MADE EASY received requests from students appeared in BPSC-2018, Assistant Engineer (Prelims) to suggest the correct answer and supporting evidence to help students to challenge the answers provided by BPSC. Therefore, we are suggesting appropriate changes and proof as mentioned in the list given below, however students are requested to make their own decision to challenge or not for any or all the suggested changes by us.

B. Singh

CMD, MADE EASY Group

आपत्ति प्रपत्र

सहायक अभियंता (प्रारंभिक) प्रतियोगिता परीक्षा, विज्ञापन संख्या ....

अनुक्रमांक .... नाम .... विषय .... प्रश्न पुस्तिका श्रृंखला ....

SET-A

क्र0 सं0	प्रश्न संख्या	प्राश्निक का उत्तर	उम्मीदवार द्वारा सुझाया गया उत्तर	आपत्ति का आधार/स्रोत/साक्ष्य
1	32	D	A	Reference Link: http://pib.nic.in/newsite/PrintRelease.aspx?relid=167493 **Press Information Bureau** **Government of India** **Ministry of Science & Technology** 17-July-2017 18:10 IST **Made in India for Global Health** **"Sohum"- An innovative Newborn hearing screening Device** The indigenously developed newborn hearing screening device – SOHUM was formally launched by the Minister of State for Science and Technology & Earth Sciences, Shri Y.S. Chowdary, in New Delhi today. The newborn hearing screening device developed by School of International Biodesign (SIB) startup M/s Sohum Innovation Labs India Pvt. Ltd. This innovative medical device has been developed under Department of Biotechnology (DBT), Ministry of Science and Technology, Government of India supported (SIB). SIB is a flagship Program of the DBT aimed to develop innovative and affordable medical devices as per unmet clinical needs of India and to train the next generation of medical technology innovators in India, it is a valuable contribution to the Make in India campaign of the Government. This Program is implemented jointly at AIIMS and IIT Delhi in collaboration with International partners. Biotech Consortium India Limited manages techno-legal activities of the Program. Sohum is a low cost and unique device which uses brainstem auditory evoked response, the gold standard in auditory testing to check for hearing response in a newborn. As of now, this technology is prohibitively expensive and inaccessible to many. Start-up Sohum has made the technology appropriate for the resource constrained settings and aims to cater to nearly 26 million babies born every year in India.

2	38	D	None	Remarks: It should be **Project Sunrise** instead of Project Sunshine. Reference Link: http://naco.gov.in/sites/default/files/Annual%20Report%202015-16_NACO.pdf **3. Project Sunrise** Project Sunrise is the strategic plan developed to upscale HIV interventions in north eastern States of India for augmenting HIV/AIDS response and to curtail the rapid spread of HIV among the High Risk Groups (HRGs) and other vulnerable groups. The strategy was being adopted after a series of consultative meetings with all the stakeholders including the State AIDS Control Societies, State Health Missions, Community Members etc. of the region. The proposed State level plans assess the programmatic gaps and barriers; enhance capacity of state level institutions and improve the quality of IDU package of services amongst other initiatives. Reference Link: https://www.indiatoday.in/education-today/gk-current-affairs/story/project-sunrise-for-aids-prevention-307722-2016-02-08 **Project Sunrise launched for AIDS prevention: Facts on the condition leading to immunodeficiency** *HIV stands for Human immunodeficiency virus infection and AIDS stands for Acquired immune deficiency syndrome. HIV is a virus that may cause an infection while AIDS is a condition or a syndrome.*
2	59	A	B	Source: MADE EASY Theory Book, Construction Materials, Edition 2018, Pg No. 28 (iii) **Cement Mortar :** In this type of mortar, the cement is used as the binding material. • Depending upon the strength requirement and importance, the proportion of cement to sand by volume varies from 1 : 2 to 1 : 6 or more. • The cement mortar is used where a mortar of high strength and water-resisting properties is required such as underground construction, water saturated soil.

				Source: Building material, TMH publisher, ML Gambhir, Page No. 232

Table 8.2 Recommended Mix Proportions for Masonry Mortars

S. No.	Type of work	Mix proportions	
		Cement–sand mortar	Cement–lime–sa[illegible]
1.	Masonry in foundations up to plinth level	1 : 6	1 : 1 : 8; 1 : 1 : 7[illegible]
2.	Masonry in superstructure	1 : 6 to 1 : 8	1 : 1 : 8 to 1 : [illegible]
3.	Arch work	1 : 3 to 1 : 4	1 : 1 : 4 to 1 : [illegible]
4.	Internal plaster	1 : 6	1 : 1 : 7 to 1 : [illegible]
5.	External plaster	1 : 5	1 : 1 : 6 to 1 : [illegible]
6.	Pointing	1 : 2 to 1 : 3	1 : 1 : 3 to 1 : [illegible]

The cement mortar mix proportions (by volume) specified for applications other than above are

1. Mortar for stone masonry: 1 : 5 to 1 : 8
2. Base coat for plaster, for covering masonry or pointing: 1 : 3 to 1 : 6
3. Plaster for RCC works: 1 : 3 to 1.4
4. Damp-proof courses and plastering inside of water retaining structures: 1 : 2 with water-proofing compound.

3	62	C	A	Source: MADE EASY Theory Book, Edition 2018, Page 99

2. **Endogenous Trees:** These trees grow inwards and fibrous mass is seen in their longitudinal sections. Timber from these trees has very limited engineering applications. Examples of endogenous trees are bamboo, cane, palm, etc.

Source: Building material, TMH publisher, ML Gambhir, Page No. 313

11.3.1 Exogenous Trees

These trees grow outward, increasing in bulk with the formation of a ring every year. These rings known as annual rings may be used for predicting the age of the tree. Timber derived from these trees is mostly used for engineering works. These trees are further divided into two groups.

Conifer or Evergreen Trees The leaves of these trees do not fall till new ones are grown. Conifers have needle shaped leaves and bear cone-shaped fruits. These trees yield *soft woods* which are generally light coloured, resinous, light weight and weak. They show distinct annual rings. The common examples of these trees are: deodar, pine and cedar.

