Answer Key for Coal India Limited (ME) 2017 Model Question Paper

Paper - 1

1.	b	2.	c	3.	b	4.	b	5.	a
6.	c	7.	d	8.	b	9.	d	10.	b
11.	d	12.	d	13.	c	14.	a	15.	c
16.	b	17.	d	18.	d	19.	d	20.	d
21.	c	22.	d	23.	a	24.	c	25.	b
26.	d	27.	d	28.	a	29.	d	30.	a
31.	c	32.	d	33.	b	34.	c	35.	c
36.	d	37.	c	38.	c	39.	d	40.	a
41.	d	42.	b	43.	c	44.	d	45.	b
46.	d	47.	c	48.	c	49.	d	50.	a
51.	a	52.	d	53.	d	54.	d	55.	d
56.	c	57.	d	58.	c	59.	b	60.	c
61.	d	62.	c	63.	c	64.	c	65.	c
66.	c	67.	b	68.	d	69.	a	70.	d
71.	d	72.	c	73.	a	74.	a	75.	c
76.	a	77.	c	78.	c	79.	a	80.	d
81.	a	82.	d	83.	b	84.	a	85.	a
86.	c	87.	b	88.	b	89.	d	90.	d
91.	c	92.	b	93.	a	94.	b	95.	b
96.	c	97.	a	98.	a	99.	a	100	d

Note: Scroll down for Answer Key for Paper 2

English Language

1. The given blank needs an adverb to denote that a factor qualifies or imposes restrictions on what was said previously. The sentence here means that *science is something modern* but it is not so. Since, 'though' expresses this idea, option 2 is the best fit answer.

2. Let's look at the meanings of the words given in the blank space.
Fluctuating: to rise and fall in number or in amount in an irregular way.
E.G. The nurse reported that the blood pressure of the patient kept fluctuating in the last two hours.
Cooperative: involving mutual assistance in working towards a common goal.
E.G. If things have to function smoothly in a team, people must be cooperative.
Conducive: good, favourable and helpful
E.G. 'You must try to make a conducive environment for the female members at our work place', said the boss to his employees.
The given sentence speaks something positive about Manorama which we can understand by the word 'exceptionally'. Thus, the word 'accomplished' is the most appropriate fit for the blank as it makes the sentence meaningful.

3. The prepositions for positions are 'below', 'on' and 'over'. 'Over' is used to cover the entire surface. *E.g. The roof is over the house*. In the given sentence, since the 'clouds' are spread like a blanket 'over' is the most suitable preposition. Hence, the correct option is 2.

4. 'Bow'(verb) means 'to bend the head or upper part of the body as a sign of respect, greeting, or shame'. *E.g. He bowed down for the charming lady and kissed her hand.* Whereas, 'Vow'(verb) means 'to take a pledge to do something'. The context of the sentence makes it clear that we are talking about the word 'vow' and hence we use 'vowed'. Thus, the correct answer is option 2.

5. The following sentence of the passage states that 'Consequently, the depositors have much higher stakes in the successful operations of private commercial banks, financially speaking, than the owners of share capital.' Thus option 1 is the correct answer.

6. To find the answer for the given question we need to take into account the following two sentences from the paragraph – 'that the ownership and control of the total finances of the banking system rests with very small number of persons who are able to determine the patterns of allocation and investment of bank finance according to their own individual interest and convenience.' And 'With the present system of private ownership of banks, the security enjoyed by the depositors is considerably weakened since it rests on the ability and competence of those who control the allocation and investment of bank finances.' From these two sentences it can be inferred that option 3 is the correct answer for the given sentence.

7. 'Encouragement' in reference to the given paragraph means 'persuasion to do something or continue doing it.' Although all given options are synonyms to the word in lesser or greater degree, in this context, 'supportive' is the best fit answer.

8. 'This is because the first claim on the resources of a bank in case of its failure would be that of depositors and not of the owners of share capital and this would be best ensured by a nationalized banking system. 'From this sentence in the paragraph it is evident that option 2 is the answer.

9. Upon careful study of the last paragraph, it can be easily inferred that option 4 is the correct answer for the given question when ownership is a strong criterion in case of public banks.

10. Trouncing means 'to defeat heavily in a contest.

The sentence describes how the tower was built to notify the villagers of Dornish raiders in the sea. Note that the expression *in across the sea.* 'Conquering' and 'Trouncing' can be eliminated as what or who is being trounced is not mentioned.

'Arriving' should be followed by 'at the sea' and not 'in the sea'. Therefore, 'Stealing' which means 'to move somewhere quietly' is appropriate in the context of 'raiders' or

the people who attack an enemy in their territory. It is also more appropriate than 'running'.

11. Let's have a look at the meanings of some of the words given in the options:

Consolidate: to make something stronger.
E.G. The teacher asked me to consolidate all my assignments in a single file.
Proliferated: to increase rapidly in number.
E.G. The Indian market has been proliferated with cheap Chinese goods.
Sprouted: appear or develop suddenly and in large numbers.
E.G. A large number of satellite towns have sprouted around the city of Delhi.
Degenerate: Decline or degenerate physically, mentally or morally.
E.G. The quality of food has degenerated at the restaurant we usually eat at.
Flowered: develop fully or richly.

The previous sentence explains that *villages had grown up around the towers*. Based on that hint, the current sentence says that these villages had converted into towns. Thus, 'consolidated', 'proliferated' and 'sprouted' can be ruled out. 'Degenerated' conveys a negative sense and can be eliminated. Thus, 'flowered which conveys the sense of 'being fully and richly developed' is the best fit answer.

12. Let's look at the meanings of the words given in the options:

Swayed: to move rhythmically backwards and forwards.
Dangled: to hang or swing loosely.
E.G. Macbeth hallucinated that a dagger dangled in the air.
Surfaced: To rise up to the surface of water or ground.
E.G. The truth about the brutal murder surfaced during the police investigation.
Lingered: to stay in a place longer than necessary.

Blank (C) requires a verb that describes the corpse of a young dragon which was left out for three days in the Weeping Town. 'Jumped' are irrelevant in the context of the corpse. 'Swayed' and 'dangled' are inappropriate to use here. Thus, 'lingered' is the best fit answer since a time duration of three days is mentioned. And option 5 is the correct answer.

13. The succeeding sentence tells us that Arianne didn't want King's Landing to know that they'd passed the way. And thus, she asked people in her company to be careful. Therefore, the correct word for Blank (D) is 'tongues'. Had the *company* opened their mouths, Kings Landing would have come to know about their presence. All the other options are irrelevant in the current context.

14. The sentence describes how Arianne's father had taught her to '*choose your side with care, and only if it has the chance to win.*' Undoubtedly the father's instruction is a kind of anecdote, teaching or a 'lesson'. Thus, option 1 is an appropriate answer.

Note that the word *teach* has been used in reference to the word in the blank space. Thus, 'warning' can be eliminated. 'Story' and 'chapter' are irrelevant as a suggestion is being talked about. Option 4 is completely out of context.

15. The previous sentence talks about the link of poverty and illiteracy to child labour and the next sentence begins with 'Still', which means that the missing sentence would be a reason which would discourage the efforts of the governments to abolish child labour. Option 1 is a positive statement, so it is incorrect. Option 2 is very vague to be the right answer. Options 4 and 5 are both related to child labour, but these are not related to the previous sentence. Option 3 is correct as it provides a bridge linking the previous and the next sentence – it tells us that it is not possible to completely eliminate child labour and it is followed by the fact that the government is still taking several steps to tackle the issue.

16. The passage makes it clear that the campaign was a success, and since option 1 seems to contradict this notion, we can eliminate it. Option 3 can also likewise be eliminated. Option 4 is out of the scope of the passage – there is no indication that there are indeed stronger cases to be made than reclassification. Thus this cannot be the concluding sentence of a paragraph that talks about reclassification. The correct conclusion is thus option 2, which caps it all with what could be perceived as the strongest push for net neutrality – the endorsement of the President.

17. Statement 1 is simply a reiteration of the third and fourth sentences of the passage. Statement 2 is out of the context of the passage as it introduces an unknown

'Sparta' into the passage. Statement 3 talks about the value of the coin. Observe that the passage has finished talking about the value of the coin and has moved on to talk about its circulation. Thus statement 3 would be regressive. Statement 4 talks further about how the long years of active circulation made it representative of coins in general. Thus the answer is statement 4.

18. "Combat" means to battle or fight against in or as if in a battle. 'Battle' means a combat. 'Alarm' means to be filled with apprehension. 'Fight' means to battle or combat. 'Conflict' means a prolonged fight, battle or struggle. From this, we can see that 'fight', 'conflict' and 'battle' are synonyms of the given word.

19. 'To interdict' is to 'prohibit or forbid' something. Hence, 'ban', 'prohibit' and 'forbid' are synonyms. 'Permit' is an antonym.

20. Generally people are quick to judge everyone according to the company they keep. Sentence two, option Q gives an example of this by saying that if we have reputable friends then we are judged as gentlemen. Option S in sentence three follows it up with saying the reverse is true too. Sentence four, option R expands further by saying that usually we seek out friends who are like minded, following it up with sentence five option P saying that just as opposites attract so also at times we make friends unlike us. Hence in conclusion we are told that we need to judge people not by the company they keep but by their individual personalities.

The correct sequence is QSRP and the correct option is 4.

21. This passage is about obesity and its repercussions. In sentence two, option S we realize that the obese are made fun of, however , sentence three in option R speaks about various serious complications that the obese can suffer from. Sentence four option Q shows us a way out by curbing our habits at the grass root level ,and follows it up in sentence five option P by saying how prevention is definitely better than the cure, concluding by pointing out the importance of creating awareness about the serious repercussions in the minds of people of all ages.

Hence, the correct sequence is SRQP and the correct option is 3.

22. The first sentence speaks of a journey. Then,Sentence P talks about the destination and the reason of sailing of the ship. The next sentence is Q which talks about a particular ship from the Armada de Molucca of five ships and its survival from an accident. Sentence R talks about it further by the use of the word 'it'. Sentence S continues the paragraph talking about the fate of the ship and its commander. Statement 6 concludes the paragraph by contradicting a popular belief. Thus the order is PQRS and the correct option is 1.

23. Sentence 1 mentions 'priority sector so Sentence Q follows 1 as it further explains the priority sectors. Sentence S follows as it talks about the identification of priority tags. Sentence P talks about the market failures which is concluded by R. Thus, the correct order is QSPR.

24. In a phrase 'No sooner' is always followed by 'than' to show that two events happen one after another. The correct sentence should read – No sooner did the rabbit come out of the bush than the hunter killed it. The error is in option 3.

25. 'The Arabian Nights' is the name of one book, so the verb should be singular 'is' not 'are'. The sentence should be--'The Arabian Nights' is enjoyed by all kinds of readers.

Reasoning

26. Let's assign each letter a value corresponding to their positions in the English alphabet, it will make the process easier.

Clearly, four such pairs exist.

