Student 8
Average 26.4 / 50
Best 37.5 / 50

12th Physics (2018 – 19)

(1stQ, Review Test)

No.	Name Solutions

In calculation problems, describe equations clearly and systematically enough to show how to solve the problems. If not enough, you won't get any points.

Gravitational acceleration rate	$g = 9.80\ m/s^2$
Universal Gravitational Constant	$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$
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	$k = 8.99 \times 10^9\ N \cdot m^2/C^2$
Avogadro's Number	$N_A = 6.022 \times 10^{23}\ mol^{-1}$
Speed of Light in vacuum	$c = 3.00 \times 10^8\ m/s$
Speed of Sound in air at 20℃	$V = 332\ m/s$

5 pt/question x 10 questions = 50 pt

／[Total 50 pt]

9/6/2018 By Tohei Moritani

[Q1] The human nervous system can propagate nerve impulse at about 10^2 m/s. Estimate the time takes for a nerve impulse generated when your finger touches a hot object to travel to your brain.

Equations

The length $\simeq$ 1 m

$$t = \frac{x}{v} = \frac{1}{10^2} = 10^{-2} \ (s)$$

[Q1] Answer

0.01 s

(60 %)

[Q2] You are driving through town at 16 m/s when suddenly a car backs out of a driveway in front of you. You apply the brakes and begin decelerating as 3.2 m/s^2.
(Q2-a) How much time does it take you to stop?
(Q2-b) How far does your car travel after braking?

(a) $v = v_0 + at$

$v_0 = 16$ m/s

$v = 0$

$a = -3.2$ m/s^2

$$t = \frac{v - v_0}{a} = \frac{0 - 16}{-3.2} = 5.00 \rightarrow 5.0$$

(b) $v^2 - v_0^2 = 2ax$

$$x = \frac{v^2 - v_0^2}{2a}$$

$$= \frac{0 - 16^2}{-2 \times 3.2}$$

$$= 40.0 \longrightarrow 40$$

[Q2-a] Answer

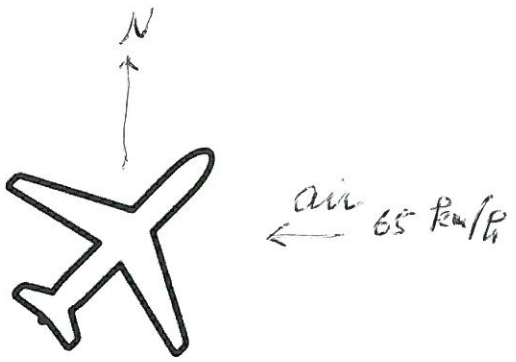
5.0 s

(90 %)

[Q2-b] Answer

40 m

[Q3] The pilot of an airplane wants to fly due north, but there is a 65 km/h wind blowing from east to west. In what direction should the pilot head her plane if its speed relative to the air is 340 km/h?

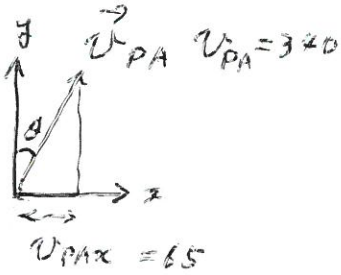


Equations

P : plane, A : air G : ground

$$\vec{v}_{PG} = \vec{v}_{PA} - \vec{v}_{AG}$$

$$\begin{cases} v_{PGx} = v_{PAx} - v_{AGx} & \text{— ①} \\ v_{PGy} = v_{PAy} - v_{AGy} & \text{— ②} \end{cases}$$



① : $0 = v_{PAx} - (-65)$

$\rightarrow v_{PAx} = 65$

$$\sin\theta = \frac{65}{340}$$

$$\theta = \sin^{-1}\left(\frac{65}{340}\right) = 11.0^\circ \rightarrow 11^\circ$$

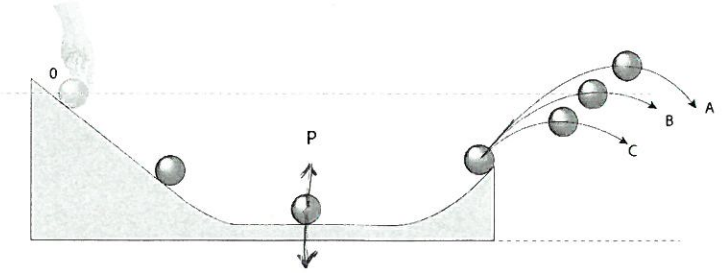
[Q3] Answer
11° to east from north

(33%)

[Q4] You place a marble ball at the position 0 of a fictionless track and release it gently. Tha ball travels thrugh the horizontal part P, goes up a rising slope and flies out of the edge, as shown in the figure.

