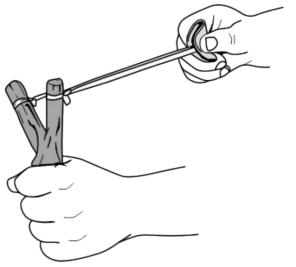
COPERNICUS OLYMPIAD
Physics and Astronomy Discipline
Category 3 - Sample Questions

1. The picture below shows an extended slingshot.



What type of energy is demonstrated by the hand holding the slingshot back in place?

A. Power
B. Kinetic energy
C. Elastic potential energy
D. Gravitational potential energy

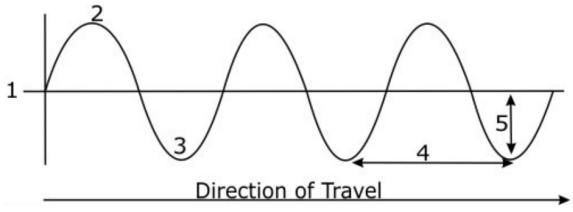
2. A red horse and a black horse raced on a 1-mile-long circular racetrack. The red horse completed the race in 120 seconds, and the black horse completed the race in 150 seconds. Which choice correctly describes the speed of the horses?

A. Only the red horse ran at a constant speed.
B. Only the black horse ran at a constant speed.
C. The red horse's average speed was greater than the black horse's average speed.
D. The black horse's average speed was greater than the red horse's average speed.

3. A scientist conducts an experiment using a red ball and a blue ball of equal size and mass. The scientist rolls each ball at the same speed on two different surfaces. The red ball rolls on a smooth tile surface, and the blue ball rolls on a carpeted surface. The scientist observes that the red ball rolls farther than the blue ball. Why does the red ball roll farther?

A. Each ball experiences an unbalanced force produced by friction, but the red ball experiences less friction.
B. Each ball experiences a balanced force produced by friction, but the red ball experiences less friction.
C. Only the blue ball experiences an unbalanced force produced by friction.
D. Only the blue ball experiences a balanced force produced by friction.

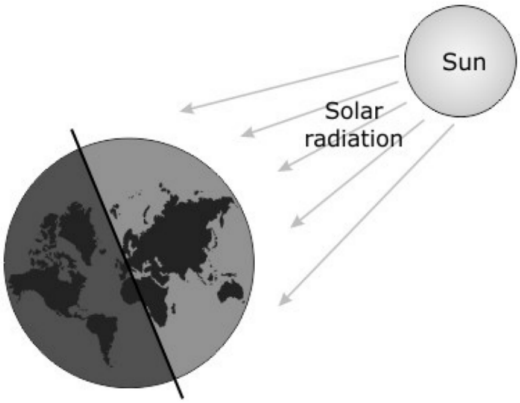
4. The diagram below shows the structure of a transverse wave.



What does number 2 represent in the diagram?

A. Amplitude
B. Crest
C. Trough
D. Wavelength

5. The diagram below shows the relationship between Earth and the sun.



Which statement best describes the impact of the sun's radiation on Earth?

A. It causes Earth to rotate.
B. It causes Earth to tilt on its axis.
C. Earth deflects heat from the sun.
D. Earth absorbs heat from the sun.

6. A sleeping bag manufacturer is making a product to keep people warm at low temperatures. Why might the manufacturer choose to use down feathers in the bags?

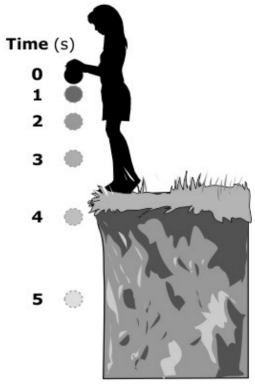
A. Down feathers make comfortable padding.
B. Down feathers are water resistant.
C. Down feathers are good insulators.
D. Down feathers are fire resistant.

7. The image below shows a grill and a piece of meat.

Which statement best describes the type of heat energy responsible for making the "marks" on the piece of meat?

A. Convective heat from the air marks the meat.
B. Radiant heat from the charcoal marks the meat.
C. Conductive heat from the metal grates marks the meat.
D. Thermal heat from both sides of the metal grill marks the meat.