27. Swimming, Sailing and Diving are related to water. Hence, driving is the odd one.

28. 17 → 17 × 9 = 153

Thus 24 → 24 × 9 = 216

Hence the next number is 216.

29. 90 – 56 = 34,

132 – 90 = 42,

184 – 132 = 52,

248 – 184 = 64

Thus difference between 2 consecutive terms are,

34, 42, 52, 64

34 + 8 = 42

42 + 10 = 52

52 +12 = 64

64 + 14 = 78

So, the answer would be 248 + 78 = 326.

30. aba_baca_ba_bacaabac_aca

Let's check all the options:

a) cacb ⇒ abacbacaabacbacaabacbaca ⇒abacbacaabacbacaabacbaca ⇒ Repeated pattern.

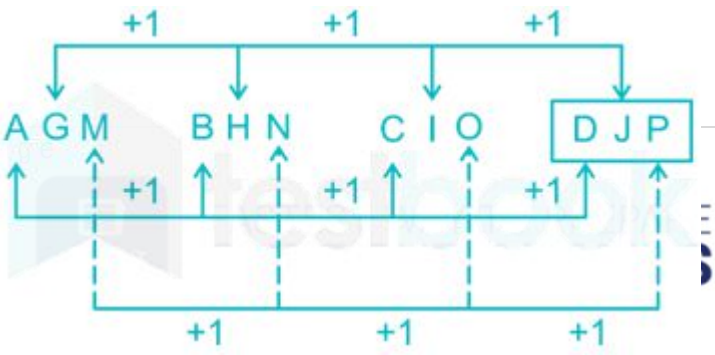
b) ccab ⇒ abacbacacbaabacaabacbaca ⇒ Meaningless.

c) cabc ⇒ abacbacaababbacaabaccaca⇒ Meaningless.

d) abcc ⇒ abaabacabbacbacaabaccaca⇒ Meaningless.

Hence, only cacb gives meaningful pattern.

31. The given series can be illustrated as:



Hence the next term will be DJP.

32. The word formed is BOARD.

Letter	A	B	C	D	E	M	N	O	S	R	U
Code							P	/			

33.

Word	P	A	L	E
Code	2	1	3	4

Word	E	A	R	T	H
Code	4	1	5	9	0

Hence PEARL can be coded as: 24153.

34. In each pair of 2 adjacent letters, the letters are exchanged.

BI	LL	IO	N
IB	LL	OI	N

→ IBLLOIN

Similarly,

CL	IN	TO	N
LC	NI	OT	N

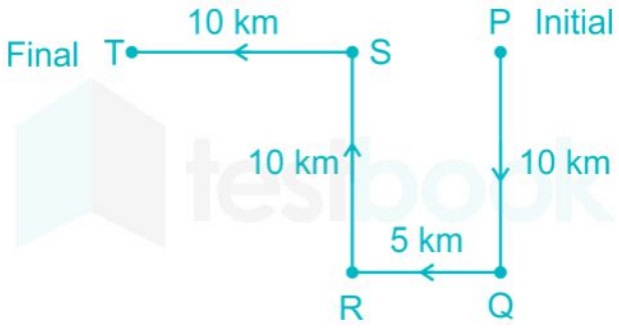
→ LCNIOTN

Hence, LCNIOTN is the correct answer.

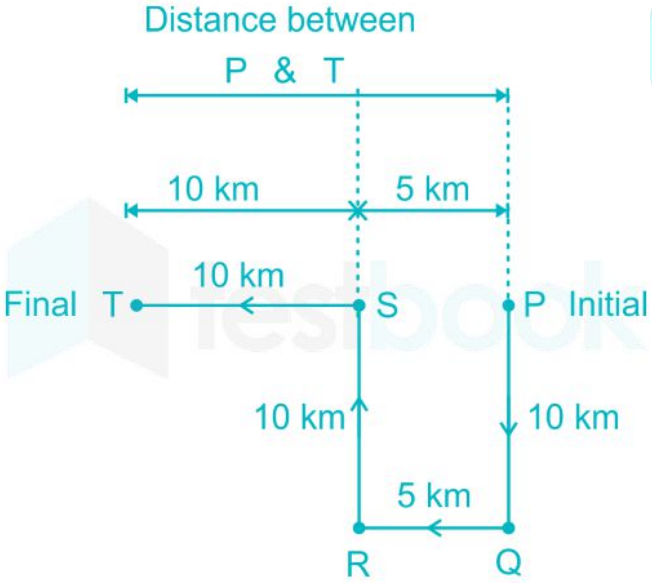
35. Since we sleep on bed and bed is called table.

Hence, we would sleep on table.

36. The route taken by the man to reach from initial Point P to final point T is shown below



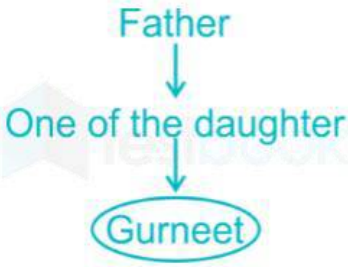
The distance between P and T can be found out by adding length of PS and ST, which is equal to (10+5) km or 15km



37. Depicting the given information diagrammatically, we get,

Referring to the woman in the photo

Combining (1) & (2)



Now 'one of the daughters' could either be Gurneet's mother or Aunt.

38.

Symbol	+	–	×	÷
Actual meaning	×	÷	–	+

16 ÷ 64 - 8 × 4 + 2

Converting: 16 + 64 ÷ 8 – 4 × 2

= 16 + 8 – 8 = 16

Hence, 16 is the answer.

39. a) Virgo ⇒ Virgo is the sixth sign in zodiac.

b) Volleyball ⇒ Volleyball is a team sport in which two teams of six players are separated by a net.

c) A highest scoring shot of a particular sport ⇒ Cricket has six as a highest scoring shot.

d) Extra sensory perceptions. ⇒ Sixth sense is extra sensory perception in human beings.

Clearly, six is the common number.

40. 5 + 3 × 8 – 12 ÷ 4 = 3

Let's check all the options:

a) – and ÷ ⇒ 5 + 3 × 8 ÷ 12 - 4 = 3

⇒ 5 + 24 ÷ 12 – 4 = 3

⇒ 5 + 2 – 4 = 3

⇒ 3 = 3 : Correct

b) + and × ⇒ 5 × 3 + 8 – 12 ÷ 4 = 3

⇒ 15 + 8 – 3 = 3

⇒ 20 ≠ 3

c) + and ÷ ⇒ 5 ÷ 3 × 8 – 12 + 4 = 3

⇒ 13 (approx.) – 8 = 3

⇒ 5 ≠ 3

d) + and – ⇒ 5 - 3 × 8 + 12 ÷ 4 = 3

⇒ 5 – 24 + 3 = 3

⇒ -16 ≠ 3

Hence, only option a) yields correct answer.

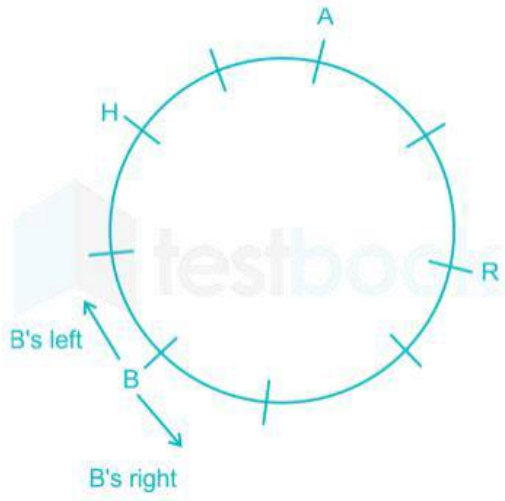
41. Check the following representation:

1. Assuming B has taken his place at random:-

2. R is third to the right of B.

3. A is second to the right of R.

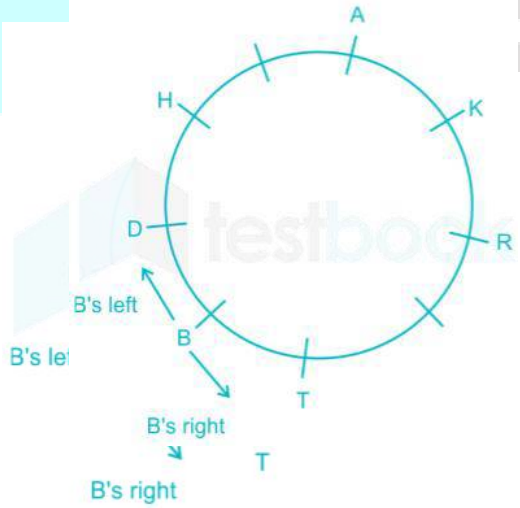
4. H is second to the right of A.



5. K is third to the right of T who is not an immediate neighbour of H. So T can only be placed immediate right to B otherwise K cannot be placed according to T.

6. D is second to the left of T.

7. M is fourth to the right of W. For this to happen W takes the position between T and R, so that M can take position between H and A. Hence the final arrangement is shown below.



Hence R is the third to left of M.

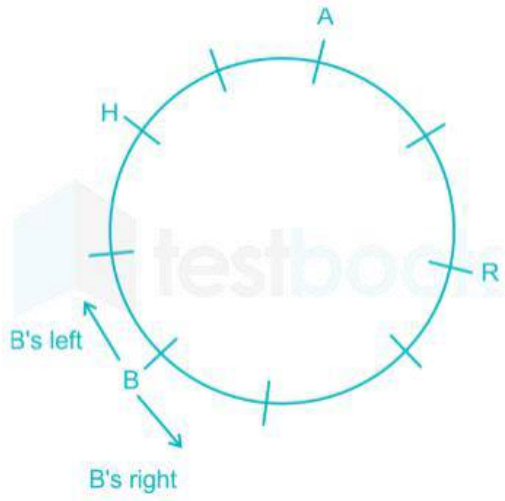
42. Check the following representation:

1. Assuming B has taken his place at random:-

2. R is third to the right of B.

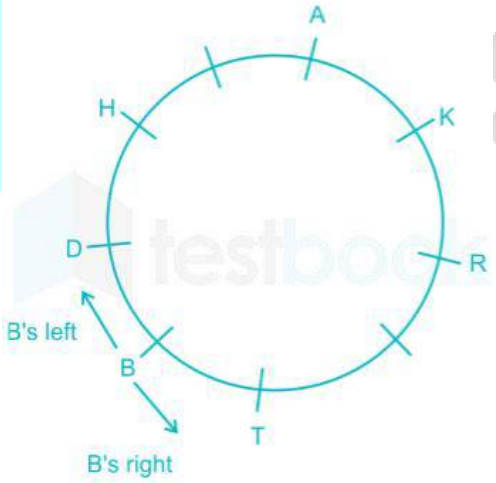
3. A is second to the right of R.