[Q4-a] Indicate the forces acting on the ball at point P with arrow(s).

[Q4-b] Which is the right trajectory after the ball flies out of the edge, A, B or C? Assume no friction or air resistance.



[Q4-a] Answer
Draw arrow(s) in the figure
[Q4-b] Answer
C

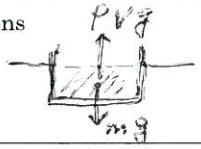
(38%)

[Q5] The mass of the largest aircraft carrier has the mass of 97,000 tons. It is mainly made of steel.
[Q5-a] Why can such a heavy ship float on water? Explain using (a) key word(s) of physics.
[Q5-b} What is the condition for floating the 97,000-ton ship on fresh-water? Explain with quantitative values. You can use diagrams.

[Q5-a] Answer

Because of the buoyancy.

Equations



Balance $\rho V g = m g$

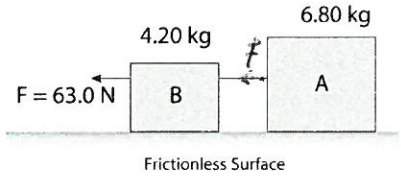
$\rightarrow V = \frac{m}{\rho} = \frac{97{,}000 \times 10^3\ kg}{10^3\ kg/m^3} = 97{,}000\ m^3$

(48%)

[Q5-b] Answer

The ship must have a space full of air more than $97{,}000\ m^3$

[Q6] A force of magnitude 63.0 N pulls two boxes with masses m_A = 6.80 kg, and m_B = 4.20 kg, connected with a rope, as shown. The floor is frictionless.
(Q6-a) Find the magnitude of the acceleration rate of the box A.
(Q6-b) Find the magnitude of the tensional force of the rope between A and B.



Equations

(a) $F = m a$

$a = \frac{F}{m} = \frac{63.0}{6.80 + 4.20} = \underline{5.727} \rightarrow 5.73$

(b) $f = m_A a$

$= 6.80 \times 5.727$

$= \underline{38.944} \rightarrow 38.9$

[Q6-a] Answer

5.73 m/s^2

[Q6-b] Answer

38.9 N

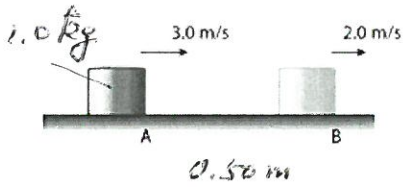
(85%)

[Q7] A 1.0 kg body is moving on a horizontal rough plane. The body passes at point A with a speed of 3.0 m/s and then at point B with a speed of 2.0 m/s. The distance between A and B is 0.50 m.

(Q7-a) Find the work done by the kinetic frictional force between A and B.

(Q7-b) Find the magnitude of the kinetic frictional force.

(Q7-c) Find the coefficient of kinetic friction.



(Equations)

(a) $W = K' - K = \frac{1}{2} m v_B^2 - \frac{1}{2} m v_A^2$

$= \frac{1}{2} \times 1.0 \left(2.0^2 - 3.0^2 \right)$

$= -2.50 \longrightarrow -2.5 \ (J)$

(b) $W = F d \cos\theta, \quad \theta = 180^\circ$ $\quad f \longleftarrow \bullet \longrightarrow d$

$F = -\frac{W}{d} = -\frac{-2.50}{0.50} = +5.00 \longrightarrow 5.0 \ N$

(c) $F = \mu N = \mu mg$

$\mu = \frac{F}{mg} = \frac{5.00}{1.0 \times 9.80} = 0.510 \longrightarrow 0.51$

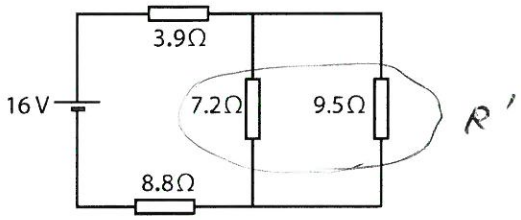
(Q7-a) Answer Work -2.5 J
(Q7-b) Answer Kinetic frictional force 5.0 N
(Q7-c) Answer Coefficient of kinetic friction 0.51

(50%)

([Q8-a] In the circuit shown, find the currrent flowing through the 3.9Ω resistor.

