Students	8
Average	30.7 /50
Best	43.5 /50

12th Physics (2017 – 18)

(1stQ, #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	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Mean radius of the Earth	6371.0 km
Volume of the Earth	$1.083 \times 10^{12}\ km^3$
Mass of the Earth	$5.972 \times 10^{24}\ kg$
Angular velocity of the Earth	$7.272 \times 10^{-5}\ rad/s$

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

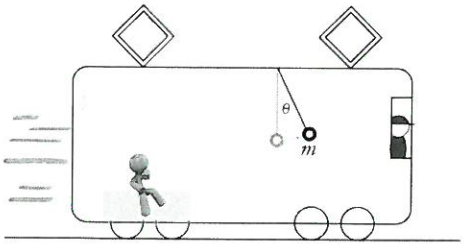
／[Total 50 pt]

10/19/2017 *By Tohei Moritani*

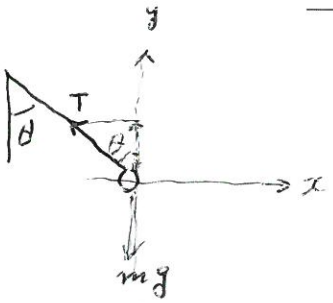
(1,2) A train is moving on a straight line at a constant velocity, Suddenly the train begins changing its velocity. A hanging object with a mass of m = 0.95 kg and a light string makes an angle $\theta = 28^\circ$ from the vertical in the travelling direction of the train, as shown.

(1) Find the tension of the string.

(2) Find the direction and magnitude of acceleration of the train.



Equations



(1) $T\cos\theta = mg$

$$T = \frac{mg}{\cos\theta} = \frac{0.95 \times 9.80}{\cos 28^\circ}$$

$$= 10.54 \longrightarrow 11 \ (N)$$

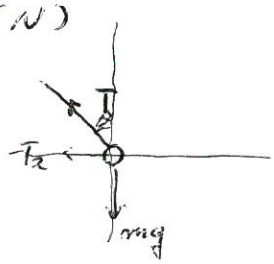
(2) $F_x = m a_x$

$T_x = m a_x$

$$a_x = \frac{T_x}{m}$$

$$= \frac{-10.54 \sin 28^\circ}{0.95}$$

$$= -5.21 \longrightarrow -5.2 \ (m/s^2)$$



(1) Answer

11 N

(63%)

(2) Answer

5.2 m/s^2 to the left

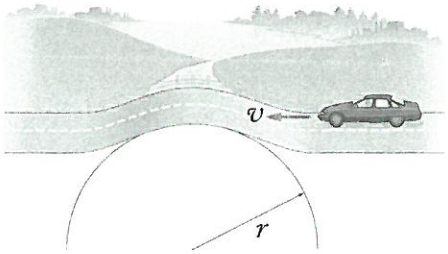
(53%)

Error of direction −1.5

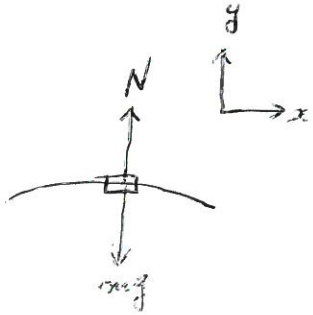
(3,4) Driving in your car with a constant speed of v =14 m/s, you encounter a bump in the road that has a circular cross section in which the radius of curvature is r = 36 m.

(3) Find the apparent weight of a 67-kg person in your car as you pass over the top of the bump.

(4) What speed must you go over the bump if the parson in your car are feel "weightless"?



Equations



(3) $F_y = m a_y$

$N - mg = m\left(-\frac{v^2}{r}\right)$

$N = m\left(g - \frac{v^2}{r}\right)$

$= 67\left(9.8 - \frac{14^2}{36}\right)$

$= 292\ (N)$

$\frac{N}{g} = \frac{292}{9.80} = 29.8 \longrightarrow 30$

(4) $N = 0$

$-mg = -m\frac{v^2}{r}$

$v = \sqrt{rg}$

$= \sqrt{36 \times 9.80}$

$= 18.8 \longrightarrow 19$

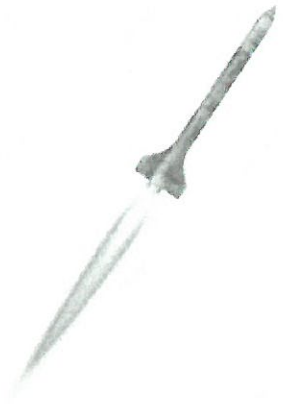
(3) Answer

30 kg (2%)

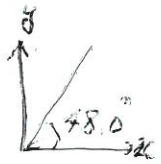
(4) Answer

more than 19 m/s (36%)

(5~7) A projectile is launched with an initial speed of 655 m/s at an angle of 48.0° above the horizontal. Find the followings assuming the ground is flat.
(5) How long is the projectile in the air?
(6) How far has the projectile traveled in the horizontal direction when it lands?
(7) Assuming that the projectile is launched at 43° north latitude, find the deviation (distance and the direction) due to the rotation of the Earth.



