Students 8
Average 21.3/50
Best 37.5/50

12th Physics (2017 – 18)

(2nd Q, #2 Mini Test)

Class	No.	Name Solutions

In calculation problems, describe equations clearly and systematically enough to show how to solve the problems.

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Radius of the Earth	$R_E = 6.37 \times 10^6$ m
Mass of the Earth	$M_E = 5.97 \times 10^{24}$ kg
Mass of the Moon	$M_M = 7.34 \times 10^{22}$ kg
Mass of the Sun	$M_S = 1.988 \times 10^{30}$ kg
Angular speed of Earth's Rotation	$\omega = 7.29 \times 10^{-5}$ rad/s
Density of Water	ρ (water) $= 1{,}000\ kg/m^3$

4 pt/question x 13 questions = 52 pt Max 50 pt

/[Total 50 pt]

1/22/2018 By Tohei Moritani

(1) At what altitude above the Earth's surface is the acceleration due to gravity equal to g/2?
Equations

$$F = G\frac{M_E}{r^2}m$$

$$\frac{g}{2} = \frac{GM_E}{r^2}, \quad r = R_E + h$$

$$r = \sqrt{\frac{2GM_E}{g}}$$

$$= \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{9.80}}$$

$$= \sqrt{8.127 \times 10^{13}}$$

$$= 9.0147 \times 10^6$$

$$h = r - R_E$$

$$= (9.0147 - 6.37) \times 10^6$$

$$= 2.6447 \times 10^6$$

$$\rightarrow 2.64 \times 10^6 \ (m)$$

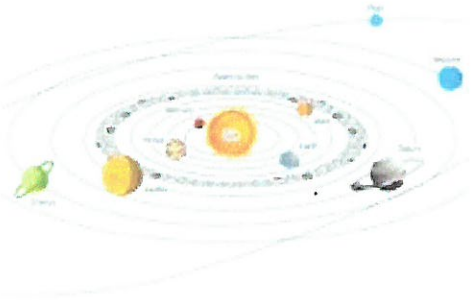
$$= 2640 \text{ km}$$

(2) Answer

2640 km

(36%)

(2) Find the period of revolution for the planet Mercury, whose average distance from the Sun is 5.79×10^{10} m.



Equations

$$m r\omega^2 = G\frac{M_s}{r^2} \cdot m$$

$$\omega = \frac{2\pi}{T}$$

$$\left(\frac{2\pi}{T}\right)^2 = \frac{GM_s}{r^3}$$

$$\frac{2\pi}{T} = \sqrt{\frac{GM_s}{r^3}}$$

$$T = 2\pi\sqrt{\frac{r^3}{GM_s}}$$

$$= 2\pi\sqrt{\frac{5.79^3 \times 10^{30}}{6.67\times10^{11} \times 1.988\times10^{30}}}$$

$$= 2\pi\sqrt{14.64\times10^{11}} = 2\pi\sqrt{1.464 \times 10^{6}}$$

$$= 7.603\times10^{6} \text{ s}$$

$$= \frac{7.603\times10^{6}}{3.6\times10^{3}\times24}$$

$$= 88.00 \text{ days}$$

$$\rightarrow 88.0 \text{ days}$$

(2) Answer: 88.0 days (67%)

(3) To what radius does the Earth have to compressed to become a black hole?
Equations

$$\frac{1}{2}mv^2 - G\frac{M_E}{r}m = 0$$

$$v = \sqrt{\frac{2GM_E}{r}} = c$$

$$r = \frac{2GM_E}{c^2}$$

$$= \frac{2 \times 6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{3.0^2 \times 10^{16}}$$

$$= 8.8 \times 10^{-11+24-16}$$

$$= 8.869 \times 10^{-3} \text{ (m)}$$

$$= 8.869 \text{ (mm)}$$

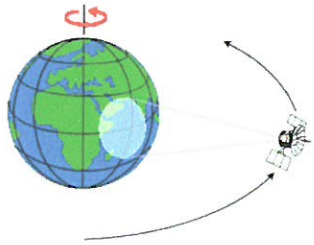
$$\longrightarrow 8.8 \text{ mm}$$

(3) Answer

8.8 mm

(0)

(4) One of the Global Positioning System satellites has a speed of 4.46 km/s at perigee and a speed of 3.64 km/s at apgee. If the distance from the center of the Earth to the satellite at pergee is 2.00 x 10^4 km, what is the corresponding distance at apogee?
Equations



$\frac{1}{2} r_a v_A = \frac{1}{2} r_p v_p$

$r_a = \frac{v_p}{v_a} r_p$

$= \frac{4.46}{3.64} \times 2.00 \times 10^4$

$= 2.451 \times 10^4$

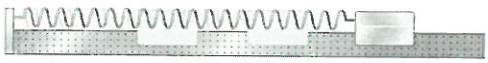
$\rightarrow 2.45 \times 10^4$ km

(4) Answer

2.45×10^4 km

(38%)

((5,6) A mass attached to a spring oscillates with a period of 3.35 s. The mass starts from rest at x = 0.0440 m and the time t = 0.
(5) Where is the mass at time t = 6.37 s?
(6) Find the direction and magnitude of the velocity of the mass at t = 6.37 s.