Deciduous or Broad Leaf Trees These trees have flat broad leaves. The leaves of these trees fall in autumn and new ones appear in spring season. They do not show distinct annual rings. These trees yield

...woods which are generally close grained, strong, heavy, dark coloured, durable and nonresinous; and are used for engineering applications. The typical examples of such trees are: teak, mahogany, sheesham, oak, etc.

11.3.2 Endogenous Trees

These trees grow inwards and fibrous mass is seen in their longitudinal sections. Timbers derived from these trees have very limited engineering applications. The typical examples are: bamboo, cane, palm, etc.

				Source: Building material, New age publisher, SK Duggal, Third edition, Page No. 92 **4.2 CLASSIFICATION OF TREES** Trees are classified as endogenous and exogenous according to the mode of growth. **Endogenous Trees** Trees grow endwards, e.g. palm, bamboo, etc. **Exogenous Trees** Trees grow outwards and are used for making structural elements. They are further subdivided as conifers and deciduous. ***Conifers*** are evergreen trees having pointed needle like leaves, e.g. deodar, chir, fir, kail, pine and larch. They show distinct annual rings, have straight fibres and are soft with pine as an exception, light in colour, resinous and light weight. ***Deciduous*** trees have flat board leaves, e.g. oak, teak, shishum, poplar and maple. The annual rings are indistinct with exception of poplar and bass wood, they yield hard wood and are non-resinous, dark in colour and heavy weight.
4	64	D	A	Engineering material, Charator Publishing House Pvt. Ltd, Rangawala Pg No. 65, Fourty-First Edition 2014 The ground-moulded bricks of better quality and with frogs on their surface are made by using a pair of pallet boards and a wooden block. A *pallet* is a piece of thin wood. The block is bigger than mould and it has a projection of about 6 mm height on its surface. The dimensions of projection correspond to the internal dimensions of mould. The design of impression or frog is made on this block. This wooden block is also known as the *moulding block or stock board.*
5	96	D	A	Source: MADE EASY Theory Book, Environmental Engineering, (Vol.1) Edition 2018, Pg No. 114 • For ground water containing excessive iron, dissolved carbon dioxide and odourous gases, the treatment processes will be Aeration → Flocculation and Sedimentation → Rapid sand gravity filter → Disinfection → Supply

<table>
<tr><td></td><td></td><td></td><td></td><td>
Source: Manual of Water Supply and Treatment, Third Edition, 1999, page 189

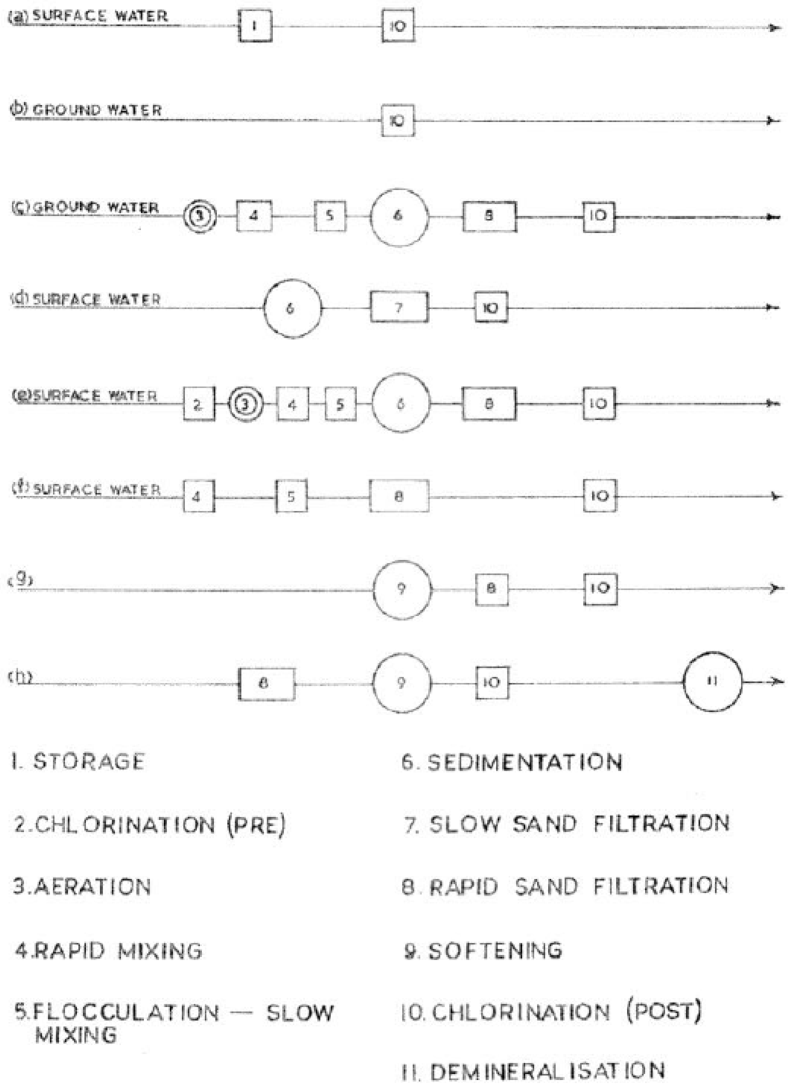
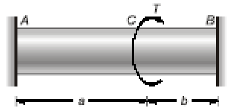


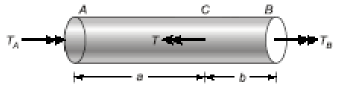
FIG.7.1 : UNIT OPERATIONS IN WATER TREATMENT
</td></tr>
</table>

7	118	A	C	Source: MADE EASY Theory Book, Strength of Material, Edition 2018, Pg No. 361

Example 8.13 A shaft is subjected to torque T at C as shown in figure. Find torsional reactions at supports A and B. Also find twisting angle at C, draw torsional moment diagram.



