Answers – Exam Review Selected Questions

1) $v_1 = 60.0\,km/h\,[E] \times \frac{1h}{3600s} \times \frac{1000m}{1km} = 16.67\,m/s\,[E]$

$\vec{a} = 0.250\,m/s^2\,[W]$

$\Delta t = 20.0s$ Let [E] = +

$\vec{V_2} = ?$

$$\vec{V_2} = \vec{V_1} + \vec{a}\Delta t$$
$$= 16.67\,m/s + \left(-0.250\,\frac{m}{s^2}\right)(20.0s)$$
$$= 11.67\,m/s$$
$$= 11.67\,m/s \times \frac{3600s}{1h} \times \frac{1km}{1000m}$$
$$= 42.0\,\frac{km}{h}\,[E]$$

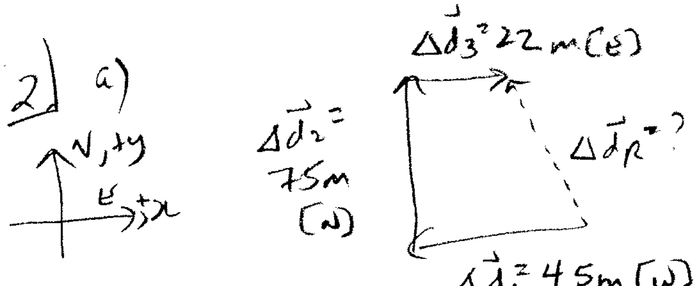
∴ the final velocity is 42.0 km/h [E]

b) $\Delta\vec{d} = ?$

$$\Delta\vec{d} = \frac{1}{2}(\vec{V_1} + \vec{V_2})\Delta t$$
$$= \frac{1}{2}(16.67\,m/s + 11.67\,m/s)(20.0s)$$
$$= 283.4\,m$$
$$\approx 283\,m\,[E]$$

∴ they travelled 283 m [E].

2) a)



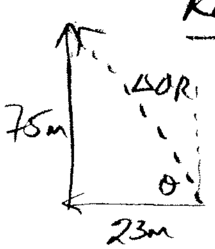
$\Delta\vec{d_R} = ?$

Component analysis

x components: $\Delta d_x = \Delta d_{1x} + \Delta d_{2x} + \Delta d_{3x}$
$= -45 + 0 + 22$
$= -23\,m$
$= 23\,m\,[W]$

y components: $\Delta d_y = \Delta d_{1y} + \Delta d_{2y} + \Delta d_{3y}$
$= 0 + 75\,m + 0$
$= 75\,m\,[N]$

Resolving components:



$$\Delta d_R = \sqrt{75^2 + 23^2}$$
$$= 78\,m$$
$$\theta = Tan^{-1}\left(\frac{75}{23}\right) = 73°$$

∴ $\Delta\vec{d_R} = 78\,m\,[73°\,N\,of\,W]$ or $78\,m\,[17°\,W\,of\,N]$

②

b) $\Delta t = 3.6\,min \times \frac{60s}{min}$
$= 216s$

$\Delta \vec{d}_R = 78m\,[17° W\,of\,N]$
$\vec{V}_{av} = ?$

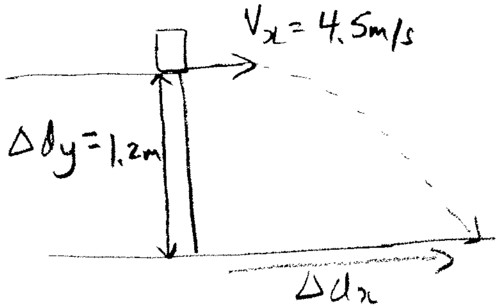
$\vec{V}_{av} = \frac{\Delta \vec{d}_R}{\Delta t} = \frac{78m\,[17° W\,of\,N]}{216s} = 0.36\,m/s\,[17° W\,of\,N]$

c) $\Delta d_T = ?$
$V_{av} = ?$
$\Delta t = 216s$

$\Delta d_T = \Delta d_1 + \Delta d_2 + \Delta d_3$
$= 45m + 75m + 22m$
$= 142m$

$V_{av} = \frac{\Delta d_T}{\Delta t} = \frac{142m}{216s} = 0.657\,m/s$
$\sim 0.66\,m/s$

3) a)



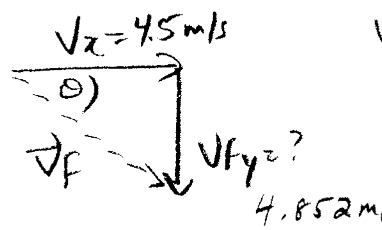
down = +
$a_y = g = 9.81\,m/s^2\,[↓]$
$V_{iy} = 0.0\,m/s$
$\Delta t = ?$

