ANSWERS TO CHECK YOUR UNDERSTANDING

Experiment 1

(i) A vernier scale is a scale with divisions slightly smaller than those on the main scale and is moveable along the main scale. It is no named after the name of its inventor Pierre Vernier.

(ii) Vernier constant is the difference between the length of one main scale division and one vernier division. It is the least count of the instrument, because we can measure a length with this much precision.

(iii) Negative

(iv) By adjusting the lower jaws for zero thickness (or the depth gauge for zero depth), observe the vernier reading and multiply it by vernier constant.

(v) Vernier scale enables is to observe the position of its zero mark on the main scale with a precision of a fraction $\left(\frac{1}{10}, \text{or } \frac{1}{20}, \text{or } \frac{1}{50}\right)$ of the main scale division.

(vi) + 0.03 cm.

(vii) First measure the inside depth of the hollow cylinder by using its depth gauge. Next measure its outside depth using the lower jaws. Substract the former from the latter to get the thickness of the bottom.

Experiment 2

(i) Because it measures the fraction of smallest division on the main scale accurately with the help of a screw.

(ii) Pitch of a screw gauge is the distance through which the screw move along its axis in one complete rotation.

(iii) Least count is the distance through which the screw moves along its axis in a rotation of one circular scale division.

$$\text{Least count} = \frac{\text{Pitch of the screw}}{\text{No. of divisions in the circular scale}}$$

(iv) Back-lash error is the error in circular scale reading caused by no movement of screw along its axis while we rotate it. It is due to play in the screw. It can be avoided by taking care to only advance the screw every time final adjustment is made for finding zero error or the diameter of the wire.

(v) Plumb line enables you to observe whether or not the piller is vertical and helps you to decide which way to adjust the levelling screws.

(vi) These nuts enable you to make the swing of the pointer of the balance equal on both sides of the zero marks. If, for example, pointer swings more on the right side, i.e. left arm of the balance is heavier, then left screw has to be moved inwards and the right screw has to be moved outward.

(vii) Ratchet arrangement prevents you from accidentally pressing hard on the fixed stud by the screw while measuring zero error, or on the wire while measuring diameter of the wire.

(viii) Zero error = −0.035 mm

Zero correction = +0.035 mm.

Experiment 3

(i) Because, it is used for the measurement of radii of curvature of spherical surfaces.

(ii) Pitch of a screw is the distance between two consecutive threads of the screw and is equal to the linear distance moved by the screw when it is given a full rotation. Pitch divided by number of divisions on circular scale gives least count.

(iii) Three legs provide the most stable structure to stand on any surface.

(iv) For a close object (at distance less than focal length).

(a) You see a magnified virtual image behind a concave mirror,

(b) You see a diminished virtual image behind a convex mirror, and

(c) You see a virtual image of same size behind of plane mirror.

(v) Distance between tip of the needle and optical centre of a lens or mirror on an optical bench is measured by the distance between marks made on their uprights. The latter can have a positive or negative error for various reasons, which is called index error. Error must be substracted to get correct distance. Negative of index error is index correction, which is algebraically added to get correct distance.

(vi) $f = \frac{R}{2}$

(vii) Spherical mirror has a defect called spherical aberration, which makes the image blurred. Smaller the aperture of the mirror, smaller is this defect.

(viii) (a) For a dressing table plane mirror must be used so that the person in front of it can see an image of same size.

(b) For shaving a concave mirror is the best so that one can see magnified image of face and observe tiny details.

(c) For driver of a car convex mirror is the best, because diminished images of vehicles behind enable one to see in a wide angle.

(ix) Removing parallax means moving together of tips of the needle and its inverted image, against the background of the mirror. When it is so observed, distance of both from the mirror is equal.

(x) A screw has back-lash error when it can rotate a little without moving forward. It is due to its being loose fit in the threads of spherometer in which it moves. It is also a necessity that it may be loose fit, otherwise it may not move. It is avoided by leting the spherometer hang on the screw for every reading.