Solution:



Let T_A and T_B be the torsional reactions at supports A and B

$\therefore$ $$\Sigma T = 0$$

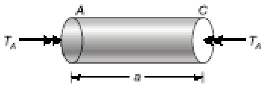
$$T_A + T_B = T \quad \text{...(i)}$$

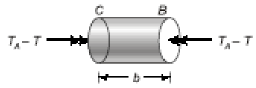
Since shaft is fixed at end A and B.

Hence, total angle of twist from A to B will be zero.

$\therefore$ $$\theta_{AC} + \theta_{BC} = 0 \quad \text{...(ii)}$$

For Portion AC





$$T_{AC}\text{(From left of section)} = +T_A$$

$\therefore$ $$\theta_{AC} = \frac{T_A a}{GI_P}$$

For Portion CB

$$T_{CB}\text{(From left of section)} = +(T_A - T)$$

$\therefore$ $$\theta_{BC} = \frac{(T_A - T)b}{GI_P}$$

Putting value of θ_{AC} and θ_{BC} in eq. (ii), we get

$$\frac{T_A a}{GI_P} + \frac{(T_A - T)b}{GI_P} = 0$$

$\therefore$ $$T_A = \frac{Tb}{a+b} = \frac{Tb}{L}$$

From eq. (i), we get

$$T_B = \frac{Ta}{L}$$

Twisting angle of C with respect to A

$$\theta_{AC} = \frac{T_A a}{GI_P} = \frac{Tab}{GI_P L}$$

$$\theta_{AC} = \theta_C - \theta_A$$

$\Rightarrow$ $$\theta_C - 0 = \frac{Tab}{GI_P L} \qquad \text{[Since end } A \text{ is fixed, } \therefore \theta_A = 0]$$

$\therefore$ $$\theta_C = \frac{Tab}{GI_P L}$$

Torsional Moment Diagram

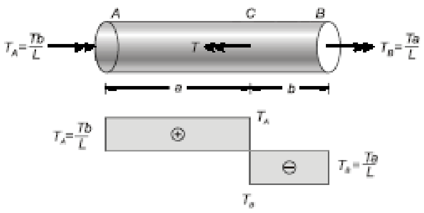
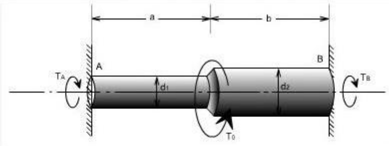


Fig. 8.18

Source: NPTEL-Mechanical Engineering-Strength of Materials (Web)-Distribution of shear stresses in circular Shafts subjected to torsion (lecture 19)



Solution: This is a statically indeterminate system because the shaft is built in at both ends. All that we can find from the statics is that the sum two reactive torque T_A and T_B at the built – in ends of the shafts must be equal to the applied torque T_0

Thus $T_A + T_B = T_0$ ------ (1)

[from static principles]

Where T_A , T_B are the reactive torque at the built in ends A and B. wheeras T_0 is the applied torque

From consideration of consistent deformation, we see that the angle of twist in each portion of the shaft must be same.

i.e $\theta_a = \theta_b = \theta_0$

using the relation for angle of twist $\frac{T}{J} = \frac{G.\theta}{l}$

or $\theta_A = \frac{T_A a}{J_A G}$

$\theta_B = \frac{T_B a}{J_B G}$

$\Rightarrow \frac{T_A a}{J_A G} = \frac{T_B b}{J_B G} = \theta_0$ or $\frac{T_A}{T_B} = \frac{J_A}{J_B} \cdot \frac{b}{a}$ (2)

$\because T_A + T_C = T_B$ — (i)

$\because \frac{T_A}{T_C} = \frac{2L/3}{L/3}$ (in NPTEL it is given) $\left[\frac{T_A}{T_C} = \frac{J_A}{J_C} \cdot \frac{c}{a}\right]$

$J_A = J_C$ ($\because$ rod with uniform cross section)

$\Rightarrow \frac{T_A}{T_C} = 2$

$\Rightarrow T_A = 2T_C$

$\Rightarrow T_C = \frac{T_A}{2}$ — (ii)

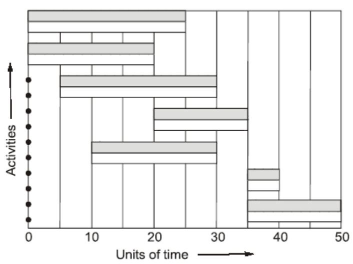
Putting (ii) in (i)

$T_A + \frac{T_A}{2} = T_B$

$\Rightarrow \frac{3T_A}{2} = t \Rightarrow T_A = \frac{2t}{3}$

8	123	C	D	**Source:** https://nptel.ac.in/courses/105106114/pdfs/Unit21/21_1.pdf PAGE NO. 11 **21.1.1 Hydraulically Efficient Channel** It is well known that the conveyance of a channel section increases with increases in the hydraulic radius or with decrease in the wetted perimeter. Therefore, from the point of hydraulic aspects, the channel section having the least wetted perimeter for a given area has the maximum conveyance; such a section is known as the Hydraulically efficient channel. But this is popularly referred as Best Hydraulic section. The semicircle has the least perimeter among all sections with the same area; hence it is the most hydraulically efficient of all sections. The geometric elements of six best hydraulic section are given in Table. It may be noted that it may not be possible to implement in the field due to difficulties in construction and use of different materials. In general, a channel section should be designed for the best hydraulic efficiency but should be modified for practicability. From a practical point of view, it should be noted that a best hydraulic section is the section that gives the minimum area of flow for a given discharge but it need not be the minimum excavation.
9	125	D	C	Source: MADE EASY Theory Book, Fluid Mechanics including Hydraulic Machines, Edition 2018, Pg No. 140 • When compressibility, turbulence and surface tension forces are neglected and only gravity, pressure and viscous forces are taken into account then the equation of motion is called **Navier-Stoke's** equation of motion. i.e. $Ma = F_g + F_p + F_v$ ...(3) Source: Fluid mechanics by Dr. R. K. Bansal, page 259 **6.2 EQUATIONS OF MOTION** According to Newton's second law of motion, the net force F_x acting on a fluid element in the direction of x is equal to mass m of the fluid element multiplied by the acceleration a_x in the x-direction. Thus mathematically, $F_x = m.a_x$ ...(6.1) In the fluid flow, the following forces are present : (i) F_g, gravity force. (ii) F_p, the pressure force. (iii) F_v, force due to viscosity. (iv) F_t, force due to turbulence. (v) F_c, force due to compressibility. Thus in equation (6.1), the net force $F_x = (F_g)_x + (F_p)_x + (F_v)_x + (F_t)_x + (F_c)_x$ (i) If the force due to compressibility, F_c is negligible, the resulting net force $F_x = (F_g)_x + (F_p)_x + (F_v)_x + (F_t)_x$ and equation of motions are called Reynold's equations of motion. (ii) For flow, where (F_t) is negligible, the resulting equations of motion are known as Navier-Stokes Equation. (iii) If the flow is assumed to be ideal, viscous force (F_v) is zero and equation of motions are known as Euler's equation of motion.