$\Delta d_y = \cancel{V_{iy}}^{\,0}\Delta t + \frac{1}{2}a_y\Delta t^2$
$\Delta d_y = \frac{1}{2}g\,\Delta t^2$
$1.2m = \frac{1}{2}(9.81\,m/s^2)\Delta t^2$
$\sqrt{\frac{2(1.2m)}{(9.81\,m/s^2)}} = \sqrt{\Delta t^2}$
$\Delta t = 0.4946s \sim \underline{0.49s}$

b) $\Delta d_x = ?$

$\Delta d_x = V_x\,\Delta t$
$= (4.5\,m/s)(0.4946s)$
$= 2.226m$
$\sim 2.2m$

c) $\vec{V}_f = ?$
$V_{fy} = ?$



$V_{fy} = \cancel{V_{iy}}^{\,0} + g\Delta t$
$= (9.81\,m/s^2)(0.4946s)$
$= 4.852\,m/s$

$V_f = \sqrt{4.5^2 + 4.852^2}$
$= 6.618\,m/s$
$= 6.6\,m/s$

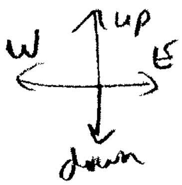
$\theta = \tan^{-1}\left(\frac{4.852}{4.5}\right) = 47.2$

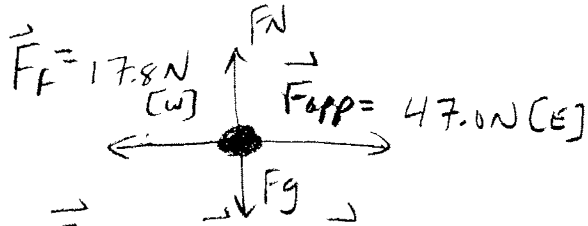
$\therefore \vec{V}_f = 6.6\,m/s\,[47°$ below horizontal$]$

Dynamics

#3] See notes or text for Newton's Laws of Motion.

#4] $m = 15.8\,kg$





$\vec{F}_{net} = ?$

$\vec{a} = ?$

$\vec{F}_{net} = \vec{F}_{app} + \vec{F}_f$ Let E = +

$= 47.0N - 17.8N$

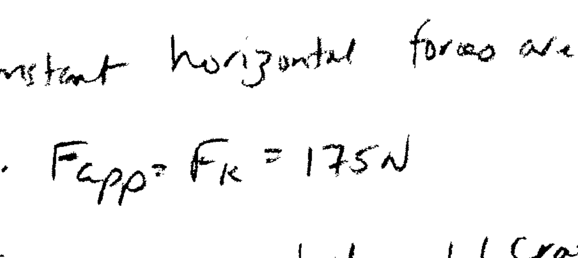
$= 29.2N$ [E]

$\vec{a} = \dfrac{\vec{F}_{net}}{m} = \dfrac{29.2N\,[E]}{15.8\,kg} = 1.848\,m/s^2\,[E] \sim 1.8\,m/s^2\,[E]$

$\therefore$ the acceleration is $1.8\,m/s^2$ [E].

#5] $m = 50.0\,kg$

$F_{app} = 175N$



$\because$ Velocity is constant horizontal forces are balanced.

$\therefore F_{app} = F_K = 175N$

Vertical forces are also balanced (Crate is at rest vertically)

$\therefore F_N = F_g = mg$.

b) $\mu_K = ?$

$F_K = F_{app} = 175N$

$F_N = F_g = mg$

$$\mu_K = \frac{F_K}{F_N}$$
$$= \frac{F_K}{mg}$$
$$= \frac{175N}{(50.0kg)(9.81\frac{N}{kg})}$$
$$= \frac{175N}{490.5N}$$
$$= 0.3568$$
$$\sim 0.357$$

∴ the coefficient of kinetic friction is 0.357.

c) Since the starting friction (the maximum value of static friction that is developed just before the object begins to move) is greater than the kinetic friction, $\mu_s > \mu_K$.

