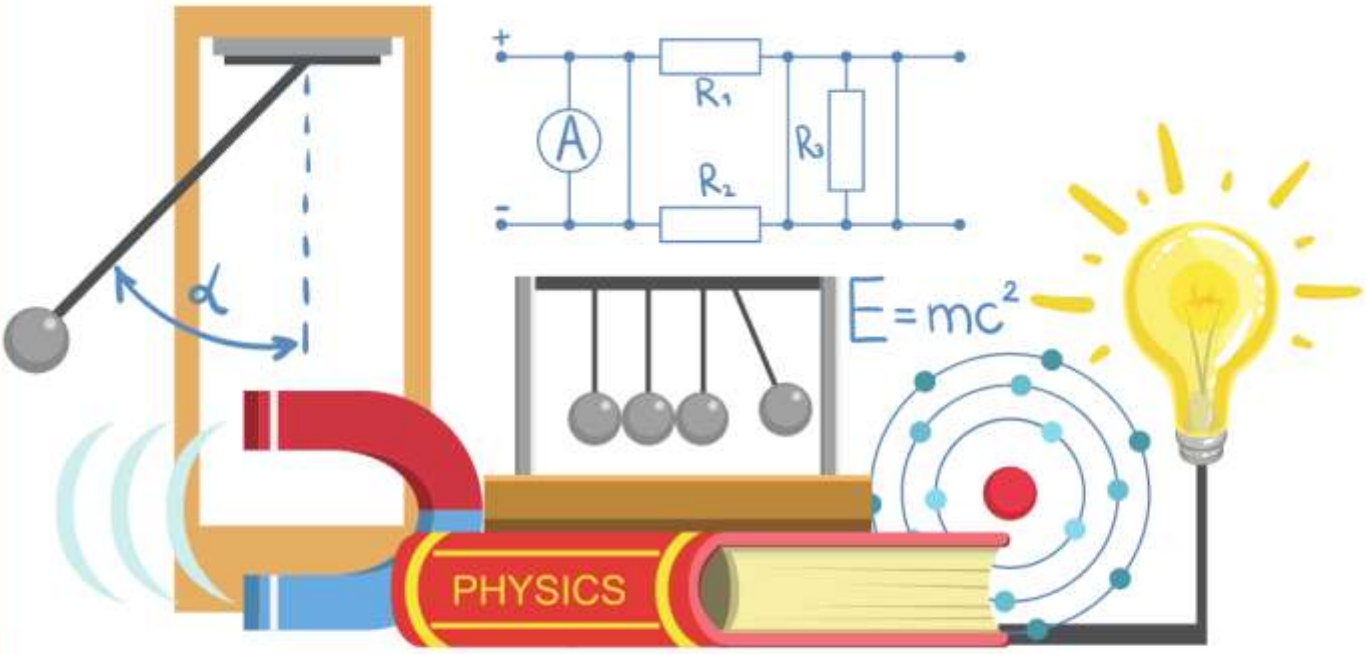
TYCHR

Friend, Philosopher, Guide

IB Physics HL Paper 2 Question Bank



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Physics
Higher level
Paper 2

2 hours and 15 minutes

Instructions to candidates

- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the physics data booklet is required for this paper.
- The maximum mark for this examination paper is **[90 marks].**

Answer all questions. Answers must be written within the answer spaces provided.

1. The air in a kitchen has a pressure of 1.20 x 10^5 Pa and a temperature of 23 C. There is a refrigerator inside the kitchen with an internal volume of 0.38 m^3.

a. When the refrigerator door is open, the temperature and pressure of the air inside the kitchen and inside the refrigerator are the same. Calculate the number of air molecules in the refrigerator.

Answer

PV = nRT
N = PV / RT
N = (1.20 x 10^5 x 0.38) / ((273 + 23) x 8.314 = 18.529 = 18.5 mol
Number of molecules = 18.5 x 6.023 x 10^{23} = ***1.1 x 10^{25}***

b. When the refrigerator door is closed, the temperature inside cools down to 4 C with the same amount of air molecules.

i. Determine the pressure of the air inside the refrigerator round to 3 significant figures

Answer

$P_1T_1 = P_2T_2$
1.2 x 10^5 x (273+23) = P_2 x (273+4)
P_2 = (1.20 x 10^5 x (273+23)) / (273+4)
*P_2 = 128231.0469 → (**1.28 x 10^5 Pa**)*

ii. The area of the door of the refrigerator is 0.75 m^2. Determine the minimum force needed to open the refrigerator door.

