Homework Solutions, Physics 117
Home Work Problem Set # 4

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Solutions by

CH 5: CQ 24, 29, 39; Ex 10, 18, 21; CH 6: CQ 6, 11; Ex 4, 9

Ch 5

CQ 24 The force on an object at a height h above the surface of the Earth is given by

$$F = \frac{G M_E m}{(R_E + h)^2}$$

where M_E is the mass of the earth, m the mass of the object and R_E is the radius of the Earth. When h is much smaller than R_E, the force can be approximated by

$$F = \frac{G M_E m}{R_E^2} = m\left(\frac{G M_E}{R_E^2}\right) = mg$$

This is a good approximation, when $h << R_E$, and is easy to use. But if h is not small compared to R_E then we cannot neglect it in the denominator and Force is then given by

$$F = \frac{G M_E m}{r^2} \quad \text{where} \quad r = R_E + h$$

CQ 29 We would expect the value of g to be larger because uranium has a larger density of mass than the average surface material of the earth, and would therefore attract nearby masses more strongly than the average location.

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CQ39. When the tide along the American Western seaboard is high, the tide in Japan would be low, since Japan is 90° west of San Francisco and tidal bulges occur on opposite sides of the Earth, i.e. 180° apart.

Ex10.
$$F_{Shuttle} = \frac{G M_E m}{(R_E + 400\,\text{Km})^2} = \frac{G M_E m}{R_E^2}\left(\frac{R_E^2}{(R_E+400\,\text{km})^2}\right)$$

$$= F_{Earth}\left(\frac{R_E}{R_E + 400\,\text{Km}}\right)^2$$

$$= F_{earth}\left(\frac{6400\,\text{Km}}{6400\,\text{Km} + 400\,\text{Km}}\right)^2$$

$$\boxed{F_{Shuttle} = F_{earth} \times (0.886).}$$

Ex18
$$g_{Mars} = \frac{G M_{Mars}}{R_{Mars}^2} = \frac{G(0.11)M_E}{(0.53 R_E)^2} = \frac{0.11}{(0.53)^2}\frac{G M_E}{R_E^2}$$

$$= \frac{0.11}{(0.53)^2}\, g_{Earth}$$

$$= (0.391) \times 9.8\,\text{m/s}^2$$

$$\boxed{g_{MARS} = 3.8\ \text{m/s}^2.}$$

[Text's answer of 3.94 is an overestimate, even if $g = 10.0$ is used]

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ERROR CORRECTION

Ch 5 ~~Ex 21~~) Ex 22) The following is the solution to Ch 5 Ex 22; see p 4/4 for Ch 5 Ex 21.

Gravitational field of the earth at a distance of $5R_E$ is given by

$$\frac{F_G}{m} = \frac{GM_E}{(5R_E)^2} = \frac{1}{25}\frac{GM_E}{R_E^2}$$

the field is reduced $\boxed{\text{by a factor of } 25,}$ from $g_0 = 9.8$ to $g_{5R_E} = 0.39\ m/sec^2$.

Ch 6

CQ 6 Padding dashboards lengthens the time for the body to stop. Then the change in momentum takes place over a longer period of time and therefore the magnitude of the force is reduced (because $\vec{\Delta P} = \vec{F} \cdot \Delta t = \text{Impulse}$).

CQ 11) The initial momentum $= mv = 2\,Kg \times 4\,m/s = 8\,Kg\,m/s$ acting downward. The final momentum is zero. the impulse is $\boxed{8\,Kg\,m/s \text{ directed upward.}}$

Ex 4

$$m_{you}\, v_{you} = m_{18\ wheeler} \times v_{18\ wheeler}$$

$$v_{you} = \frac{m_{18\ wheeler} \times v_{18\text{-}wheeler}}{m_{you}}$$

$$= \frac{24{,}000\ \cancel{Kg} \times 1\,mph}{60\ \cancel{Kg}}$$

$$= \boxed{400\ mph.}$$

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Ex9) Impulse = Change in momentum = Avg Force × Δt

Final momentum = 0, Initial momentum = mv
$= 1500\ \text{kg} \times 30\ \text{m/s}$

$$\text{Impulse} = 0 - 1500\ \text{Kg} \times 30\ \text{m/s}$$

$$\boxed{-45{,}000\ \text{Kg m/s.}}$$

$$\text{Average force} = \frac{\text{Change in momentum}}{\Delta t}$$

$$= \frac{-45{,}000\ \text{Kg m/s}}{8\ \text{s.}}$$

$$= 5625\ \text{Kg m/s}^2$$

$$= \boxed{-5{,}625\ \text{N.}}$$

Error Correction: In error the solution to Ex 22 was provided above. The solution to Ch5 Ex 21, which was assigned, follows

Given: R_{SV} = Distance Sun to Venus = $0.72\ R_{SE}$, where R_{SE} is EARTH to SUN distance. At Venus sun's Gravity Field is $\frac{F_V}{m} = G\frac{M_S}{(R_{SV})^2}$

At earth the " " " " $\frac{F_E}{m} = G\frac{M_S}{(R_{SE})^2}$

& the ratio is $\frac{F_V/m}{F_E/m} = \frac{\cancel{G}\cancel{M_S}/(R_{SV})^2}{\cancel{G}\cancel{M_S}/(R_{SE})^2} = \left[\frac{(R_{SE})}{(R_{SV})}\right]^2 = \left(\frac{1}{0.72}\right)^2 = 1.93$

Thus the SUN's field at Venus is $\boxed{1.93\times \text{ stronger}}$ than it is at earth.

— end of HW Solutions #4