PHYSICS GRADES 10-11 2024

EXPLANATIONS

1. C

The Aurora Borealis results from the interplay between the Sun's solar wind, Earth's magnetic field, and the atmospheric gases. Solar storms on the Sun's surface release massive clouds of electrically charged particles, known as solar winds. Some particles become captured within the earth's magnetic field.

These captured particles accelerate toward the north and south poles of the Earth. As these particles slam into atoms and molecules in the Earth's atmosphere, they heat them up. Nitrogen produces pale green hues.

Oxygen contributes to shades of rose-pink and even a fiery crimson at the bottom edge.

2. B

Nuclear fission is a remarkable process that powers our nuclear reactors and contributes to our energy needs. In nuclear fission, a heavy atomic nucleus (such as uranium-235 or plutonium-239) breaks apart into two smaller nuclei.

This splitting occurs spontaneously or upon impact with another particle.

As the nucleus splits, it releases a significant amount of energy.

3. C

When an object (such as a red-hot plate) is heated, it emits infrared waves.

These waves carry energy and can be absorbed by objects, such as food.

4. D

UV radiation is a form of energy naturally emitted by the sun and artificially from sunbeds. Too much exposure to UV radiation is the main cause of skin cancer.

When our skin absorbs UV rays, it can lead to DNA damage inside our cells.

5. B

$v = f \times \lambda$ (v = speed of light, given by c on the datasheet)

$3 \times 10^{8} = f \times 620 \times 10^{-9}$

$f = 4{,}84 \times 10^{14}$ Hz

6. A

Contact forces are forces that require direct physical contact between two objects. Non-contact forces are forces that act on an object without the need for physical contact. Friction is the resistance force offered by the floor when a box slides over it.

7. C

The object experiences a net force to the west and would therefore slow down.

$E_k = \frac{1}{2} mv^2$. A decrease in velocity will decrease the kinetic energy of the object (direct proportionality).

8. A

According to Newton's law of universal gravitation, the gravitational force ((F)) between two masses ((m1) and (m2)) is inversely proportional to the square of the distance (r) between their centres.

$$F = G\frac{m_1 m_2}{r^2}$$

Therefore, when the distance between the centres of the two bodies is doubled, the magnitude of the gravitational force becomes one-fourth of the original force.

9. B

The normal force (N) is the supporting force exerted by the table on the block.

It acts perpendicular to the surface of the table. The block exerts an equal and opposite force on the table according to Newton's third law. These are forces exerted on each other by two different objects and will always be the same in magnitude, but opposite in direction.

10. D

The direction of an electric field is determined by the direction that a positive test charge would experience at that point. Like charges repel each other. The direction of the electric field is therefore always away from a positive charge and towards a negative charge.

11. B

P and Q have opposite charges (different signs).

Q and R have the same charges (same signs).

Hence, P and R have opposite signs.

12. B

Coulombs Law states: $F = k\frac{q_1 q_2}{r^2}$

The force is inversely proportional to r^2. Inverse proportionality occurs when one quantity increases while the other decreases, and vice versa. The graph of an inverse proportion is a hyperbola.

13. D

Initially, as the charges moves closer to each other, the net force between them will increase (Coulombs Law).

Newton II states that the net force is directly proportional to the acceleration. The acceleration will therefore increase.

14. A

Distant objects appear blurred, while near objects remain clear.

The condition usually first appears in childhood.

Corrective measures such as prescription glasses, contact lenses, or laser surgery can help achieve good vision.

15. A

When light interacts with a surface, the angle at which it approaches (angle of incidence) is always equal to the angle at which it reflects (angle of reflection). This fundamental principle governs the behaviour of light when it reflects off smooth surfaces.

16. A

When bulbs are connected in parallel, each bulb has its own branch directly connected to the power supply. Each branch receives the full supply voltage.

Therefore, bulbs in parallel glow brighter because they have higher power dissipation.

17. C

In a series circuit, resistors share the same current flowing through the circuit.

