Student 8
Average 18.6/50
Best 28.5/50

12th Physics (2018 – 19)

(1stQ, #1 Mini Test)

Class	No.	Name Solutions

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

	$\pi = 3.141593$
Gravitational acceleration rate	$g = 9.80\ m/s^2$
The speed of sound	$V = 331.5 + 0.6t\ [m/s]$ t: ℃
Elementary Charge	$e = 1.60 \times 10^{-19}\ C$
Electron Mass	$m_e = 9.11 \times 10^{-31}\ kg$
Proton Mass	$m_p = 1.673 \times 10^{-27}\ kg$
Coulomb's Law Constant	$k = 8.99 \times 10^9\ N \cdot m^2/C^2$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
Avogadro's Number	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Magnetic Permeability of Free Space	$\mu_0 = 4\pi \times 10^{-7}\ T \cdot m/A$

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

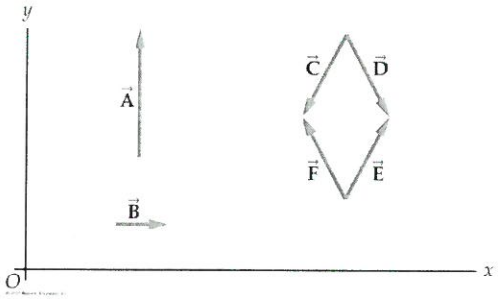
／[Total 50 pt]

(Q1) In the figure at the right, which of the four vectors, $\vec{C}$, $\vec{D}$, $\vec{E}$, and $\vec{F}$, best represents the following equations:

(Q1-a) $\vec{A} + \vec{B}$

(Q1-b) $\vec{A} - \vec{B}$

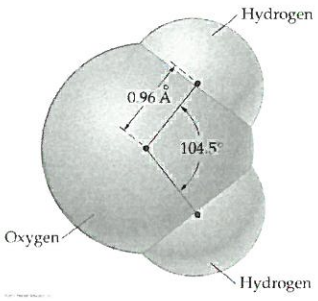
(Q1-c)) $\vec{B} - \vec{A}$



(Q1-a) Answer	$\vec{E}$
(Q1-b) Answer	$\vec{F}$
(Q1-c) Answer	$\vec{D}$

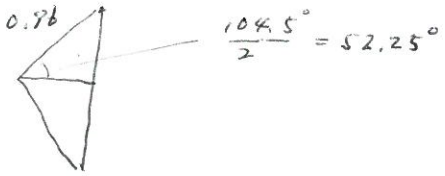
(63%)

(Q2) A water molecule is shown schematically in the figure. The distance from the center of the oxygen atom to the center of a hydrogen atom is 0.96 Å, and the angle between the hydrogen atoms is 104.5° . Find the center-to-center distance between the hydrogen atoms. ($1Å = 10^{-10}m$) (Equations)



$d = 0.96 \sin 52.25° \times 2$

$= 1.518 \longrightarrow 1.5\ (Å)$



(Q2) Answer

1.5 Å

(48%)

(Q3) Find the direction and magnitude of the vectors

(Q3-a) $\vec{A} = (5.0\,m)\,\hat{x} + (-2.0\,m)\hat{y}$

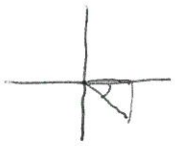
(Q3-b) $\vec{B} = (-2.0\,m)\,\hat{x} + (5.0\,m)\,\hat{y}$

(Q3-c) $\vec{A} + \vec{B}$

(Equations)

(a) $A = \sqrt{5.0^2 + (-2.0)^2}$

$= 5.39 \longrightarrow 5.4$



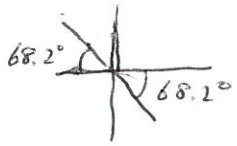
$\theta = \tan^{-1}\left(\frac{-2.0}{5.0}\right) = -21.8^\circ$

$\longrightarrow -22^\circ$

(b) $B = \sqrt{(-2.0)^2 + (5.0)^2}$

$= 5.39 \longrightarrow 5.4$

$\theta = \tan^{-1}\left(\frac{5.0}{-2.0}\right) = -68.2^\circ$



$180.0^\circ - 68.2^\circ = 111.8^\circ$

$\longrightarrow 112^\circ$

(c) $\vec{A} + \vec{B} = (5.0 - 2.0)\,\hat{x} + (-2.0 + 5.0)\,\hat{y}$

$= 3.0\,\hat{x} + 3.0\,\hat{y}$

$A+B = \sqrt{3.0^2 + 3.0^2} = 4.24 \longrightarrow 4.2$

$\theta = \tan^{-1}\left(\frac{3.0}{3.0}\right) = 45.0^\circ \longrightarrow 45^\circ$

