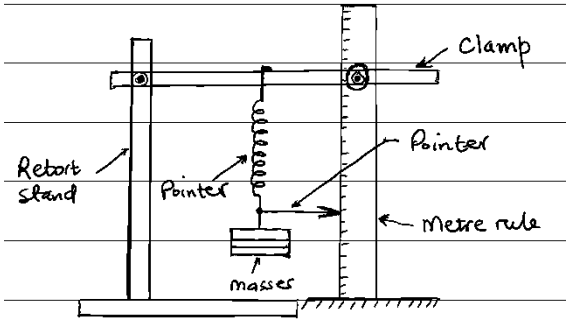
Uganda Certificate of Education
535/2 PHYSICS (Paper 2) Marking Guide
JJEB 2023

Question 1

(a) (i) Hooke's law states that, the extension of an elastic material is directly proportional to the applied (stretching) force, provided the elastic limit is not exceeded.

(ii)



A spring with a pointer and no mass attached to it is suspended from clamp on a retort stand as shown in the diagram.
The initial position, ***X*** of the pointer is noted.
A standard mass, ***m*** is then attached to the free end of the spring. The spring stretches.
The new position, ***Y*** of the pointer is noted.
The extension, ***e*** of the spring is determined from: $e = Y - X$
The procedures are repeated, using different masses
The results are tabulated including values of load, $L = mg$, where, $g = 10\ ms^{-2}$.
A graph of ***L*** against ***e*** is plotted.
A straight line graph through the origin is obtained, showing that $L \propto e$, hence verifying Hooke's law.

(b) (i) Tensile stress = Force, F / cross-section area, A
$\Rightarrow$ Tensile Stress = $\frac{4}{2.5 \times 10^{-6}}$
$= 1.6 \times 10^{6}\ N\,m^{-2}$ or Tensile stress $= 1.6 \times 10^{6}\ Pa$.

$F = mg$: $m = 400g = 0.4\ kg$, $g = 10\ ms^{-2}$
$\Rightarrow F = 0.4 \times 10 = 4N$
$A = 2.5 \times 10^{-6}\ m^2$

(ii) Tensile strain = extension, e / original length, l_o
$\Rightarrow$ Tensile Strain = $\frac{0.032}{0.2}$
$= 6.25$. Note: Tensile strain has no unit.

$e = 59.5 - 56.3 = 3.2cm = 0.032m$
$l_o = 20cm = 0.2m$

(c) (i) Diffusion refers to the movement of molecules from a region of high concentration to a region of low concentration.

(ii) Temperature of the gas.
Size of the diffusing molecules
The concentration gradient.
Density of the gas containing the diffusing molecules.

Turn Over

(d) When a gas is cooled, its temperature drops to condensation temperature at which the temperature remains constant until all the gas has turned into a liquid. The temperature of the liquid drops to freezing point, which remains constant until all the liquid turns to solid. There after, the temperature of the solid starts to drop.

Question two

(a) Non-uniform velocity is when the rate of change of displacement with time is not constant, while uniform velocity is when the rate of change of displacement with time is constant.

(b) (i) The motorcyclist moving at a velocity of 40 ms^{-1} decelerates uniformly at a rate of 2 ms^{-2} to rest in 20 seconds. He then accelerates uniformly at a rate of 3 ms^{-2} in the next 20 seconds.

(ii) Distance, s = area under the graph = $\frac{1}{2}b_1h_1 + \frac{1}{2}b_2h_2$

$b_1 = 20s$, $h_1 = 40ms^{-1}$

$b_2 = 14s$, $h_2 = 42ms^{-1}$

$\Rightarrow s = \left(\frac{1}{2} \times 20 \times 40\right) + \left(\frac{1}{2} \times 14 \times 42\right)$

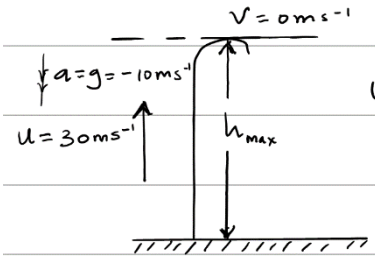
$\Leftrightarrow s = 400m + 294m \quad \therefore s = 694m$

(c) (i) The law of inertia states that, for every action, there is an equal and opposite reaction.

(ii) When a bullet is fired from a gun, the gun exerts a forward force on the bullet and the bullet exerts a an equal but opposite force on the gun. Due to the high mass of the gun, it moves a little distance backward and gives a backward jerk to the shoulder of the gunman.