Experiment 4

(i) Chance error of measuring a time interval by stop watch, which depends on your personal skill, remains the same whatever is the length of the time interval. By taking 20 oscillations, the fractional error (i.e. percentage error) in the measurement is smaller by a factor 1/20, as the time interval is 20 times longer.

(ii) When you measure time of 50 oscillations, instead of 20 you measure a time interval 2.5 times longer. Thus percentage error in measuring this time interval (and also the calculated time of one oscillation) is smaller by a factor 1/2.5.

(iii) (a) 1/3rd (b) 3 times.

(iv) (a) Time period changes. Because bob accelerates faster, T decreases.

(b) Length of second's pendulum also changes. It increases - a longer pendulum will be required for same time period of 2 s.

Experiment 4(A)

(i) Chance error of measuring a time interval by stop watch, which depends on your personal skill, remains the same whatever is the length of the time interval. By taking 20 oscillations, the fractional error (i.e. percentage error) in the measurement is smaller by a factor 1/20, as the time interval is 20 times longer.

(ii) When you measure time of 50 oscillations, instead of 20 you measure a time interval 2.5 times longer. Thus percentage error in measuring this time interval (and also the calculated time of one oscillation) is smaller by a factor 1/2.5.

(iii) (a) 1/3rd (b) 3 times.

(iv) (a) Time period changes. Because bob accelerates faster, T decreases.

(b) Length of second's pendulum also changes. It increases - a longer pendulum will be required for same time period of 2 s.

(v) No. 80° to 10° is probably the entire range in which you want to study variation of time period. During the single observation change of amplitude should be a small fraction of initial amplitude, say 80° to 70°.

Experiment 5

(i) A body is said to be at rest if it does not change its position relative to its surroundings with the passage of time.

(ii) The junction may not come to rest at the same position due to friction.

(iii) The weights are kept away from the table or board so as to avoid effect of friction.

(iv) (a) 320 g wt. (b) 390 g wt. (c) 443 g wt.

(v) The resultant force is almost equal to sum of the individual forces and when it falls down, it does not fall on any of the workers.

Experiment 6

(i) Cooling curves are similar because the rate of cooling depends on the temperature different between calorimeter and surroundings.

(ii) Animals curl up to sleep during winter. By doing so they reduce the surface area of exposed body and avoid loss of heat.

(iii) Mass and specific heat of oil are less. Thus for same loss of heat in one second, its fall of temperature is more.

(iv) No. The doctor's thermometer cannot be used because of low range of temperature (say upto 44°C approximately only). Also it has to be given a jerk to lower its reading.

(v) The liquid is stirred continuously so that exchange of heat is done soon and equillibrium temperature is obtained.

(vi) No. Because its range is only from 35°C to 43°C and its reading will not decrease with cooling of calorimeter.

(vii) So that the comparison is possible and effect of density and specific heat on cooling can be observed.

Experiment 7

(i) Yes. This method can be used. In this case hotter water and calorimeter will give heat to colder solid brass bob. However, it will be difficult to find the steady final temperature of the mixture.

Because, the temperature of water with bob dipped in it, will keep on falling continuously.

(ii) No. Wood is bad conductor of heat. It can not acquire uniform temperature throughout.

(iii) The pure water boils at 100°C only when the atmospheric pressure is 76 cm of mercury.

(iv) The temperature of the water during stirring initially rises; becomes maximum and steady for some time and then starts falling again due to heat losses by radiation. This steady maximum temperature of the water is the final temperature of the mixture.

(v) The mixture is stirred continuously to keep the temperature uniform throughout.

(vi) Specific heat of water = 1 cal g^{-1} $°C^{-1}$.

Let the specific heat of brass = S

Heat lost by brass piece = $200 \times S \times (100 - 23)$

Heat gained by water = $500 \times 1 \times (23 - 20)$.

Assuming no loss of heat to the surrounding,

$$S = \frac{500 \times 3}{200 \times 77} = \frac{15}{154} = 0.098 \text{ cal } g^{-1}\ C^{o-1}.$$

(vii) For marble of 1 gm, to raise its temperature by unity, 0.215 cals of heat are required. Similarly, 1 kg of Aluminium requires 900 J of heat to raise its temperature by one degree celcius.