Equations

$T = 3.35\ (s)$

$A = 0.0440\ m$

$$x = A\cos\left(\frac{2\pi}{T}\,t\ [\text{rad}]\right)$$

$$= A\cos\left(\frac{2\pi}{T}\cdot\frac{360}{2\pi}\cdot t\ [\text{degree}]\right)$$

$$= 0.0440\cos\left(\frac{360}{T}\,t\ [\text{degree}]\right)$$

(5) $t = 6.37$ s

$$x = 0.0440\cos\left(\frac{360}{3.35}\times 6.37\right)$$

$$= 0.03584 \longrightarrow 0.0358\ (m)$$

(6) ~~$x = -A\sin$~~

$$x = -A\frac{2\pi}{T}\sin\left(\frac{2\pi}{T}\,t\ [\text{rad}]\right)$$

$$= -A\frac{2\pi}{T}\sin\left(\frac{2\pi}{T}\times\frac{360}{2\pi}\,t\ [\text{degree}]\right)$$

$$= -0.0440\sin\left(\frac{360}{3.35}\times 6.37\right)$$

$$= -0.04789$$

$$\longrightarrow -0.0479$$

(5) Answer
0.0358 m (positive x) (45%)

(6) Answer
0.0479 m/s to negative x (41%)

(7,8) Two people with a combined mass of 135 kg hop into an old car with worn-out shock absorbers. This causes the springs to compresses by 8.50 cm. When the car hits a bump in the road, it oscillates up and down with a period of T= 1.65 s.

(7) Find the spring constant of the springs.
(8) Find the mass of the car.
(9) Assuming the motion is simple harmonic, find the magnitude of position, velocity, and acceleration of the ~~apple~~ car at the times T/4.
Equations

(7) $F = kx$

$k = \frac{F}{x} = \frac{135 \times 9.80}{8.50 \times 10^{-2}} = 15565$

$\rightarrow 15600$

(8) $T = 2\pi\sqrt{\frac{M}{k}}$

$M = k\left(\frac{T}{2\pi}\right)^2$

$= 15565 \times \left(\frac{1.65}{2\pi}\right)^2$

$= 1073$

$\rightarrow 1070$

(9)

$x = A\cos\left(\frac{2\pi}{T} \cdot \frac{T}{4}\right)$

$= A\cos\frac{\pi}{2} = 0$

$v = -8.50\frac{2\pi}{1.65}\sin\frac{\pi}{2}$

$= -32.37$

$\rightarrow -32.4$ (cm/s)

$a = -\omega^2 x = 0$

8.50 cm

0

123 cm/s²

(7) Answer: 15600 N/m (84%)

(8) Answer: 1070 kg (75%)

(9) Answer

position: 0

velocity: 32.4 cm/s

acceleration: 0 (50%)

(10,11) The vertical displacement of a wave on a string is described by the equation $y(x,t) = Asin(Bx + Ct)$, in which A, B, and C are positive constants.

(10-a) Does this wave propagate in the positive or negative x direction?

(10-b) What is the physical meaning of the constant A?

(11-c) What is the speed of this wave?

(11-d) What is the smallest positive time t for which the wave has zero displacement at the point $x = 0$?

Equations

$$y(x,t) = A\sin 2\pi\left(\frac{x}{\lambda} + \frac{t}{T}\right)$$

$$B = \frac{2\pi}{\lambda} \qquad C = \frac{2\pi}{T}$$

$$\lambda = \frac{2\pi}{B}, \quad T = \frac{2\pi}{C} \qquad f = \frac{1}{T} = \frac{C}{2\pi}$$

(c) $$v = f\lambda = \frac{C}{2\pi} \times \frac{2\pi}{B} = \frac{C}{B}$$

(d) $$y(0,t) = A\sin 2\pi\left(\frac{t}{T}\right) = 0$$

$$\frac{2\pi}{T}t = \pi$$

$$t = \frac{T}{2\pi}\pi = \frac{T}{2}$$

(10) Answer

(a) negative

(b) amplitude

(50%)

(11) Answer

(c) $c = 1/B$

(d) $\frac{T}{2}$

(0)

(12) Sound 1 has the intensity of 38.0 W/m². Sound 2 has an intensity level that is 2.60 dB greater than the intensity of level of sound 1. What is the intensity of sound 2?
Equations

$$\frac{I_2}{I_1} = 10^{\beta} = 10^{0.26} = 1.820$$

$$I_2 = 1.820 \times 38.0 = 69.148$$

$$\rightarrow 69.1$$

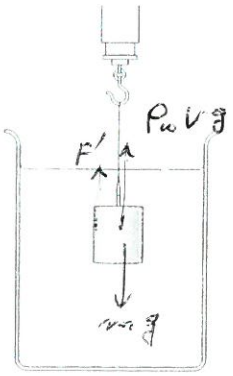
(12) Answer

69.1 W/m²

(13%)

( )

(13) A solid block is suspended from a spring scale. When the block is in air, the scale reads 35.0 N and when immersed in water the scale reads 31.1 N.
What is the density of the block?
Equations



$$F = mg \rightarrow m = \frac{F}{g} = \frac{35.0}{9.80} = 3.571\ (kg)$$

$$P_w V g + F' = mg$$

$$V = \frac{mg - F'}{P_w g}$$

$$= \frac{35.0 - 31.1}{1000 \times 9.80} \quad \frac{3.9}{9800}$$

$$= 3.980 \times 10^{-4}$$

$$\rho = \frac{m}{V} = \frac{3.571}{3.980 \times 10^{-4}}$$

$$= 8974$$

$$\rightarrow 9000$$

$$9.0 \times 10^3 \ kg/m^3$$

(13) Answer	(33%)
9000 kg/m^3	

$9.0 \times 10^3\ kg/m^3$

(13-a) Answer