				Source: Fluid mechanics by Modi &Seth, page --- Further for laminar or viscous flows the turbulent forces also become less significant and hence these may be neglected. The Eqs. 7.4 and 7.4 (a) may then be modified as $Ma = F_g + F_p + F_v$ ...(7.5) and $Ma_x = F_{gx} + F_{px} + F_{vx}$, $Ma_y = F_{gy} + F_{py} + F_{vy}$, $Ma_z = F_{gz} + F_{pz} + F_{vz}$ ...(7.5a) Equation 7.5 (a) are known as Navier–Stokes equations which are useful in the analysis of viscous flow. Further if the viscous forces are also of little significance in the problems of fluid flows, then these forces may also be neglected. The viscous forces will become insignificant if the flowing fluid is an ideal fluid. However, in the case of real fluids also the viscous forces may be considered to be insignificant if the viscosity of the flowing fluid is small. In such cases the Eqs 7.5 and 7.5(a) may be further modified as $M_a = F_g + F_p$ ... (7.6) and $Ma_x = F_{gx} + F_{px}$, $Ma_y = F_{gy} + F_{py}$, $Ma_z = F_{gz} + F_{pz}$ ... (7.6 a) Equations 7.6 (a) are known as *Euler's equations of motion.* A detailed study of the Reynolds equations of motion and the Navier–Stokes equations are beyond the scope of this book. The Euler's equations of motion are however dealt with in detail in the next section. Source: Solid and fluid mechanics by SS Bhavikatti, page 426 **Equations of Motion** In a fluid flow the following type of forces may be present. 1. Gravity force, F_g. 2. Pressure force, F_p. 3. Force due to viscocity, F_u. 4. Force due to turbulence, F_r 5. Force due to compressibility, F_c. • Thus, from Newton's second law $ma_x = (F_g)_x + (F_p)_x + (F_v)_x + \ldots$ when a sm[...] force due to compressibility is neglected. • [...]en expressions involved in the above equation and other similar equations are s[...]stituted, the resulting equations are known as Reynolds equations. For flow at low Reynolds number, the force due to turbulence is neglected. Hence, $ma_x = (F_g)_x + (F_p)_x + (F_v)_x$ [...]his equations is known as *Navier–Stokes equation.* If the flow is assumed to be ideal, i.e., possesses no viscocity, equation is known [...] *Euler's equation* for motion. In this case $ma_x = (F_g)_x + (F_p)_x$ Bernoulli equation is obtained by integrating the Euler's equation of motion. It st[...]es that for a steady, ideal flow of an incompressible fluid, the total energy at any point of the [...]uid is constant. [...]hus $\frac{p_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{V_2^2}{2g} + Z_2.$
10	128	D	C	Source: MADE EASY Theory Book, Construction Practice, Planning and Management, Edition 2018, Pg No. 16 **Critical Path** In CPM analysis, the path along which total floats are zero or minimum is called as critical path. All activities on this path are critical. There can be more than one critical paths. **Subcritical Path:** It is the path joining all subcritical activities. For a subcritical activity total float is greater than zero i.e., $F_T > 0$ **Supercritical Path:** It is the path joining all super critical activities. For a supercritical activities total float is less than zero i.e., $F_T < 0.$

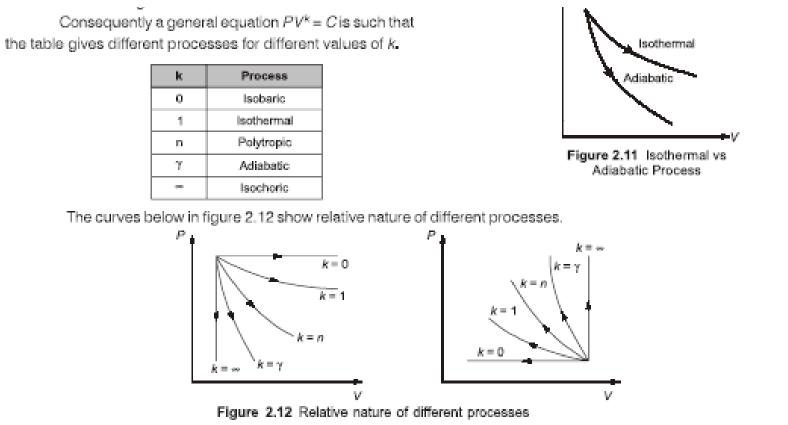
				Source: Civil Engineering (Conventional and objective), S.Chand, RS Khurmi, page-637 **7.2. CRITICAL PATH** It is important to note that the value of slack, associated with an event, determine how critical that event is. The less the slack (more negative), the more critical an event is. A *critical path* is the one which connects the events having zero or minimum slack times. All the events along the *critical path* are considered to be *critical* in the sense that any delay in their occurrence will result in the delay in the scheduled completion of the project. *Eventually, a critical path is the longest path (time wise) connecting the initial and end event.* Source: Construction Planning and Management By Dr. U.K. Srivastava, Galgotia Publication, 3th Edition, page No. 24 time over activity time. In some cases the absorption of this float affects neither predecessor nor the successor activity. That's why, it is called independent. If it is desired to increase duration time in order to release efforts elsewhere, independent float can be used without any replanning. $(IF)_{i-j} = [(EOT)_j - (LOT)_i] - t_{i-j}$ If the value of independent float is negative, it is taken as zero for all practical purposes. **d) Interfering Float (INT. F)** Interfering float of an activity is the difference between the total float and free float. It is equal to the head event slack. $(INT.F)_{ij} = [(LOT)_j - (EOT)_j]$ or $(TF)_{i-j} - (FF)_{i-j}$. The confirmation of the critical path in a CPM network is made only when all the above four floats of each activity lying on the path are zero. **SLACK**
11	129	C	B	Source: MADE EASY Theory Book, Construction Practice, Planning and Management, Edition 2018, Pg No. 2 **1.3.1 Bar Chart** Firstly introduced by Henry Gantt around 1900 AD. *Features of bar chart are:* 1. It is a pictorial chart 2. It has two coordinate axes, the horizontal coordinate represents the elapsed time and vertical coordinate represents the job or activity to be performed. 3. The beginning and end of each bar represents starting and finishing time of a particular activity respectively. 4. The length of bar shows the time required for completion. • Jobs can be concurrent or can be started one after other. So some bars can run parallel or overlap each other or may run serially.  *Fig.1.1* Bar Chart