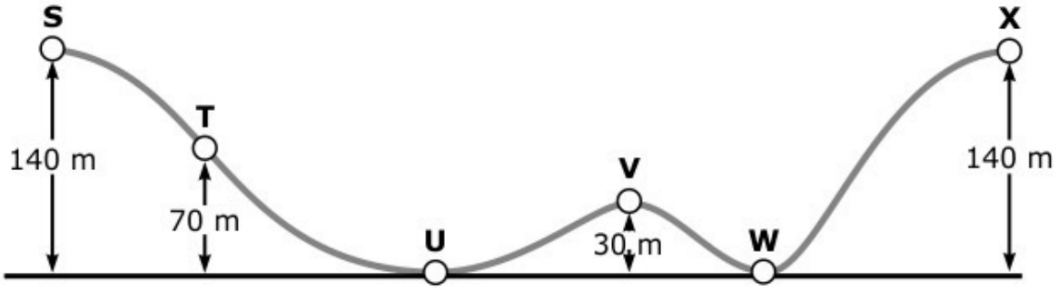
8. The diagram below shows the motion of a ball while being dropped.



What happens to the energy of the ball from when t = 0 s to when *t* = 5 s?

A. Potential energy decreases and kinetic energy increases, but the total amount of mechanical energy remains the same.
B. Potential energy increases and kinetic energy decreases, but the total amount of mechanical energy remains the same.
C. Potential energy and kinetic energy both increase, and the total amount of mechanical energy increases.
D. Potential energy and kinetic energy both decrease, and the total amount of mechanical energy decreases.

9. The diagram below shows the path of an object.



The object is placed on point S and released toward point X. At which point will the object have the same amount of potential energy as it does when it is at point S?

A. T
B. U
C. V
D. X

10. A net force of 100 N is applied to an object, making the object accelerate at a rate of 5.00 m/s^2. What is the object's mass?

A. 10.0 kg
B. 20.0 kg
C. 100 kg
D. 500 kg

11. What is the force of gravitational attraction between two identical objects with a mass of 40.00 kg each and are situated 10.00 m apart?

A. 1.06×10^{-8} N
B. 1.16×10^{-8} N
C. 1.07×10^{-9} N
D. 1.17×10^{-9} N

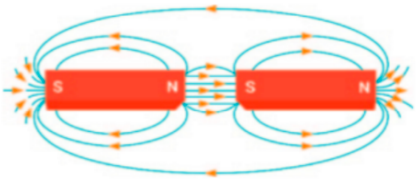
12. What is the kinetic energy of a 5.00-kg object moving at a speed of 10.0 m/s?

A. 25 J
B. 50 J
C. 100 J
D. 250 J

13. What is the momentum of an object if it has a mass of 400 kg and a velocity of 2.00 m/s?

A. 100 kg-m/s
B. 200 kg-m/s
C. 400 kg-m/s
D. 800 kg-m/s

14. What happens to the magnetic field lines of two magnets placed in close proximity as illustrated below?

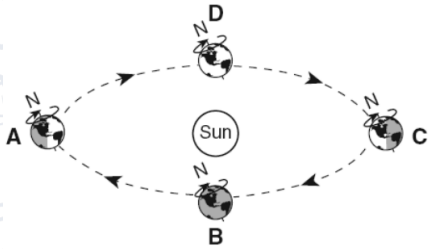


A. The field lines go around the two magnets, maintaining the distance between them.
B. The field lines between two magnets converge, causing the magnets to attract each other.
C. The field lines between two magnets are doubled in close proximity to each other, increasing the magnitude of the magnetic field of both magnets.
D. The field lines between two magnets bend in close proximity to each other, creating a repulsive force that pushes the magnets away from each other.

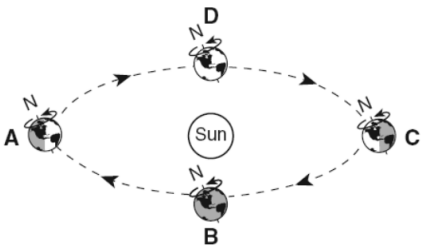
15. Two objects that collided has a total momentum of 30 kg-m/s and 60 J of kinetic energy before collision. If the collision is elastic, what is the kinetic energy of the system after the collision?