4. H is second to the right of A.

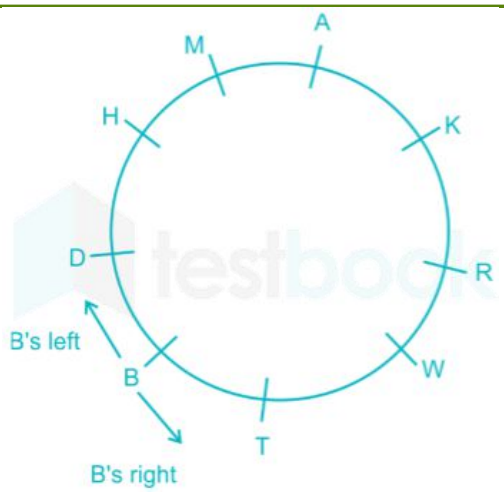


5. K is third to the right of T who is not an immediate neighbour of H. So T can only be placed immediate right to B otherwise K cannot be placed according to T.

6. D is second to the left of T.



7. M is fourth to the right of W. For this to happen W takes the position between T and R, so that M can take position between H and A. Hence the final arrangement is shown below.



Clearly, T is to the left of W.

43. Suresh is shorter than Kaushal but taller than Ramesh.

Ramesh < Suresh < Kaushal

Madhur is the tallest. Amit is a little shorter than Kaushal but little taller than Suresh.

Ramesh < Suresh < Amit < Kaushal < Madhur.

Hence, Ramesh is shortest.

44. Shahrukh: Truth – Morning only;

Salman: Truth – Afternoon only.

A says that B is Shahrukh.

Let's assume that:

a) A is Salman & B is Shahrukh then if A i.e. Salman is telling the truth & it's afternoon time.

b) A is Shahrukh & B is Salman then A i.e. Shahrukh is telling the lie & it's afternoon time.

So, A can be Shahrukh or Salman & its afternoon time.

45. Sandeep is 50 weeks older than Anna and Sandeep was born on Tuesday. Thus, Anna was also

born on Tuesday.

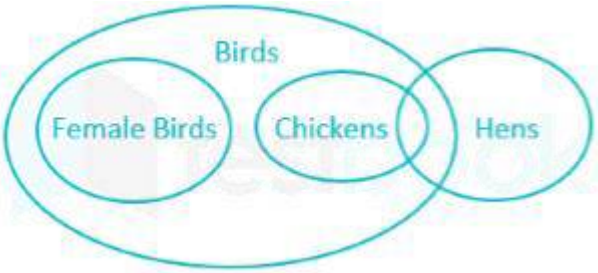
Anna is 300 days older than Varun.

300 days means 42 weeks and 6 days.

Thus, Varun was born on Tuesday + 6 days = Monday.

46. Clearly, the urban educated who are not hardworking are represented by the area IV.

47. The least possibility Venn diagram is,

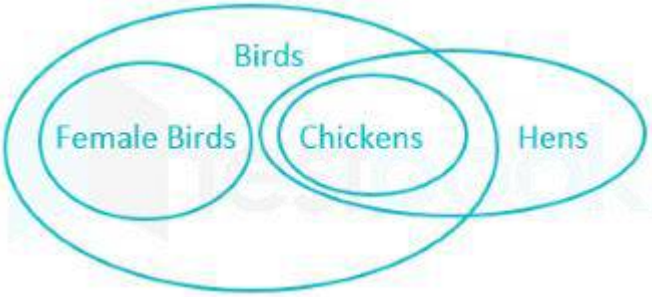


Conclusion:

I. All birds lay eggs → We can see from the figure that female birds who lay eggs are only a part of the birds, hence this option is false.

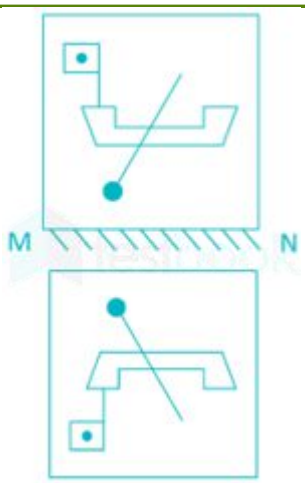
II. Some hens are birds → Clearly true.

III. Some chickens are not hens → It's not definite. We cannot deny the possibility of all chickens being hens. Hence false.



Hence only conclusion II follows.

48. The mirror image follows lateral inversion of the object about axis MN. So, the correct answer is option C.



49. Let us analyze both the statement and conclusions:

Statement: A car had driven off the road and hit a tree. The driver was efficient enough. The road was not good. The driver drove the car for last fifteen years.

Conclusion:

I. The accident occurred due to bad condition of road. ⇒ Since it is stated in the statement that the road condition was not good, it could be the reason for the accident. Also, it is said that driver was efficient. So, it is unlikely that he was responsible for the accident. But we cannot be sure that the road was the culprit. There could be other reasons like mechanical failure or another car veering this car off the road. So we cannot definitely conclude this to be true.

II. There was a mechanical fault in the car. ⇒ There is no mention that there is any mechanical fault in the car. So, this conclusion need not be true.

Hence, none follows.

50. If people are intelligent they should be creative but it is not necessary that all intelligent people are creative or creative people are intelligent. In this way, creativity and intelligence are not related always. So, both the assumptions are invalid.

Quantitative Aptitude

51. We know that 2016 was a leap year so it had 29 days on February

We know that,

Average = (sum of entities)/(number of entities)

∴ Sum of entities = Average × Number of entities

Average of first 15 days (i.e. 1st Feb to 15 Feb) = 12.4

Total consumption of first 15 days = 12.4×15 = 186 litres

Average of Last 15 days (i.e. 15st Feb to 29 Feb) = 12.6

Total consumption of last 15 days = 12.6×15 = 189 litres

Total consumption of last 14 days =Total consumption of last 15 days – Consumptions of 15 Feb

Let us assume truck driver consume x litres on 15th Feb

Total consumption of last 14 days = 189 – x

Average consumption Feb 2016 = 12.3

Total consumption Feb 2016 = 12.3 × 29 = 356.7

Also total consumption of Feb 2016 =Total consumption of first 15 days + Total consumption of last 14 days

⇒ 356.7 = 186 + 189 – x

⇒ x = 375 – 356.7 = 18.3 litres

52. Given, milk and water in two vessels A and B are in the ratio of 3 : 7 and 3 : 2 respectively.

∴ Amount of milk in A = 3/10 and Amount of water in A = 7/10

Amount of milk in B = 3/5 and Amount of water in B = 2/5

Let the fraction taken from A be 'x'.

∴ Fraction taken from B = 1 – x

Given, in C milk and water are in the ratio 1 : 2

∴ Amount of milk in C = 1/3

$\Rightarrow x \times \frac{3}{10} + (1 - x) \times \frac{3}{5} = \frac{1}{3}$

⇒ 3x + 6 – 6x = 10/3

⇒ x = 8/9

Ratio in which the amount from the two vessels should be mixed

$= \frac{x}{1-x} = \frac{\frac{8}{9}}{1-\frac{8}{9}}$

⇒ Ratio in which the amount from the two vessels should be mixed = 8 : 1

53. Given, ratio of number of boys and girls in a school is 2 : 3.

Let the number of boys and girls be 2a and 3a respectively. Where a is any constant

Given, 30% of the boys and 40% of the girls are scholarship holders.

∴ Total number of boys who are not getting scholarship = 70% of 2a = 1.4a

Total number of girls who are not getting scholarship = 60% of 3a = 1.8a

Total number of students not getting scholarship = 1.4a + 1.8a = 3.2a

% of students not getting scholarship $= \frac{3.2a}{5a} \times 100\%$

⇒ % of students not getting scholarship = 64%

54. Profit received by Bimal for managing the business = 12.5 % of Rs. 8800

=12.5/100 × 8800 = Rs. 1100

∴ Balance profit = Rs. 8800 – 1100 = Rs. 7700.

Ratio of investment of Bimal: Aditya = 50, 000: 60, 000 = 5: 6

∴ Profit shared by Bimal due to his investment = 5/11 × 7700 = 3500.

∴ Total Profit shared by Bimal = Rs. 1100 + Rs. 3500 = Rs. 4600

55. We know that,

Volume of cylinder = $\pi (R^2 - r^2)L$ where,

R = External radius of cross section

r = Internal radius of cross section

L = Length of the pipe

According to the question,

External radius = 9 cm

Length of the pipe = 14 cm

∴ $\pi (9^2 - r^2) \times 14 = 748$

⇒ $(22/7) \times (81 - r^2) \times 14 = 748$

⇒ $22 \times (81 - r^2) = 374$

⇒ $(81 - r^2) = 17$

⇒ $r^2 = 64$

⇒ r = 8 cm

∴ Thickness = 9 cm – 8 cm = 1 cm

56. M = monthly income = Rs 2000

The money saved by the man in 4 months = 4 × M – 3 × M = M

Therefore the money saved by the man in an year = M × (12/4) = 3 × M = Rs 6000

57. Concept – Relative speed of two moving objects when moving in same direction = (s_1 - s_2) and when moving in opposite direction = (s_1+ s_2)

Where, s_1 and s_2 are speed of moving objects and $s_1 > s_2$

Speed = Distance/time

Let the speed of train be 'v' m/s and its length be 'l' m.

Now, train overtakes the man walking in same direction at 2 km/hr and passes it completely in 9 sec,

Converting speed of man into m/s we get, $V_m = 2 \times \frac{5}{18} = 5/9$ m/s

Relative speed of train with respect to this man = (v - 5/9) m/s

∴ v - 5/9 = l/9 --------equation1

Also, train overtakes the man walking in same direction at 4 km/hr and passes it completely in 10 sec

Speed of man in m/s = $4 \times \frac{5}{18}$ = 10/9 m/s

Relative speed of train with respect to this man = (v - 10/9) m/s

∴ v - 10/9 = l/10 ---------equation2

Subtraction equation 2 from equation 1 we get,

(v - 5/9) – (v – 10/9) = l/9 – l/10

⇒ 5/9 = l/90

⇒ l = 50 m

58. Let the money Supravat be deposited be Rs. x.

In case of simple interest, we know,

(P × T × r)/100 = SI

Where, P = Principal amount, T = Duration in years, i = Interest rate per year, SI = Total simple interest

Total days from, 1st January, 2016 till 20th July, 2016 = 31 + 29 + 31 + 30 + 31 + 30 + 19 = 201 days = 201/365 years.

We can write here,

x + [x × (201/365) × (5/100)] = 3750

⇒ x ≈ 3650

∴ The money he deposited with the bank was Rs. 3650.

59. We know, $\sec^2\theta - \tan^2\theta = 1$

And $\sec^2\theta + \tan^2\theta = 5/3$

Let $\sec^2\theta$ be X and $\tan^2\theta$ be Y.

Hence, we get 2 equations, X – Y = 1 and X + Y = 5/3

Solving the above two,

We get, 2X = 8/3,

Hence, X = 4/3

∴ $\sec^2\theta = 4/3$

$\text{Sec}\theta = 2/\sqrt{3}$

∴ $\theta = 30°$

60. Given, water reservoir has two inlets and one outlet. Through the inlet it can be filled in 3 hours and 3 hours 45 mins respectively. It can be emptied completely in 1 hour by the outlet.