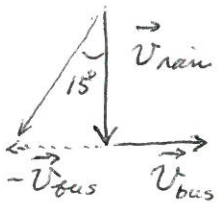
(Q3-a) Answer	5.4 m , −22°
(Q3-b) Answer	5.4 m , 112°
(Q3-c) Answer	4.2 m , 45°

(67%)

(Q4) A passenger on a stopped bus notices that rain is falling vertically just outside the window. When the bus moves with constant speed 18 m/s forward, the passenger observes that the falling raindrops are now making an angle of 15° with respect to the vertical. Find the speed of the raindrops.

(Equations)

$\vec{v} = \vec{v}_{rain} - \vec{v}_{bus}$



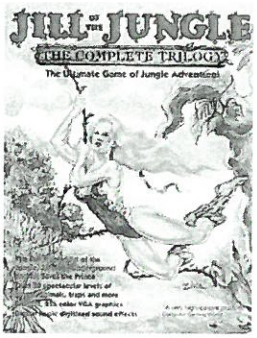
$\vec{v}_{bus} = (18\ m/s)\,\hat{x}$

$\tan 15^\circ = \dfrac{18}{v_{rain}}$

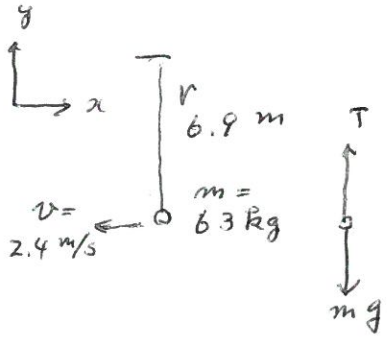
$v_{rain} = \dfrac{18}{\tan 15^\circ} = 67.2 \longrightarrow 67$

(Q4) Answer
67 m/s

(17 %)



(Q5) Jill of the Jungle swings on a vine 6.9 m long. What is the tension in the vine if jill, whose mass is 63 kg, is moving at 2.4 m/s when the vine is vertical?
(Equations)



$F_y = m a_y$

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

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

$= 63\left(9.80 + \frac{2.4^2}{6.9}\right)$

$= 63(9.80 + 0.835)$

$= 63 \times 10.635$

$= 669.99 \longrightarrow 670$

(Q5) Answer 670 N (31%)

(Q6) Which and how much is larger in angular velocity, a jogger running at 7.0 km/hr and 5.0 m apart or an Shinkansen at 260 km/hr apart 2000 m.

Jogger $\omega_J = \frac{v}{r} = \frac{7.0\ km/h}{5.0\ m} = \frac{1.4\ km/h}{1.0\ m}$

Shinkansen $\omega_s = \frac{v}{r} = \frac{260\ km/h}{2000\ m} = \frac{0.13\ km/h}{1.0\ m}$

$\frac{\omega_J}{\omega_s} = \frac{1.4}{0.13} = 10.8 \longrightarrow 11$

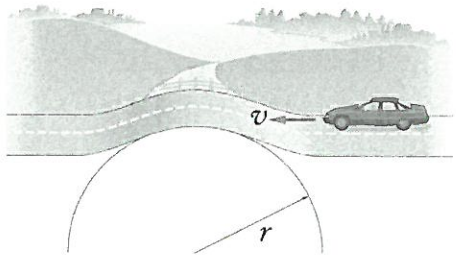
(Q6) Answer Jogger's angular velocity is larger by 11 times (25%)

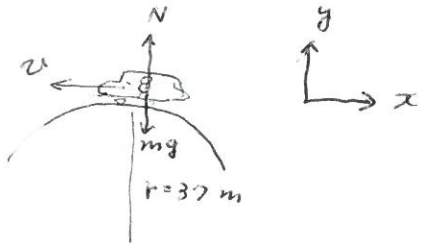
(Q7, 8) Driving in your car with a constant speed, you encounter a bump in the road that has a circular cross section, as indicated in the figure. The radius of curvature of the bump is $r = 37$ m, and the mass of your friend in the car is 67 kg.