Current (I) = V/R. Therefore, the ratio of V/R would be the same for both.

(The voltage drop across each resistor is proportional to its resistance. $V_2 > V_1$).

18. D

The transition E_0 to E_1 corresponds to absorption of light to a higher energy level. Red light has a lower frequency and less energy than green light. (E = hf)

19. B

Speed is a scalar and acceleration is a vector. Scalars have magnitude only.

Vectors have magnitude and direction.

20. C

Velocity (v) is represented on the x-axis. The horizontal line indicates no change, and the straight line with negative gradient indicates that the car is uniformly slowing down.

21. C

Loudness depends on the amplitude (energy) of the sound wave.

Pitch depends on the frequency (vibration rate) of the sound wave.

22. A

Any force that is not horizontal or vertical, will have a horizontal and a vertical component.

Force R has an upward component as well as a component to the left.

If exerted on an object, it will tend to lift the object as well as pull it to the left.

23. C

Total internal reflection happens when waves (such as light, microwaves, sound, or water waves) arrive at an interface (boundary) from one medium to another. This happens when the angle of incidence is bigger than the critical angle.

Instead of being refracted into the second (external) medium, the waves are completely reflected back into the first (internal) medium. The critical angle is the angle of incidence beyond which total internal reflection occurs.

24. B

The period (T) is the time it takes for a wave to complete one oscillation or cycle. One oscillation is equivalent to one wave. The period and frequency are inversely related.

25. A

v = f x λ
= 0,5 x 0,25
= 0,125 m.s^{-1}

$f = \frac{1}{T}$ = ½ = 0,5 Hz

λ = 0,5/2 = 0,25 m

26. D

A wave crest is the highest point of a wave, while a trough is the lowest point.
In this case, point Y represents a crest. As the wave moves to the right, point Y will move downward.

27. C

$v = \frac{x}{t}$ or $x = v.t$ (t to reach the bottom = ½ t to receive the signal)

x = 1450 x (1,5/2) = 1087,5 m

28. B

Earth behaves like a giant magnet, with invisible lines of magnetic force running from its magnetic north pole to its magnetic south pole. When a compass needle is suspended freely, it aligns itself along these magnetic lines.

29. C

When the positively charged sphere B approaches the neutral object A, it induces a separation of charges within the neutral object.
The side of the neutral object closer to the charged sphere becomes negatively charged (due to the accumulation of electrons), while the other side becomes positively charged (due to the lack of electrons). Electrons will not be transferred unless the objects touch.

30. A

At constant speed, the distance between oil drops will be even (Q to V).
When the truck slows down, the distance will decrease (M to Q).
When the truck speeds up, the distance will increase (V to Z).

31. C

$E_p = mgh$ where units are (kg)(m.s^{-2})(m) = kg·m^2·s^{-2}

32. D

The potential difference (voltage) between two points in an electric field represents the work done or the energy released when transferring a unit quantity of electricity (usually one coulomb of charge) from one point to another. When a potential

difference exists between two points, it drives the flow of electric charge (current) through conductors.

33. A

The gradient of a velocity-time graph corresponds to the acceleration of the object.
When the graph has a steep positive slope, it indicates that the object is accelerating rapidly, while a shallow slope suggests that the object's acceleration is gentler.
If the slope is negative (directed downward), the acceleration is negative (deceleration).
A horizontal graph indicates zero acceleration.
In this case the slope is constant throughout the movement.
The gradient ($\Delta y/\Delta x$) and constant acceleration, a = +1 $m.s^{-2}$)

34. D

The area under a velocity vs. time graph represents the displacement/distance of an object. Distance is a scalar quantity while displacement is a vector quantity with direction. The sum of the areas under a velocity vs time graph will give the distance travelled by the object.

$$\Delta x = \frac{1}{2}bh + \frac{1}{2}bh = \frac{1}{2}(4)(4) + \frac{1}{2}(3)(3)$$