				Source: Civil Engineering (Conventional and objective), S.Chand, RS Khurmi, page-637 **16.12 Bar Chart or Gantt Chart** The bar chart or Gantt chart was developed by Henry Gantt for planning and scheduling the methods of construction. This chart is a graphical representation of various activities involved in a construction work. It consists of two co-ordinates. The horizontal ordinate or bar represents the various activities involved in a construction work and the duration of times required for completion of the activities. The vertical abscissa or bar represents the respective jobs to be performed. The length of the bar indicates the duration of activity or job for its completion. The various activities are shown parallel to each other along ordinates. Since the various activities are shown by a number of parallel ordinates or bars, therefore it is called a *bar chart*. The duration of the activities are represented from the left to the right. Each bar is divided longitudinally into two portions. The top portion indicates the progress of completion of the activity and the bottom portion indicates the duration of the activity. Source: Project Planning and Control with pert and cpm, BC Punamia, 4th Edition, page No. 13 13 magnitude. A *bar chart* consists of two co-ordinate axes, one (usually horizontal axis) representing the time elapsed and the other (the vertical axis) represent the jobs or activities to be performed. Each bar represent one specific job or activity of the project. The beginning and end of each bar represent the time of start and ... Source: Construction Planning and Management By Dr. U.K. Srivastava, Galghotia Publication, 3th Edition, page No. 60 **Construction of a bar chart** In this type of chart, the time duration of an activity is represented by the horizontal line. The length of the time is proportional to the time duration of the activity. Since several activities are represented on the same chart a rectangular framework is chosen. The activities are listed from top to bottom on the extreme left hand side of the framework. An activity duration flows from left to right. It is illustrated in Fig. 1.60, which is meant for the following project.
12	130	B	D	Source: MADE EASY Theory Book, Construction Practice, Planning and Management, Edition 2018, Pg No. 31 **3.4.1 Resource Levelling** Here resources are considered unlimited. Project duration is maintained and critical activities remain unchanged. Start time of some of non-critical activities are shifted within their available floats to create uniform demand throughout. **3.4.2 Resource Smoothening** Here resources are considered limited. Project duration may be changed. Activities are rescheduled to cut down the peak requirement of resources so that it does not cross the limit of resources. Available resources should never be less than the maximum quantity required for any activity of project. Firstly, available floats are used then if needed duration of some activities is increased or decreased as per the resource requirement. Source: Project Planning and Control with PERT and CPM By BC Punamia, Laxmi Publication, 4th Edition, Page No. 137 **7.2. CRITICAL PATH** It is important to note that the value of slack, associated with an event, determine how critical that event is. The less the slack (more negative), the more critical an event is. A *critical path* is the one which connects the events having zero or minimum slack times. All the events along the *critical path* are considered to be *critical* in the sense that any delay in their occurrence will result in the delay in the scheduled completion of the project. *Eventually, a critical path is the longest path (time wise) connecting the initial and end event.*

13	132	D	C	In this question there are only three activity have been mention: 1. Supply of material for concrete 2. Formwork reinforcing and placing of concrete 3. Removal of the formwork and curing of concrete So the number of bars required on bar chart is three. So answer should be (C).
14	133	A	C	Source: NPTEL, Lecture 2 **Lecture 2** **COAL CARBONIZATION AND COKE OVEN PLANT** Coal carbonization is used for processing of coal to produce coke using metallurgical grade coal. Coal carbonization involves heating of coal in the absence of air. Coke making process is multistep complex process and variety of solid liquids and gaseous products are produced which contain many valuable products. Various products from coal carbonization in addition to coke are coke oven gases. coal tar, light oil, and aqueous solution of ammonia and ammonia salt. Coke oven gases are about 310-340 cum per tone of dry coal which contains gaseous products, coal tar vapours, light oil and water [Mukhulyonov et al., 1974]. With the development of steel industry there has been continuous development in coke oven plant since latter half of nineteenth century. to improve the process conditions, recovery of chemicals and environmental pollution control strategies and energy consumption measures Carbonization can be carried out at low temperature or high temperature. Low temperature carbonization is used to produce liquid fuels while high temperature carbonization is used to produce gaseous products [Trodakar & Belgaonnkar1991]. **Low temperature carbonization (450-750°C)**: In low temperature carbonization quantity of gaseous product is less while liquid products are large. **High temperature carbonization (above 900°C)**: In high temperature carbonization, the yield of gaseous product is more than liquid products with production of tar relatively low. The potential availability of chemicals from high temperature carbonization (above 900°C) and low temperature carbonization (450-750°C) is given in Table M-II 2.1 and Table M-II 2.2 respectively.