(d) (i) Acceleration due to gravity refers to the rate of change of velocity with time, for a free falling body.

(ii)



Using: $v^2 = u^2 + 2gh \Rightarrow h_{max} = \frac{v^2 - u^2}{2g}$

$\Rightarrow h_{max} = \frac{0^2 - 30^2}{(2 \times -10)} \quad \therefore h_{max} = 45m$

Question three

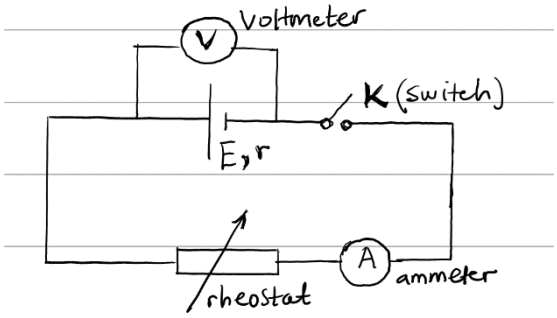
(a) (i) Electromotive force of a cell refers to the total voltage across the terminals of a cell on an open circuit. ***OR***, It is the total work done to convey (or to drive) one coulomb of charge round a complete circuit in which the cell is connected.

(ii) ***Polarization:*** It is minimized by adding a depolarizer (potassium dichromate) which turns hydrogen molecules into water. *It can also be minimized by brushing off the hydrogen bubbles from the copper electrode by use of a small paint brush.*

Local action: It is minimized by zinc amalgamation (that's cleaning the zinc plate using sulphuric acid and covering the plate with mercury). *It can also be minimized by using pure zinc.*

03

(iii)



With the circuit connected as shown above, switch, K is closed and the rheostat is adjusted such that the ammeter gives an appropriate reading of current, I.
The ammeter reading, I and voltmeter reading, V are noted.
The procedure is repeated using different values of current, I.
The results are tabulated including the values of V.
A graph of V against I is plotted and its slope **S** is calculated.
The internal resistance, ***r* = -S.**
The V-intercept, V_o is noted from the V-axis.
The emf, E of the cell is $E = V_o$.

(b) (i) When switch is open, Voltmeter reading = emf of the cell.
= 4·5 V

01

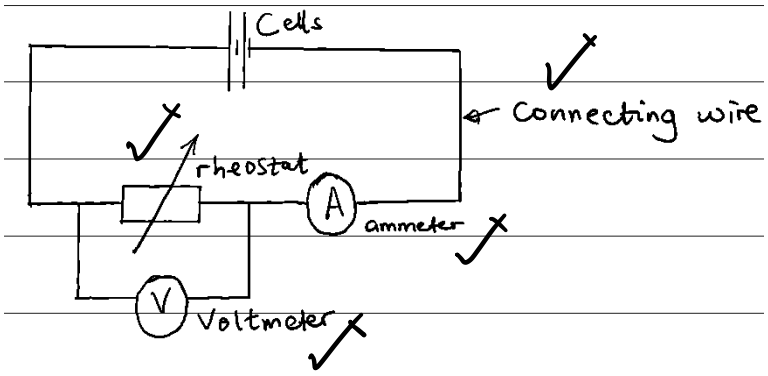
(ii) When switch is closed, Ammeter reading = total current, I supplied by the cell.

But $E = I(R+r)$
$\Rightarrow 4.5 = I(3+0)$
$\Leftrightarrow I = (4.5/3)$ $\therefore I = 1.5\ A$

$E = 4.5\ V$, $r = 0\ \Omega$
$R = 1.5 + \frac{(3\times3)}{(3+3)} = 1.5 + 1.5$
$\Rightarrow R = 3\ \Omega$.

05

(c)



02

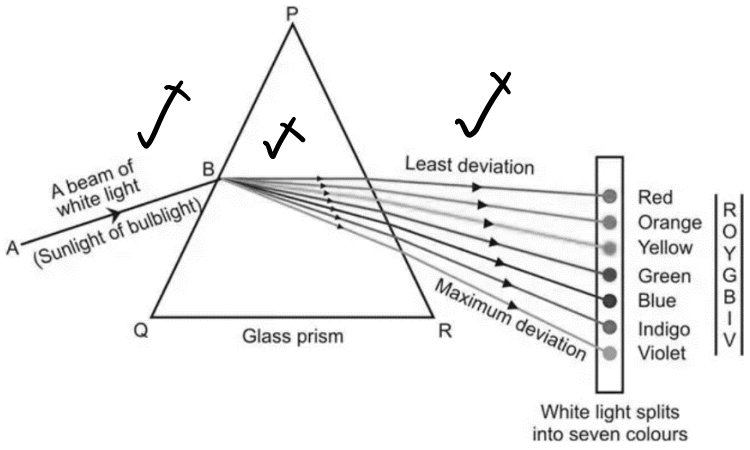
Question four

(a) (i) The angle of incidence is equal to the angle of reflection.
The incident ray, the reflected ray and the normal line at the point of incidence, all lie in (***or on***) the same plane.