= 8 + 4,5 = 12,5 m

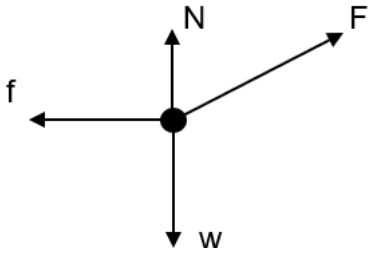
35. D

$$v = \frac{\Delta x}{\Delta t} = \frac{12}{7} = 1{,}79\ m.s^{-1}$$

36. A

The gradient of a velocity-time graph corresponds to the acceleration of the object.
When the acceleration is constant, the slope remains the same throughout the graph.

37. B



w = mg = 1 x 9,8 = 9,8 N

$F_y = F\sin30^\circ = 8\sin30^\circ = 4$ N

$N = w - F_y = 9{,}8 - 4 = 5{,}8$ N

38. C

$F_x = F\cos30^\circ = 8\cos30^\circ = 6{,}87$ N

39. A

F_x is smaller than the maximum frictional force. The block will therefore not move to the right.
F_y is smaller than w. The block will therefore not be lifted.

40. D

$E_p = mgh = 1 \times 9{,}8 \times 10 = 98$ J (Point C is at the same height as point A)

41. B

$E_k = \frac{1}{2} mv^2$

At the highest point of motion, the velocity (v) will be zero. The kinetic energy will therefore be zero at point B.

42. B

The sum of kinetic energy and potential energy at any position within the system remains the same over time.

$E_m = E_k + E_p$

At point D the total mechanical energy is 117,6 J. ($E_p = 0$ J)

At point B the total mechanical energy is 117,6 J. ($E_k = 0$ J)

E_p at point B is therefore 117,6 J

$E_p = mgh$

$117{,}6 = 1 \times 9{,}8 \times h$

$h = 12$ m

43. C

With the switch open, no current will flow through R1.

The total supply voltage (emf) across the resistors is equal to the sum of the potential differences across R2 and R3.

Since R1 and R2 are identical, they have the same resistance value.

Therefore, the potential difference across each resistor is the same.

Resistors in series will share the total voltage.

$V = 3/2 = 1{,}5$ V

44. C

$I = V/R$

$= \frac{3}{4}$ ($R_{TOT} = R2 + R3 = 2 + 2 = 4\Omega$)

$= 0{,}75$ A

45. C

R1 is now in parallel with R2 and R3.

Adding resistors in parallel does not alter the voltage across the original resistor.

The voltage over R2 will therefore remain 1,5 V.

46. C

The voltage over R2 remains the same.

Therefore, the current through R2 remains the same.

I = V/R

= 1,5/2

= 0,75 A

47. A

The parcel will follow a curved path known as a parabolic trajectory. This is due to two independent motions:

Horizontal Motion: The parcel will continue moving at the same horizontal speed as the helicopter (80 km/h) due to the principle of inertia. This is because an object in motion tends to stay in motion unless acted upon by an external force. In this case, there's no horizontal force acting on the parcel after it's dropped.

Vertical Motion: At the same time, the parcel will accelerate downwards due to gravity. This vertical motion will be a uniformly accelerated motion, starting from rest (when it's dropped) and gaining speed as it falls.

48. B

Opposite charges attract and like charges repel.

$$F = k\frac{q_1 q_2}{r^2}$$

The magnitude of the charges is the same.

The force will be stronger when r is smaller.

Forces on P: Repelling force of Q to the left will be stronger.

Forces on Q: Both P and R exerts a force to the right.

Forces on R: Both P and Q exerts a force to the left (attract).

49. A

The reading on the scale will be equal to the normal force.

If the elevator were stationary (not accelerating), the normal force would be equal to the girl's weight (600 N), resulting in a total reading of 600 N on the scale.

However, since the scale reads 620 N, there must be an upward acceleration (opposite to gravity) that increases the normal force.

50. A

N30°W reads as North, 30 degrees West, meaning 30 degrees west of north.

