



Subject: Grade 11 Physical Sciences

Topic: Physical Sciences: Term 1 - Mini-Exam

Total: 111 Marks

1. Oxygen | Potassium chloride | Ammonia

6 marks

Explanation:

Oxygen (O_2) is a diatomic molecule and both atoms have the same electronegativity. The two atoms share the bonding electrons equally. Therefore **oxygen** has non-polar **covalent bonds**.

Potassium chloride (KCl) consist of K^+ and Cl^- ions that forms an ionic bond because of **strong electrostatic attraction** between the ions.

Ammonia is a polar molecule and has dipole-dipole intermolecular forces. In **ammonia** (NH_3), the nitrogen atom has a **lone pair of electrons**, allowing it to form **hydrogen bonds** with hydrogen atoms of neighboring (NH_3) molecules. Hydrogen bonds is the strongest intermolecular forces.

2. B

3 marks

Explanation:

The frictional force is determined by the formula:

$$f = \mu \times N$$

When the object is **pulled** at an angle of 60° with the horizontal, the vertical component of the applied force will act upwards, decreasing the normal force. The normal force in this case is:

$$N = F_g - F_y$$

When the object is **pushed** at an angle of 60° with the horizontal, the vertical component of the applied force will act downwards, increasing the normal force. The normal force in this case is:

$$N = F_g + F_y$$

Since frictional force is directly proportional to the normal force, in the case of pushing (diagram B), the normal force is larger than in the case of pulling (diagram A), the **frictional force would be larger** in **diagram B**, where the object is **pushed**.



3. A: Halve the distance between the masses.

4 marks

Explanation:

Newton's Law of Universal Gravitation states: Each body in the universe attracts every other body with a force that is **directly proportional to the product of their masses** and **inversely proportional to the square of the distance** between their centres.

$$F = \frac{GMm}{r^2}$$

Double the mass, **increases** the force by the factor 2.

Halve the mass, decreases the force by the factor 2.

Double the distance, decreases the force by the factor 4.

Halve the distance, **increases** the force by the factor 4.

Decreasing the **distance by half increases the force four times**. This is the factor which causes the greatest increase in force.

4. false

2 marks

Explanation:

The forces, F_1 , F_2 and F_3 , **follow tail-to-head** and forms a closed vector diagram with the last force ending where the first force is starting.

The forces are balanced, and the system is in equilibrium. There is a **zero resultant force**.

$\therefore F_1$ cannot be the resultant force.

Explanation:

The free-body diagram represents the horizontal forces acting on **crate Y**.

The forces acting on crate Y is the applied force (F_A) to the **right**, the tension (T) to the **left** and the frictional force (f_k) to the **left**.

The magnitude of the total frictional force:

Ratio of frictional forces is 1 : 3

Take the frictional force on X as $1x$ and on Y as $3x$.

Crate X

$$T - f_k = ma$$

$$T - 1x = 10 \times 4$$

$$T = 40 + x \dots (1)$$

Crate Y

$$F_A - T - f_k = ma$$

$$400 - T - 3x = 30 \times 4$$

$$T = 280 - 3x \dots (2)$$

$$(1) = (2)$$

$$40 + x = 280 - 3x$$

$$4x = 240 \text{ N}$$

Total frictional force = 240 N

The frictional force acting on the 10 kg crate is:

$$4x = 240$$

$$x = 60$$

$$x = 60 \text{ N left}$$

Explanation:

If the chemical bond between atom X and Y is formed through a transfer of electrons, then the type of bond would be an ionic bond.

Water (H_2O) is a molecule formed through **sharing of electrons** and would form a covalent bond. Therefore water is **incorrect**.

The other three options are all representing ionic compounds.

The correct formula of lithium oxide is Li_2O and not LiO .

The correct formula of sodium sulphide is Na_2S and not NaS_2 .

Potassium oxide is correct with the formula K_2O .

7. false

2 marks

Explanation:

The force **T** is acting down the inclined plank.

The wooden crate slides down the plank, therefore the **frictional force** must act **up** the plank. Force **T cannot** represent the frictional force. The frictional force is represented by **S**.

The force **T** represents the **parallel component of the gravitational force**.

8. D: The normal force of an object on an inclined plane is equal to the perpendicular component of the object's weight. 4 marks

Explanation:

Only when an object is at rest or moving on a flat, horizontal surface, and **only horizontal forces** are acting on it, the **normal force equals the gravitational force** in magnitude, but acts in the opposite direction.

