

AP Physics 2 – Practice Set

AP Physics 2 (algebra-based) · Total marks: 41 · Answers on the last page

Free-response-style practice covering fluids, thermodynamics, electricity, magnetism, optics and modern physics. A calculator is allowed; use $g = 9.81 \text{ m s}^{-2}$, $k = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$ and $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ unless stated otherwise.

Section A – Fluids and thermodynamics

1. A hydraulic lift has a small piston of area 0.0050 m^2 and a large piston of area 0.045 m^2 . A force of 250 N is applied to the small piston.
Calculate the force produced on the large piston. [3]
2. A block of density 700 kg m^{-3} and volume 0.020 m^3 floats in water of density 1000 kg m^{-3} .
(a) Calculate the fraction of the block's volume that is submerged.
(b) Calculate the buoyant force acting on the block. [4]
3. An ideal gas consists of 2.0 mol confined to a volume of 0.050 m^3 at a temperature of 300 K .
Calculate the pressure of the gas. [3]
4. A gas absorbs 500 J of heat while doing 200 J of work on its surroundings as it expands.
(a) Calculate the change in internal energy of the gas.
(b) State whether the internal energy of the gas increases or decreases, with a reason. [3]

Section B – Electricity and magnetism

5. Two point charges, $q_1 = +3.0 \mu\text{C}$ and $q_2 = +5.0 \mu\text{C}$, are separated by 0.20 m in air.
Calculate the magnitude of the electrostatic force between them. [3]
6. A 12 V battery is connected to a 10Ω resistor in series with a parallel combination of two 20Ω resistors.
(a) Calculate the total resistance of the circuit.
(b) Calculate the total current supplied by the battery.
(c) Calculate the current through each 20Ω resistor. [5]
7. A straight wire of length 0.30 m carries a current of 4.0 A perpendicular to a uniform magnetic field of strength 0.50 T .
Calculate the magnitude of the magnetic force on the wire. [3]
8. A circular loop of area 0.020 m^2 is in a magnetic field that decreases uniformly from 0.40 T to 0.10 T in 0.50 s .
Calculate the magnitude of the EMF induced in the loop. [3]

Section C – Optics and modern physics

9. Light travelling in air ($n = 1.00$) strikes a glass surface ($n = 1.50$) at an angle of incidence of 30° .
Calculate the angle of refraction in the glass. [3]
10. An object is placed 20 cm from a converging lens of focal length 15 cm .
(a) Calculate the image distance.
(b) Calculate the magnification and describe the image (real/virtual, upright/inverted). [4]

11. Light of wavelength 600 nm passes through two slits separated by 0.20 mm and forms an interference pattern on a screen 2.0 m away.
Calculate the fringe spacing on the screen. [3]
12. The work function of a metal surface is 2.3 eV. Light of wavelength 400 nm is incident on the surface.
(a) Calculate the energy of an incident photon in eV (use $hc = 1240 \text{ eV nm}$).
(b) Calculate the maximum kinetic energy of an emitted photoelectron. [4]

Answers

Check your working against these. If an answer does not match, try the question again before looking for the method.

- By Pascal's principle, pressure is equal: $F_2 = F_1 \frac{A_2}{A_1} = 250 \times \frac{0.045}{0.0050} = 2250 \text{ N}$.
- (a) At equilibrium, buoyant force = weight, so $\rho_{\text{water}} V_{\text{sub}} g = \rho_{\text{block}} V g \Rightarrow \frac{V_{\text{sub}}}{V} = \frac{700}{1000} = 0.70$ (70 percent submerged).
(b) $F_B = \rho_{\text{block}} V g = 700 \times 0.020 \times 9.81 = 137 \text{ N}$.
- $PV = nRT \Rightarrow P = \frac{nRT}{V} = \frac{2.0 \times 8.31 \times 300}{0.050} = 9.97 \times 10^4 \text{ Pa}$.
- (a) First law: $\Delta U = Q - W = 500 - 200 = 300 \text{ J}$.
(b) The internal energy increases, because the heat added exceeds the work done by the gas.
- $F = \frac{kq_1q_2}{r^2} = \frac{8.99 \times 10^9 \times 3.0 \times 10^{-6} \times 5.0 \times 10^{-6}}{0.20^2} = 3.4 \text{ N}$.
- (a) Parallel pair: $\frac{1}{R_p} = \frac{1}{20} + \frac{1}{20} \Rightarrow R_p = 10 \Omega$. Total $R = 10 + 10 = 20 \Omega$.
(b) $I = \frac{V}{R} = \frac{12}{20} = 0.60 \text{ A}$.
(c) Voltage across parallel pair = $I \times R_p = 0.60 \times 10 = 6.0 \text{ V}$; current in each branch = $6.0/20 = 0.30 \text{ A}$.
- $F = BIL = 0.50 \times 4.0 \times 0.30 = 0.60 \text{ N}$.
- $\varepsilon = \left| \frac{\Delta\Phi}{\Delta t} \right| = \frac{|(0.10 - 0.40) \times 0.020|}{0.50} = 1.2 \times 10^{-2} \text{ V}$.
- Snell's law: $n_1 \sin \theta_1 = n_2 \sin \theta_2 \Rightarrow \sin \theta_2 = \frac{\sin 30^\circ}{1.50} = 0.333 \Rightarrow \theta_2 = 19.5^\circ$.
- (a) $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \Rightarrow \frac{1}{d_i} = \frac{1}{15} - \frac{1}{20} = \frac{1}{60} \Rightarrow d_i = 60 \text{ cm}$.
(b) $m = -\frac{d_i}{d_o} = -\frac{60}{20} = -3.0$; the image is real, inverted and magnified 3 times.
- $\Delta y = \frac{\lambda L}{d} = \frac{600 \times 10^{-9} \times 2.0}{0.20 \times 10^{-3}} = 6.0 \times 10^{-3} \text{ m} = 6.0 \text{ mm}$.
- (a) $E = \frac{hc}{\lambda} = \frac{1240}{400} = 3.1 \text{ eV}$.
(b) $KE_{\text{max}} = E - \phi = 3.1 - 2.3 = 0.80 \text{ eV}$.

Need this topic taught, not just practised? Book a trial lesson at 50% off with Mr. Ahmad — online worldwide or in person in Dubai.

WhatsApp +971 55 373 5695 · mathandsciencetutor.com