51. D

Plastics do not enhance coral reef growth. In fact, plastic pollution harms coral reefs by smothering them, preventing healthy growth, and disrupting delicate ecosystems.

52. D

The number of water molecules in 1 kg of water can be calculated using Avogadro's number and the molar mass of water.
First, we need to convert the mass of water from kilograms to grams. 1 kg of water is equal to 1000 g.
The molar mass of water (H_2O) is approximately 18.015 g/mol.
So, the number of moles of water in 1 kg of water is 1000 g / 18.015 g/mol = 55.5 moles.
Avogadro's number, which is the number of molecules in one mole, is approximately 6.022×10^{23}.
Therefore, the number of water molecules in 1 kg of water is
55.5 moles x 6.022×10^{23} molecules/mole = 3.34×10^{25} molecules.

53. C

The noble gases (historically known as the inert gases) are the naturally occurring members of Group 18 of the periodic table.

54. C

The total number of electrons in element M is 14. It represents the element Silicon (Si). The reason why the electron configuration of Si corresponds to Group 14, is that the highest energy level contains 4 valency electrons, represented by 3s2 3p2.

55. C

Valency first increases and then decreases as we go from left to right in a period but remains the same in a group. Elements in the same group (vertical column) have similar valency due to their similar electron configurations.

56. B

Cooking utensils, such as pots, pans, and menu trays, are often made from aluminium because it is lightweight and conducts heat well, making it energy-efficient for heating and cooling.

57. B

2 moles of hydrochloric acid react with 1 mole of barium hydroxide to produce 1 mole of barium chloride and 2 moles of water.

58. A

HCl (hydrochloric acid) is a strong acid. It dissociates completely in water to form hydrogen ions (H^+) and chloride ions (Cl^-).
CH_3COOH (acetic acid) is a weak acid commonly found in vinegar.
Lemon juice contains citric acid, which is also a weak acid.
Pure milk is not acidic; it is slightly basic due to the presence of dissolved calcium hydroxide.

59. C
Na_2CO_3 is also known as washing soda or soda ash. It is commonly used for various purposes, including cleaning, water softening, and as a pH regulator.

60. D
An aqueous solution turns red litmus paper blue. To reverse this change and turn blue litmus paper back to red, we need to add an acid.

61. D
Biodegradable waste includes any organic matter in waste that can be broken down into simpler compounds by microorganisms and other living things.
Wood shavings is the only option that break down naturally over time.

62. A
The theoretical yield is the maximum amount of product that could be formed based on stoichiometry.
From the balanced equation, 1 mole of $CaCO_3$ produces 1 mole of CO_2.
Given that 1 mol of $CaCO_3$ reacts to form 0.78 mol of CO_2, the theoretical yield of CO_2 is 0.78 mol.

% Yield = $\frac{actual\ yeild}{theoretical\ yield}\ x\ 100 = \frac{78}{100}\ x\ 100 = 78\ \%$

63. A
Across the period (from left to right), as the electrons get added to the same shell, the number of shells remains the same. But the number of protons increases. Thus, the protons pull the electrons harder, causing the shells to shrink, reducing the atomic size.
As you move down in a group, addition of new shells tends to increase the atomic size.

64. C
Sublimation involves the direct transition from a solid to a gas without passing through the liquid phase.

65. C
Nitrogen is a crucial component of amino acids, which are the building blocks of proteins. Proteins play vital roles in various biological processes, including enzyme function, cell structure, and immune response.

66. B
In combustion reactions, a substance reacts with oxygen to produce heat and light energy. Gasoline burning in an engine is an exothermic process that releases energy in the form of heat and kinetic energy.

67. B
A covalent bond is a chemical bond between two atoms where they share one or more pairs of electrons. This sharing of electrons allows each atom to achieve a full valence shell, making the resulting compound more stable than its constituent atoms are on their own.

68. A
Hydrogen and carbon have similar electronegativities (around 2.1 for carbon and 2.2 for hydrogen).
The difference in electronegativity is very small (close to zero).
Therefore, the H – C bond is nonpolar covalent.