The normal force is **not always upward**; it acts perpendicular to the surface. On an incline, the normal force is at an angle, and in cases like a person pushing against a wall, the normal force acts horizontally.

The normal force is based on the forces acting perpendicular to the surface, **not the motion of the object**. A box sliding on a table at constant velocity still experiences the same normal force as when at rest.

When an object is on an inclined plane, the normal force is less than the gravitational force because it only balances the **perpendicular component of the gravitational force**.

$$N = F_g \perp$$

9. 150 | 259,81

4 marks

Explanation:

The force is applied at an angle with the horizontal and can be resolved into a vertical and horizontal component.

Vertical component

$$\begin{aligned} F_y &= F \sin \theta \\ &= 300 \times \sin 30^\circ \\ &= 150 \text{ N} \end{aligned}$$

Horizontal component

$$\begin{aligned} F_x &= F \cos \theta \\ &= 300 \times \cos 30^\circ \\ &= 259,81 \text{ N} \end{aligned}$$

10. right

3 marks

Explanation:

The block is moving to the left, so the forces acting on it in the parallel plane include:

The applied force (pulling it to the left).

The kinetic frictional force (acting to the right, opposing motion).

According to Newton's Second Law the acceleration is in the same direction as the resultant force.

Since the block is **slowing down**, it means that the resultant force and acceleration must be **opposite to the direction of motion**.

The resultant force and the acceleration is acting to the **right**.

11. B: dependent on the area of the contact surfaces.

4 marks

Explanation:

Kinetic frictional force can be determined by the following formula:

$$f_k = \mu_k \times F_N$$

Dependent on mass? **True** - when calculating normal force the weight (mg) or component of the weight is needed .

Dependent on the type of surface? **True** - Different surfaces have different coefficients of kinetic friction.

Smaller than maximum static friction? **True** - Kinetic frictional force is less than the maximum static frictional force, because the coefficient of kinetic friction is smaller than the coefficient of static friction for the same surface.

Dependent on contact area? **False** - Friction is independent of the contact area because frictional forces arises from the microscopic interactions between surfaces, not the visible surface area in contact.

12. false

2 marks

Explanation:

The carbon atom (C) in CO₂ forms two double bonds with oxygen atoms (O). The electron pairs repel each other and arrange themselves as far apart as possible, resulting in a **linear shape**.

Carbon has no lone pairs in its valence shell so there is no extra repulsion to bend the molecule.

13. C: 21, 07 N

4 marks

Explanation:

Convert

$$5\,000\text{ g} \div 1000 = 5\text{ kg}$$

Determine the normal force

$$\begin{aligned} N &= F_g \\ &= 5 \times 9,8 \\ &= 49\text{ N} \end{aligned}$$

Calculate the maximum static frictional force

The formula for the maximum static frictional force is:

$$\begin{aligned} f_s^{max} &= \mu_s N \\ &= 0,43 \times 49 \\ &= 21,07\text{ N} \end{aligned}$$

14. First

3 marks

Explanation:

Newton's First Law states that:

An object will remain at rest or move with constant velocity in a straight line unless acted upon by a net external force.

This describes **inertia**—the object's resistance to changes in its state of motion.

15. higher | greater

2 marks

Explanation:

- **Iodine** is a **larger molecule** compared to chlorine.
- The atoms of iodine are bigger, with **more electrons and larger temporary dipoles**, while chlorine atoms are much smaller and have fewer electrons.
- This increases the strength of **temporary dipoles**, leading to **stronger London dispersion forces** between iodine molecules.
- Iodine requires **more energy** to overcome the London dispersion forces. Therefore, iodine has a significantly **higher** boiling point than chlorine.

Explanation:

The 0,5 kg object (m) will **accelerate upwards** and the 1,5 kg object (M) will **accelerate downwards**.

The magnitude of the tension is the same in the string (it is only one string).