(ii) Formation of a mirage.
Formation of a rainbow.
Fish's eye view.

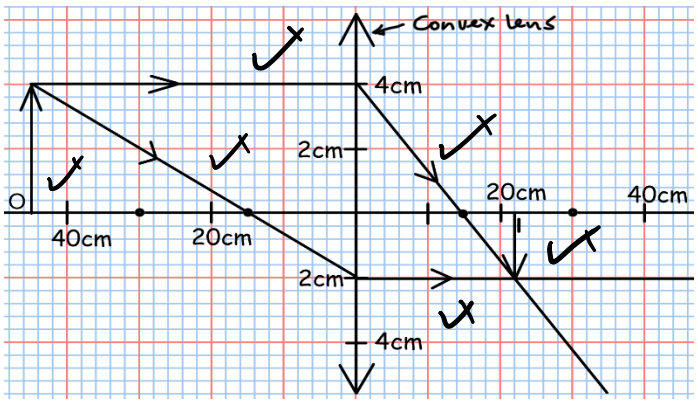
(b) (i) Dispersion is the splitting of white light into its component colours when it is passed through a glass prism.

(ii)



(iii) Viewing distant objects in prismatic binoculars.
Viewing objects behind obstacles in prismatic periscopes.

(c)



(i) Image size, $h_i = 5 \times 0.4$
$= 2.0\ cm$

(ii) Magnification, $m = \frac{h_i}{h_o}$; $h_i = 2.0cm$, $h_o = 4.0cm$

$\Rightarrow m = \frac{2.0}{4.0}$ $\therefore m = 0.5$

OR: $m = \frac{v}{u}$ $v = 22.5\ cm$, $u = 45.0\ cm$

$\Rightarrow m = \frac{22.5}{45.0}$

$\therefore m = 0.5$

(d)

Human eye	**Lens camera.**
* It is made of a flexible substance	* It is made of a solid glass.
* Focal length of the eye lens is variable by action of ciliary muscles.	* Focal length of the camera lens is fixed.
* Retina retains the image for a very short time.	* Photographic plate retains the image permanently.
* Light is refracted by the cornea, lens and fluid in the eye.	* Light is refracted by the lens only.
* The intensity of light is adjusted by the iris reducing the size of the pupil.	* The intensity of light is adjusted by changing the size of the aperture using the focusing screws.

Question five

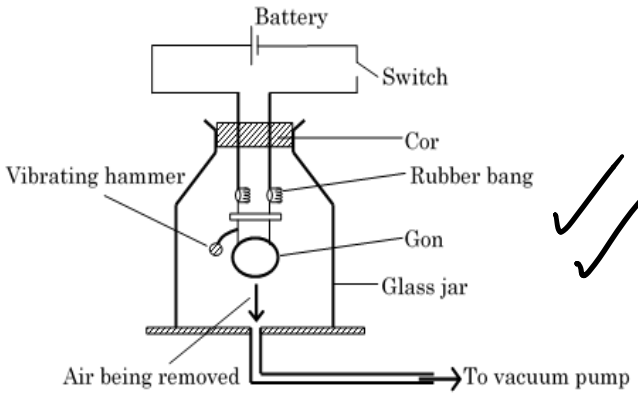
(a) (i) This refers to a wave produced by mechanical vibrations of objects.

(ii) **Temperature**. As the temperature of the air increases, the speed of sound increases and the speed decreases as the temperature of air reduces.

Humidity. When air is completely dry (low humidity), speed of sound is low and for moist air (high humidity), the speed of sound is high.

Direction of wind. Speed of sound increases if wind is moving in the direction of sound and reduces if wind is moving in a direction opposite to that of sound.

(iii)



An electric bell is placed in a glass (bell) jar with the jar connected to the vacuum pump. Both the electric bell and the pump are switched on and observed for some time. The sound of the bell gradually decreases until it is finally not heard even though the hammer is seen striking the gong. This is because, the pump removes all the air in the glass jar, hence no material medium to transmit the sound waves. Therefore, sound waves require a material medium for transmission.