6) $F_{g_E} = 1.225 \times 10^3 N$

$F_{g_M} = 4.50 \times 10^2 N$

$g_{Earth} = 9.81 \, N/kg$

$g_{mars} = ?$

$m = ?$

Solve for mass:

$$F_{g_E} = m g_{Earth}$$

$$m = \frac{F_{g_E}}{g_{Earth}} = \frac{1.225 \times 10^3 N}{9.81 \, N/kg} = 124.87 \, kg$$

Solve for g_{mars}:

$$g_{mars} = \frac{F_{g_M}}{m} = \frac{4.50 \times 10^2 N}{124.87 \, kg} = 3.604 \frac{N}{kg}$$
$$= 3.60 \frac{N}{kg}$$

7] $m_1 = 55.0\,kg$

$m_2 = 75.0\,kg$

$r = 2.25\,m$

$G = 6.67 \times 10^{-11}\,\frac{Nm^2}{kg^2}$

$F_G = ?$

$$F_G = \frac{G m_1 m_2}{r^2}$$

$$= \frac{(6.67\times10^{-11}\,\frac{Nm^2}{kg^2})(55.0\,kg)(75.0\,kg)}{(2.25\,m)^2}$$

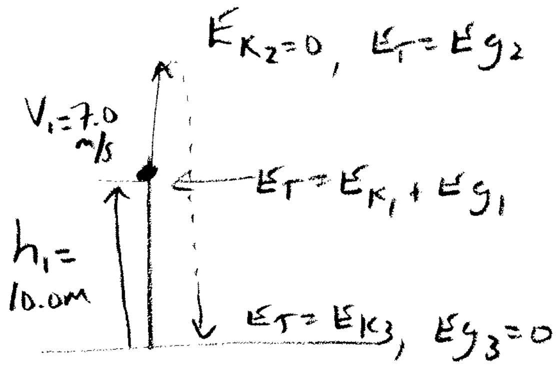
$$= 5.43 \times 10^{-8}\,N$$

8] $m = 500.0\,g$

$= 0.5000\,kg$

$h_2 = ?$

$v_3 = ?$



a) $E_{g1} = mgh_1 = (0.5000\,kg)(9.81\,\frac{N}{kg})(10.0\,m) = 49.05\,J \sim 49\,J$

$E_{K1} = \frac{1}{2}mv_1^2 = \frac{1}{2}(0.5000\,kg)(7.0\,m/s)^2 = 12.25\,J \sim 12\,J$

$E_T = E_{g1} + E_{K1} = 49.05 + 12.25\,J$

$= 61.30\,J$

$\sim 61\,J$

b) $h_2 = ?$

$E_{K2} = 0.0\,m/s$

$E_T = 61.30\,J$

$E_T = E_{g2}$

$61.30\,J = mgh_2$

$$h_2 = \frac{61.30\,J}{mg} = \frac{61.30\,J}{(0.5000\,kg)(9.81\,\frac{N}{kg})} = 12.497\,m$$

$\sim 12\,m$

c) $E_{K3} = \frac{1}{2}mv_3^2$

$E_{K3} = E_T$

$\frac{1}{2}mv_3^2 = E_T$

$$v_3 = \sqrt{\frac{2E_T}{m}} = \sqrt{\frac{2(61.30\,J)}{(0.5000\,kg)}} = 15.66\,m/s \sim 16\,m/s$$

9] $m = 1.00\,kg$

$T_1 = 85.0°c$

$T_2 = 25.0°c$

$Q_1 = -2.712 \times 10^4 J$

$c = ?$

$Q = mc\Delta T = mc(T_2 - T_1)$

$\therefore c = \dfrac{Q}{m(T_2 - T_1)}$

$= \dfrac{-2.712 \times 10^4 J}{(1.00 kg)(25.0°c - 85.0°c)}$

$= \dfrac{-2.712 \times 10^4 J}{(1.00 kg)(-60.0°c)}$

$= 452 \dfrac{J}{kg°c}$

$\therefore$ the specific heat capacity of iron is $452 \frac{J}{kg°c}$.

10] a) Nuclear fission is a reaction in which a larger nucleus splits into two or more smaller nuclei accompanied by the release of energy.

Nuclear fusion is a nuclear reaction in which two smaller nuclei combine to form a larger nucleus

b) Fissiun is currently used in the CANDU reactors. The process inside the reactor is induced fission in which free neutrons cause a uranium atom to split producing smaller nuclei and additional neutrons. The neutrons produced go on to cause further uranium atoms to split in a controlled

11) a) $V = 1.500 \times 10^3 \, m/s$

$\lambda = 145 \, cm = 1.45 \, m$

$f = ?$

$$f = \frac{V}{\lambda} = \frac{1.500 \times 10^3 \, m/s}{1.45 \, m}$$

$$= 1034.48 \, Hz$$

$$\sim 1.03 \times 10^3 \, Hz$$

b) $T = 15.0 °C$

$V_{air} = ?$

$\lambda_{air} = ?$

$$V_{air} = 331.6 \, m/s + 0.606 \, \frac{m/s}{°C} (15.0 °C)$$

$$= 331.6 \, m/s + 9.09 \, m/s$$

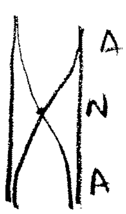
$$= 340.69 \, m/s$$

* frequency unchanged as wave is transmitted into a second medium

$$\lambda_{air} = \frac{V_{air}}{f} = \frac{340.69 \, m/s}{1034.48 \, Hz} = 0.32933 \, m \sim 0.329 \, m$$