Answer

Force = Difference in pressure x Area
Force = (128231 - 120000) x 0.75 = 6173.25 = ***6.17 kN***

2. A closed box has a fixed volume of 0.21m^3 and contains 4 mol of ideal monatomic gas. The temperature of the gas is 294 K.

a. Calculate the pressure of the gas

Answer

PV = nRT
P = nRT / V
P = (4 x 8.3145 x 294) / 0.21 = 46561.2 Pa = **46.5 kPa**

b. When the gas is supplied with 0.81 kJ of energy, the temperature of the gas increases by 25 K. The specific heat capacity of the gas is 3.1 kJ / kgK

i. Calculate the mass of the gas in kg

Answer

$Q = mc\Delta T$

$M = Q / c\Delta T$

$M = 0.81 / (3.1 \times 25) = 0.0104516\ kg =$ ***0.0105 kg***

ii. Determine the total kinetic energy of the gas particles in kJ

Answer

Average kinetic energy = 3/2 kB T

$Avg\ KE = 3/2\ (1.38 \times 10^{-23}) \times 319 = 6.6033 \times 10^{-21}$

$Number\ of\ molecules = 4 \times 6.023 \times 10^{23} = 2.4092 \times 10^{24}$

$Total\ kinetic\ energy = 6.6033 \times 10^{-21} \times 2.4092 \times 10^{24} = 15908.67036\ J =$ ***16 kJ***

3. An electron is placed 0.50 m from a fixed point charge of -5.8 mC.

a. Determine the electric field strength due to the point charge at the position of the electron

Answer

$E = kq / r^2$

$E = (8.99 \times 10^9 \times 5.8 \times 10^{-3}) / 0.5^2$

$E = 208568000 =$ ***2.09×10^8 N/C***

b. Calculate the force acting on the electron

Answer

$F = qE$

$F = 1.6 \times 10^{-19} \times 2.09 \times 10^8 =$ ***3.344×10^{-11} N***

4. An electron follows a circular motion in a uniform magnetic field. The velocity of the electron at a Point P is 7.2×10^5 m/s towards the right direction. The magnitude of the magnetic field is 8.1T.

a. State the direction of the magnetic field

Answer

Out of the page according to the Right hand rule. The index finger is pointed towards the direction in which the electron is moving. The thumb points down and the middle finger points outwards indicating that it's out of the page.

b. Calculate the magnitude of the magnetic force acting on the electron in terms of N.

Answer

$F = qvB$

$F = 1.6 \times 10^{-19} \times 7.2 \times 10^{5} \times 8.1$

$F = 9.3312 \times 10^{-13} \rightarrow$ ***9.3 ×10⁻¹³ N***

c. State why the electron moves

i. at a constant speed

Answer

The magnetic force does not act on the electron or does not do any work on the electron. Because of this, it does not change the kinetic energy of the electron. The kinetic energy remains constant only if the speed is constant.

ii. along a circular path

Answer

The velocity of the electron is at a right angle to the magnetic field. Since the magnetic force is acting towards the center of the circle, there is a centripetal force acting on the charge

5.

a. Define the term impulse

Answer

It is used to describe or quantify the effect of force acting over time to change the momentum of an object. Impulse = force x time

b. A chicken egg that weighed 61 grams dropped to the ground from a height of 1.3 m. Assume two things: there is negligible air resistance and that the egg does not bounce back or break.

i. Determine the kinetic energy of the egg before impact

Answer

Kinetic energy = Potential energy so E = mgh

Ke = 0.061 x 1.3 x 9.81 = 0.777 J = ***0.78 J***

ii. It takes 53 ms for the egg to come to a rest. Determine the average decelerating force that the ground exerts on the egg

Answer

Momentum (p) = mass x velocity
To find velocity, the kinetic energy formula can be rearranged
Ke = ½ mv^2
V = $((2(Ke) / m))^{½} = ((2 \times 0.78) / 0.061)^{1/2}$
p = $0.061 \times ((2 \times 0.78) / 0.061)^{1/2}$
Momentum = 0.061 x 5.05667 = 0.308 = ***0.31 kgm/s***

Force = change in momentum / time
Force = 0.31 / 0.053 = 5.849 N = ***5.85 N***

6.

a. State what happens to the density of a nucleus when there is a change in the number of nucleons

Answer

The density remains constant. It does not vary with the number of nucleons in the nucleus

b. Determine the radius of a Magnesium-24's nucleus

Answer

Radius = R0 x $A^{1/3}$
Radius = $1.2 \times 10^{-15} \times 24^{1/3}$
Radius = ***3.46×10^{-15} m***

c. Define decay constant

Answer

The decay constant of a radioactive nuclide is its probability of decay per unit time.