In 1 hour, inlet 1 fills part of work = 1/3

In 1 hour, inlet 2 fills part of work = 1/3.75

In 1 hour, outlet completely empties the tank.

Let the number of hours taken to empty from the time the first inlet was opened be 'd' hours.

Given, the two inlets are opened at 2 pm and 3 pm respectively and the outlet at 4 pm.

∴ Number of hours for which inlet 2 was opened = d – 1 hours.

Number of hours for which outlet was opened be = d – 2 hours

$$\therefore d \times \frac{1}{3} + (d-1) \times \frac{1}{3.75} - (d-2) \times 1 = 0$$

$\Rightarrow d = 4\frac{1}{3}$

⇒ d = 4 hours 20 minutes

61. Given, $x + \frac{1}{x} = 3$

Squaring both sides,

$x^2 + \frac{1}{x^2} + 2 = 9$

$\Rightarrow x^2 + \frac{1}{x^2} = 7$ ------(i)

Now, we know that, $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$

$\Rightarrow x^3 + \frac{1}{x^3} = (x + \frac{1}{x})(x^2 + \frac{1}{x^2} - 1)$

$\Rightarrow x^3 + \frac{1}{x^3} = 3 \times (7 - 1) = 18$ ----(ii)

Now,

$(x^2 + \frac{1}{x^2})(x^3 + \frac{1}{x^3}) = x^5 + \frac{1}{x^5} + x + \frac{1}{x}$

$\Rightarrow x^5 + \frac{1}{x^5} = (x^2 + \frac{1}{x^2})(x^3 + \frac{1}{x^3}) - (x + \frac{1}{x})$

$\Rightarrow x^5 + \frac{1}{x^5} = 7 \times 18 - 3 = 123$

62. The Rs. 50 note and Rs. 10 notes are separately divided into envelopes such that each envelope contains same number of notes. Therefore, the maximum number of notes in each envelope would be the H.C.F of 945 and 2475.

Factors of 945 = 3 × 3 × 3 × 5 × 7

Factors of 2475 = 3 × 3 × 5 × 5 × 11

Hence, H.C.F = 3 × 3 × 5 = 45

Hence, maximum number of notes in each envelope is 45.

Now number of envelopes required for Rs. 50 notes = 945/45 = 21

And number of envelopes required for Rs. 10 notes = 2475/45 = 55

∴ Total (55 + 21 =) 76 envelopes are required.

63. PQ is a tower with Q on the ground. The angle of elevation of P form A is x° such that tan x° = ¾

AQ = 300m

So, tan x° = PQ/AQ = PQ/300

⇒ PQ = ¾ × 300

⇒ PQ = 225

The angle of elevation of P from a nearer point B is y° with BQ = 225 m.

So, tan y° = PQ/BQ = 225/225

⇒ y° = $\tan^{-1}(1)$ = 45°

∴ The value of y° is 45°.

64. We know that,

Area of a triangle = (1/2) × Height × Base

Let,

Height of the triangle = x

And length of side = a

In equilateral triangle, In circle radius is $(1/3)^{th}$ of height.

∴ In centre radius = x/3

In equilateral triangle, Circumcircle radius is 2 times of its In-centre radius.

∴ Circumcircle radius = 2x/3

∵ Area of circle = πr^2 where, r = Radius

According to the question,

$\pi(2x/3)^2 - \pi(x/3)^2 = 44$

⇒ $(22/7)(3x^2/9) = 44$

⇒ $x^2 = 2 \times 7 \times 3 = 42$

⇒ $x = \sqrt{42}$

As, in equilateral triangle height = $(\sqrt{3}/2) \times$ (side)

⇒ $a\frac{\sqrt{3}}{2} = \sqrt{42}$

⇒ $a = 2\sqrt{14}$

∴ Area = $(1/2) \times \sqrt{42} \times 2\sqrt{14} = 14\sqrt{3}$ cm^2

65. The given word is OLIVER. If vowels are arranged in dictionary order, then E will come before I and I will come before O.

There are 6 letters in this word which need to be arranged.

Let's first arrange the vowels. They can be placed in any 3 of the 6 places.

Number of ways of choosing these places = ${}^6C_3$

There's only one way of arranging the vowels in the selected places, and that is the alphabetical order.

Now, the remaining three letters, i.e. L, V and R are to be placed in remaining 3 places. This can be done in 3! Ways.

∴ Total number of possible arrangements = ${}^6C_3 \times 3! = 6 \times 5 \times 4 = 120$

66. Given, vendor purchased 40 dozen bananas for Rs. 300.

Profit% = 25%

30 bananas were rotten.

Thus number of bananas he can sell = 40 × 12 – 30 = 450

Number of dozens he can sell = 450/12 = 37.5

Total selling price of 37.5 dozens = 300 + 25% of 300 = Rs. 375

Thus, selling price per dozen = 375/37.5 = Rs. 10

67. Perimeter of a triangle = sum of length of all sides

Given, sides of a triangle in decreasing order are in the ratio $\frac{1}{3}:\frac{1}{x}:\frac{1}{5}$

Multiplying each by ratio by the LCM of denominators, we get

Ratio of sides of triangle =5x:15:3x

Let the sides be 5xa, 15a and 3xa respectively.

Given, shortest side = 24cm

∴ 3xa = 24

⇒ a = 24/3x = 8/x

Given, perimeter of the triangle is 94cm

∴ 5xa + 15a + 3xa = 94cm

⇒ a(5x+15+3x)=94

$\Rightarrow \frac{8}{x} \times (8x + 15) = 94$

⇒ 64x + 120 = 94x

⇒ 30x = 120

⇒ x = 4

68. Part of work done by 350 workers in 14 days = 2/9

∴ Part of work done by 350 workers in 1 days = 2/(9 × 14) = 1/63

∴ Part of work done by 1 workers in 1 day = 1/(63 × 350) = 1/22050

Part of work remained = 1 – 2/9 = 7/9

Let, Total 'x' numbers of workers are needed to complete the rest work in 35 days.

∴ (1/22050) × x × 35 = 7/9

⇒ x = (22050 × 7)/(35 × 9) = 490

∴ Number of workers employed = 490 – 350 = 140

69. Let the number of sides of each polygon be X_1 and X_2.

For any regular polygon, interior angle, $a = \frac{(X-2)\times 180^\circ}{X}$

Where, X = number of sides of the polygon

Let a_1 and a_2 be the interior angles of the polygon,

Here, given that $a_1 - a_2 = 6^\circ$

$$\therefore \frac{(X_1 - 2) \times 180^\circ}{X_1} - \frac{(X_2 - 2) \times 180^\circ}{X_2} = 6^\circ$$

$$\therefore \frac{(X_1 - 2)}{X_1} - \frac{(X_2 - 2)}{X_2} = \frac{6}{180} = \frac{1}{30}$$

$$\Rightarrow \frac{2}{X_2} - \frac{2}{X_1} = \frac{1}{30}$$

But $X_1/X_2 = 5/4$

$\therefore X_1 = 5n$ and $X_2 = 4n$

$\Rightarrow \frac{2}{4n} - \frac{2}{5n} = \frac{1}{30}$

$\Rightarrow 2/20n = 1/30$

$\Rightarrow n = 3$

So, $X_1 = 5n = 15$ and $X_2 = 4n = 12$

70. Let time taken to reach the station = k minutes.

Then

We have $5 \times (k + 7)/60 = 6 \times (k - 5)/60$

$\Rightarrow 5k + 35 = 6k - 30$

$\Rightarrow 35 + 30 = 6k - 5k$

$\Rightarrow k = 65$

Hence, distance = $5 \times (65 + 7)/60$ mins

$= 5 \times 1.2$

$= 6$ km.

71. $\Rightarrow$ Sum of the population of city 'A' in 2007 and 2010

$= (50 + 50) = 100$ thousands

$\Rightarrow$ Population of the city 'B' in 2006 = 40 thousands

$\therefore$ Required ratio = 100 : 40

= 5 : 2

72. Population of City 'A' in 2007 = 50 thousands,

And, population of city 'A' in 2008 = 60 thousands,

$\Rightarrow$ Increase in population = (60 – 50) = 10 thousands

∴ Required percentage $= \frac{10}{50} \times 100\% = 20\%$

73. ⇒ Population of City 'B' in 2006 = 40 thousand,

⇒ Population of city 'B' in 2010 = 60 thousand,

∴ Increment in population = (60 - 40) = 20 thousands

∴ required percentage $= \frac{20}{40} \times 100\% = 50\%$

74. We know that

$\Rightarrow \{A_E = \frac{S_E}{n_E} or S_E = A_E \times n_E\}$

Where,

SE = sum of entities,

nE = number of entities,

AE = Average of entities.

∴ Required average $= \frac{285}{5}$ thousands = 57 thousands.

75. We know that:

$\Rightarrow \{A_E = \frac{S_E}{n_E} or S_E = A_E \times n_E\}$

Where,

S_E = sum of entities,

n_E = number of entities,

A_E = Average of entities.

∴ Average population of city 'B' in 2006, 2008 and 2009

$= \frac{175}{3} \times 1000,$

And, average population of city 'A' in 2009 and 2010 –

$= \frac{115}{2} \times 1000,$

∴ Required ratio $= \frac{175}{3} \times 1000 : \frac{115}{2} \times 1000$

= 70 : 6

General Awareness

76. Losar festival has begun in Ladakh region of Jammu and Kashmir. It is a ten day festival marking the new year in Ladakh. Losar is a Tibetan word for new year. Following the old tradition, people from Ladakh visit graveyards of ancestor family members and pray for peace for the departed soul.

77. ISKCON's Govardhan village is located in Thane, Maharashtra.On January 20 it was conferred the United Nations award for taking innovative measures of 'sustainable tourism' in country. It is presented at Madrid in Spain First time India has won such recognition from the UN in the NGO sector, an ISKCON release said on Friday.

78. The Prime Minister Shri Narendra Modi has congratulated Mahabodhi International Meditation Centre, Leh Ladakh on Mahakaruna Diwas 2017 celebrations.He said life & teachings of Lord Buddha embody service, compassion and renunciation.

79. Assam government announced a new legislation to deduct the salary of government employees who failed to take care of their elderly parents. Employees working in the government, state PSUs and companies will be expected to take care of their elderly parents and in case of non-compliance, certain portion of the salary of such employees would be deducted to be given to their respective parents.

80. Bhitarkanika national park is located in Odisha. It is the home to the rrawaddy Dolphins. As per a recent report the salt-water estuaries of Bhitarkanika national park and Gahirmatha marine sanctuary in Odisha continue to be a congenial habitat for endangered Irrawaddy dolphins species. The census conducted in the year 2015 had accounted for 58 Irrawaddy dolphins.

81. Sports Minister Vijay Goel on February 5 laid the foundation stone of the Center of Excellence for Para Sports Gandhinagar, Gujarat which will be the first ever

training facility in the country dedicated to para athletes. The Cente is being set up at an estimated budget of over Rs 50 crore and will have world class facilities where para athletes can train for various international competitions.