(b) (i) Trough ✓ (01)

(ii) Region A. The deeper the region, the longer the wavelength. ✓ (01)

(iii) Velocity, $v = \lambda f$ ✓

$\Rightarrow v = 20 \times 40$ ✓

$\therefore v = 800 ms^{-1}$ ✓

$\frac{\lambda}{2} = 10 \Rightarrow \lambda = 20m$ ✓

$f = 40Hz$

(04)

(c) Air in open-ended pipes vibrates in both odd and even harmonics and so produces musical notes which are richer in quality unlike closed-ended pipes which produce only odd harmonics, so poor quality musical notes. ✓ ✓ (02)

Question six

(a) (i) Thermometry refers to the branch of physics that deals with temperature measurement and the design of instruments for measuring temperature. ✓ (01)

(ii)
* Length of a liquid in a capillary tube. ✓
* Pressure of a fixed mass of a gas at constant temperature. ✓ (02)
* Resistance of a material in form of a wire.
* Thermoelectric emf.

(b) (i) Evacuation of the space above the liquid is to prevent a high pressure of the trapped air when the liquid expands a lot. ✓ (01)

(ii) The tube is made finer to increase the sensitivity of the thermometer ✓ and it is made uniform to give an even expansion of the liquid along it. ✓ (02)

(c) (i) When salt is sprinkled on ice, it weakens the intermolecular forces of ✓ attraction in ice. In addition to the latent heat absorbed by ice, the intermolecular spacing increases faster and so, the ice melts faster. ✓ (02)

(ii) The intermolecular forces in liquids are weaker than those in solids. On ✓ heating, the molecules gain internal energy and move faster. Since ✓ molecules in liquids are less tightly packed, they therefore liquids expand faster than solids when subjected to the same amount of heat. ✓ (03)

(d) (i)
* There might be heat loss while transferring the solid into the calorimeter. ✓
* During conduction, convection and radiation, there might be some heat loss. ✓ (02)
* The bulb of the thermometer might not be completely inside the solid.

(ii) Electrical energy lost = Heat energy gained
by the heater by the solid
$\Rightarrow Pt = mc\Delta\theta$
$\Rightarrow 54 \times 500 = (1.5 \times 20)c$
$\therefore$ Specific heat capacity, $c = 900 J kg^{-1} K^{-1}$

$m = 1.5 kg$
$\Delta\theta = 50 - 30 = 20^{\circ}C$
$t = (8 \times 60) + 20 = 500s$
$P = 54 W$

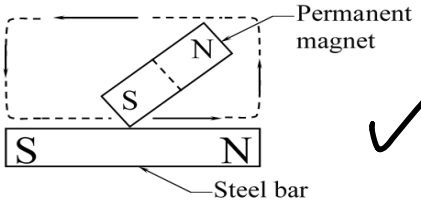
03

Question seven

(a) Ferro-magnetic materials refer to materials which are strongly attracted by a magnet.
Examples of Ferro-magnetic materials are: iron, steel, cobalt, and nickel.

02

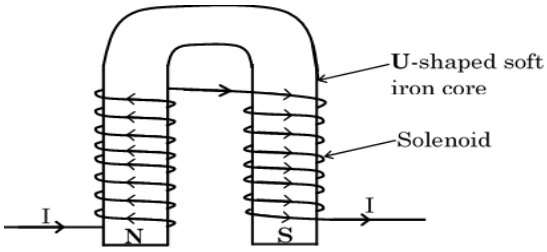
(b) (i)



03

The steel bar is stroked with the same pole of a permanent magnet from one end to the other end in the same direction several times. When the magnet reaches the other end, it is lifted sufficiently high above the steel bar between successive strokes. The pole of the magnetized steel bar where the stroking finishes is always opposite to the pole of the permanent magnet used for stroking.

(ii)



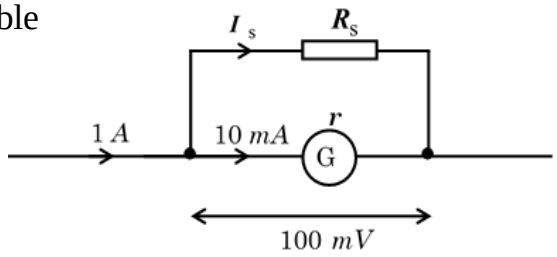
03

An insulated copper wire is wound on a U-shaped soft iron core so as to have a solenoid on each side. When the current passes through the solenoid, the soft iron gets magnetized, with the two sides acquiring opposite polarity, since the coils are wound in opposite sense. The opposite adjacent poles increase the lifting power of the electromagnet, making it to lift the scrap metals.