<table>
<tr>
<td>15</td>
<td>134</td>
<td>D</td>
<td>C</td>
<td>

Source: Made Easy Theory Book Thermodynamics Page 17



Consequently a general equation $PV^k = C$ is such that the table gives different processes for different values of k.

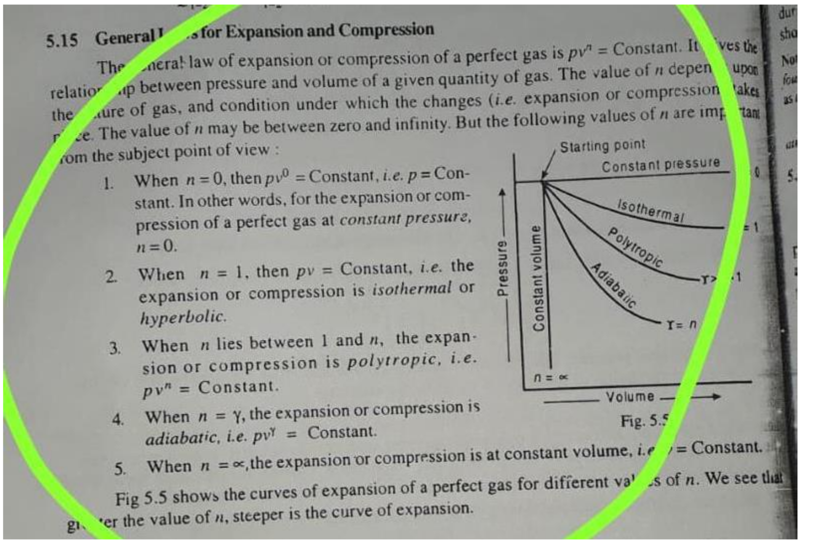
k	Process
0	Isobaric
1	Isothermal
n	Polytropic
γ	Adiabatic
∞	Isochoric

Figure 2.11 Isothermal vs Adiabatic Process

The curves below in figure 2.12 show relative nature of different processes.

Figure 2.12 Relative nature of different processes

Source: A textbook of thermal engineering by RS Khurmi, Page no-216



5.15 General l ...s for Expansion and Compression

The ...neral law of expansion or compression of a perfect gas is pv^n = Constant. It ...ves the relatio... ...ip between pressure and volume of a given quantity of gas. The value of n depen... upon the ...ure of gas, and condition under which the changes (*i.e.* expansion or compression) takes ...ce. The value of n may be between zero and infinity. But the following values of n are imp... ...tant ...om the subject point of view :

1. When $n = 0$, then pv^0 = Constant, *i.e.* p = Constant. In other words, for the expansion or compression of a perfect gas at *constant pressure*, $n = 0$.
2. When $n = 1$, then pv = Constant, *i.e.* the expansion or compression is *isothermal* or *hyperbolic*.
3. When n lies between 1 and n, the expansion or compression is *polytropic*, *i.e.* pv^n = Constant.
4. When $n = \gamma$, the expansion or compression is *adiabatic*, *i.e.* pv^γ = Constant.
5. When $n = \infty$, the expansion or compression is at constant volume, *i.e.* ... = Constant.

Fig 5.5 shows the curves of expansion of a perfect gas for different va... ...s of n. We see that gr... ...er the value of n, steeper is the curve of expansion.

Fig. 5.5

Source: Engineering Thermodynamics PK NAG 5th edition .. Pg 52, figure 3.10....

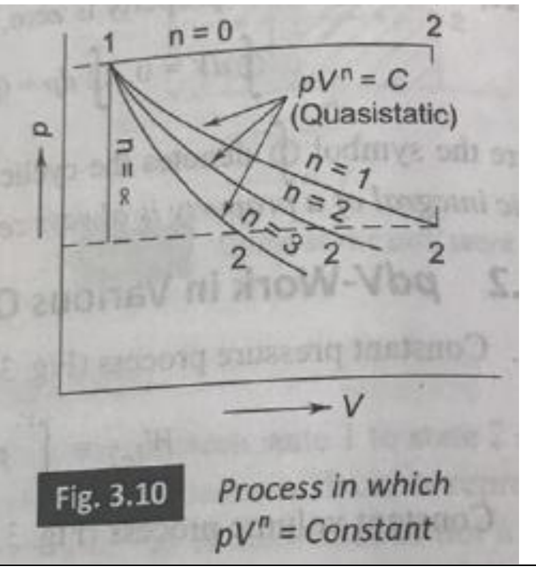


Fig. 3.10 Process in which pV^n = Constant

</td>
</tr>
</table>

16	135	C	D	Source: A textbook of thermal engineering by RS Khurmi, Page no-208 & 209

5.6 Laws of Perfect Gases

A perfect gas (or an ideal gas) may be defined as a state of a substance, whose evaporation from its liquid state is complete. It may be noted that if its evaporation is partial, the substance is called *vapour*. A vapour contains some particles of liquid in suspension. The behaviour of superheated vapours is similar to that of a perfect gas.

The physical properties of a gas are controlled by the following three variables :

1. Pressure exerted by the gas, 2. Volume occupied by the gas, and 3. Temperature of the gas.

The behaviour of a perfect gas, undergoing any change in these three variables, is governed by the following laws :

1. *Boyle's law. This law was formulated by Robert Boyle in 1662. It states, "The absolute pressure of a given mass of a perfect gas varies inversely as its volume, when the temperature remains constant."* Mathematically,

$$p \propto \frac{1}{v} \quad \text{or} \quad pv = \text{Constant}$$

The more useful form of the above equation is :

$$p_1 v_1 = p_2 v_2 = p_3 v_3 = \ldots = \text{Constant}$$

where suffixes $_1$, $_2$ and $_3$ ..... refer to different sets of conditions.