(viii) Yes. Instead of water, the given liquid is used. In this case, however, the specific heat of the material of solid bob is taken as known.

(ix) No. It can be of any shape.

Experiment 8

(i) If the oscillations are to large, maximum extension of the spring during a downward swing can be beyond the elastic limit.

(ii) We are concerned with oscillations which occur in the suspended mass M due to elastic force of the spring only? If there is a horizontal component of motion, somewhat like a pendulum, then gravitational force makes the motion complicated.

(iii) These will be equal. The oscillations are S.H.M. If these are within elastic limit, i.e. maximum extension during a downward swing is within elastic limit of the spring. For a simple harmonic motion, time period is independent of amplitude.

(iv) Extension decreases due to smaller gravitational force pulling down the spring. But time period of oscillations remains unaltered, because according to eq (3) neither spring constant λ, nor inertial property of the load *M* changes.

Experiment 9

(i) At low values of *V* the force of surface tension becomes comparable to pressure of water column which causes the flow of water.

(ii) At high values of *V*, if there is turbulent flow of water in the narrow stopper of the burette, fraction rate of flow could be too low.

(iii) This ensures that only pressure of the water column in the burette above the bottom mark causes the flow of water through the narrow stopper of the burette.

(iv) (b) is larger. Rate of flow of water at $V = 40$ ml is 4/5th of that at $V = 50$ ml because fractional rate of flow is same.

(v) (a) Rate of flow of water.

(b) Volume of water, *V*, in the burette at any point of time.

(c) Half life of water flow : T (1/2) or T (1/4)/2, etc.

(vi) (a) About 7 half-lives.

Experiment 10

(i) (a) There is always a random error in the time measurement. Its magnitude depends on personal skill of the experiments. By taking mean of several observations, the random error is less.

(b) There is always a chance of counting error by a human experimenter. Repeat observation helps detect this error and then repeat the observations.

(ii) Because, for a given angular displacement (Fig. 10.1), the restoring torque due to force of gravity increases with *h* whereas there is little change in I. Thus it accelerates faster.

(iii) By plotting points for axle positions on the left of C.G. in 3rd quadrant, we get a straight line graph instead of a V-shaped one. It enables us to calculate a more accurate value of the slope of the graph.

(iv) (a) *I* has significantly increased for farther axle positions in your set of observations.

(b) Giving weightage to points of oscillations close to C.G., take the slope of this graph at the C.G.

(v) The very basis of this experiment is that we take points of oscillation close to C.G., the value of *I* about which is not significantly different from that about C.G. If we take a 30 cm scale, the points of oscillation will have to be not more than 15mm away from C.G.

Experiment 11

(i) 0.67 m and 2.01 m.

(ii) Equation (1) says that from even one length, we can determine the wavelength and hence the velocity of sound. But the antinode does not occur exactly at the open end of the tube. It is at a slight distance above it. This is approximately equal to 0.3D where D is the internal diameter of the tube. Therefore, the real length of the resonating air column is not equal to length of air column l, but is $l + e$. Taking the difference in the lengths of resonating air columns for two positions elimate this end correction.

(iii) For a given source of sound, frequency is constant and hence wavelength is directly proportional to the velocity of sound. Since the velocity increases with temperature, wavelength will also increase accordingly. Now length of resonating air column $L = \frac{n\lambda}{4}$. Hence, if the temperature is 5°C more, length of air column for each resonance will increase.

Experiment 12

(i) A tuning fork should be set into oscillation by striking it with a rubber mallet/block whichever is available. Striking the tuning fork with any hard object may damage the fork and cause a change in its characteristic frequency.

(ii) (a) 3; (b) 6

(iii) 1073 Hz.