16. Which diagram correctly shows the directions of Earth's revolution and rotation?

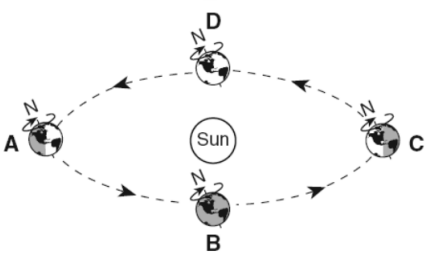
A.

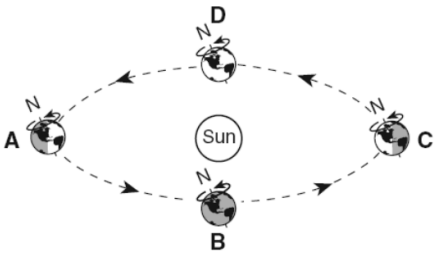


B.



C.

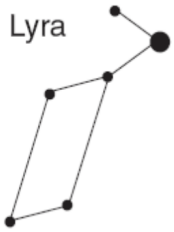




D.

17. Evidence that the universe is expanding is best provided by the
A. Parallelism of Earth's axis in orbit.
B. Spiral shape of the Milky Way Galaxy.
C. Red shift in the light from distant galaxy.
D. Change in the swing direction of a Foucault pendulum on Earth.

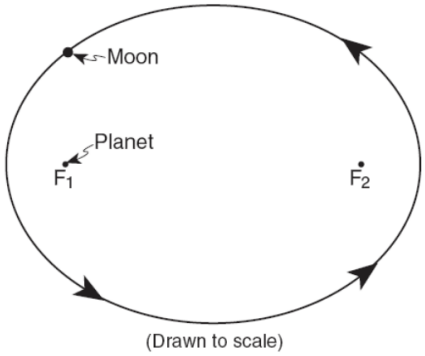
18. The diagram below represents the constellation Lyra.



Which statement best explains why Lyra is visible to an observer in New York State at midnight in July but is not visible at midnight in December?
A. Lyra orbits Earth.
B. Lyra spins on its axis.
C. Earth orbits the Sun.
D. Earth spins on its axis.

19. Which list of three planets and Earth's Moon is arranged in order of increasing equatorial diameter?
A. Earth's Moon, Pluto, Mars, Mercury
B. Pluto, Earth's Moon, Mercury, Mars
C. Mercury, Mars, Earth's Moon, Pluto
D. Mars, Mercury, Pluto, Earth's Moon

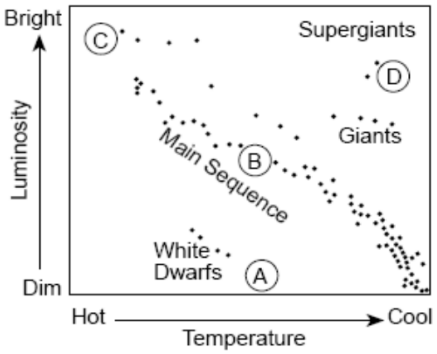
20. The diagram below represents the elliptical orbit of a moon revolving around a planet. The foci of this orbit are the points labeled F_1 and F_2.



(Drawn to scale)

What is the approximate eccentricity of this elliptical orbit?
A. 0.3
B. 0.5
C. 0.7
D. 1.4

21. The graph below represents the brightness and temperature of stars visible from Earth.



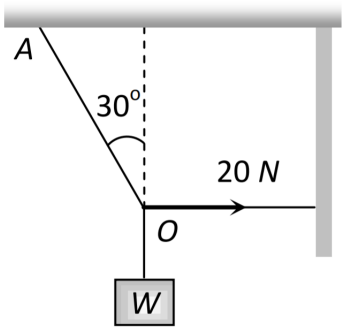
Which location on the graph best represents a star with average brightness and temperature?

