



RADLEY

Warm-up problems

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Warm up problems: don't forget ESAU!

- 1 If an object of mass 5 kg experiences a force of 3 N, what is its acceleration?
- 2 A car's speed increases from 25 m/s to 60 m/s in 5 s. What is its acceleration?
- 3 If the mass of the car is 1200 kg, what is its final kinetic energy at 60 m/s?
- 4 How many protons, neutrons and electrons are there in a $^{108}\text{Ag}^+$ ion?
- 5 If a 9 V battery is connected to a circuit of resistance $45\ \Omega$, what current flows?

Solutions (1)

$$1 \quad F = ma, \quad a = \frac{F}{m} = \frac{3 \text{ N}}{5 \text{ kg}} = 0.6 \text{ m/s}^2$$

$$2 \quad a = \frac{\Delta v}{t} = \frac{60 \text{ m/s} - 25 \text{ m/s}}{5 \text{ s}} = \frac{35 \text{ m/s}}{5 \text{ s}} = 7 \text{ m/s}^2$$

$$3 \quad KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 1200 \text{ kg} \times (60 \text{ m/s})^2 = 2\,160\,000 \text{ J}$$

4 47 protons, 61 neutrons and 46 electrons

$$5 \quad V = IR, \quad I = \frac{V}{R} = \frac{9 \text{ V}}{45 \, \Omega} = 0.2 \text{ A}$$

Warm up problems (2): use ESAU!

- 1 If a charge of 2 C flows through an ammeter in 5 s, what will the current read?
- 2 A car starting at a speed of 5 m/s accelerates at 3 m/s^2 for 12 s. What is its final speed?
- 3 If a battery supplies a current of 0.8 A for 28 s, what charge has flowed?
- 4 A pure gold ring has mass 15 g and gold has density 19.6 g/cm^3 . What is its volume?
- 5 If a lightbulb has a current of 1.2 A flowing through it, how long will it take for 90 C of charge to flow through it?

Solutions (2)

$$1 \quad I = \frac{Q}{t} = \frac{2 \text{ C}}{5 \text{ s}} = 0.4 \text{ A}$$

$$2 \quad a = \frac{\Delta v}{t}, \Delta v = at = 3 \text{ m/s}^2 \times 12 \text{ s} = 36 \text{ m/s}$$

Starting speed = 5 m/s, so final speed = 41 m/s.

$$3 \quad Q = It = 0.8 \text{ s} \times 28 \text{ s} = 22.4 \text{ C}$$

$$4 \quad \rho = \frac{m}{V}, V = \frac{m}{\rho} = \frac{15 \text{ g}}{19.6 \text{ g/cm}^3} = 0.77 \text{ cm}^3$$

$$5 \quad Q = It, t = \frac{Q}{I} = \frac{90 \text{ C}}{1.2 \text{ A}} = 75 \text{ s}$$

Warm up problems (3): use ESAU!

- 1 A car drives 82.0 miles in 3 h 46 min. What is its average speed
 - (a) in mph?
 - (b) in m/s? [Hint: 1 mile = 1600 m]
- 2 A Nissan LEAF accelerates to 27.5 m/s from rest in 11.5 s. What is its acceleration?
- 3 An electric car charging point supplies a voltage of 394 V and a current of 104 A.
 - (a) What is the resistance of the car charging (connected to the charging point)?
 - (b) The car is connected for 29 min. How much charge has flowed?

Solutions (3)

$$1 \quad (a) \quad v = \frac{d}{t} = \frac{82.0 \text{ mile}}{3 \text{ h} + \frac{46}{60} \text{ h}} = 21.8 \text{ mph}$$

$$(b) \quad 21.8 \frac{\text{mile}}{\text{h}} \times \frac{1600 \text{ m}}{\text{mile}} \times \frac{1 \text{ h}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 9.7 \text{ m/s}$$

$$2 \quad a = \frac{\Delta v}{t} = \frac{27.5 \text{ m/s}}{11.5 \text{ s}} = 2.39 \text{ m/s}^2$$

$$3 \quad (a) \quad V = IR, R = \frac{V}{I} = \frac{394 \text{ V}}{104 \text{ A}} = 3.79 \Omega$$

$$(b) \quad Q = It = 29 \text{ min} \times \frac{60 \text{ s}}{\text{min}} \times 104 \text{ A} = 181\,000 \text{ C}$$

Warm up problems (4): use ESAU!

- 1 A solar panel generates 300 J of electrical energy for every 1400 J of light energy. What is its efficiency?
- 2 A flashlamp bulb operates at a voltage of 2.5 V and a current of 0.3 A. What is its resistance?
- 3 A Nissan LEAF has mass 1557 kg. If it accelerates at 2.3 m/s^2 , what is the unbalanced force on it?
- 4 A man has mass of 77.5 kg. What is his weight on the Moon (gravitational field strength = 1.63 N/kg)?
- 5 A laser beam entering water (refractive index = 1.33) refracts at 12° to the normal. What was the angle of incidence?