82. Moon Express has raised $20 million to become the first private entity to travel to the moon, with a planned 2017 voyage. Moon Express is one of 16 teams that have competed for funding as part of Google's Lunar X Prize initiative. USA,China and Russia are the only countries that have landed spacecraft on the moon. Moon Express has said it aims to mine the moon for minerals.

83. India has been world's largest recipient of remittances from abroad since last many years and was the same for 2016 as well. Although, a $1 billion drop from the previous year was recorded which was first such decline since 2009.

84. The National Capital Region is the designation for a conurbation or metropolitan area in India. It encompasses the entire National Capital Territory of Delhi, including New Delhi and urban areas surrounding it in neighboring states of Haryana, Uttar Pradesh and Rajasthan. Delhi and its urban region have been given the special status of National Capital Region (NCR) under the Constitution of India's 69th Amendment Act of 1991.In July 2013, NCR was expanded to include three more districts, Bhiwani, and Mahendragarh in the state of Haryana, as well as Bharatpur in the state of Rajasthan.

85. Mumbai is built on what was once an archipelago of seven islands: Bombay Island, Parel, Mazagaon, Mahim, Colaba, Worli, and Old Woman's Island (also known as Little Colaba). The Portuguese first settled the islands in 1507 and later leased to the Britist in 1668 who ruled it till 1947. Post independence it was a part of Gujarat and became a part of Maharashtra on May 1 1960.

86. The Mullaperiyar Dam is a masonry gravity dam on the Periyar River in Kerala. It is located 881 m above mean sea level,It is a center to a recent dispute between Kerala and Tamil Nadu

87. Terra Rossa is a type of red clay soil produced by the weathering of limestone. It is typically found in regions with a Mediterranean climate

88. The Tropic of cancer and Capricorn both run through the continent of Africa.

89. The Ilbert Bill was introduced in 1883 by the then Viceroy of India, Marquess of Ripon. The bill proposed that the Indian magistrates should be able to put the British offenders to trial on District level, which was not previously allowed. It was named after Courtenay Ilbert who recently appointed legal adviser to the council of ministers.

90. The Indian Statutory Commission was a group of seven British Members of Parliament of United Kingdom that had been dispatched to India in 1928 to study constitutional reform in Britain's most important colonial dependency. It was commonly referred to as the Simon Commission after its chairman, Sir John Simon.

91. In the early 11th century, Mahmud of Ghazni launched seventeen expeditions into South Asia. In 1001, Sultan Mahmud of Ghazni defeated Raja Jayapala of Gandhara in Peshawar and marched further into India in 1005 and made it the center for his forces.

92. Narasimhavarman I was a Tamil king of the Pallava dynasty who ruled South India from 630–668 AD. He completed the work started by Mahendravarman in Mahabalipuram.

93. Article 16 provides for Equality of opportunity in matters of public employment. Article 17 provides for Abolition of Untouchability and Article 18 provides for Abolition of titles.

94. Red blood cells (RBCs), also called erythrocytes, are the most common type of blood cell and the vertebrate organism's principal means of delivering oxygen (O_2) to the body tissues—via blood flow through the circulatory system.

95. In physics, escape velocity is the minimum speed needed for an object to "break free" from the gravitational attraction of a massive body.

96. India-based Neutrino Observatory is a particle physics research project under construction to primarily study atmospheric neutrinos in a 1,300 meters deep cave in Theni (Tamil Nadu).

97. Methane is the chief constituent of Gobar Gas.

98. A constellation is a group of stars that, when seen from Earth, form a pattern. The stars in the sky are divided into 88 constellations.

99. Mantle is a layer between the crust and the outer core. It makes up about 84% of Earth's volume.

100. Chickenpox, SARS and Influenza are all diseases caused by viruses.

Paper – 2

1.	a	2.	a	3.	d	4.	d	5.	c
6.	b	7.	d	8.	c	9.	a	10.	c
11.	d	12.	b	13.	c	14.	a	15.	a
16.	c	17.	b	18.	b	19.	a	20.	c
21.	b	22.	d	23.	a	24.	a	25.	d
26.	b	27.	a	28.	c	29.	a	30.	c
31.	d	32.	c	33.	b	34.	d	35.	c
36.	b	37.	c	38.	a	39.	d	40.	b
41.	c	42.	a	43.	d	44.	b	45.	a
46.	b	47.	a	48.	b	49.	c	50.	b
51.	a	52.	a	53.	c	54.	b	55.	d
56.	a	57.	a	58.	a	59.	c	60.	a
61.	a	62.	d	63.	c	64.	c	65.	a
66.	c	67.	c	68.	b	69.	b	70.	a
71.	c	72.	b	73.	a	74.	d	75.	a
76.	b	77.	b	78.	c	79.	b	80.	d
81.	c	82.	c	83.	c	84.	a	85.	c
86.	c	87.	b	88.	d	89.	a	90.	a
91.	c	92.	d	93.	a	94.	d	95.	c
96.	c	97.	c	98.	d	99.	b	100.	b

Mechanical Paper

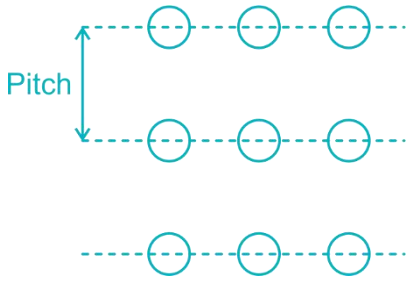
1. The critical temperatures of certain refrigerant is given below

Refrigerant	Critical Temperature
Water	374.15°C
CO_2	31.1°C
Freon 12	112.04°C
Ammonia	133°C

2. Pitch: This is the distance between two centres of the consecutive rivets in a single row.

   Back Pitch: This is the shortest distance between two successive rows in a multiple riveted joint. Diagonal pitch: This is the distance between the centers of rivets in adjacent rows of zigzag riveted joint.

   Margin or marginal pitch: This is the distance between the centre of the rivet hole to the nearest edge of the plate.



3. The requirement of TTT diagram arises because the Fe-C diagram does not provide information about the transformation of austenite to any structure other than equilibrium structures nor does it provides any details about the influence of cooling rates on the formation of different structures.

TTT diagram is more practical diagram. It graphically describes the cooling rate required for the transformation of austenite to pearlite, bainite or martensite. TTT diagram also gives the temperature at which such transformations take place.

4. According to Chvorinov's rule for solidification time (t_s)

$$t_s \propto \left(\frac{V}{A}\right)^2$$

$$t_s = K\left(\frac{V}{S.A}\right)^2 = \frac{\frac{4}{3}\pi r^3}{4\pi r^2} = K\left(\frac{r}{3}\right)^2$$

$$t_s \propto \left(\frac{r}{3}\right)^2$$

$$\frac{t_{s_1}}{t_{s_2}} = \left(\frac{r_1}{r_2}\right)^2 \Rightarrow \frac{10}{t_{s_2}} = \frac{4}{16}$$

$$t_{s_2} = 40\ sec$$

5. $\theta_A = \theta_B$

$$\left(\frac{TL}{GJ}\right)_A = \left(\frac{TL}{GJ}\right)_B$$

$$\frac{T_A}{T_B} = \frac{L}{2L} \times \frac{G_A}{G_B} \times \frac{(2d)^4}{d^4}$$

$$= \frac{1}{2} \times \frac{1}{2} \times 16 = 4$$

6. There are three types of similarities exists between model and prototype.

Geometric Similarity: When the ratio of all corresponding linear dimensions in the model and prototype are equal.

Kinematic Similarity: Kinematic similarity means the similarity of motion between model and prototype. If the ratio of velocity and acceleration at the

corresponding points in the model and at the corresponding points in the prototype are same.

Dynamic Similarity: This similarity exists when the ration of forces between model and prototype are equal.

7. The Benson boiler is a water tube boiler, works on the basic principle of critical pressure of water. The critical pressure is the pressure at which the liquid and gas phase are at equilibrium. The water enters in the boiler at just above the critical pressure so it suddenly convert into steam without generating air bubbles. No air water separator drum is required. It also takes less fuel to generate steam.

8. For an ideal gas

dH = m C_P dT

$$\int dH = \int_{300}^{400} 0.9 + (2.7 \times 10^{-4}) T \, dT$$

$$= 0.9T + (2.7 \times 10^{4}) \frac{T^2}{2}\Big|_{300}^{400}$$

= 99.45 kJ/kg

9. Diameter of best size wire $D_b = \frac{P}{2} \sec \frac{\alpha}{2}$

Where P is the pitch and α is the thread angle.

$$D_b = \frac{2.5 \sec 30}{2} = 1.44\ mm$$

10. A cash discount is an incentive that a seller offers to a buyer in return for paying a bill at the time of purchasing or before the schedule date of payment. The

buyer often refers to the same discount as a purchase discount. The cash discount is also known as an early payment discount.

11. $16 \times 50 = B_1 \times 40 + B_2 \times 60$

$\Rightarrow 4B_1 + 6B_2 = 80$

$B_1 \times 40 \times 50 = B_2 \times 60 \times 75$

$\Rightarrow B_2 = 0.44B_1$

Now, $6.667B_1 = 80$

$\Rightarrow B_1 = 12$ kg

12. Advantages of Powder Metallurgy

- Good tolerances and surface finish
- Highly complex shapes made quickly
- Can produce porous parts and hard to manufacture materials (e.g. cemented oxides)
- Pores in the metal can be filled with other materials/metals
- Surfaces can have high wear resistance
- Porosity can be controlled
- Low waste
- Automation is easy
- Physical properties can be controlled
- Variation from part to part is low
- Hard to machine metals can be used easily
- No molten metals
- No need for many/any finishing operations
- Permits high volume production of complex shapes
- Allows non-traditional alloy combinations

- Good control of final density

Disadvantages of Powder Metallurgy

- Metal powders deteriorate quickly when stored improperly
- In powder metallurgy, equipment cost is very-very high this is the reason powder metallurgy is justified only for mass production.
- Part size is limited by the press, and compression of the powder used
- Sharp corners and varying thickness can be hard to produce
- Non-moldable features are impossible to produce

13. PV = mRT m = PV/RT

$$R = \frac{8314}{Mol.Wt} = \frac{8314}{32} = 259.8 \frac{J}{mol.K}$$

$$m = \frac{10^5 \times 1}{259.8 \times (47+273)} = 1.2\ kg$$

14. $\frac{W(L-x)^2}{L^2} = \frac{WL(L-x)[2x-(L-x)]}{L^2}$

$x^2 + 2L - L^2 = 0$

$$X = \frac{L}{\sqrt{2}+1}$$

15. Streamlines are a family of curves that are instantaneously tangent to the velocity vector of the flow. These show the direction in which a massless fluid element will travel at any point in time

Streaklines are the loci of points of all the fluid particles that have passed continuously through a particular spatial point in the past. Dye steadily injected into the fluid at a fixed point extends along a streakline.