69. C
Bond Length:
The bond length refers to the distance between the nuclei of two adjacent atoms when they are bonded to each other. For C - N, the atoms are single bonded to each other. The bond length for the C – N single bond is approximately 125 picometers (pm). A shorter bond length indicates a stronger bond.
Bond Energy (Bond Dissociation Energy):
The bond energy (also known as bond dissociation energy) represents the amount of energy required to break the bond that has formed. For the C - N single bond, the average bond energy is approximately 418 kJ/mol. This means that it takes 418 kilojoules of energy to completely break the bond.

70. C
Ethanol (C_2H_5OH) contains a hydroxyl group (–OH), which allows it to form hydrogen bonds with water molecules. Hydrogen bonding between ethanol and water leads to their mutual solubility.

71. D
Vapor pressure is the pressure exerted by the vapor phase of a liquid above its surface when it is in equilibrium with the liquid phase. Liquids with weaker intermolecular forces (IMF) tend to have higher vapor pressures.
Water and ethanol have strong hydrogen bonds between their molecules.
Chloroform has weaker dipole-dipole forces. Bromine has the weakest IMF (London forces). It's low molecular weight also contribute to its weaker IMF.

72. B
$pV = n\,RT$ (Use correct SI-units)
$105\,000\ Pa \times 12{,}6\ m^3 = n(8{,}31)(298\ K)$ ($T = 25 + 273 = 298\ K$)
$n = 534{,}25\ mol$

73. C
There are seven oxygen atoms, so the total charge contributed by oxygen is $-2 \times 7 = -14$.
The ionic charge on the ~~molecule~~ compound ion is -2.
Therefore, two chromium atoms have a total oxidation number of +12.

One chromium atom therefore has an oxidation number of +12/2 = +6.

74. C
Oxidation is the loss of electrons during a chemical reaction by a molecule, atom, or ion. It occurs when the oxidation state of a chemical species increases.
In this reaction Fe^{2+} is oxidized to Fe^{3+}.

75. A
The oxidizing agent is the species that undergoes reduction (i.e., gains electrons). Since the $Cr_2O_7^{-2}$ ion is reduced to Cr^{3+}, it acts as the oxidizing agent in this reaction.

76. D
1 mole of any gas at STP (Standard Temperature and Pressure) occupy a volume of 22.4 dm^3. Therefore, the correct answer is 44.8 dm^3.

77. B
A redox reaction involves the transfer of electrons between reactants and therefore a change in oxidation numbers. In reaction B Mg loses 2 electrons and it's oxidation number changes from 0 to +2. Cu ions gain 2 electrons and it's oxidation number changes from +2 to 0. Mg is oxidized and Cu ions is reduced. In all the other reactions there are no change in oxidation numbers.

78. A
$V \propto \frac{T}{p}$
V is directly proportional to T and inversely proportional to p. If the temperature is doubled, the initial volume becomes (2V). If the pressure is halved, the new volume becomes (2V). The final volume after doubling the temperature and halving the pressure is 4V.

79. B
$n = c \times V = 0{,}2 \times 200 \times 10^{-3} = 0{,}04$ mol

$n(SO_2) = ½\ n(HCl) = ½\ (0{,}04) = 0{,}02$ mol

$n = \frac{V}{V_m}$

$\therefore V = (0{,}02)(22{,}4) = 0{,}45\ dm^3$

80. D
An ampholyte can act either as an acid or a base. In aqueous solution, water can:
Gain a proton (H^+) to form a hydronium ion (H_3O^+) or
Lose a proton (H^+) to form a hydroxide ion (OH^-).

81. B
When HCl donates a proton (H^+), it forms Cl^- as its conjugate base.

82. C
Both solar and wind energy do not emit greenhouse gases that cause climate change. Therefore, using them to produce hydrogen does not contribute to global warming.
Solar and wind energy are renewable, meaning they are replenished naturally and continuously. Using these sources for hydrogen production ensures that the process is sustainable and does not deplete resources.