(5)



$v_{0x} = 655 \cos 48.0^\circ = 438.3 \ (m/s)$

$v_{0y} = 655 \sin 48.0^\circ = 486.8 \ (m/s)$

$y = v_{0y} t - \frac{1}{2} g t^2 = 0$

$v_{0y} - \frac{1}{2} g t = 0$

$t = \frac{2 v_{0y}}{g} = \frac{2 \times 486.8}{9.80} = 99.34 \ (s) \longrightarrow 99.3 (s)$

(6) $x = v_{0x} t$

$= 438.3 \times 99.34$

$= 43541 \ (m) \longrightarrow 43.5$ km

(7) $X = x \omega t$

$= 43541 \times 7.272 \times 10^{-5} \times 99.35 \sin 43^\circ$

$= 214.5 \ (m) \longrightarrow 210$ m

(5) Answer
99.3 s
(80%)

(6) Answer
43.5 km
(61%)

(7) Answer
210 m to the right
(13%)

(8,9) A 0.144 kg baseball is moving toward home plate with a speed of 42.0 m/s when it bunted (hit softly). The bat exerts an average force of 7.30×10^3 N on the ball for 1.20 ms (1.20×10^{-3} s).

(8) When the average force is directed toward the pitcher, what is the final speed of the ball?

(9) When the average force is directed toward 24.0° right from the direction to the pitcher, what is the final velocity (the direction and the speed) of the ball?

42.0 m/s ← $F = 7.30 \times 10^3$ N

$t = 1.20 \times 10^{-3}$ s

→ x

(8)

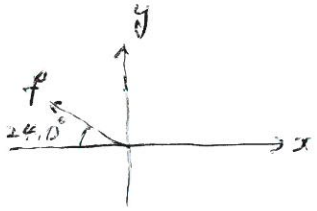
$$mv' - mv = Ft$$

$$v' - v = \frac{Ft}{m}$$

$$v' = v + \frac{Ft}{m}$$

$$= 42.0 + \frac{(-7.30 \times 10^3) \times 1.20 \times 10^{-3}}{0.144}$$

$$= -18.83 \longrightarrow -18.8 \text{ (m/s)}$$



(9)

$$\begin{cases} mv_x' - mv_x = F_x \cdot t \\ mv_y' - mv_y = F_y \cdot t \end{cases}$$

$$v_x' = v_x + \frac{F_y \cdot t}{m}$$

$$= 42.0 + \frac{(-7.30 \times 10^3) \times 1.20 \times 10^{-3}}{m} \cos 24^\circ$$

$$= -13.57$$

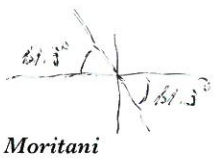
$$v_y' = v_y + \frac{F_y \cdot t}{m}$$

$$= 0 + \frac{7.30 \times 10^3 \times 1.20 \times 10^{-3}}{m} \sin 24^\circ$$

$$= 24.74$$

$$v' = \sqrt{v_x'^2 + v_y'^2} = 28.22 \rightarrow 28.2 \text{ (m/s)}$$

$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = \tan^{-1}\left(\frac{24.74}{-13.57}\right) = -61.25^\circ \rightarrow -61.3^\circ$$



(8) Answer

18.8 m/s

in the direction to the pitcher

(72%)

(9) Answer

28.2 m/s

61.3° right from the direction to the pitcher

(63%)

(10) Two ice skaters stand at rest in the center of an ice rink. When they push of against one another the 46-kg skater acquires a speed of 0.62 m/s. If the speed of the other skater is 0.88 m/s, what is this skater's mass?

$$0 = m_1 v_1 + m_2 v_2$$

$$0 = 46 \times 0.62 + m_2 \times (-0.88)$$

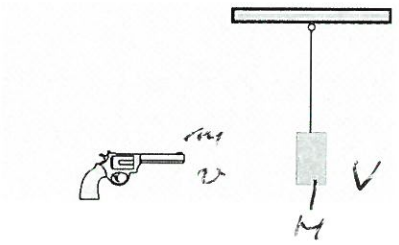
$$m_2 = \frac{46 \times 0.62}{0.88}$$

$$= 32.4 \longrightarrow 32$$

(10) Answer: 32 kg

(98%)