(7) Find the apparent weight of your friend if your car is passing over the top of the bump at $v = 13$ m/s.

(8) At what speed must you go over the bump if your friend is to feel "weightless"?

(Equations)





(7) $F = ma$

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

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

$$= 67\left(9.80 - \frac{13^2}{37}\right)$$

$$= 67(9.80 - 4.57)$$

$$= 350.4\ (N)$$

$\frac{350.4}{9.80} = 35.8 \longrightarrow 36\ (kg)$

(8) weightless : $N = 0$

$$0 = mg - m\frac{v^2}{r}$$

$$v = \sqrt{rg}$$

$$= \sqrt{37 \times 9.80}$$

$$= 19.04$$

$\longrightarrow 19$

(Q7) Answer	36 kg	(38%)

(Q8) Answer	19 m/s	(56%)

(Q9) As you ride on a Ferris wheel, your apparent weight is different between at the top and at the bottom.
Calculate your apparent weight at the top and bottom of a Ferris wheel, given that the radius of the wheel is 7.2 m, it completes one revolution every 28 s, and your mass is 55 kg.
(Equations)

$T = \frac{2\pi r}{v}$ $\quad v = \frac{2\pi \times 7.2}{28} = 1.615$ (m/s)

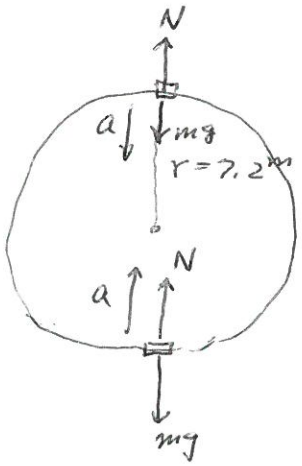
Top. $N - mg = -m\frac{v^2}{r}$

$N = m\left(g - \frac{v^2}{r}\right)$ $\quad T = 28$ s

$= 55\left(9.80 - \frac{1.615^2}{7.2}\right)$

$= 519.1$

$\frac{N}{g} = 52.97 \longrightarrow 53$



$m = 55$ kg

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

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

$= 55\left(9.80 + \frac{1.615^2}{7.2}\right)$

$= 558.9$

$\frac{N}{g} = 57.03 \longrightarrow 57$

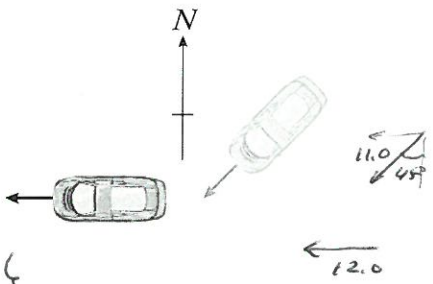
(Q9) Answer

Top: 53 kg

Bottom: 57 kg

(13%)

(Q10) A car is traveling to southwest at 11.0 m/s. 15.0 seconds later it has rounded a corner and is now heading west at 12.0 m/s. What are the magnitude and direction of its average acceleration during those 15.0 seconds?
(Equations)



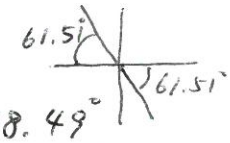
$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

$$= \frac{1}{15.0}\left\{-12\hat{x} + 0\hat{y} - (-11\cos 45^\circ \hat{x} - 11\sin 45^\circ \hat{y})\right\}$$

$$= \frac{1}{15.0}\left\{\left(\frac{11}{\sqrt{2}} - 12\right)\hat{x} + \frac{11}{\sqrt{2}}\hat{y}\right\} = \frac{1}{15}\left(-4.222\hat{x} + 7.778\hat{y}\right)$$

$$a = \frac{1}{15}\sqrt{4.222^2 + 7.778^2} = \frac{1}{15} \times 8.850 = 0.5900 \rightarrow 0.590$$

$$\theta = \tan^{-1}\left(\frac{7.778}{-4.222}\right) = -61.51^\circ$$



$$90.0 - 61.51^\circ = 28.49^\circ$$

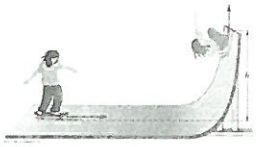
$$\rightarrow 28.5^\circ$$

(Q10) Answer

0.590 m/s² To 28.5° west of north

(20 %)