2. *Charles' law.* This law was formulated by a Frenchman Jacques A.C. Charles in about 1787. It may be stated in two different forms :

(*i*) *"The volume of a given mass of a perfect gas varies directly as its absolute temperature, when the absolute pressure remains constant."* Mathematically,

$$v \propto T \quad \text{or} \quad \frac{v}{T} = \text{Constant}$$

or

$$\frac{v_1}{T_1} = \frac{v_2}{T_2} = \frac{v_3}{T_3} = \ldots\ldots = \text{Constant}$$

where suffixes $_1$, $_2$ and $_3$ .....refer to different sets of conditions.

THERMODYNAMICS 209

(*ii*) *"All perfect gases change in volume by 1 / 273 th of its original volume at 0° C for every 1° C change in temperature, when the pressure remains constant."*

Let v_0 = Volume of a given mass of gas at 0° C, and

v_t = Volume of the same mass of gas at t° C.

Then, according to the above statement,

$$v_t = v_0 + \frac{1}{273} v_0 t = v_0 \left(\frac{273 + t}{273} \right) = v_0 \times \frac{T}{T_0}$$

or

$$\frac{v_t}{T} = \frac{v_0}{T_0}$$

where T = Absolute temperature corresponding to t° C.

T_0 = Absolute temperature corresponding to 0° C.

A little consideration will show, that the volume of a gas goes on decreasing by 1/ 273th of its original volume for every 1°C decrease in temperature. It is thus obvious, that at a temperature of – 273° C, the volume of the gas would become zero. The temperature at which the volume of a gas becomes zero is called *absolute zero temperature*.

3. *Gay – Lussac law.* This law states, *"The absolute pressure of a given mass of a perfect gas varies directly as its absolute temperature, when the volume remains constant."* Mathematically

$$p \propto T \quad \text{or} \quad \frac{p}{T} = \text{Constant}$$

or

$$\frac{p_1}{T_1} = \frac{p_2}{T_2} = \frac{p_3}{T_3} = \ldots\ldots = \text{Constant}$$

where suffixes $_1$, $_2$ and $_3$.... refer to different sets of conditions.

Note : In dealing with a perfect gas, the values of pressure and temperature are expressed in absolute units.

Soruce: Thermodynamics and Thermal Engg by J.Selwin Rajadurai Pg 160 and Pg 165.... ISBN 81-224-1493-1

2. If a perfect gas, undergoing any change in the variable, which control physical properties, it's behaviour is governed by
   (a) Boyle's law (b) Charle's law
   (c) Gay Lussac law (d) all of the above

ANSWERS

1. c 2. d 3. a 4. a 5. b 6. c 7. c

<table>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>17</td><td>136</td><td>D</td><td>A</td><td>

Source: NPTEL

4 | Page

Blast furnace gas

Blast furnace gas is a by-product of the reduction reaction of iron ore with coke in the blast furnace, to produce metallic iron. The calorific value of this gas is very low, about 1000 kcal/m^3. The reason for the low calorific value is that, the gas contains about 60% nitrogen, 18-20% carbon dioxide and rest is mainly carbon monoxide with a little oxygen. The first two gases do not contribute to the calorific value and occupies major volume.

</td></tr>
<tr><td>18</td><td>140</td><td>C</td><td>D</td><td>

Source: MADE EASY Theory Book, Electronics Devices and Circuits, Edition 2018 Pg. 101

3.2.4 Expression for Collector Current (in active region)

- In active region collector current is essentially independent of collector voltage and depends only upon emitter current.
- From our discussion of transistor currents we see that if transistor is in its active region, then collector current is given by equation (3.4), or

$$I_C = -\alpha I_E + I_{CO} \quad ...(3.7)$$

If currents I_E, I_B and I_C are assumed to be flowing into the transistor then

$$I_E + I_B + I_C = 0$$

or $$I_E = -(I_B + I_C) \quad ...(3.8)$$

From Eqs. (3.7) and (3.8) we get,

$$I_C = +\alpha(I_B + I_C) + I_{CO}$$

$$I_C - \alpha I_C = \alpha I_B + I_{CO}$$

$$\Rightarrow \quad I_C(1-\alpha) = \alpha I_B + I_{CO}$$

$$\Rightarrow \quad I_C = \frac{\alpha}{1-\alpha} I_B + \frac{1}{1-\alpha} I_{CO} \quad ...(3.9)$$

Let, $$\frac{\alpha}{1-\alpha} = \beta \quad \Rightarrow \quad 1+\beta = 1+\frac{\alpha}{1-\alpha} = \frac{1}{1-\alpha}$$

From Eq. (3.9) we get,

$$I_C = \beta I_B + (1+\beta) I_{CO} \quad ...(3.10)$$

Source: Basic Electronics and Linear Circuits by N.N Bhargava, page 224

In this equation, βI_B is the portion of current transferred from the input side. The current I_{CEO} is the leakage current in the CE configuration. Though the current I_{CEO} is not as small as the leakage current in the CB configuration I_{CBO}, yet it is very small compared to the usual values of I_C. A very small error will be introduced if we neglect the current I_{CEO} in our calculations. Therefore, to a good approximation, the collector current I_C is given as