A. Location A
B. Location B
C. Location C
D. Location D

22. The velocity of a body depends on time according to the equation $v = 40 + 0.2t^3$. The body is undergoing

A. Uniform acceleration
B. Uniform retardation
C. Non-uniform acceleration
D. Zero acceleration

23. As shown in figure the tension in the horizontal cord is 20 N.



The weight *W* and tension in the string OA in newton are

A. $30\sqrt{3}$, 30
B. $20\sqrt{3}$, 40
C. $60\sqrt{3}$, 30
D. $40\sqrt{3}$, 30

24. Which of the following is not true of gases, as compared to liquids or solids?

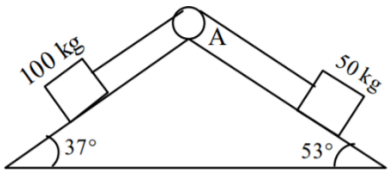
A. Gas molecules are in constant, rapid motion.
B. Molecules in a gas are tightly bound to each other by strong attractive forces.
C. The kinetic energy of a gas is directly proportional to its temperature.
D. The volume of a gas molecule itself is very small compared to the space the gas occupies.

25. What is the frequency of an electromagnetic wave with a wavelength of 1.0×10^5 m?

A. 1.0×10^{13} Hz
B. 3.0×10^3 Hz

C. 3.0×10^{13} Hz
D. 1.0×10^{3} Hz

26. Two blocks are connected by a cord passing over a small frictionless pulley and resting on frictionless planes as shown in the figure.



The acceleration of the blocks is

A. 0.33 m/s^2
B. 0.66 m/s^2
C. 1 m/s^2
D. 1.33 m/s^2

27. A person is standing in an elevator. In which situation he finds his weight less

A. When the elevator moves upward with constant acceleration.
B. When the elevator moves downward with constant acceleration.
C. When the elevator moves upward with uniform velocity.
D. When the elevator moves downward with uniform velocity.

28. An airplane flying 490 m above ground level at 100 m/s, releases a block. How far on the ground will it strike?

A. 2 km
B. 0.1 km
C. 1 km
D. None of the above.

29. If the K.E of a body is increased by 300% its momentum will increase by

A. 100%
B. 150%
C. 200%
D. 175%

30. Two particles of equal masses are revolving in circular paths of radii r_1 and r_2 respectively with the same speed. The ratio of their centripetal forces is

A. $\frac{r_1}{r_2}$
B. $\sqrt{\frac{r_2}{r_1}}$
C. $[\frac{r_1}{r_2}]^2$
D. $[\frac{r_2}{r_1}]^2$

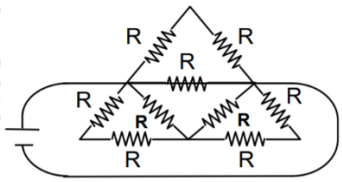
31. If a particle moves with constant angular velocity in a circle, then during the motion its

A. Momentum is conserved.
B. Energy is conserved.
C. Both energy and momentum are conserved.
D. None of the above is conserved.

32. A body of mass 5 kg, projected at an angle of 60° from the ground with an initial velocity of 25 m/s, acceleration due to gravity is g = 10 m/s^2, what is the maximum horizontal range covered?

A. 54.13 m
B. 49 m
C. 49.16 m
D. 60 m

33. For maximum power from battery the internal resistance of battery r is



A. 10 R
B. 4R/9
C. R/8
D. 10R/9

34. A body has 15J of heat energy in a particular state. At the same state it has an internal energy of 30J. Assume no work is done, what will happen to the internal energy if 5J of heat is added to the system?

A. Heat energy = 20 J, Internal energy = 35 J
B. Heat energy = 15 J, Internal energy = 30 J
C. Heat energy = 15 J, Internal energy = 35 J
D. A body cannot have heat energy in a particular state.

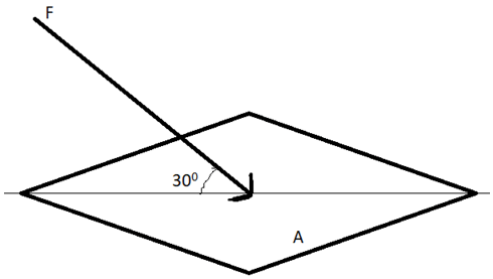
35. What is a necessary condition for a reaction to be spontaneous at all temperatures?