(11) In the ballistic pendulum shown, a bullet of 80.8 g is fired at the bob of a pendulum. The bob has the mass of 812 g, and is suspended by a rod of negligible mass. After firing, the bullet and the bob stick together and swing through an arc, eventually gaining a height 5.23 m. Find the speed of the bullet fired from the gun.



$$m v = (m + M) V \quad \text{—①}$$

$$\frac{1}{2}(m+M) V^2 = (m+M) g h$$

$$V = \sqrt{2gh} \quad \text{—②}$$

① and ②

$$m v = (m+M)\sqrt{2gh}$$

$$v = \frac{m+M}{m}\sqrt{2gh}$$

$$= \frac{(80.8 + 812) \times 10^{-3}}{80.8 \times 10^{-3}} \sqrt{2 \times 9.80 \times 5.23}$$

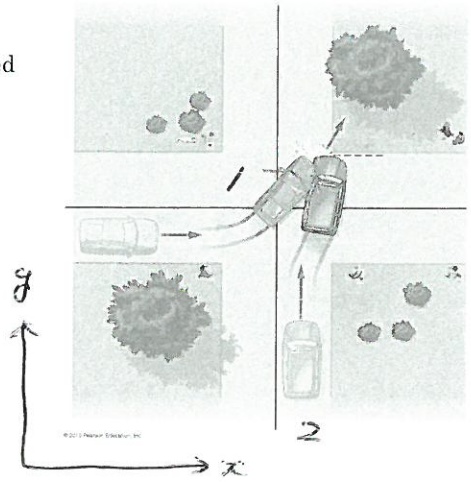
$$= 11.050 \times 10.125$$

$$= 111.9 \longrightarrow 112 \text{ (m/s)}$$

(11) Answer: 112 m/s

(67%)

(12) A 1270 kg orange car is traveling east at a speed of 22 m/s. It collides at an intersection with a 1350 kg blue car traveling north at 13 m/s. The vehicles stick together on impact. What is the velocity (speed and direction) of the wreckage immediately after impact?
Equations



$$m_1\vec{v}_1 + m_2\vec{v}_2 = (m_1+m_2)\vec{V}$$

$$\begin{cases} m_1 v_{1x} + m_2 v_{2x} = (m_1+m_2)V_x \\ m_1 v_{1y} + m_2 v_{2y} = (m_1+m_2)V_y \end{cases}$$

$$1270\times 22 + 0 = (1270+1350)V_x$$

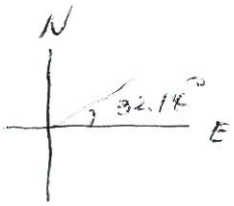
$$0 + 1350\times 13 = (1270\times 1350)V_y$$

$$V_x = \frac{1270\times 22}{2620} = 10.66$$

$$V_y = \frac{1350\times 13}{2620} = 6.698$$

$$V = \sqrt{V_x^2 + V_y^2} = 12.59 \longrightarrow 13 \text{ (m/s}$$

$$\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right) = 32.14^\circ \longrightarrow 32^\circ$$



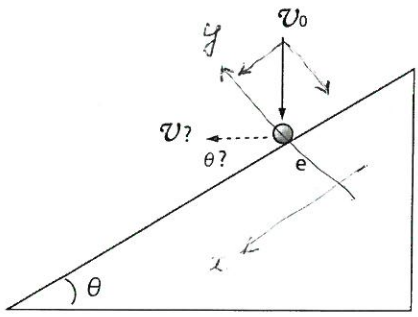
(12) Answer

13 m/s

32° north of east

(83%)

(13) A small boll falls vertically and collides to a slope with an angle of θ = 27.0° from the horizontal. The speed at the collision is 2.00 m/s and the rebound coefficient is 0.330. Find the speed and direction after the collision.



$v_x' = v_{0x} = v_0 \sin\theta$

$= 2.00 \sin 27.0°$

$= 0.9080$ (m/s)

$e = -\dfrac{v_y'}{v_{0y}}$

$\therefore v_y' = -e\, v_{0y} = -e(-v_0 \cos\theta)$

$= +0.330 \times 2.00 \cos 27.0°$

$= 0.5881$

$v' = \sqrt{v_x'^2 + v_y'^2} = 1.082 \longrightarrow 1.08$ (m/s)

$\theta = \tan^{-1}\left(\dfrac{v_y'}{v_x'}\right) = \tan^{-1}\left(\dfrac{0.5881}{0.9082}\right)$

$= 32.93° \longrightarrow 32.9°$

(13) Answer

1.08 m/s

32.9° above the slope

(78%)