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SPARDHA 2017-18

ALMA FIESTA 2018

11-12

Indian Institute of Technology, Bhubaneswar

NAME:

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CLASS:

Contact Info:

SCHOOL NAME:

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Email - ID (if available):

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INSTRUCTIONS

- Write your name, class and school name in the space provided above.
- Test will be of **1 hour**.
- Use only **black ball-point pen** to choose answers.
- Darken the circle in the OMR to select your answer. Do NOT circle, highlight, tick, etc. Answers chosen with anything else will not be considered for mark evaluation.
- **2 marks will be awarded** for a correct answer and **1 will be deducted** for an incorrect answer.
- No marks will be awarded for questions left unanswered.
- Rough work should **strictly** be done on the last page provided. Marks will be deducted for scribbling rough work on papers with questions on it.
- Calculators and other electronic gadgets are **strictly not allowed** inside the examination hall. If found with any such device, the candidate will be **immediately disqualified**.
- Candidates are advised to bring pencil, eraser, pen and school ID card (if available).

ALL THE BEST

MATHEMATICS

1. The perpendicular from origin to the tangent at any point on a curve is equal to the abscissa of the point of contact. If the curve passes through the point (1, 2), then it also passes through

- (A) (1, -2) (B) (1, 3) (C) (2, 3) (D) (-2, 1)

2. The number of ordered triplets of positive integers which are solutions of the equation $x + y + z = 100$ is:

- (A) 3125 (B) 508 (C) 6005 (D) 4851

3. Minimum distance between the curve $y^2 = 4x$ and $x^2 + y^2 - 12x + 31 = 0$ is equal to

- (A) $\sqrt{21}$ (B) $\sqrt{26} - \sqrt{5}$ (C) $\sqrt{21} - \sqrt{5}$ (D) $\sqrt{28} - \sqrt{5}$

4. Let us define: For $n, m \in \mathbb{N}$,

$F(n)$ = the sum of all terms of a GP with first term $(1+x)^n$, with common ratio $(1+x)/2$, and the number of terms = $n+1$. Now the coefficient of x^n in $F(n)$ is:

- (A) 2^n (B) $2^{(n+1)}$ (C) $2^{(2n)}$ (D) $2^{(2n+1)}$

5. If the equation of pair of direct common tangent to the circles $(x + 2)^2 + y^2 = 1$ and $(x - 4)^2 + y^2 = 9$ is given by $x^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$. Then $b^2 - c$ is equal to

- (A) 39 (B) 93 (C) 36 (D) 35

6. For what real values of p does the equation $(p^2-16)x^2 - (4+5p+p^2)x - p^3-4p^2-4p-16=0$ have more than two solutions?

- (A) None (B) 4, -4 (C) -4 (D) 4, -4, -1

7. On an $(n \times n)$ square grid, two vertices are chosen at random and a segment is drawn connecting them. As n tends to infinity, what is the probability that the segment does not cross any vertices of this graph besides the two chosen ones?

- (A) 0.433 (B) 0.542 (C) 0.641 (D) 0.607

8. In triangle ABC, let AD, BE and CF be the internal angle bisectors with D, E and F on the sides BC, CA and AB respectively. Suppose AD, BE and CF concur at I and B, D, I, F are concyclic, then angle $\angle IFD$ has measure:

- (A) 15° (B) 30° (C) 45° (D) any value $\leq 90^\circ$

9. Consider n^2 -unit squares in the xy -plane centred at point (i, j) with integer coordinates, $1 \leq i \leq n$, $1 \leq j \leq n$. It is required to colour each unit square in such a way that whenever $1 \leq i < j \leq n$ and $1 \leq k < l \leq n$, the three squares with centres at (i, k) , (j, k) , (j, l) have distinct colours. What is the least possible number of colours needed?

- (A) $2n$ (B) $2n+1$ (C) $2n-1$ (D) NONE

10. If A and B are square matrices of size $n \times n$ such that $A^2 - B^2 = (A - B)(A + B)$, then which of the following will be always true?

