d)(i) Describe the operation of a simple dynamo. (05marks)

The question required the operation of a.c or d.c generators

(a) d.c. generator



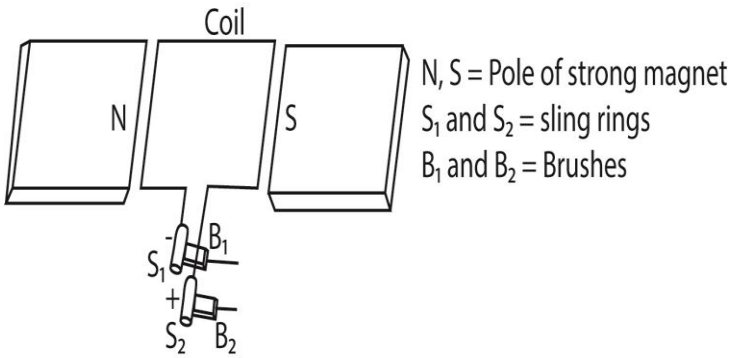
It consists of a rectangular coil abcd of wire pivoted between curved poles of a strong magnet and free to rotate about its axis with a uniform velocity.

The ends of the coil are connected to two halves of sprit ring (commutators) which press lightly against the carbon brush.

Mode of action

- When the coil rotates at uniform velocity in magnetic field, e.m.f is induced in it.
- When the coil is in vertical position, the commutators change brushes C_1 to B_2 and C_2 to B_1.
- E.m.f reverses direction but the current does not change direction. Hence current flows in the same direction in a resistor.

(b) a.c. generator



Mode of action

- The coils is turned with uniform speed in magnetic field.
- Because of change in magnetic field linking the coil, an e.m.f is induced in the coil.

(ii) State three factors on which the e.m.f produced by a dynamo depends. (03marks)

- Strength of magnetic field
- Number of terns in the coil
- Speed of rotation
- Cross sectional area of the coil

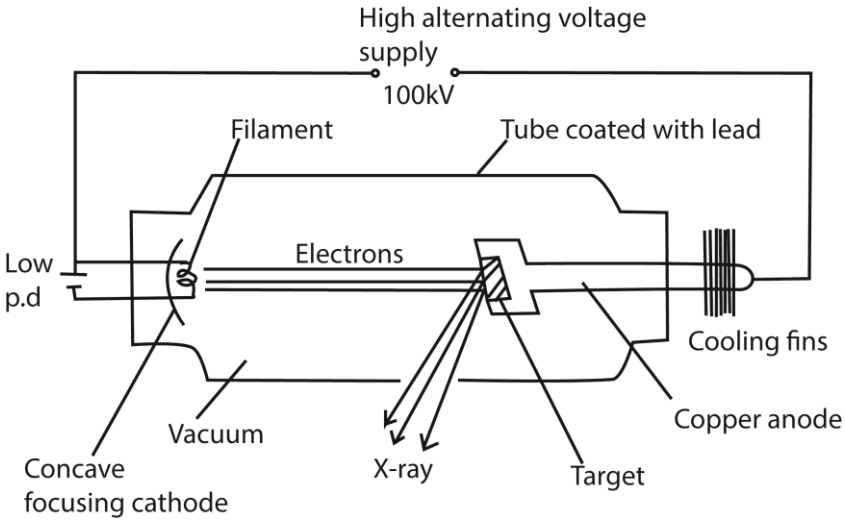
8. (a) List any two difference between X-rays and gamma rays(02marks)

Differences between X-rays and gamma rays

x-rays	Gamma rays
Less penetrative	High penetration power
Longer wavelength	Short wavelength

(b) With the aid of a labelled diagram describe how X-rays are produced. (07marks)

Production of X-rays



Mode of operation

- The filament is heated by a low voltage supply and the electrons are emitted by thermionic emission.
- The concave focusing cathode focuses the electrons from the filament onto the target.
- These electrons are accelerated towards the anode by the high voltage between the filament and the Anode.
- When the electrons (cathode rays) strike the metal target, about only 1% their kinetic energy is converted to X-rays and the 99% of their kinetic energy is converted to heat, which is conducted away by the cooling fins.

(c) What are the differences between hard and soft X-rays.

Differences between hard X-rays and soft X-ray

	Hard X-ray	Soft X-ray
Production	High voltage is required	High voltage is required
wave length	Short	long
Penetrating power	High	low
Frequency	High	low

(d) Define the following

(i) radioactive nuclide (01mark)

Radioactive nuclide is an unstable nuclei which undergoes spontaneous disintegration

(ii) isotope (01mark)

Isotopes are atoms with the same number of protons but different number of neutrons.

(e) outline three uses of radioactivity. (03mark)

- carbon dating
- treatment of cancer
- sterilizing medical equipment
- monitor thickness of paper in paper production