83. C
In a hydrogen fuel cell, hydrogen gas (H_2) and oxygen gas (O_2) are used as fuel. The products of a hydrogen fuel cell are electricity, water, and heat.

84. B
South Africa produces between 80 and 85% of the world's iridium and 75% of the world's platinum, resources needed as a catalyst to produce hydrogen.
South Africa has strong solar and wind energy resources, which can be used to produce clean and sustainable hydrogen.

85. D
When green hydrogen is used as a fuel, it only produces water as a byproduct, emitting no greenhouse gases. Green hydrogen is produced by using electricity from renewable sources to split water into hydrogen and oxygen. This process, known as electrolysis, does not produce greenhouse gases if the electricity comes from renewable sources.

86. A
The activation energy (E_a) represents the minimum amount of energy required for a reaction to occur. The activation energy is the difference in energy between the reactants and the activated complex (point A).

87. C
Enthalpy change (ΔH) is the heat energy exchanged during a chemical reaction. It represents the difference in enthalpy between the products and the reactants.

$$\Delta H = E_{products} - E_{reactants}$$

For the reverse reaction, B represents the products and C, the reactants.

88. A
1 mol $Ba(OH)_2$ releases: 116 kJ
0,18 mol $Ba(OH)_2$ releases: 0,18 x 116 = 20,88 kJ

89. B
Chloride ion has an electron configuration of $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$, which is the same as Argon. All the others have the same electron configuration as neon.

90. B
The boiling point of water depends on the atmospheric pressure, which changes according to elevation.
In Cape Town, which is at sea level, the boiling point of water is typically 100°C.
On the other hand, Gauteng is located on the Highveld plateau, which is at a higher elevation. As a result, the atmospheric pressure is lower, and water boils at a temperature lower than 100°C.

91. D
To convert MHz (megahertz) to kHz (kilohertz), you need to multiply by 1000.
So, 8.6 MHz is equal to $8{,}6 \times 1000 = 8{,}6 \times 10^3 = 8600$ kHz

92. A
A homogeneous mixture is one where the components are blended so thoroughly that individual substances cannot be discerned visually.

93. C
When the mixture is heated, water will evaporate (change phase from a liquid to a gas). When all the water evaporates, only the sugar will remain in the beaker.

94. A
Distillation is a process used to separate a mixture of liquids based on their different boiling points. It involves heating the mixture until the components with the lower boiling point turn into vapor, and then cooling it down so that the vapor condenses back into liquid form. Ethanol boils at 78 °C and water boils at 100 °C at sea level.

95. C
In an alcohol molecule, the oxygen atom of the O-H bond pulls electron density away from the hydrogen atom.
As a result, the hydrogen atom becomes polarized, carrying a partial positive charge.
This polarized hydrogen can then form a hydrogen bond with a pair of nonbonding electrons on another oxygen atom.

96. C
It is a naturally occurring form of the element carbon, characterized by its black to steel grey colour. It is widely used in pencils, lubricants, and electrodes due to its stability and conductivity.

97. B
Copper ions (Cu^{2+}) will be attracted to the negative cathode and will be reduced. The half-reaction for this process is:
$Cu^{2+} + 2e^- \rightarrow Cu$
As a result, solid copper (Cu) will be deposited on the cathode.

98. B
Solid copper (Cu) will be deposited on the cathode (negative electrode).

99. A
The reactivity of halogens generally increases as you move up the group from iodine to fluorine. Fluorine has a strong tendency to gain an electron and form a fluoride ion, making it highly reactive. It readily reacts with other elements and compounds, including metals, to form fluorides.

100. B
Argon is a monatomic gas, meaning it exists as individual atoms (Ar) rather than molecules. Chlorine (Cl), oxygen (O), and nitrogen (N) are diatomic gases, meaning they exist as molecules composed of two atoms (Cl_2, O_2, N_2).