Pathlines are the trajectories that individual fluid particles follow. These can be thought of as "recording" the path of a fluid element in the flow over a certain period. The direction the path taken will be determined by the streamlines of the fluid at each moment in time.

For steady flow, path lines, streamlines and streak lines coincides.

16. Grades of Tolerance: Grade is an indication of the level of accuracy.

IT01 to IT4 - For production of gauges, plug gauges, measuring instruments

IT5 to IT 7 - For fits in precision engineering applications

IT8 to IT11 – For General Engineering

IT12 to IT14 – For Sheet metal working or press working

IT15 to IT16 – For processes like casting, general cutting

IT 6 = 10 i

IT 7 = 16 i

IT 8 = 25 i

Here i is the standard tolerance unit or Fundamental tolerance unit

$i = 0.45\sqrt[3]{D} + 0.001D \quad \text{in } \mu\text{m}$

D = D_1 x D_2 (D_1 and D_2 are the nominal sizes marking the beginning and the end of a range of sizes, in mm)

17. Heat rejection factor = $1.2 = \frac{Q_{Rejected}}{RE}$

Refrigeration capacity = 2100 kJ/min

$Q_{Rejected}$ = 1.2 × 2100 = 2520 kJ/min

$$COP = \frac{RE}{W_{in}}$$

W_{in} = 2520 – 2100 = 420 kJ/min

$$COP = \frac{2100}{420} = 5$$

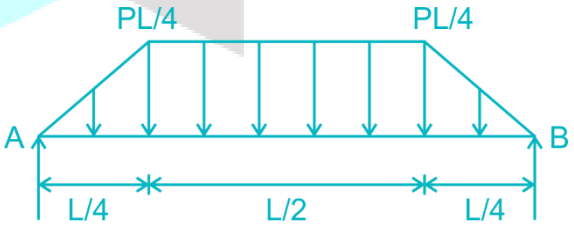
Shortcut Method:

$$\boldsymbol{HRR = 1 + \frac{1}{COP}}$$

18. If DC is used and the work piece is positive (the anode of the circuit) and electrode is negative (cathode). This condition is known as straight polarity (SPDC).

If work piece is negative and electrode is positive then this condition is known as reverse polarity (RPDC).

19. M/EI diagram for the beam is



Taking moment about point B

$$R_A \times L = \frac{1}{2} \times \frac{L}{4} \times \frac{PL}{4} \times \left[\frac{L}{3} \times \frac{L}{4} + \frac{3L}{4}\right] + \frac{PL}{4} \times \frac{L}{2} \times \left[\frac{L}{4} + \frac{L}{4}\right] + \frac{1}{2} \times \frac{L}{4} \times \frac{PL}{4}\left[\frac{2L}{3} \times \frac{L}{4}\right]$$

$$R_A L \Rightarrow \frac{3}{32}\frac{PL^3}{EI}$$

$$R_A = \frac{3}{32}\frac{PL^2}{EI}$$

Hence, shear force in conjugate beam = slope in real beam = $\frac{3}{32}\frac{PL^2}{EI}$

20. $\eta_{maximum} = \cos^2\alpha = (\cos 30^\circ)^2 = 0.75$

21. As both fluids are air only so heat capacity of both is equal.

Number of transfer units, $NTU = \frac{U.A}{C_{min}} = \frac{60\times25}{1000} = 1.5$

Now effectiveness for the counter flow heat exchanger with same heat capacity

$\epsilon = \frac{NTU}{NTU+1} = \frac{1.5}{2.5} = 0.6$

22. For Watt's governor

The height (h) of governor is given by

$h = \frac{895}{N^2}$

N = RPM $N^2 = \frac{895}{0.2}$

$N = \sqrt{4475} = 66.89$

$\omega = \frac{2\pi N}{60} = \frac{2\pi\times66.89}{60} = 7\frac{rad}{s}$

23. For Uniform pressure theory

$r_m = \frac{2}{3}\left[\frac{r_0^3-r_1^3}{r_0^2-r_1^2}\right] = \frac{2}{3}\left[\frac{100^3-50^3}{100^2-50^2}\right] = 77.77$

For Uniform wear theory the mean radius of friction surface is given as

$r_m = \frac{r_o + r_i}{2}$

24. $T_E = 22$

$\sqrt{\frac{T_P - T_o}{6}} = \sigma = \sqrt{16}$

$T_p - T_0 = 24$ _____1)

Now, $T_E = \frac{T_0 + T_p + 4T_m}{6}$

$22 = \frac{T_o + T_p + 4\times 23}{6}$

$T_0 + T_p = 40$ _____ 2)

Hence, from 1) and 2),

$T_p = 32, T_o = 8$

$\frac{T_p}{T_o} = \frac{32}{8} = 4$

25. Normal reaction N = 200 + P sin 30° = 200 + 0.5 P

$F = \mu N = 0.25\ (200 + 0.5\ P) = 50 + 0.125\ P$

For block to slide,

P cos30° > 50 + 0.125 P

0.866 P – 0.125 P > 50

$P > \frac{50}{0.741} > 67.5N$

26. A venturimeter is a device used for measuring the rate of flow of a fluid flowing through a pipe. The venturimeter always have smaller convergent portion and larger divergent portion. This is done to ensure a rapid converging passage and a gradual diverging passage in the direction of flow to avoid the loss of energy due to separation. In course of a flow through the converging part, the velocity increases

in the direction of flow according to the principle of continuity, while the pressure decreases according to Bernoulli's theorem.

The velocity reaches its maximum value and pressure reaches its minimum value at the throat. Subsequently, a decrease in the velocity and an increase in the pressure take place in course of flow through the divergent part

Angle of convergence $\approx 20^{\circ}$

Angle of divergence = 6° - 7° → It should be not greater than 7° to avoid flow separation.

27. In reverted gear train, first and last gear is on the same axis. Such an arrangement has application on speed reducers, clocks and machine tools.

28. The diamond shape is a critical feature that helps with machining inaccuracies and smoother locating operation. When two round head pins are installed onto one plate, the distance between two mounting holes must be extremely precise and even then, the work piece will not be placed on the base as easily as it would with the use of a diamond shape pin. Diamond pin location is used in fixture because it takes care of any variation in center distance between two holes.

29. Isolated system does not exchange mass and energy from the surrounding. But a chemical reaction can take place within the system with no exchange of mass and energy with surrounding. So out of given options a is correct.

30. $E = 3K(1-2\nu)$

$$K = \frac{E}{3(1-2\nu)} = \frac{1000}{3\times 0.5} = 666.67\ GPa$$

31. For triangular weir or notch,

$$\frac{dQ}{Q} = \frac{5}{2}\frac{dH}{H} = 2.5 \times 6 = 15\%$$

32. Octane number of natural gas is around 110 which makes it a very good SI engine fuel. Because of this high octane number the flame speed is higher and engine can operate with high compression ratio.

33. $\frac{V_s+V_c}{V_c} = 8.7 \ \therefore \frac{V_s}{V_c} = 7.7$

Now total displaced volume for three cylinders is 770 cc. So for one cylinder the $V_S = 770/3$ cc

$$\frac{770}{3V_c} = 7.7 \Rightarrow V_c = 33.33\ cc$$

34. MRP stands for material requirement planning. It is a computer based system that takes master production schedule (MPS) to explode it into required amount of raw materials, parts, sub-assemblies, and assemblies needed in each of the planning horizon, and then reducing these material requirements to account for materials that are in inventory or on order and finally developing a schedule of order for purchased materials and produced parts over the planning horizon.

35. Δ_1 = 1 Deflection due to self-weight of $AB = \frac{\gamma L^2}{2E}$

Δ_2 = Deflection due to self-weight of $BC = \frac{\gamma L^2}{2E}$

Δ_3 = Deflection of BC due to weight of $AB = \frac{\gamma \times \frac{\pi}{4}D^2 \times L \times L}{\frac{\pi}{4}(2D)^2 \times E} = \frac{\gamma L^2}{4E}$

Total deflection = $\Delta_1 + \Delta_2 + \Delta_3 = \frac{5}{4}\frac{\gamma L^2}{E}$

36. Boundary layer separation occurs at adverse pressure gradient

i.e. $\frac{dP}{dx} > 0 \; and \; \frac{du}{dy} = 0$

When the pressure goes on increasing in the direction of flow, the pressure force acts against the direction of direction of flow in the boundary layer and hence thickens the boundary layer more rapidly. The boundary shear bring the fluid in the boundary layer to rest and causes back flow. Due to this the boundary layer no more sticks to the boundary but is shifted away from the boundary. This phenomenon is called as "Boundary layer separation".

37. The triple point of water has a unique value of 273.16 K. At particular value of volume and pressure the triple point of water is always 273.16 K. The melting point of ice and boiling point of water do not have particular values because these points depend on pressure and temperature

38. For fine wire, the material is passed through a number of dies, receiving successive reductions in diameter, before being coiled and this is known as Tandem Drawing. Tandem drawing of wires and tubes is necessary because it is not possible to reduce at one stage.

39. The percentage utilization of labor on the assembly line is the average of utilization of time at all 6 stations.

$\therefore$ % utilization $= \frac{1}{6}\left[\frac{7}{9} + \frac{7}{9} + \frac{8}{9} + \frac{7}{9} + \frac{8}{9} + \frac{6}{9}\right]$

= 0.7962 or 79.62%

40. Block will topple about point D.

Taking $\sum M_C = 0$

$mg \times \frac{a}{2} - P\sqrt{2}a = 0$

$P = \frac{mg}{2\sqrt{2}}$

41. A venturimeter is a device which is used for measuring the rate of flow of fluid through a pipe. The basic principle on which a venture meter works in that by reducing the cross-sectional area of the flow passage, a pressure difference is created and the measurement of the pressure difference enables the determination of the discharge through the pipe.

42. Volumetric efficiency is given by

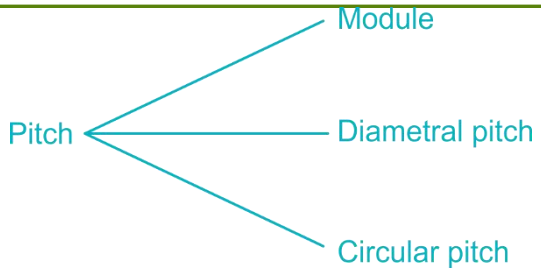
$\eta_v = 1 + c - c\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}}$

Where, c = Clearance ratio

$\frac{P_2}{P_1} = Pressure\ ratio$

As clearance ratio increases, volumetric efficiency of reciprocating compressor decreases as pressure ratio increases.

43. Size of gear is specified by its pitch and pitch can be classified as



Circular Pitch: It is the distance measured along the circumference of the pitch circle from a point on one tooth to the corresponding point on the adjacent tooth.

$$p = \frac{\pi d}{T}$$

Diametral Pitch: It is the number of teeth per unit length of the pitch circle diameter in inches.

$$p = \frac{T}{d}$$

Module (m): It is the ratio of the pitch diameter in mm to the number of teeth.

$$m = \frac{d}{T}$$

Hence circular pitch, diametral pitch and module represents size of gear.