Experiment 13

(i) Tension F has the dimensions of MLT^{-2} and μ has the dimension of μ/L or ML^{-1}. Therefore, RHS of equation (13.1) has the dimension of

$$\frac{1}{L}\left[\frac{MLT^{-2}}{ML^{-1}}\right]^{\frac{1}{2}} = T^{-1}$$

Left hand side of the equation is frequency which has the dimension of T^{-1}. Thus both sides of the given equation have the same dimensions.

(ii) Soundboard communicates the vibrations of tuning fork to the string. When natural frequency of the string is same as that of tuning fork, resonance takes place and paper rider flutters vigorously and falls.

(iii) 12N, 1.225 kg.

(iv) 256 Hz.

(v) For constant F and L, the fundamental frequency of a string $f \times \frac{1}{\sqrt{\mu}}$. (See Eqn. 13.1 in the text). Therefore, the fundamental frequency of the string with greater mass density could be not half but $\frac{1}{\sqrt{2}}$ times the fundamental frequency of the other.

Experiment 14

(i) Relative shift in the position of a body with respect to another body, on viewing it from two different stand-points, is called parallax. Parallax between the tip of the real image of a pin and the tip of another pin is removed by moving the image-pin on the optical bench till we find that their tips remain coincident as we see them from different positions by moving our head side-ways.

(ii) As we move an object away from a concave mirror between its pole and focus the size of its virtual image increases. On placing it at a point beyond focus the image formed is real and the size of the real image decreases as we move the object from focus to infinity.

(iii) We will get a virtual image from a concave mirror when the object is positioned between the focus and the pole of the mirror.

(iv) Rough focal-length is determined so that the object pin may be placed between f and $2f$. Thus we will manage to keep our image-pin beyond $2f$ and the real image of object pin may be formed on it.

(v) Place an object very close to the mirror. If its image in the mirror is enlarged, the mirror is concave if the image is diminished in size, the mirror is convex.

(vi) We use spherical mirrors of aperture (diameter) small in comparison to focal length, because the mirror formula is applicable only for paraaxial rays.

(vii) No. Because the image formed by a convex mirror is always virtual.

(viii) We could also determine f by plotting graphs between (i) on y-axis (uv) and (ii) on x-axis ($u + v$). Slope of this straight line graph passing through origin is the focal length.

(ix) Yes. Because the real image of candle may be obtained on screen and thus the value of u and v may be accurately determined.

(x) Yes. We can obtain the real image of a pin on itself when it is placed at the centre of curvature. Thus we can determine R. Then $f = \frac{R}{2}$.

Experiment 15

(i) Lenses are used in (i) spectacles, (ii) microscopes, (iii) telescopes,

(iv) Phto-cameras etc.

(ii) $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R}\right) = \frac{0.5}{R} = \frac{1}{2R}$

$\Rightarrow f = 2R.$

(iii) (a) $P = -2.5\ m^{-1}$, $f = \frac{1}{p} = -\frac{1}{2.5}\ m = -40\ cm.$

(b) Negative sign of focal length indicates that the lens is a diverging (concave) lens.

(iv) Yes. Because the image formed by a convex lens in this experiment is real, we can use a candle in place of object pin and a translucent screen in place of image-pin.

(v) When in air $\frac{1}{f} = (1.5 - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

When in water $\frac{1}{f_1} = \left(\frac{1.5}{\frac{4}{3}} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = \left(\frac{9}{8} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$\frac{f_1}{f} = \frac{.5}{\frac{1}{8}} = 4$

$\Rightarrow f_1 = 4f$

i.e. in water the focal length will be four-times the value in air.

(vi) The image is same size as object when the object is placed at $2f$.

(vii) No. The image will be virtual when the object is placed between focus and optical centre of the lens.

(viii) If the object pin is placed at the focus of the lens, rays from any point of it will emerge out as parallel beam (Fig. 15.4). Hence if the lens is backed by a plane mirror the rays will retrace their path and hence the real and inverted image of the object pin will be formed at the same position. Thus f can be measured.