A. $\Delta H < \Delta G$
B. ΔG and ΔH should be positive
C. $\Delta H = \Delta G = 0$
D. ΔG and ΔH should be negative

36. A force F is applied on a uniform rod of cross-section A and a force F′ is applied on a uniform rod of cross-section 3A. What is the relation between F and F′ if the pressure on both is the same?

A. F/F′ = 1/3
B. F/F′ = 3
C. F′/F = 1/3
D. F/F′ = 1/9

37. A force F is applied in a cross-sectional area as shown. The value of F is 20 N and the value of A is 2 m^2. Find the pressure on the surface.



A. 20 Pa
B. 40 Pa
C. 5 Pa
D. 10 Pa

38. Find the false statement.
A. Sum of voltage over any closed loop is zero.
B. Kirchhoff's Laws can be applied to any circuit, regardless of its structure and composition.
C. Kirchhoff's 2nd law is applied at nodes.
D. Kirchhoff's 1st law can be applied for both planar and non-planar circuits.

39. An observer is standing stationary in air moving at a speed of 2m/s. A source of frequency 20Hz is moving in the direction of wind with speed 10m/s towards the observer. What will be the frequency as heard by the observer? Speed of sound in air is 330m/s.
A. 20.62 Hz
B. 19.40 Hz
C. 21.68 Hz
D. 22.63 Hz

40. A source of sound moves towards an observer. What happens to the speed of sound in the medium?
A. Increases
B. Decreases
C. Remains the same
D. Depends on speed with which source moves

41. A spring of length 1m has two cars connected to both of its ends. The two cars move towards each other such that the spring is compressed to 0.5m. If the spring constant is 500 N/m, what is the elastic potential energy stored?
A. 125 J
B. -125 J
C. 62.5 J
D. -62.5 J

42. A hollow sphere has a radius of 6.4 m. Minimum velocity required by a motorcyclist at the bottom to complete the circle will be
A. 17.7 m/s
B. 10.2 m/s
C. 12.4 m/s
D. 16.0 m/s

43. In a vertical circle of radius *r*, at what point in its path does a particle have tension equal to zero, if it is just able to complete the vertical circle?
A. Highest point
B. Lowest point
C. Any point
D. At a point horizontally from the center of the circle of radius *r*

44. What is the gravitational force experienced by an object of 10kg 200m away from an object weighing 1 ton?
A. 1.6675 N
B. 2.6675 N
C. 3.6675 N
D. 4.6675 N

45. Moment of inertia, of a spinning body about an axis, doesn't depend on which of the following factors?
A. Distribution of mass around axis
B. Orientation of axis

C. Mass
D. Angular velocity

46. Assuming standard notations, which of the following quantities is dimensionless?
A. v/a
B. P/F v
C. FE/L
D. V^2/g

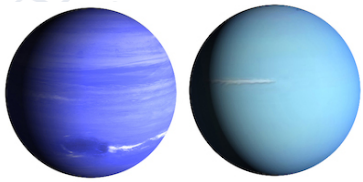
47. What is the speed of Milky Way Galaxy?

A. 5 km/s
B. 354 km/s
C. 5000 km/s
D. 600 km/s

48. Name one of the following parallels of latitudes as Tropic of Cancer.

A. 0°
B. 23° 30′ S
C. 23° 30′ N
D. 66° 30′ N

49. Which gas gives the planets shown below their color?



A. Nitrogen
B. Methane
C. Ammonia
D. Carbon Dioxide

50. Based on radiometric dating, the solar system formed about how many years ago?
A. Between 6,000 and 10,000 years
B. Between 1 and 2 million years
C. Between 100 and 200 million years
D. Between 4 and 5 billion years

51. Who proposed the heliocentric model of the solar system?

A. Copernicus
B. Kepler
C. Ptolemy
D. Galileo

52. How many electrons are contained in $^{238}_{92}U$ nucleus?
A. 92
B. 146
C. 238
D. 0

53. A body of M.I. 3 kg m² rotating with an angular velocity 2 rad/s has the same K.E. as a mass of 12 kg moving with a velocity of
A. 1 m/s
B. 2 m/s
C. 4 m/s
D. 8 m/s