44. Since black body is perfect absorber of radiation hence absorptivity of black body $\alpha = 1$.

$\alpha + \tau + \rho = 1$ so for black body $\tau = \rho = 0$.

White body : $\rho = 1$ so $\tau = \alpha = 0$

Transparent body : $\tau = 1$ so $\alpha = \rho = 0$

Opaque body : $\tau = 0$

45. Maximum reduction in rolling is given as $\Delta h = \mu^2 R$ (for unaided entry)

$$\Rightarrow \mu = \sqrt{\frac{\Delta h}{R}} = \sqrt{\frac{(30-15)}{150}}$$

$= 0.316 \simeq 0.35$

46. (Point function) = (Integrating factor) × (Path function)

Quasi-static work,

$$dW = P\,dV$$

$$dV = \frac{1}{P}dW$$

An inexact different dW when multiplied by an integrating factor 1/P becomes an exact differential dV.

47. Sinking fund factor is typically used to determine how much must be set aside each period in order to meet a future monetary obligations.

Sinking fund factor $= \frac{r}{(1+r)^n - 1}$

r = rate of interest

n = no. of years

48. Critical pressure ratio

$$\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$$

For superheated steam

n = 1.3

$$\frac{P_2}{P_1} = \left(\frac{2}{2.3}\right)^{\frac{1.3}{0.3}} = 0.546$$

49. Dieseling is the phenomenon in which an SI engine sometimes continues to run for a very small period even after the ignition is switched off. Dieseling may take place due to following reasons:

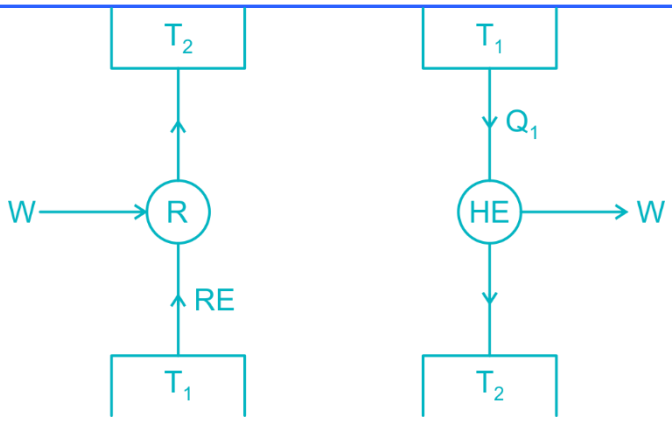
- Engine overheating
- Too high spark plug heat range
- High engine idling speed
- Oil entry into the cylinder
- Increase in compression ratio due to carbon deposits
- Incorrect adjustment of idle fuel-air mixture
- Sticking of throttle
- Requirement of tune up of engine

50. Riser provides metal during the liquid shrinkage and shrinkage during phase change. The solid shrinkage is compensated by providing allowance on the pattern.

Hence volume of metal compensated by the riser is 3 + 4 = 7% of volume of metal compensation from the riser.

51. $\eta_{thermal} = 0.4$

$(COP)_{ref} = 5$



For heat engine

$0.4 = \frac{W}{Q_1}$

For refrigerator

$COP = \frac{\text{Refrigerating Effect}}{\text{Work Input}}$

$5 = \frac{RE}{W}$

If RE = 1 kJ

$W = \frac{1}{5} kJ = 0.2\ kJ$

$Q_1 = \frac{W}{0.4} = \frac{0.2}{0.4} = 0.5\ kJ$

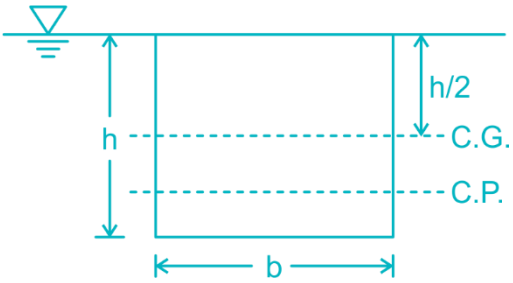
52. Slope at B = 0

Hence, point B will act as fixed.

$\frac{wL^2}{12} = wa^2$

$a = \frac{L}{\sqrt{6}}$

53. $C.P. = \bar{x} + \frac{I_G}{A\bar{x}}$



$C.P. = \frac{h}{2} + \frac{b \times h^3}{12 \times b \times h \times \frac{h}{2}}$

$= \frac{h}{2} + \frac{h}{6} = \frac{2h}{3}$

54. Extrusion Ratio is the ratio of the cross-sectional area of the billet to the cross sectional area of the product.

Extrusion ratio $R = \frac{A_i}{A_f} = 20$

$\%$ reduction $= \frac{A_i - A_f}{A_i} = 1 - \frac{A_f}{A_i}$

$= \left(1 - \frac{1}{20}\right) \times 100 = 95\%$

55. $BEP = \frac{Fixed\ cost}{Selling\ price - Variance\ cost}$

$= \frac{800000}{200-40} = 5000\ units$

56. In impregnation component is kept in an oil bath. The oil penetrates into the voids by capillary forces and remains there. The oil is used for lubrication of the component when necessary. During the actual service conditions, the oil is released slowly to provide the necessary lubrication. The components can absorb

between 12% and 30% oil by volume. It is being used on P/M self-lubricating bearing and bushing components for self-lubrication.

57. How effectively a fin can enhance heat transfer is characterized by the fin effectiveness, ε, which is the ratio of fin heat transfer and the heat transfer without the fin. Effectiveness of the fin is given by

$\varepsilon_{fin} = \sqrt{\left(\frac{KP}{hA}\right)}$

Hence, $\varepsilon_{fin}\ \alpha \frac{1}{h}$

Since $h_{forced\ conv} > h_{free\ conv}$

Hence, Effectiveness of the fin will be more in free convection than forced convection.

58. The efficiency of the Carnot engine is given as follows

$\eta = 1 - \frac{T_{sink}}{T_{source}}$

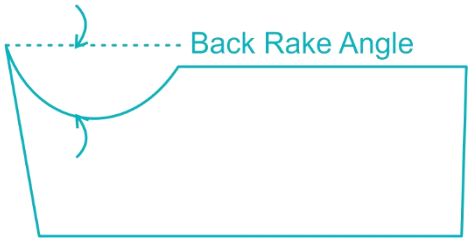
$\therefore T_{source} \uparrow and \left(\frac{T_{sink}}{T_{source}}\right) \downarrow \quad \therefore \eta\uparrow$

59. The tool life exponent for different tool materials is given below

Tool material	Cutting speed (m/min)	n
Carbon steel	5	0.08-0.1
High speed steel	30	0.1 to 0.25

Cemented carbide	150	0.25 to 0.45
Coated carbide	350	
Ceramic	600	0.5 to 0.7

60. The angle between the face of the tool and the plane parallel to the base of the cutting tool is called back rake angle



61. $EOQ = \sqrt{\frac{2DC_O}{C_h}}$

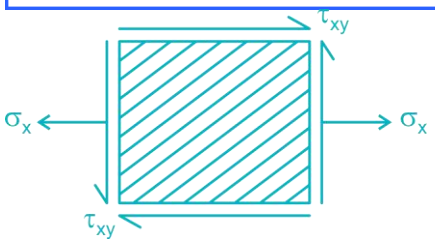
$(EOQ)_1 \propto \sqrt{\frac{DC_O}{C_h}}$

If carrying cost, ordering cost and demand is doubled

Then $(EOQ)_2 \propto \sqrt{\frac{2D \times 2C_O}{2C_h}}$

$(EOQ)_2 = \sqrt{2}(EOQ)_1$

62. $\sigma_1/\sigma_2 = \frac{\sigma_x+0}{2} \pm \sqrt{\left(\frac{\sigma_x-0}{2}\right) + \tau_{xy}^2}$



$$= \frac{\sigma_x}{2} \pm \frac{1}{2}\sqrt{\sigma_x^2 + 4\tau_{xy}^2}$$

$$\tau_{max} = \frac{1}{2}\sqrt{\sigma_x^2 + 4\tau_{xy}^2}$$

63. At vena-contracta velocity of fluid is maximum. At stagnation point velocity is zero and all kinetic energy is converted to pressure energy.

64. For a laminar flow between parallel plates:

$$V_{max} = \frac{B^2}{8u}\left(\frac{-\partial P}{\partial x}\right)$$

$$V_{avg} = \frac{B^2}{12u}\left(\frac{-\partial P}{\partial x}\right)$$

$$\Rightarrow \frac{V_{max}}{V_{avg}} = \frac{3}{2}$$

65. Reference is always taken from atmospheric pressure. Barometer measures the atmospheric pressure so absolute pressure = 700 – 380 = 320 mm of Hg vacuum.

66. Moisture content in the mixture

$$= \frac{1\times0.004+(3\times0.0051)}{3+1}$$

= 0.0048 Kg/kg of moisture in saturated air of mixture

Specific humidity of saturated air = 0.01 kg/kg of air

Degree of saturation $= \frac{0.0048}{0.01} \times 100 = 48\%$

67. In case of unsteady state conduction

$\frac{T-T_\infty}{T_i-T_\infty} = e^{-Bi.Fo}$

Where, Bi = Biot number

Fo = Fourier number

68. Bearing Pressure $P = \frac{F}{LD} = \frac{150\times10^3}{300\times500} = 1\frac{N}{mm^2} = 1\ MPa$

69. Coordination number of an atom in a molecule or crystal is the number of its near neighbors.

Crystal Structure	Coordination No.
Simple cubic	6
BCC	8
FCC, HCP	12

70. The flow time for the jobs is given below

Jobs (in order of arrival)	Processing time (days)	Due date (days hence)	Flow time (days)	Tardiness

D	3	5	3	0
A	4	7	7	0
E	5	8	12	4
B	7	4	19	15
C	8	11	27	16

So number of jobs delayed are 3 i.e. job E, B and C.

71. Esteem Value: The properties, features or attractiveness of an object makes its ownership desirable.

Use Value: The properties or qualities which accomplish a use, work or service.

Cost Value: The sum of labour, material and other cost required to produce the object (also called as Economic value).

Exchange Value: The properties or qualities of an object that make it possible to exchange it for something else that one wants.

72. On-off control is done by thermostat. In the On-off control of the air-handling unit, the fan motor is operated intermittently by the room thermostat the bulb of which is installed in the return air.