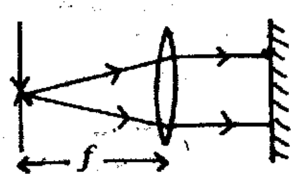

Fig. 15.4

Experiment 16

(i) Radius of curvature of a spherical mirror may be determined using the formula $R = \frac{l^2}{6h} + \frac{h}{2}$ where l = average distance between the legs of the spherometer and h = height of the spherical surface above any planner section (measured by spherometer), then $f = \frac{R}{2}$.

(ii) The magnification for a convex mirror is given by $M = -\left(\frac{f}{u+f}\right)$

The formula shows that the image formed will be virtual and diminished.

(iii) A convex mirror is used as a rear-view mirror in automobiles, because, the erect, diminished images formed in the mirror help in seeing the wider portion of the rear-traffic.

(iv) Yes. Referring to Fig. 16.1, if OL is slightly more than f_1, image distance LI can be as large as we like and more than R. Hence, experiment can be done even if $f_1 < \frac{R}{2}$. However, if f_1 is too small, precision of the experiment is less as the image of O at I becomes highly magnified. Procedure for doing the experiment remains the same even if $f_1 < \frac{R}{2}$.

(v) Ordinarily when we place a real object in front of a convex mirror its virtual image is formed behind the mirror. But in case of the present experiment we are forming the real image of a virtual object by the convex mirror. The virtual object is image at I formed by the lens, but rays forming that image are reflected by the mirror before reaching I.

Experiment 17

(i) Focal length of a lens depends on

(a) refractive index of the material of the lens.

(b) refractive index of the surrounding medium.

(c) radii of curvature of the surfaces of the lens.

(d) wavelength of light used.

(ii) (a) In air red and violet colour lights travel with the same speed.

(b) In water red light travels faster than violet light.

(iii) Focal length is more for red light, because $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ and $\mu = A + \frac{B}{\lambda^2}$ (Cauchy's formula). Red light has larger wavelength λ and hence smaller μ. Therefore, for red light the lens shows larger focal length.

(iv) No. Because, the image formed by a concave lens is virtual.

(v) Minimum distance between an object and its real image formed by a lens = $4f$.

(vi) (i) The combination of the two lenses in contact should form an enlarged image of a near-by object. This ensure that the focal length of the convex lens is smaller than the focal length of the concave lens.

(ii) This is necessary because we want to form a real image with the combination.

(vii) Yes. When we mount the lenses in two separate uprights the real image formed by the convex lens serves as the virtual object for the concave lens which finally forms its real image. By measuring u and v, focal length can be calculated.

Experiment 18

(i) In minimum deviation

$$A = 2r$$

$$\Rightarrow \quad r = \frac{60}{2} = 30^\circ$$

$$\mu = \frac{\sin i}{\sin r}$$

$$\Rightarrow \quad \sin i = 1.5 \times \frac{1}{2} = 0.75$$

$$i = \sin^{-1}(0.75)$$

(ii) The angle of minimum deviation occurs for a particular wavelength when a ray of that wavelength passes through the prism symmetrically, i.e. parallel to the base of the prism.

(iii) 1.64

(iv) The index of refraction is slightly different for different wavelengths. When the incident beam is not monochromatic, each wavelength (colour) is refracted differently because the wave velocity is slightly different for different wavelengths in a material medium. Here different wavelengths for different colours refers to their wavelengths in air (or in vacuum). But the frequencies of the waves are unchanged, when they enter from one medium to another. Thus we can also take of different μ for different frequencies (for different colours).

(v) 51.2°

Experiment 19

(i) At the centre of curvature i.e. at the object pin itself.

(ii) Below the object pin at a smaller distance than the radius of curvature.

(iii) No real image is formed. A virtual and erect image is formed behind the mirror.

(iv) Towards the concave mirror, because

$$h_2 < h_1 \text{ (Since } n > 1 \text{ and } n = \frac{h_1}{h_2}\text{)}.$$

(v) Image also moves. The image moves away from the concave mirror. The two coincide in between.