(c) (i)
* Increasing the strength of the magnetic field.
* Using weak springs (using springs of low force constant).
* Increasing the number of turns of the coil.
* Using a coil of low resistance.
* Using larger coils (coils of large area).

02

(ii) We need to calculate the value of shunt resistance, $\boldsymbol{R}_S$ that can make it possible



Using, P.d across the shunt = P.d across the G

$\Rightarrow \quad (I - I_f) \times R_s = I_f \times r$ and thus,

$\Rightarrow \quad (1 - 0.01) \times R_s = (I_f \times r) = 0.1 \quad \therefore \quad R_s = \dfrac{0.1}{0.99} = 0.10\Omega$

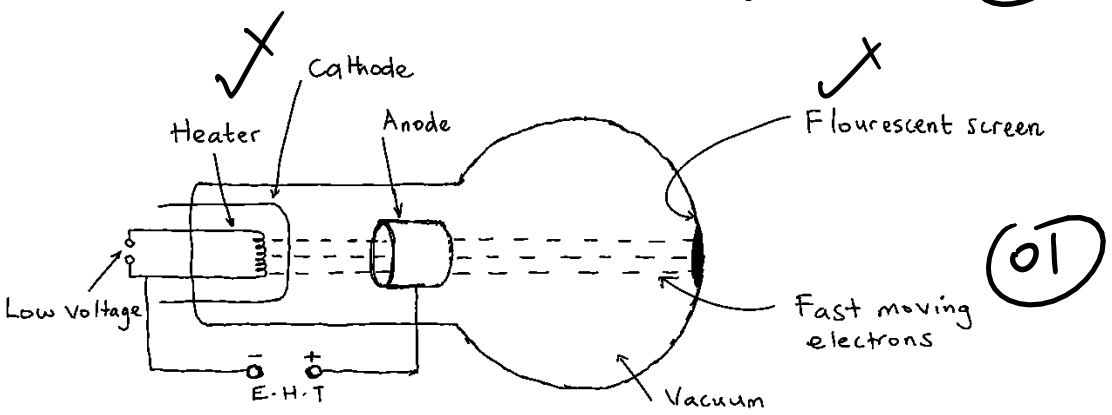
Thus, we must connect a shunt resistance of 0.10 Ω across the meter.

(d) When switch ***K*** is closed, the galvanometer deflects in one direction. When switch ***K*** is closed, current from the source flows in the solenoid connected to it, increasing to a maximum value. This changing current creates a changing magnetic flux in this primary solenoid. This changing magnetic flux then links up the solenoid connected to the galvanometer and so an e.m.f is induced in this secondary solenoid. An induced current therefore flows through the galvanometer, hence a deflection in one direction.

Question eight

(a) (i) Thermionic emission is the process by which electrons are emitted from a metal surface when heated, while, photoelectric emission refers to the process by which electrons are ejected from a metal surface when illuminated by an electromagnetic radiation of a high frequency such as ultra-violet radiation.

(ii)



The cathode is heated by a low voltage applied across the heater. The cathode then emits electrons by thermionic emission. The emitted electrons are then accelerated by a high voltage applied between the heater and the anode so that they move with a very high speed hence forming cathode rays. Some of the electrons (cathode rays) pass through the anode and a parallel beam of electrons is obtained which is received as spot on the fluorescent screen. (03)

(b) Dangers encountered.

* They destroy body cells.
* They cause genetic mutation. (02)
* They cause skin burns since they are highly penetrative.
* They cause skin cancer on excessive exposure to them.
* They damage blood and eye sight.

Safety precautions taken.

* Unnecessary exposure must be avoided.
* The exposure must be of a very short time. (02)
* There should be no X-ray exposure for babies, born or unborn.
* The technicians in the X-ray laboratories should wear protective gears.
* The exposure should be for the part affected only.
* Avoid using hard X-rays on humans. Only soft X-rays should be used.
* The X-ray equipment should be shielded using thick lead.

(c) (i) Half-life refers to the time taken for atoms of a radioactive substance to reduce to half its original value. (01)

(ii)

Remaining mass (grams):	12	6	3	1.5	0.75
Time taken (years):	0	7	14	21	28

The time taken is 28 years. (03)

(d) Alpha particles have mass are more ionizing than gamma radiations which have no mass. Therefore, more pulse current is produced in the ion chamber region by alpha than the gamma radiations. (02)