Write an equation for the 0,5 kg object:

$$F_{net} = ma$$

$$T - w = ma \quad (T > w \text{ for the 0,5 kg})$$

$$T - 4,9 = 0,5 \times a$$

$$T = 0,5a + 4,9 \dots (1)$$

Write an equation for the 1,5 kg object:

$$F_{net} = ma$$

$$w - T = ma \quad (w > T \text{ for the 1,5 kg})$$

$$14,7 - T = 1,5 \times a$$

$$T = -1,5a + 14,7 \dots (2)$$

Solve for the acceleration: (1) = (2)

$$0,5a + 4,9 = -1,5a + 14,7$$

$$2a = 9,8$$

$$a = 4,9 \text{ m} \cdot \text{s}^{-2}$$

Determine the tension by substituting acceleration in equation 1:

$$T = 0,5a + 4,9$$

$$T = (0,5 \times 4,9) + 4,9$$

$$= 7,35 \text{ N}$$

NB! Tension can also be calculated by substituting acceleration in equation 2.

Explanation:

Valence electrons are electrons in the **highest energy level**/ outermost electron shell.

For **group 1 to 2** elements the valence electrons are **equal to the group number** and for **group 13 to 18** the valence electrons are the **group number subtract 10**.

Phosphorous is situated in group 15, therefore the number of valence electrons are $15 - 10 = 5$. **Phosphorous has 5 valence electrons**.

18. false

2 marks

Explanation:

Use the formula: $g = \frac{GM}{r^2}$ to determine the relationship between the gravitational acceleration and mass of the planet and the radius of the planet.

$g \propto M$ (g is directly proportional to the mass of the planet)

If the mass of the planet **decreases**, the value of g will also **decrease**.

$g \propto \frac{1}{r^2}$ (g is inversely proportional to the square radius of the planet)

If the radius **decreases**, the value of g **increases** with the square.

The gravitational acceleration on Planet X will be:

$$g = \frac{\frac{1}{3}}{(0,75)^2} \times 9,8$$
$$= 5,81 \text{ m} \cdot \text{s}^{-2}$$

$\therefore$ The gravitational acceleration on Planet X is **smaller** than the gravitational acceleration on Earth.

The decrease in mass of the planet had a greater effect than the decrease of the radius of the planet.

19. 0 | 180 | 490 | upwards

8 marks

Explanation:

The magnitude of the net force acting on block Q:

Block Q is in equilibrium, therefore the net force acting on it would be zero.

$$F_{net} = 0 \text{ N}$$

The tension in rope T_1 :

Block P experiences a frictional force of 180 N to the right. The tension in rope T_1 is also 180 N.

$$T_1 = 180 \text{ N}$$

The vertical component of T_2 :

The **upward vertical component** in rope T_2 must be equal to the **weight** of block Q which is acting **downwards**.

$$\begin{aligned} F_g &= mg \\ &= 50 \times 9,8 \\ &= 490 \text{ N} \end{aligned}$$

$$T_{Y2} = 490 \text{ N upwards}$$

20. true

2 marks

Explanation:

The component of the block's weight parallel to the inclined plane, acts down the inclined plane, trying to pull the block down the plane.

$$\begin{aligned} F_g \parallel &= mg \times \sin \theta \\ &= 1,5 \times 9,8 \times \sin 75^\circ \\ &= 14,2 \text{ N} \end{aligned}$$

The block moves at a constant velocity, therefore the net force is zero.

$$\begin{aligned} f_k + F_g \parallel &= F_A \\ f_k + 14,2 &= 20 \\ f_k &= 5,8 \text{ N down the inclined plane} \end{aligned}$$

21. 180

3 marks

Explanation:

When two forces act on an object, the **minimum resultant force** is obtained when the **angle** between the two forces is 180° , meaning the forces are acting in the **opposite direction**.

$$F_{net} = F_1 - F_2$$

Any time the angle is smaller than 180° , the resultant force will be greater than the minimum.

22. B: force of the book on the Earth.

4 marks

Explanation:

The **weight** of the book is the force that the **Earth exerts on the book**, which is directed downwards. This is the action force.

The reaction force is the force that the **book exerts on the Earth**. This reaction force is equal in magnitude but opposite in direction to the weight of the book, and it acts upward.

According to Newton's Third Law of Motion, the reaction force to the weight of a book lying on a table is the **force exerted by the book on the Earth**.

23. true

2 marks

Explanation:

- The CCl_4 molecule has a **tetrahedral shape** with **equal electron distribution**.
 - The molecule is symmetrical and therefore carbon tetrachloride is a **non-polar molecule**.
 - The type of intermolecular forces between non-polar molecules are **London forces**, which is also referred to as dispersion forces.
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24. lower | weaker | molten | ions

8 marks

Explanation:

Substance A consist of small **nitrogen molecules** which are non-polar molecules. The main intermolecular forces between non-polar molecules are **weak London forces**.