$$I_C = \beta I_B \quad (7.6)$$

β=100

Base current I_β= 30 μA

Collector current= Ic = βI_β = 100 x 30x10^{-6} =3x10^{-3} =3mA

</td></tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>
Source: Electronic Devices and Circuit Theory (Tenth Edition) Authors: Robert L. Boylestad and Louis Nashelsky; Page number: 141
Beta (β)
In the dc mode the levels of I_C and I_B are related by a quantity called beta and defined by the following equation:
$$\beta_{dc} = \frac{I_C}{I_B} \qquad (3.10)$$
where I_C and I_B are determined at a particular operating point on the characteristics. For practical devices the level of β typically ranges from about 50 to over 400, with most in the midrange. As for α, β certainly reveals the relative magnitude of one current to the other. For a device with a β of 200, the collector current is 200 times the magnitude of the base current.
Source: Electronic Devices (Ninth Edition); Author: Thomas L. Floyd; Page number: 178
DC Beta (β_{DC}) and DC Alpha (α_{DC})
The dc current gain of a transistor is the ratio of the dc collector current (I_C) to the dc base current (I_B) and is designated dc beta (β_{DC}).
$$\beta_{DC} = \frac{I_C}{I_B}$$
</td>
</tr>
<tr>
<td>19</td>
<td>145</td>
<td>B</td>
<td>A</td>
<td>
Source: MADE EASY Theory Book, Network Theory, Edition 2018 Pg. 148-149
8.5 Impedance and Admittance
In the preceding section, we obtained the voltage current relations for the three passive elements as
$$\mathbf{V} = R\mathbf{I}, \quad \mathbf{V} = j\omega L\mathbf{I}, \quad \mathbf{V} = \frac{\mathbf{I}}{j\omega C} \qquad ...(8.12)$$
These equations may be written in terms of the ratio of the phasor voltage to the phasor current as
$$\frac{\mathbf{V}}{\mathbf{I}} = R, \quad \frac{\mathbf{V}}{\mathbf{I}} = j\omega L, \quad \frac{\mathbf{V}}{\mathbf{I}} = \frac{1}{j\omega C} \qquad ...(8.13)$$
From these three expression, we obtain Ohm's law in phasor form for any type of element as
$$Z = \frac{\mathbf{V}}{\mathbf{I}} \quad \text{or} \quad \mathbf{V} = Z\mathbf{I}$$
where $\mathbf{Z}$ is a frequency dependent quantity known as impedance, measured in ohms. The impedance $\mathbf{Z}$ of a circuit is the ratio of the phasor voltage $\mathbf{V}$ to the phasor current $\mathbf{I}$, measured in ohms (Ω).
The voltage and current phasors are $\mathbf{V} = V_m\angle\theta_v$ and $\mathbf{I} = I_m\angle\theta_i$, we have
$$\mathbf{Z} = \frac{V_m\angle\theta_v}{I_m\angle\theta_i} = \frac{V_m}{I_m}\angle(\theta_v - \theta_i)$$
Thus, the impedance is said to have a magnitude $|Z|$ and a phase angle $\theta_v - \theta_i$. Therefore,
$$|Z| = \frac{V_m}{I_m} \quad \text{and} \quad \theta = (\theta_v - \theta_i)$$
Since it is a ratio of volts to amperes, impedance has unit of ohms. The impedance in AC circuits is similar to resistance in DC circuits. Impedance is the ratio of two phasors; however, it is not a phasor itself since it does not represent a sinusoidally varying quantity. Impedance is a complex number that relates one phasor $\mathbf{V}$ to the other phasor $\mathbf{I}$ as
$$\mathbf{V} = Z\mathbf{I}$$
The phasors $\mathbf{V}$ and $\mathbf{I}$ may be transformed to the time domain to obtain the steady-state voltage or current respectively. However, impedance has no meaning in the time domain.
As a complex quantity, the impedance may be expressed in rectangular form as
$$\mathbf{Z} = R + jX$$
where $R = Re\,\mathbf{Z}$ is the resistance and $X = \text{Im}\,\mathbf{Z}$ is the reactance. The reactance X may be positive or negative. We say that the impedance is inductive when X is positive or capacitive when X is negative. Thus, impedance $\mathbf{Z} = R + jX$ is said to be inductive or lagging since current lags voltage, while impedance $\mathbf{Z} = R - jX$ is capacitive or leading because current leads voltage. Therefore, the magnitude of the impedance is
</td>
</tr>
</table>

$$|Z| = \sqrt{R^2 + X^2}$$

and the phase angle is, $\theta = \tan^{-1}\left(\frac{X}{R}\right)$

$\Rightarrow$ $R = |Z|\cos\theta$ and $X = |Z|\sin\theta$

These relationships are shown graphically in Figure 8.6.

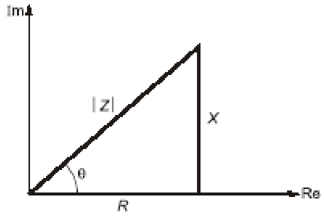


***Figure-8.6**: Graphical representation of impedance*

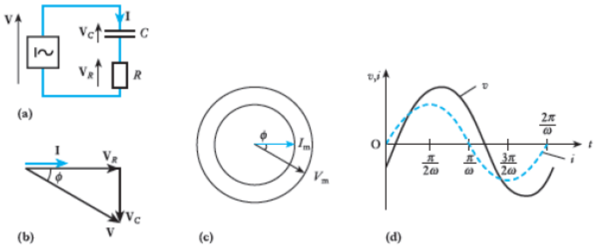
Impedance and Admittance of Element *R, L* and *C*

Table-8.2: *Impedance and Admittance of R, L, C*

Element	Impedance	Admittance
R	$Z = R$	$Y = \frac{1}{R}$
L	$Z = j\omega L$	$Y = \frac{1}{j\omega L}$
C	$Z = \frac{1}{j\omega C}$	$Y = j\omega C$

Source: Electrical and Electronic Technology (Tenth Edition); Author: Edward Hughes; Page number: 235

Fig. 10.22 Resistance and capacitance in series. (a) Circuit diagram; (b) phasor diagram; (c) instantaneous phasor diagram; (d) wave diagram



where $Z = (R^2 + X_C^2)^{\frac{1}{2}}$ [10.17]

and $Z = \left(R^2 + \frac{1}{\omega^2 C^2}\right)^{\frac{1}{2}}$

Again Z is the impedance of the circuit. For any given frequency, the impedance remains constant and is thus the constant used in Ohm's law, i.e. the impedance is the ratio of the voltage across the circuit to the current flowing through it, other conditions remaining unchanged.

उम्मीदवार का नाम एवं हस्ताक्षर (तिथि सहित)

उम्मीदवार का दूरभाष/मोबाइल सं. –

संयुक्त सचिव–सह–परीक्षा नियंत्रक,

बिहार लोक सेवा आयोग, पटना