(vi) $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}=\frac{2}{R}$ (Mirror formula).

$$\frac{1}{-20}+\frac{1}{-30}=\frac{2}{R} \quad \text{(suing modern sign convention)}$$

$$\frac{-3-2}{60}=\frac{2}{R} \quad \Rightarrow -\frac{5}{60}=\frac{2}{R} \quad \Rightarrow R = -24 \text{ cm}$$

The two will meet at centre of curvature. Therefore the object pin is to move a distance of (30 − 24) = 6 cm to meet its image at centre of curvature.

The answer is (b).

(vii) $\frac{na}{nb} = \frac{h_1/h_{2a}}{h_1/h_{2b}}$

$$\Rightarrow \frac{n_a}{n_b} = \frac{h_{2b}}{h_{2a}} \quad \Rightarrow \frac{1.3}{1.2}=\frac{x}{25} \quad \Rightarrow x = \frac{25 \times 1.3}{1.25} \text{ cm}$$

i.e. $x = 26$ cm.

(viii) No. Mercury is non-transparent and nearly a perfect reflector. The refractive index of Mercury is ∞.

Experiment 20

(i) $m = f_o/f_e$ = 80 cm/100 mm = 80cm/10 cm = 8

(ii) Distance between objective lens and eye lens $= f_o + f_e$

= 80 cm + 10 cm

= 90 cm.

When object is kept at 8 m from objective lens, let the distance of image made by it be v. Then, $u = -800$ cm and by lens formula we have

$$\frac{1}{v} - \frac{1}{(-800)} = \frac{1}{80} \quad \Rightarrow v = 88.9 \text{ cm}$$

Therefore, distance between objective lens and eye lens = $v + f_e$

$= 88.9 + 10$ cm

$= 98.9$ cm.

(iii) Exit pupil of a telescope is the real image of the objective lens made by the eye lens.

(iv) It is necessary for us to keep the pupil of our eye at the exit pupil of telescope so that all the light coming through objective lens and eye lens enters the eye. This enables us to see all the objects that the telescope is capable of seeing at one time.

(v) Let distance of exit pupil from eye lens be v. Since the objective lens at a distance of 90 cm is functioning as object here, $u = -90$ cm. Thus by using lens formula, we have

$$\frac{1}{v} - \frac{1}{(-90)\text{ cm}} = \frac{1}{10 \text{ cm}}$$

$\Rightarrow v = 11.2$ cm.

(vi) Let f_o and f_e be focal lengths of objective lens and eye lens of the desired telescope. Then

$m = f_o/f_e = 25$ (1)

and distance between the lenses = $f_o + f_e = 52$ (2)

Solving equations (1) and (2) for f_o and f_e we get

$f_o = 50$ cm and $f_e = 2$ cm.

(vii) The final image in the astronomical telescope is inverted. Thus the words of the newspaper will be seen inverted, which cannot be read comfortably.

(viii) Distance of newspaper is 10 times of that at which the words can be read by unaided eye. Also the telescope magnifies 10 times. Hence, words will be seen as big as by unaided eye at 4 m distance. Had the telescope been perfect the words could be read. But as ordinary lenses are used, the final image is slightly blurred. Hence, the words cannot be read in the given situation. In fact, the advantage in clarity by the telescope is always less than its magnifying power.

Experiment 21

(i) Resistance of thick connecting wires is small and negligible.

(ii) Current in the circuit will become much less than what it was before inserting the voltmeter. Thus functioning of the circuit will change.

(iii) Large current may heat up the wire. Thus its resistance may change.

(iv) If the graph between current passing in it and potential difference across it is a straight line passing through the origin, it obeys Ohm's law.

(v) Perhaps the voltmeter has been connected in series with the battery and the combination of resistances being investigated.

(vi) Voltmeter, wrongly connected in series with the combination of resistances, will be removed from there and then connected in parallel with the combination of resistances.

(vii) Since voltmeter is a high resistance instrument, and is connected in series all the battery voltage will be applied at it and it will show the battery e.m.f. Even then very small current will pass in the circuit, which ammeter may not be able to measure. Its needle will stay at close to zero-mark.

Experiment 22

(i) e.m.f. of a cell is the potential difference across its terminals when no current is drawn from the cell.