7. In a school experiment, a small electric motor is used with a capacitor of 14 mF and a battery. The capacitor is charged with the help of the battery when the switch is connected to a point X. However, when the switch is connected to Y, the capacitor fully discharges through the small electric motor and helps raise a small mass.

a. The battery has an electromotive force (emf) of 6.8 volts. Determine how much charge flows through the motor when the mass is raised.

Answer

Charge = Capacitance x Volts
Charge = $14 \times 10^{-3} \times 6.8 =$ ***0.0952 C***

b. The electric motor has the ability to transfer ⅔ of the electric energy stored in the capacitor into the gravitational potential energy. What is the maximum height that a 52 g mass can be raised?

Answer

Energy that is stored in the capacitor is denoted by ½ CV^2
$E = ½ \times 14 \times 10^{-3} \times 6.8^2 = 0.324$ J
Using that energy, the height can be found using the standard mgh formula
Therefore, Energy = mgh
Height = Energy / mg
Height = ⅔ x (0.324 / (0.052 x 9.81)) = 0.423 = 0.42 m
The height was multiplied by ⅔ because it said that the motor is only able to transfer ⅔ of the electric energy stored in the capacitor

8. Mars has two moons orbiting around it in a circular orbit. The moon Deimos and Phobos. This question will be about the moon Deimos.

a. State the origin of the force that acts on the moon Deimos.
Answer
Gravitational force of Mars acts on the moon Deimos to keep it orbiting around

b. This force does not do any work on the moon Deimos. Outline why.
Answer
Since the force and the velocity are perpendicular to each other, no work is done on the moon. When they are at 90 degrees to each other, there is no change in the gravitational potential energy.

9. A boy is riding a bicycle up a slope that is inclined by 5 degrees from the horizontal. The boy's bicycle is powered by an electric motor and has a battery that transfers energy to the electric motor. The total weight of the boy and the bicycle is 70 kgs.

a. Calculate the weight component of the boy and the bicycle acting down the slope.
Answer
Weight component is mass x gravitational constant x sin theta
Weight = 70g x sin(5) = 59.849 = ***59.8 N***

b. When the boy goes up the slope again, he takes an additional bag with him. Outline and explain if this would change the maximum distance he can travel on his bicycle along the slope.
Answer
Since he is carrying more weight, more resistive forces will act on him. Due to this increase in the opposing force, the maximum distance he covers will reduce. It also reduces for two other reasons: if he carries more mass up a slope, more work needs to be done to cover a larger distance. Another reason is that most of the kinetic energy is now potential energy since the speed of the boy has also reduced.

c. The boy's bicycle has a meter on it. It displays the emf and the current for the battery when the bicycle is in motion. This is what was displayed at one such moment:

Current: 6.2 A Potential Difference: 15 V emf of the cell: 18 V

Determine the internal resistance of the battery

Answer

Resistance = potential difference / current

Resistance = (18 - 15) / 6.2 = ***0.483 ohms***

d. The bicycles battery is an arrangement of 10 identical cells where 5 are connected in series and in one series circuit, two are connected in parallel. Calculate the emf one cell.

Answer

Emf of the cell / number of cells in a circuit

Emf of one cell = 18 / 5 = ***3.6V***

10. Through a beta plus decay, Phosphorus - 30 can be formed from Silicon - 30.

a. Write down the nuclear reaction that shows the beta plus decay

Answer

$^{30}_{15}P \rightarrow {}^{30}_{14}Si + {}^{0}_{+1}e + \nu_e$

b. Sketch the Feynman diagram that represents the above reaction

Answer

udu quarks become udd - W^+ is emitted

Electron neutrino direction is outside

Positron direction is inside

c. Define quark confinement

Answer

A quark is an elementary particle with an electric charge. But a single quark is never found alone. Instead, when particles are smashed together and quarks are detected, they are described like ends of rubber bands that stretch, but eventually pull quarks back together again. This is known as quark confinement.

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