(Q11)A 65-kg skateboarder enters a ramp moving horizontally with a speed of 7.5 m/s and leaves the ramp moving vertically. What is the skateboarder's maximum height above the bottom of the ramp?
(Equations)



$$\frac{1}{2}mv^2 = mgh$$

$$h = \frac{v^2}{2g}$$

$$= \frac{7.5^2}{2 \times 9.80}$$

$$= 2.87$$

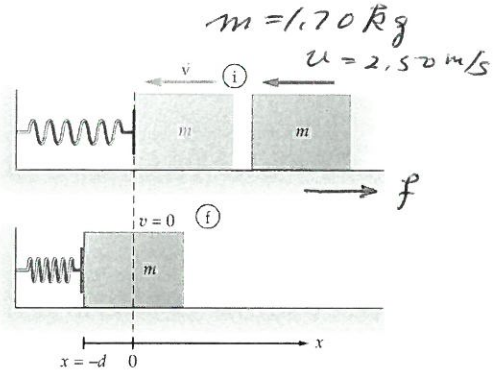
$$\rightarrow 2.9$$

(Q11) Answer

2.9 m

(75 %)

(Q12) A 1.70 kg block slides on a rough horizontal surface. The block hits a spring with a speed of 2.50 m/s and compresses it a distance of 13.0 cm before coming to rest. If the coefficient of kinetic friction between the block and the surface is $\mu' =$ 0.510, what is the force constant of the spring.
(Equations)



$$W_{nc} = E' - E$$

$$= \frac{1}{2} k x^2 - \frac{1}{2} m v^2$$

$$W_{nc} = f x \cos\theta = -fx$$

$$= -\mu m g x$$

$$m v^2 - 2\mu m g x = k x^2$$

$$k = \frac{m v^2 - 2\mu m g x}{x^2}$$

$x = 13.0\,cm = 0.130\,m$

$\mu = 0.510$

$$-\mu m g x = \frac{1}{2} k x^2 - \frac{1}{2} m v^2$$

$$\frac{1}{2} k x^2 = \frac{1}{2} m v^2 - \mu m g x$$

$$k = \frac{m v^2 - 2\mu m g x}{x^2}$$

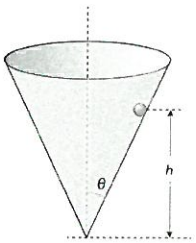
$$= \frac{1.70 \times 2.50^2 - 2 \times 0.510 \times 1.70 \times 9.80 \times 0.130}{0.130^2}$$

$$= \frac{10.625 - 2.209}{0.130^2} = \frac{8.416}{0.130^2} = 498 \rightarrow 500$$

(Q12) Answer
500 N/m

(O)

(Q13) The figure at the right is a hollow cone where its apex directs downward, the angle between the axis and generatrix is $\theta = 25^\circ$ and the inner surface is frictionless. A small particle moves in a horizontal circular path on the surface at the height of $h = 35$ cm.
(13-a) What force plays a role of the centripetal force?
(13-b) Find the period of the particle's motion.

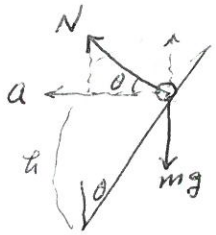


(Equations)

$$\tan\theta = \frac{r}{h} \rightarrow r = h\tan\theta$$

$$y: \quad N\sin\theta - mg = 0 \rightarrow N = \frac{mg}{\sin\theta}$$

$$x \quad -N\cos\theta = -mr\omega^2$$



$$\omega^2 = \frac{\cos\theta}{mr}\cdot N$$

$$= \frac{\cos\theta}{mr}\frac{mg}{\sin\theta} = \frac{g}{r\tan\theta} = \frac{g}{h\tan^2\theta}$$

$\theta = 25^\circ$ $\quad h = 35\text{cm} = 0.35\text{m}$

$$= \frac{9.80}{0.35 \times \tan^2 25^\circ}$$

$$= 128.77 \qquad \omega = \sqrt{128.77} = 11.35$$

$$\omega = \quad T = \frac{2\pi}{\omega} = \frac{2\pi}{11.35} = 0.554 \rightarrow 0.55$$

(Q13-a) Answer The horizontal component of normal force
(Q13-b) Answer 0.55 s

(13%)

Your opinions