(ii) Potentiometer is a device for measuring potential difference between two points without drawing any current. When a current is passed through a wire of uniform connection, then potential difference across any segment of the wire is proportional to the length of that segment.

(iii) Potential gradient along the potentiometer wire is the potential drop per unit length.

(iv) Potential gradient depends on :

(a) current passing through the wire. Greater the current, greater is the potential gradient.

(b) material of the wire. Greater the resistivity, greater is the potential gradient.

(c) crossection of the wire. Greater the crossectional area smaller is the potential gradient.

(v) If a portion of the wire is thinner, than others, then potential drop in every cm of that portion is more than the other portions. Thus the proportionality relation between potential difference and length does not hold in this wire and it cannot be used for a potentiometer.

(vi) Rheostar enables us to so adjust the current that potential difference across the entire length of potentiometer wire is a little more than the largest of the potential differences to be compared.

(vii) The smaller the length l_1 or l_2, the greater is percentage error in the result.

(viii) Eureka (or constantan) is preferred because its resistivity changes only little by change of temperature.

(ix) Current in the wire is decreased. It decreases potential gradient and thus increases the length across which potential difference equals the potential difference being measured.

(x) Balance point is found first for the leclanche cell because it is of higher e.m.f. After its balance point is found within the length of potentiometer wire, the balance point for second cell of smaller e.m.f. must be within the length of the wire.

Experiment 23

(i) In the derivation of the formula $s=(\frac{100-l}{l})R$, it has been assusmed that resistance per unit length of the metre bridge wire is constant throughout. For a wire of varying crossectional area, this will not be true.

(ii) Usually a small contact resistance in series with the wire exists at each end due to loose fixing of the ends of wire to the screws. This is called end resistance.

(iii) When position of jockey on the wire of metre bridge has been so chosen that potential difference across galvanometer in zero, this position is called null point.

(iv) So that the lengths l & $(100-l)$ are comparable. The wheat stone bridge is more sensitive when all the four resistances are of the same order of magnitudes.

(v) It may cause variation in the crossectional area, thereby ausing a variation in the resistance per unit length of the metre-brdige wire.

(vi) If the current through the wire is passed continuously, it would get heated causing an increase in its resistance. This may change the value of the ratio $\frac{l}{100-l}$, thus changing the null-point.

(vii) Galvanometer is a sensitive instrument. Initially when jockey is far from the null point then current through the galvanometer may be high causing deflection beyond the maximum deflection mark on the scale. A sudden flow of high current may damage the galvanometer. To allow a small and safe value of current to flow through the galvanometer when it is far from the null point, a high series resistance is connected. Alternatively, a shunt is connected across the galvanometer to by-pass a major portion of the current.

Experiment 24

(i) As R increases, the current drawn from cell decreases. Since $V = \varepsilon - Ir$, the term (Ir) decreases thereby making V larger. Since $V \propto l_2$ therefore l_2 increases. As R aproaches infinity, V approaches ε and l_2 approaches l_1.

(ii) By measuring *p.d.* of the cell for two different values of current drawn from it. Internal resistance of the cell and the *emf* of the cell can be calculated from the following equations

$$V_1 = \varepsilon - I_1 r$$

$$V_2 = \varepsilon - I_2 r$$

(iii) Internal resistance of a cell depends on the current drawn from it. Since for different R, the current drawn from the cell is different, the calculated value of internal resistance will also be different.

(iv) This constant of proportionality, called the potential gradient along the potentiometer wire depends on current in it and its resistance per unit length.

(v) Smaller is the potential gradient, greater is the accuracy (precision) of a measurement using a potentiometer.

(vi) A 10-m wire potentiometer will be preferred. Other factors remaining the same, potential gradient along the10-m wire potentiometer will be smaller.

(vii) It is an alloy called constantan.

(viii) It is because only for uniform area of cross-section the potential difference across any two points on the potentiometer wire is proportional to the length of the wire between the points.

(ix) Term Ir gives the potential drop across the cell itself.