54. Which of the following quantities connected with S.H.M. do not vary periodically?
A. Displacement
B. Velocity
C. Acceleration
D. Total energy

55. A current carrying coil is placed in a uniform magnetic field. If the coil turns through an angle θ, then the torque is directly proportional to
A. Sin θ
B. Cos θ
C. Cot θ
D. Tan θ

56. Moment of inertia depends on
A. Distribution of particles
B. Mass
C. Position of axis of rotation
D. All of these.

57. Which of the following pairs has the same dimensions?
A. Specific heat and latent heat
B. Impulse and momentum
C. Surface tension and force
D. Moment of inertia and torque

58. The atmospheric pressure is 106 dyne/cm². What is its value in SI unit?

A. 105 newton/m²
B. 106 newton/m²
C. 104 newton/m²
D. 103 newton/m²

59. Three charges + 3q + q and Q are placed on a straight line with equal separation. In order to make the net force on q to be zero, the value of Q will be

A. +3q
B. +2q
C. -3q
D. -4q

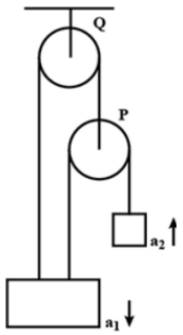
60. The resistance of a human body is about

A. 12 Ω
B. 120 Ω
C. 12 KΩ
D. 120 MΩ

61. A bird is sitting in a wire cage hanging from the spring balance. Let the reading of the spring balance be W1. If the bird flies about inside the cage, the reading of the spring balance becomes W2. Which of the following is true?

A. W1 > W2
B. W1 < W2
C. W1 = W2
D. None of the above.

62. Pulley Q is fixed while pulley P is movable.



If both pulleys are light and smooth and the strings are massless, the relation between a_1 and a_2 will be

A. $a_2 = 3a_1$
B. $a_2 = 2a_1$
C. $a_2 = a_1$
D. $a_2 = a_1/2$

63. Which of the following is NOT the property of equipotential surface?

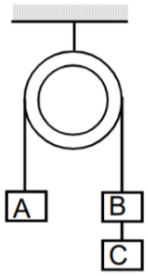
A. They do not cross each other.
B. The rate of change of potential with distance on them is zero.
C. For a uniform electric field, they are concentric spheres.
D. They can be imaginary spheres.

64. Which statement is true for Gauss Law?

A. All the charges whether inside or outside the gaussian surface contribute to the electric flux.

B. Electric flux depends upon the geometry of the gaussian surface.
C. Gauss theorem can be applied to non-uniform electric field.
D. The electric field over the gaussian surface remains continuous and uniform at every point.

65. Three equal weights A, B, C of mass 2 kg each are hanging on a string passing over a fixed frictionless pulley as shown in the figure.



The tension in the string connecting weights B and C is
A. Zero
B. 13 Newton
C. 3.3 Newton
D. 19.6 Newton

66. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon the
A. Rate at which current change in the two coils.
B. Relative position and orientation of the coils.
C. Rate at which voltage induced across two coils.
D. Currents in the two coils.

67. With fall of temperature, the forbidden energy gap of a semiconductor
A. Increases
B. Decreases
C. Sometimes increases and sometimes decreases
D. Remains unchanged

68. Heliocentric theory proposed by Nicolas Copernicus was
A. Replaced by circular orbits to fit the data better.
B. Replaced by elliptical orbits to fit the data better.
C. Replaced by elliptical orbits to fit the taste of new rulers of Italy.
D. Replaced by parabolic orbits to fit the data better.