Solutions (4)

$$\begin{aligned} 1 \quad \text{efficiency} &= \frac{\text{useful energy out}}{\text{total energy in}} \times 100\% = \\ & \frac{300 \text{ J}}{1400 \text{ J}} \times 100\% = 21.4\% \end{aligned}$$

$$2 \quad V = IR, R = \frac{V}{I} = \frac{2.5 \text{ V}}{0.3 \text{ A}} = 8.33 \Omega$$

$$3 \quad F = ma = 1557 \text{ kg} \times 2.3 \text{ m/s}^2 = 3580 \text{ N}$$

$$4 \quad W = mg = 77.5 \text{ kg} \times 1.63 \text{ N/kg}$$

$$\begin{aligned} 5 \quad n &= \frac{\sin(\text{big})}{\sin(\text{small})}, \\ \sin(\text{big}) &= n \sin(\text{small}) = 1.33 \times \sin(12^\circ) = 0.27652 \dots \\ \text{big} &= \sin^{-1}(0.27652 \dots) = 16.1^\circ \end{aligned}$$

Warm up problems (5): use ESAU!

- 1 A light beam hits glass (refractive index = 1.52) at an angle of incidence of 48° . What is the angle of refraction?
- 2 A man pushed a car 8 m, doing 1800 J of work in the process. What force did he push the car with?
- 3 78 C of charge flow through an ammeter in 32.5 s. What current does the ammeter read?
- 4 A marble of mass 25 g rolls at 0.6 m/s along a track. What is its kinetic energy?
- 5 45 C of electrical charge leave a 9 V battery. How much energy does this charge carry?

Solutions (5)

$$1 \quad n = \frac{\sin(\text{big})}{\sin(\text{small})},$$

$$\sin(\text{small}) = \frac{\sin(\text{big})}{n} = \frac{\sin(48^\circ)}{1.52} = 0.488911 \dots$$

$$\text{small} = \sin^{-1}(0.488911 \dots) = 29.3^\circ$$

$$2 \quad W = Fd, \quad F = \frac{W}{d} = \frac{1800 \text{ J}}{8 \text{ m}} = 225 \text{ N}$$

$$3 \quad Q = It, \quad I = \frac{Q}{t} = \frac{78 \text{ C}}{32.5 \text{ s}} = 2.4 \text{ A}$$

$$4 \quad \text{KE} = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.025 \text{ kg} \times (0.6 \text{ m/s})^2 = 4.5 \times 10^{-3} \text{ J}$$

$$5 \quad E = QV = 45 \text{ C} \times 9 \text{ V} = 405 \text{ J}$$

Warm up problems (6): use ESAU!

- 1 What is the mass of an object if a force of 72 N makes it accelerate at 8 m/s^2 ?
- 2 How far under water (density 1000 kg/m^3) do you have to go for the pressure to increase by $9 \times 10^5 \text{ Pa}$?
- 3 If light refracts into diamond (refractive index = 2.42) at 12° to the normal, what was the angle of incidence?
- 4 How far up a staircase does a man of mass 85 kg need to go to gain 10 000 J of GPE?
- 5 What is the *critical angle* for diamond?

Warm up problems (6): use ESAU!

$$1 \quad F = ma, \quad m = \frac{F}{a} = \frac{72 \text{ N}}{8 \text{ m/s}^2} = 9 \text{ kg}$$

$$2 \quad P = \rho gh, \quad h = \frac{P}{\rho g} = \frac{9 \times 10^5 \text{ Pa}}{1000 \text{ kg/m}^3 \times 10 \text{ N/kg}} = 90 \text{ m}$$

$$3 \quad n = \frac{\sin(\text{big})}{\sin(\text{small})},$$

$$\sin(\text{big}) = n \sin(\text{small}) = 2.42 \times \sin(12^\circ) = 0.5031 \dots$$

$$\text{big} = \sin^{-1}(0.5031 \dots) = 30.2^\circ$$

$$4 \quad \text{GPE} = mgh, \quad h = \frac{\text{GPE}}{mg} = \frac{10\,000 \text{ J}}{85 \text{ kg} \times 10 \text{ N/kg}} = 11.8 \text{ m}$$

$$5 \quad \sin c = \frac{1}{n}, \quad c = \sin^{-1} \left(\frac{1}{2.42} \right) = 24.4^\circ$$

Warm up problems (7): use ESAU!

- 1 What is the mass of an object which weighs 80 N on Jupiter (where the gravitational field strength is 25 N/kg)?
- 2 What is the kinetic energy of a tennis ball of mass 58 g and served at 64 m/s?
- 3 How long will it take for a long distance runner at 2.4 m/s to cover 180 km?
- 4 How much work does a horse pulling a cart with a force of 4100 N for a distance of 15 m do?
- 5 What was the starting speed if a car accelerating at 3 m/s^2 for 4 s reaches a speed of 28 m/s?

Warm up problems (8): use ESAU!

- 1 What is the mass of a piece of lead of volume 8.3 cm^3 and density 11.3 g/cm^3 ?
- 2 How much energy dissipates in a lightbulb with potential difference 3.5 V across it if 12 C flow through?
- 3 What is the current in the bulb it has resistance 15Ω ?
- 4 If the critical angle of perspex is 42° , what is the refractive index?
- 5 How much GPE does a cannonball of mass 5 kg gain ascending to the top floor of the Eiffel tower, 276 m above the ground?

Warm up problems (9): use ESAU!

- 1 How much light energy comes from a 78% efficient lightbulb if 350 J of electrical energy is transferred to it?
- 2 What is the acceleration if a 2400 kg truck experiences an unbalanced force of 1800 N?
- 3 What is the voltage across an LED if its resistance is $6.5\ \Omega$ when a current of 200 mA flows?
- 4 How far does light travel in 8 minutes? What is the astronomical significance of this distance?
- 5 How much energy is transferred if 2.6 C of charge flows from a 1.5 V battery?