(x) Yes. When a current I is forced into a cell in a direction opposite to what the cell supplies, its terminal potential difference will be $V = \varepsilon + Ir$.

Experiment 25

(i) It depends on the number of turns, length of the coil, radius of each turn and the permeability of the core.

(ii) Its R will remain unchanged whereas its L will diminish to almost zero.

(iii) Impedance = 12 ohm, inductive reactance = 10.4 ohm approximately.

(iv) (a) By measuring it straightaway using a multimeter.

(b) By applying a known DC p.d. across the inductor and measuring the current in it.

(v) 50 volts.

(vi) No. By a DC source only internal resistance r of the coil can be measured and not its inductance L.

(vii) Current will be less.

(viii) Current will decrease.

(ix) Because V_R and V_L are not in phase.

(x) Less than 90°. [Phase difference is 90° in the case of a resistor and a pure inductor]. Referring to Fig. 25.4 it is equal to angle $\angle$CBD.

Experiment 26

(i) Both will charge to the same applied potential difference.

(ii) Electrolytic capacitor because of their large capacitance.

(iii) (a) 80 seconds (as C gets doubled)

(b) 20 seconds (as R gets halved)

(iv) Curve 2 corresponds to larger time constant. Because it takes longer for it to decrease to half its initial value.

(v) Area under the current verses time curve gives the total charge given to the capacitor.

(vi) The time constant RC should be large enough so that it is manually possible to observe and record the fall in charging current with time.

(vii) With 1000μF capacitor a 100kΩ resistor will be preferred as the combination gives a time constant of 100 seconds which is fairly large.

(viii) (a) combination (A) gives the longest time constant.

(b) combination (B) gives largest discharging current at t =O because of smallest R.

(ix) Yes. Because in that case the capacitor will also discharge through the voltmeter also combined resistance of that resistor and voltmeter in parallel has to be considered.

Experiment 27

(i) Dynamic resistance of a diode is much smaller and DC resistance is much higher. It is because for some initial voltage across the diode, no current flows through it. When current starts flowing then for a small incremental voltage, there is a large incremental current.

(ii) Dynamic resistance is reciprocal of the slope of the V-I characteristic (I being plotted along y-axis). The slope is constant along straight portion of the characteristic and so is the dynamic resistance. Static resistance keeps changing along the graph, because slopes of lines from origin to different points on the graph are different.

(iii) Current drawn by voltmeter is an error in current reading of the mA-metre, which measures total current passing in the voltmeter and the diode. Hence voltmeter should be sensitive and draw very small current.

(iv) The ratio of incremental current/incremental voltage gives average slope of the graph between the two points. This will be equal to slope of the graph at A, if A is their mid-point, even in the case when slope of the graph is changing along the graph.

Experiment 28

(i) The transistor heats up and can be damaged.

(ii) The transistor can withstand either I_c = 150 mA or V_{ce} = 50 V. If both are simultaneously applied, the transistor will damage immediately.

(iii) Voltage gain will be very large, roughly about 4000. No reading with δV_i of 0.01 V can be taken as δV_o can be at the most 4 V.

(iv) You have to take several vertical lines, say at V_{ce} = 4V, 5 V, 6 V, 7 V, 8 V, and 9 V. Then work according to steps 28.4 (iv) and (v) for each value of V_{ce}.

(v) Yes, it is possible to do this experiment without a separate battery for base circuit. We can take a fraction of P.D. of the 9V battery of collector circuit by a rheostat RG_1 of 1000 ohm in series with a resistance of 5 k ohm and feed it to the base through R_i. This can be done for finding current gain as well as for finding voltage gain.

Experiment 29

(i) It is a locus of the points on the surface of earth which are equi-distant from the two magnetic poles of the earth.

(ii) Magnetic S pole is located near the geographical North pole of the earth.

(iii) Neutral points cannot be found in a single magnetic field.

Experiment 30

(i) Resistance of 1000 ohms in series.

(ii) A shunt resistance of 0.1 ohm in parallel.

(iii) In parallel.

(iv) In series.

(v) Entire circuit, only the device across which shunt is connected.