- (A) $A = B$ (B) $AB = BA$
 (C) either of A or B is a zero matrix (D) either A or B is an identity matrix

11. If $A = \cos(\cos x) + \sin(\cos x)$, then least and greatest value of A are

- (A) 0 and 2 (B) -1 and 1 (C) $-2^{1/2}$ and $2^{1/2}$ (D) 0 and $2^{1/2}$

12. A circle C whose radius is 1 unit, touches the x-axis at point A. The centre Q of C lies in first quadrant. The tangent from origin O to the circle touches it at T and a point P lies on it such that $\triangle OAP$ is a right-angled triangle at A and its perimeter is 8 units. The length of QP is:

- (A) $\frac{1}{2}$ (B) $\frac{4}{3}$ (C) $\frac{5}{3}$ (D) none of these

13. Let complex numbers α and $1/\alpha$ lie on circles $(x-a)^2 + (y-b)^2 = r^2$ and $(x-a)^2 + (y-b)^2 = 4r^2$ respectively. If $z = a + ib$ satisfies the equation $2|z|^2 = r^2 + 2$, then $|\alpha| =$

- (A) $1/\sqrt{2}$ (B) $\frac{1}{2}$ (C) $1/\sqrt{7}$ (D) $1/3$

14. From a point P ($\lambda, \lambda, \lambda$), perpendiculars PQ and PR are drawn respectively on the lines y

$= x, z = 1$ and $y = -x, z = -1$. If P is such that $\angle QPR$ is a right angle, then the possible value of λ is:

- (A) $\sqrt{2}$ (B) 1 (C) -1 (D) $-\sqrt{2}$

15. The function $y = f(x)$ is the solution of the differential equation

$$(dy/dx) + (xy)/(x^2 - 1) = (x^4 + 2x)/\sqrt{1 - x^2}$$

in $(-1, 1)$ satisfying $f(0) = 0$. Then integration of $f(x)$ with respect to dx having limits $-(\sqrt{3})/2$ to $(\sqrt{3})/2$ is

- (A) $\pi/3 - (\sqrt{3})/2$ (B) $\pi/3 - (\sqrt{3})/4$ (C) $\pi/6 - (\sqrt{3})/4$ (D) $\pi/6 - (\sqrt{3})/2$

16. Coefficient of x^{11} in the expansion of $(1 + x^2)^4 (1 + x^3)^7 (1 + x^4)^{12}$ is:

- (A) 1051 (B) 1106 (C) 1113 (D) 1120

PHYSICS

17. Two thin symmetrical lenses of different nature have equal radii of curvature with $R=20\text{cm}$. The lenses are put close together and immersed in water. The focal length of the system is 24cm . The difference between the refractive indices of the lenses is $(5/n)$. Find n . The refractive index of water is $4/3$.

(A)3 (B)9 (C)8 (D)4

18. A 10m long nichrome wire having $80\ \Omega$ resistance has a current carrying capacity of 5A . This wire can be cut into equal parts and these equal parts can in turn be connected in either series or parallel. What is the maximum power which can be obtained as heat from the wire having a 200V mains supply (in KW).

(A)2 (B)13 (C)9 (D)11

19. Two spherical planets P and Q have the same uniform density ρ , masses M_p and M_q and surface areas A and $4A$ respectively. A spherical planet R also has uniform density ρ and its mass is $(M_p + M_q)$. The escape velocities from the planets P, Q and R are V_p , V_q and V_r , respectively. Then:

(A) $V_q > V_r > V_p$ (B) $V_r > V_q > V_p$ (C) $V_r / V_p = 9$ (D) $V_p / V_q = 1/4$

20. Two solid cylinders P and Q of same mass and same radius start rolling down a fixed inclined plane from the same height at the same time. Cylinder P has most of its mass concentrated near its surface, while Q has most of its mass concentrated near the axis. Which statement is correct?

- (A) Both cylinders P and Q reach the ground at the same time.
- (B) Cylinder P has larger linear acceleration than cylinder Q.
- (C) Both cylinders reach the ground with same translational kinetic energy.
- (D) Cylinder Q reaches the ground with larger angular speed.