69. A 180-meter-long train is moving due north at a speed of 25 m/s. A small bird is flying due south, a little above the train, with a speed of 5 m/s. The time taken by the bird to cross the train is
A. 10 s
B. 12 s
C. 9 s
D. 6 s

70. Which of the following has dimensions different from the rest?
A. L/R
B. 1/RC
C. $\sqrt{LC}$
D. RC

71. A concave mirror of focal length f produces an image n times the size of the object. If the image is real, then the distance of the object is

A. (n – 1) f
B. (n + 1) f
C. $\frac{(n+1)}{n} f$
D. $\frac{(n-1)}{n} f$

72. An atom stays in an excited state for about

A. 10 microseconds
B. 10 milliseconds
C. 10 nanoseconds
D. 10 seconds

73. The binding energy of a deuteron is about

A. 2.22 MeV
B. 2.22 J
C. 2.22 eV
D. None of these.

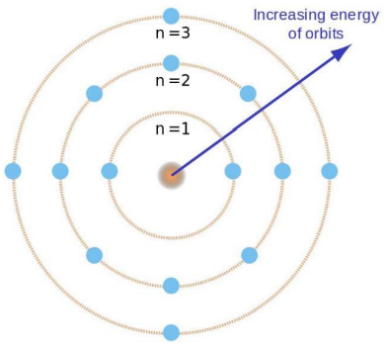
74. A black body at a temperature of 227°C radiates heat at the rate of 20 cal m^{-2} s^{-1}. When its temperature rises to 727°C, the heat radiated will be

A. 40 units
B. 160 units
C. 320 units
D. 640 units

75. In a thermodynamic process pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 J of heat and 8 J of work is done on the gas if the initial internal energy of the gas was 30 J. The final internal energy will be

A. 26 J
B. 15 J
C. 18 J
D. 9 J

76. The Bohr model of the atom was proposed by Neil Bohr in 1915. It came into existence with the modification of Rutherford's model of an atom. Rutherford's model introduced the nuclear model of an atom in which he explained that a nucleus (positively charged) is surrounded by negatively charged electrons.



Answer the following:

(1) Give any two Postulates of Bohr's Atomic Model
(2) What is in the center of the Rutherford model?
(3) When an electron jumps from its orbit to another orbit, then what happens with the energy?

(4) Write two important limitations of Rutherford model which could not explain the observed features of atomic spectra.

(5) What are the 5 series in hydrogen spectrum?

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Physics and Astronomy Discipline
Category 3 - ANSWER KEY

No	Answer
1	C
2	C
3	A
4	B
5	D
6	C
7	C
8	A
9	D
10	B
11	C
12	D
13	D
14	B
15	60 J
16	B
17	C
18	C
19	B
20	C

No	Answer
21	B
22	C
23	B
24	B
25	B
26	D
27	D
28	C
29	A
30	A
31	B
32	A
33	B
34	D
35	D
36	A
37	C
38	C
39	A
40	C

No	Answer
41	C
42	A
43	A
44	A
45	D
46	B
47	D
48	C
49	B
50	D
51	A
52	D
53	A
54	D
55	B
56	D
57	B
58	A
59	A
60	C

No	Answer
61	A
62	A
63	C
64	D
65	B
66	B
67	D
68	B
69	D
70	B
71	C
72	C
73	A
74	C
75	C

76.1	Electrons revolve around the nucleus in a fixed circular path termed “orbits” or “shells” or “energy level.”
	The orbits are termed as “stationary orbit.”
	Every circular orbit will have a certain amount of fixed energy and these circular orbits were termed orbital shells. The electrons will not radiate energy as long as they continue to revolve around the nucleus in the fixed orbital shells.
	The different energy levels are denoted by integers such as n=1 or n=2 or n=3 and so on. These are called as quantum numbers. The range of quantum number may vary and begin from the lowest energy level (nucleus side n=1) to highest energy level.
	The different energy levels or orbits are represented in two ways such as 1, 2, 3, 4… or K, L, M, N... shells. The lowest energy level of the electron is called the ground state.
	The change in energy occurs when the electrons jump from one energy level to other. In an atom, the electrons move from lower to higher energy level by acquiring the required energy. However, when an electron loses energy, it moves from higher to lower energy level.
76.2	Nucleus
76.3	When an electron jumps from lower orbit to higher orbit energy is absorbed and when an electron jumps from higher orbit to lower orbit energy is emitted.
76.4	Electron moving in a circular orbit around the nucleus would get accelerated, therefore it would spiral into the nucleus, as it loses its energy.
	It must emit a continuous spectrum.
76.5	Balmer, Lyman, Paschen, brackett, and Pfund series