[Q8-b] Find the potential difference between the terminals of the 9.5Ω resistor.

Equations



(a) $\frac{1}{R'} = \frac{1}{7.2} + \frac{1}{9.5} = 0.2442$

$R' = 4.096$

$R = 4.096 + 3.9 + 8.8 = \underline{16.796}$

$I = \frac{E}{R} = \frac{16}{16.796} = 0.953 \longrightarrow 0.95\ (A)$

(b)

[Solution-1] $\Delta V_{3.9} = 0.953 \times 3.9 = \underline{3.715}\ (V)$

$16 - 3.715 = \underline{12.284}$

$\Delta V_{8.8} = 0.953 \times 8.8 = \underline{8.386}\ (V)$

$\Delta V = \underline{12.284} - \underline{8.386} = \underline{3.898} \longrightarrow 4\ (V)$

[solution-2]

$I_{7.2} = 0.9526 \times \frac{9.5}{7.2 + 9.5} = 0.953 \times 0.5688 = 0.5421\ (A)$

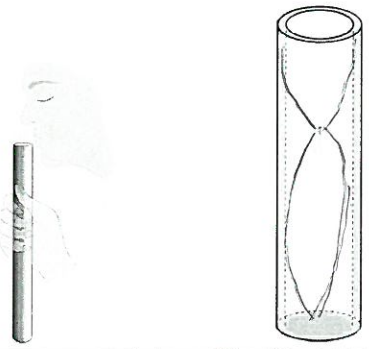
$\Delta V_{7.2} = 0.5421 \times 7.2 = \underline{3.90}$

(Q8-a) Answer
0.95 A
(Q8-b) Answer
3.9 V

(55%)

or 4 V

[Q9-a] Draw the shape of the standing wave of the third harmonic frequency in a column of air that is open at one end, with a transverse-wave expression.
[Q9-b] Find the wavelength and frequency of the third harmonic frequency at 20°C for the column of 0.550 m length.
Equations



(b) $\frac{\lambda}{4} \times 3 = 0.550\ (m)$

$\lambda = 0.550 \times \frac{4}{3} = 0.7333\ m$

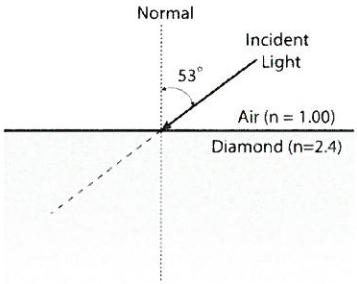
$V = f\lambda \rightarrow f = \frac{V}{\lambda} = \frac{332}{0.7333}$

$= 452.7 \rightarrow 453$

(Q9-a) Answer Illustrate in the figure.	
{Q9-b) Answer	Wavelength 0.733 m Frequency 453 Hz

(6 %)

[Q10}A beam of light in air enters diamond (n = 2.4) at an angle of $\theta = 53°$ relative to the normal.
(Q10-a) Find the angle of refraction.
(Q10-b) Find the speed of light in diamond.
Equations



(a) $n_1 \sin\theta_1 = n_2 \sin\theta_2$ (Snell's eq.)

$n_1 = 1.00 \quad n_2 = 2.4$

$\theta_1 = 53°$

$\sin\theta_2 = \frac{n_1}{n_2}\sin\theta_1 = \frac{1.00}{2.4}\sin 53° = 0.3328$

$\theta_2 = \sin^{-1} 0.3328 = 19.4° \rightarrow 19°$

(b) $\frac{v_1}{v_2} = \frac{n_2}{n_1}$

$v_2 = v_1 \times \frac{n_1}{n_2}$

$= 3.00 \times 10^8 \times \frac{1.00}{2.4}$

$= 1.25 \times 10^8$

$\rightarrow 1.2 \times 10^8$

(Q10-a) Answer	19°
(Q10-b) Answer	1.2×10^8 m/s

(64 %)