21. A negative surface charge density (σ) is distributed on a disc. Find field at a point O which lies along the axis of the disc (on right side of vertically standing disc), and line from rim of disc to O makes 60° with axis.

- (A) $2.27 \times 10^{11}\text{ N/C}$ towards right
- (B) $8.47 \times 10^{11}\text{ N/C}$ towards right
- (C) $8.47 \times 10^{11}\text{ N/C}$ towards left
- (D) $2.27 \times 10^{11}\text{ N/C}$ towards left

22. A small ball thrown with an initial velocity u directed at an angle $\theta = 37^\circ$ above the horizontal collides inelastically ($e = 1/4$) with a vertical massive wall moving with a uniform horizontal velocity $u/5$ towards ball. After collision with the wall, the ball returns to the point from where it was thrown. Neglect friction between ball and wall. The time t from beginning of motion of the ball till the moment of its impact with the wall is? Given ($\tan 37^\circ = 3/4$)

- (A) $3u/5g$
- (B) $18u/25g$
- (C) $54u/125g$
- (D) $54u/25g$

23. A wooden cube is placed on a rough horizontal table. A force is applied to cube. Gradually the force is increased. Whether the cube slides before toppling or topples before sliding is independent of

- (A) the position of point of application of the force
- (B) the length of the edge of the cube
- (C) mass of the cube
- (D) coefficient of friction between the cube and the table

24. A bead slides from rest down a wire that's bent into a helix, which can be parametrized in the following way:

$$\{x=\cos A, y=\sin A, z=A\}$$

Find the magnitude of the bead's vertical acceleration.

Assumptions: The bead slides without friction and there is a uniform, gravitational field

-g \hat{k} , z axis is in vertical direction.

- (A) $-g/2$ (B) $-g/1.414$ (C) $-g/3$ (D) $-g/1.7132$

25. A piece of uniform string hangs vertically so that its free end just touches the horizontal surface of the table. During the falling of string, the total force on the surface of table is _____ times the weight of the part of string lying on surface.

- (A) One (B) Two (C) Three (D) Four

26. A man X drops a stone from fifteenth floor of building. A man Y ascending in an elevator at a constant speed 10m/s passed the fifteenth floor of the building just as the stone is released. The position, velocity of the stone seen by the man Y at 3 second

- (A) 70m, 39m/s (B) 39m, 70m/s (C) 19m, 70m/s (D) 14m, 29m/s

27. The capacitor of an oscillatory circuit of frequency 104Hz is enclosed in a container. When the container is evacuated, the frequency changes by 50 Hz, the dielectric constant of the gas is

- (A) 1.1 (B) 1.01 (C) 1.001 (D) 1.0001

28. A block of mass M is moving on a smooth horizontal surface with constant speed u. Bullets are fired horizontally against the block to reduce the velocity of the block to half its initial value. Bullets get embedded in the block. Mass of each bullet is 'm' and speed 'u'. Then the number of bullets required is-

- (A) $M/3m$ (B) M/m (C) $M/2m$ (D) None of these

CHEMISTRY

29. Which one of the following is not true about diborane?

- (A) It has two bridging hydrogens and four terminal hydrogens.
(B) The bridging hydrogen are in a plane perpendicular to the rest of B-H bonds
(C) All the six B-H bonds are equal
(D) None of these

30. Which one of the following is the most electronegative among them?

- (A) Sulphur (B) Iodine (C) Phosphorus (D) Carbon

31. A particular adsorption process has the following characteristics: (i) It arises due to van der Waals forces and (ii) it is reversible. Identify the correct statement that describes the above adsorption process:

- (A) Enthalpy of adsorption is greater than 100 kJ mol^{-1} .
- (B) Energy of activation is low.
- (C) Adsorption is monolayer.
- (D) Adsorption increases with increase in temperature.

32. $[\text{Co}_2(\text{CO})_8]$ signifies:

- (A) No Co-Co bond, six terminal CO and two bridging CO
- (B) No Co-Co bond, four terminal CO and four bridging CO
- (C) One Co-Co bond, six terminal CO and two bridging CO
- (D) One Co-Co bond, four terminal CO and four bridging CO sulphuric acid (H_2SO_4).