Substance B is **lithium chloride** which is an ionic compound with **strong electrostatic forces** between the positive and negative ions which are arranged in a giant crystal lattice.

Nitrogen has a **lower boiling point** because its **weak** London dispersion forces require very little energy to overcome the intermolecular forces.

Lithium chloride has a much **higher boiling point** because its **strong** ionic bonds require a lot of energy to break the bonds..

When lithium chloride is in the solid phase, the ions are in fixed positions in the crystal lattice and would not be able to conduct electricity. When lithium chloride is **molten**, the **ions** are free to move and can conduct electricity.

25. true

2 marks

Explanation:

Each block experiences the same downward gravitational force because the **mass of the blocks are the same**.

The strings are not connected to each other, meaning each string only supports one block. The **length of the strings does not affect the tension**.

Since each string only supports one identical block, **the tension** in each string is simply the **weight of the block**.

$$T_P = T_Q = T_R$$

26. larger

3 marks

Explanation:

When the lift is **accelerating upwards**, the reading on the scale **increases** because the scale measures the normal force, which includes both the force due to gravity and the additional force required to accelerate the man upwards.

$$\begin{aligned} F_{net} &= ma \\ N - w &= ma \\ N - 784 &= 80 \times 2 \\ N &= 944 \text{ N} \end{aligned}$$

When a lift **accelerates upwards**, the apparent weight (reading on the scale) of the man inside the lift will be **larger** than his actual weight.

27. B: Carbon dioxide

4 marks

Explanation:

To determine molecular polarity, electronegativity difference, molecular shape and electron distribution must be considered.

Water (H_2O): The O — H bonds are polar, and the molecule has a bent shape (due to lone pairs on oxygen). Uneven electron distribution, therefore it is a **polar molecule**.

Hydrogen bromide (HBr): Is a linear molecule with a significant electronegativity difference between H and Br. Dipoles are formed and there is an uneven electron distribution. Hydrogen bromide is a **polar molecule**.

Ammonia (NH_3): Has a trigonal pyramidal shape due to a lone pair on nitrogen. The N — H bonds are polar, with uneven electron distribution. Ammonia is a **polar molecule**.

Carbon Dioxide (CO_2): Consists of a carbon atom double bonded to two oxygen atoms ($\text{O}=\text{C}=\text{O}$). Oxygen is more electronegative than carbon, so the C=O bonds are polar. However, CO_2 is linear with equal electron distribution. The molecule has no overall dipole moment, making it a **non-polar molecule**.

28. 6,79 | 28,11

4 marks

Explanation:

The frictional force:

$$\begin{aligned}F_N &= F_g \times \cos \theta \\&= 4 \times 9,8 \cos 30^\circ \\&= 33,95 \text{ N}\end{aligned}$$

$$\begin{aligned}f_k &= \mu_k N \\&= 0,2 \times 33,95 \\&= 6,79 \text{ N}\end{aligned}$$

The tension in the string:

$$\begin{aligned}F_{g \parallel} &= 4 \times 9,8 \sin 30^\circ \\&= 19,6 \text{ N}\end{aligned}$$

$$\begin{aligned}T - f_k - F_{g \parallel} &= ma \\T - 6,79 - 19,6 &= 4 \times 0,43 \\T &= 28,11 \text{ N}\end{aligned}$$

29. bond energy

3 marks

Explanation:

Bond energy is the amount of energy required to break one mole of a specific chemical bond in a gaseous substance. It is measured in **kilojoules per mole** (kJ/mol) and represents the strength of a bond between two atoms.

The strength of a bond is related to the **bond length**, the **size of the bonded atoms** and the **number of bonds between the atoms**. In general:

- the shorter the bond length, the stronger the bond between the atoms.
- the smaller the atoms involved, the stronger the bond.
- the more bonds that exist between the same atoms, the stronger the bond.

30. true

2 marks

Explanation:

NH₃ consists of nitrogen N with an **electronegativity of 3,0** and hydrogen H with an **electronegativity of 2,1**.

The difference in electronegativity is 0,9 which is smaller than 1,7 and bigger than zero.

∴ NH₃ has **polar covalent bonds**.

Total: 111 Marks