A thermostatic expansion valve maintains a constant degree of superheat at the exit of evaporator, hence it is most effective for dry evaporators in preventing the slugging of the compressors since it does not allow the liquid refrigerant to enter the compressor

73. The ratio of maximum displacement of forced vibration to the deflection due to the static force (F) is known as Magnification factor

$$MF = \frac{1}{\sqrt{\left(1-\frac{\omega^2}{\omega_n^2}\right)^2 + \left(\frac{2\zeta\omega}{\omega_n}\right)^2}}$$

74. Taylor equation for tool life is $VT^n = C$

$VT^{0.5} = 400$

$\therefore V_1T_1^{0.5} = V_2T_2^{0.5}$

$\therefore \left(\frac{T_2}{T_1}\right)^{0.5} = \frac{V_1}{V_2} = 2$

$\Rightarrow \frac{T_2}{T_1} = 4$

The tool-life change is

$\frac{T_2-T_1}{T_1} = \frac{T_2}{T_1} - 1 = 3\ or\ 300\%$

75. $PV = \frac{FV}{(1+r)^n}$

Where, FV = Future value

r = rate of interest

n = no. of years

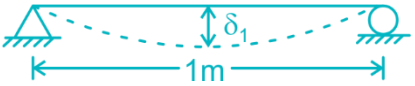
$$PV = \frac{1000}{\left(1+\frac{4.5}{100}\right)^2} = Rs.9157$$

76. Techniques of PMTS are:

1. Method Time Measurement (MTM)
2. Work Factor System (WFS)
3. Basic Motion Time Study (BMTS)

77. $\delta_1 = \frac{wL^3}{48EI} = 1cm$ {w = 960 kg} _____1)

When column is pinned, Leff. = L = 2m



$Peritical = \frac{\pi^2 EI}{2^2} \Rightarrow \frac{\pi^2 EI}{4}$ _____2)

From 1), $EI = \frac{960 \times 1^3}{48 \times 10^{-2}} = 2000$

Hence, $P_{critical} = \frac{\pi^2}{4} \times 2000 \Rightarrow 500\pi^2\ kg$

78. In turbulent flow shear stress at distance y from pipe boundary

$\tau = \tau_0 \left(1 - \frac{y}{R}\right)$

$\tau = T_0/3$

$\frac{\tau_0}{3} = \tau_0 \left(1 - \frac{y}{R}\right)$

$\Rightarrow y = \frac{2}{3}R$

79. Cupola has been the most widely used furnace for melting cast iron i.e. Ferrous metals. The Input to Cupola is Pig Iron which is obtained from blast furnace. In hot blast cupola, the flue gases are used to preheat the air blast to the cupola so that the temperature in the furnace is considerably higher than that in a conventional cupola. Coke is fuel and Lime stone ($CaCO_3$) is mostly used flux. Main disadvantages of cupola is that it is not possible to produce iron below 2.8% carbon.

Product of various furnaces are as followed

Puddling Furnace- Wrought Iron

Bessemer Convertor- Steel

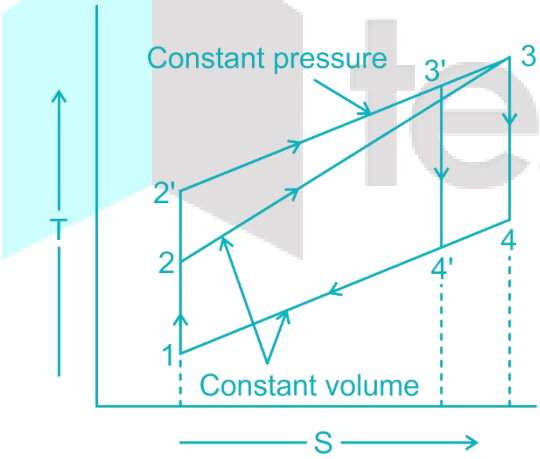
Electrical Furnace- Special Steels

Blast Furnace- Pig Iron

80. Saddle key is a key that fits in the key way of the hub only. In this case there is no keyway provided on the shaft and friction between shaft, key and hub prevents relative motion between the shaft and the hub and power is transmitted by means of friction only.

81. Otto cycle ⇒ 1-2-3-4

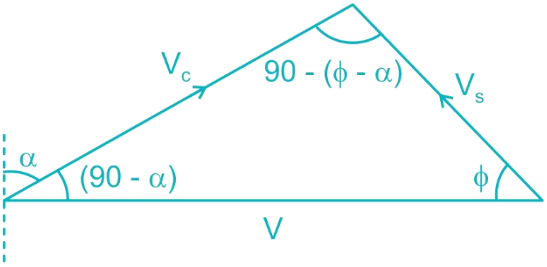
Diesel cycle 1-2'-3'-4'



It is clear from T-s diagram that the heat rejected by the Diesel cycle (area below 4'-1) is less than the heat rejection by the Otto cycle (area below 4-1); hence the diesel cycle is more efficient than Otto cycle for the condition of same maximum pressure heat input. The dual cycle efficiency lies between the Otto and Diesel cycle.

82. In any Cam follower design the jerk must be finite across the entire interval. In cycloidal motion there are no abrupt changes in the velocity and acceleration at any stage of the motion. Thus in this type there are least jerks and this is most ideal motion for high speed follower motion.

83. In an orthogonal cutting the velocity triangle is given as



Applying the sine law

$$\frac{V_c}{sin\phi} = \frac{V}{\sin[90-(\phi-\alpha)]}$$

$$V_c = \frac{Vsin\,\phi}{\cos(\phi-\alpha)} = \frac{35\sin 45°}{\cos(45°-15°)}$$

$$V_c = \frac{35\times 0.707}{0.866} = 28.57\frac{m}{min}$$

84. In Electrochemical Machining (ECM) material is removed by electrolysis process and between the tool and work piece medium is electrolyte. NaCI or NaCIO is commonly used electrolyte.

Prime requirements EDM tool Material

1. It should be electrically conductive.

2. It should have good machinability, thus allowing easy manufacture of complex shapes.

3. It should have low erosion rate or good work to tool wear ratio.

4. It should have low electrical resistance.

5. It should have high melting point.

6. It should have high electron emission

The usual choices for tool (electrode) materials are

Copper, brass, alloys of zinc and tin, hardened plain carbon steel, copper tungsten, silver tungsten, tungsten carbide, copper graphite and graphite etc.

85. Standardization is done to make interchangeable manufacturing possible. By the Standardization it is possible to simplify the manufacturing process. The various parts of the assembly can be made in different plants and then assembling is done at one place.

86. Centre distance between the shaft = 75 mm (Given)

Hence $\frac{D_1+D_2}{2} = 75$

$D_1 + D_2 = 150$

Also, $D_1 = 2D_2$ (As the output shaft rotates at 50 % of the speed of input shaft so the diameter of output shaft is half of the input shaft)

$3\ D_2 = 150$; $D_2 = 50$ mm

$D_1 = 100$ mm

87. ferrite (α) – an interstitial solid solution of carbon in Iron having BCC structure

Austenite (γ) is an interstitial solid solution of carbon in Fe having FCC structure.

88. $Brake\ power = \frac{2\pi NT}{60\times1000} = \frac{2\times\pi\times1800\times8}{60\times1000} = 1.508\ kW$

Friction power = Indicated Power – Brake Power = 1.8 - 1.508 = 0.292

$\text{Percentage loss} = \frac{0.292}{1.8} \times 100 = 16.22\%$

89. $AOQ = \frac{3}{100} \times 0.97$

= 0.0291

90. $I_{AB} = \frac{bh^3}{12}$

$I_{EF} = I_{XX} + A(y^2)$

$= \frac{bh^3}{36} + \frac{bh}{2}\left(\frac{2h}{3}\right)^2 = \frac{bh^3}{4}$

$\frac{I_{AB}}{I_{EF}} = 3$

91. $\frac{dp}{dx} = \frac{d\tau}{dy}$ is valid for a steady uniform laminar flow.

92. Heat generated $H = I^2 R t$

Where I is the current supply

R is the resistance

t is the time for which the current is supplied

$H = (5500)^2 \times 250 \times 10^{-6} \times 0.15$

= 1134 J

93. Given, λ = 4 per hour

μ = 4 per hour

Traffic intensity $\rho = \frac{\mu}{\lambda} = \frac{4}{4} = 1$

We know that,

$\sum_{n=10}^{10} P_n = 1$

∴ $P_0 + P_1 + P_3 + \ldots + P_{10} = 1$

$P_0 + \rho P_0 + \rho^2 P_0 + \rho^3 P_0 + \ldots + \rho^{10} P_0 = 1$

$P_0(1 + \rho + \rho^2 + \ldots. + \rho^{10}) = 1$

$P_0(1 + 1 + \ldots. + 1) = 1$

$P_0 = \frac{1}{11}$

Probability that a person who comes in leaves without joining the queue i.e.

$P_{11} = \rho^{11} P_0 = (1)^{11} \times \frac{1}{11} = \frac{1}{11}$

94. Shear failure of cotter joint

$2 \times t \times b \times \tau_s = F$

$2 \times 12 \times 50 \times \tau_s = 60 \times 10^3$

$\tau_s = \frac{60 \times 1000}{2 \times 12 \times 50} = 5 \times 10$

= 50 N/mm^2

95. Reaming removes a small amount of material from the surface of holes. It is done for two purposes:

1. To bring holes to a more exact size

2. To improve the finish of an existing hole

96. $F_n = F_{n-1} + \alpha(D_{n-1} - F_{n-1})$

F_n = current month forecast

$F_n - 1$ = last month forecast

$D_n - 1$ = last month demand

α = smoothening constant

$F_n = 10275 + 0.25(12000 - 10275)$

$F_n = 10706.25$

97. Heat dissipation is maximum when the radius is equal to the critical radius of insulation.

$(r_{cr})_{Sphere} = \frac{2K}{h}$

$(r_{cr})_{cylinder} = \frac{K}{h}$

Where k is the thermal conductivity of the material and h is the outside fluid convection coefficient.

Hence, $(r_{cr})_{Sp} = (r_{cr})_{Cy} \times 2$

$(r_{cr})_{Sp} = 2 \times 16 = 32mm$

So the diameter is 64 mm

98. We know that coefficient of fluctuation of speed (C_1) is

$$C_1 = \frac{(\omega_{max} - \omega_{min})}{\omega_{mean}}$$

$$C_1 = \frac{(\omega_{max} - \omega_{min})}{\left(\frac{\omega_{max} + \omega_{min}}{2}\right)}$$

Or, $C_1 \omega_{max} + C_1 \omega_{min} = 2\omega_{max} - 2\omega_{min}$

$$\therefore \frac{\omega_{max}}{\omega_{min}} = \frac{2 + C_1}{2 - C_1}$$

99. $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$

$$\sigma = \frac{Ey}{R} = \frac{2 \times 10^3 t}{1000} \times 1 = 2t/cm^2$$

100. $\frac{v}{V} = \left(\frac{y}{\delta}\right)^{1/m}$

Given m = 5

$$\frac{\delta^*}{\delta} = \frac{1}{(m+1)}$$

and $\frac{\theta}{\delta} = \frac{m}{(m+1)(m+2)}$

δ is boundary layer thickness

δ^* is displacement thickness

θ is momentum thickness

Shape factor,

$$H = \frac{\delta^*}{\theta} = \left(\frac{m+2}{m}\right)$$

For $m = 5, \frac{\delta^*}{\delta} = \frac{1}{(5+1)} = \frac{1}{6}$

Here is the CIL ME Model Question Paper for this Answer Key:

Model Question Paper Coal India Limited (ME) 2017