33. The standard electron potential of Zn^{2+}/Zn is -0.76 V and that of Cu^{2+}/Cu is 0.34 V . The emf V and the free energy change respectively, for a Daniel Cell will be -

- a) -0.42 and 81
- b) 1.1 and -231
- c) -1.1 and 213
- d) $.42$ and -81

34. The number of P-OH bonds and the oxidation state of phosphorus atom in pyrophosphoric acid ($\text{H}_4\text{P}_2\text{O}_7$) respectively are:

- (A) five and four
- (B) four and five
- (C) five and five
- (D) four and four

35. The incorrect statement among the following is:

- (A) α -D-glucose and β -D-glucose are enantiomers.
- (B) The penta-acetate of glucose does not react with hydroxyl amine.
- (C) α -D-glucose and β -D-glucose are anomers.
- (D) Cellulose is a straight chain polysaccharide made up of only β -D-glucose units.

36. Purification of copper is done mostly by?

- (A) Poling
- (B) Van-Arkel
- (C) Cupellation
- (D) Zone Refining

37. Haemoglobin contains 0.25% iron by weight. The molecular weight of haemoglobin is 89600. What is the number of iron atom per molecule of haemoglobin? (at. weight Fe = 56)

- (A) 2
- (B) 1
- (C) 4
- (D) 7

38. Identify the incorrect statement among the following:

- (A) If spin quantum number curve were to have 3 possible values, then the 4th period of periodic table would have a maximum of 27 elements.
- (B) Platinum (Pt) is one of the typical transition metals.
- (C) Total number of f - electrons in Gd (at. No. 64) is 8.
- (D) Atomic radius of Ga is nearly equal to that of Al.

39. Which of the following salt will not produce black ppt on passing $\text{H}_2\text{S}_{(\text{g})}$ through their aqueous salt solution in acidic medium?

- (A) CuSO_4
- (B) PbCl_2
- (C) CdSO_4
- (D) NiCl_2

- 40.** 1 kg block of ice at 0°C is placed in a perfectly insulated, sealed container that contains 2 kg of water, also at 0°C . The water and ice completely fill the container, but the container is flexible. After some time:
- (A) Water will freeze, mass of ice increases. (B) Ice will melt, mass of water decreases.
(C) Both the amount of water and ice remain constant.
(D) Both the amounts of water and ice will decrease.

General Awareness

- 41.** Personnel management is a
- (A) Point of view (B) Technique of thinking (C) Philosophy of management (D) All
- 42.** Demonstration type of training method is used to train
- (A) Workers (B) Supervision (C) Managers (D) All of the above
- 43.** Name the campaign that will be launched by India on the occasion of the first ever UN World Youth Skills Day?
- (A) Namami Gange Campaign (B) Skill India Campaign
(C) Yuva Kalyan Kosh (D) Sab Haath Rozgaar Campaign
- 44.** You see a "Drive slow" sign in front of you, which of the following buildings might be nearby?
- (A) Music club (B) Theatre Hall (C) School (D) Shopping Mall
- 45.** You are deserted in an island, just like Bear Grylls. What should be your most important concern?
- (A) Lighting a fire (B) Finding fresh water (C) Hunting for food (D) Creating a shelter
- 46.** Which of these is a 'soft' skill?
- (A) Analysing (B) Monitoring (C) Budgeting (D) Counselling
- 47.** Integrity is essential in all functions, but is it most crucial in?
- (A) Leadership (B) Management (C) Supervision (D) Compliance
- 48.** Subtle behaviours and communication styles that are used in the work environment and interactions with others are called:
- (A) Hard skills (B) Computer skills (C) Soft skills (D) Time management
- 49.** Hard skills are _____ skills used to perform daily job functions.
- (A) Subtle (B) Time management (C) Creative thinking (D) Technical
- 50.** You are on an absolutely frictionless surface (suppose on top of an ice block). How will you move?

(A) Take really big steps (B) Try to jump (C) Try to sneeze (D) None of these