c) open-ended pipe

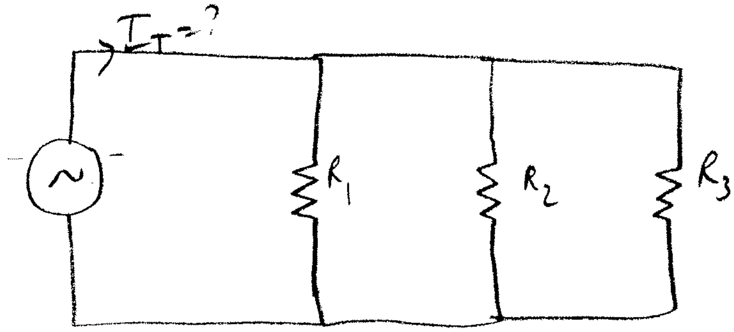
$L = ?$



$$L = \frac{\lambda}{2} = \frac{0.32933 \, m}{2} = 0.1647 \, m \sim 16.5 \, cm$$

12) a)

$V_T = 120 \, V$

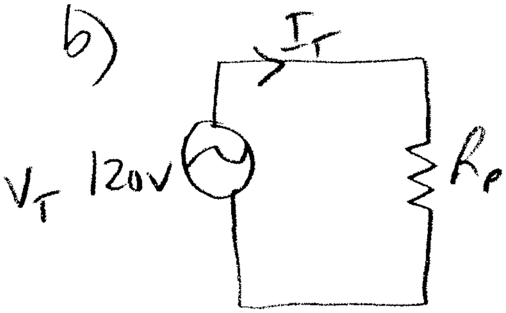


$R_1 = 18.0 \, \Omega$

$R_2 = 48.0 \, \Omega$

$R_3 = 16.0 \, \Omega$

b)



$R_p = ?$

$I_T = ?$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{18.0} + \frac{1}{48.0} + \frac{1}{16.0}$$

$$\frac{1}{R_p} = \frac{48.0}{864} + \frac{18.0}{864} + \frac{54.0}{864}$$

$$\frac{1}{R_p} = \frac{120.}{864}$$

$$R_p = \frac{864}{120} = 7.20\,\Omega$$

$$I_T = \frac{V_T}{R_p} = \frac{120\text{V}}{7.20\Omega} = 16.6\dot{6}\text{ A} \sim 17\text{ A}$$

c) $P_1 = ?$, $I_1 = ?$
$P_2 = ?$ $I_2 = ?$
$P_3 = ?$ $I_3 = ?$

$$P_1 = \frac{V_T^2}{R_1} = \frac{(120\text{V})^2}{(18.0\Omega)} = 800\text{W} = 8.0 \times 10^2\text{ W}$$

$$I_1 = \frac{V_T}{R_1} = \frac{120\text{V}}{18.0\Omega} = 6.6\dot{6}\text{ A} \sim 6.7\text{ A}$$

$$P_2 = \frac{V_T^2}{R_2} = \frac{(120\text{V})^2}{(48.0\Omega)} = 300\text{W} \approx 3.0 \times 10^2\text{ W}$$

$$I_2 = \frac{V_T}{R_2} = \frac{120\text{V}}{48.0\Omega} = 2.5\text{A}$$

$$P_3 = \frac{V_T^2}{R_3} = \frac{(120\text{V})^2}{(16.0\Omega)} = 900\text{W} \sim 9.0 \times 10^2\text{ W}$$

$$I_3 = \frac{V_T}{R_3} = \frac{(120\text{V})}{(16.0\Omega)} = 7.5\text{ A}$$

#13a] Principle of Electromagnetism – a current carrying conductor has an associated magnetic field surrounding it.

* See following page for solutions to (b)

#14a] Faraday's Law – a changing magnetic field in the area of a closed loop conductor will induce a current in the conductor.

(Lenz's Law – the induced current will have an associated magnetic field that will oppose the changing magnetic field conditions).

Sound and Waves

11. a) What is the frequency of a sound wave that travels at 1.500×10^3 m/s in water with a wavelength of 145 cm?
   b) What is the wavelength of the wave when it is transmitted into air at temperature of 15.0 ° C?
   c) The wave enters a large open-ended pipe and causes it resonate in its first resonant mode.
   What is the length of the pipe? (Sketch the wave pattern).

ANS: a) [redacted] Hz b) [redacted] m c) 16.5 cm

0.327

1.03×10^3 Hz

Electricity and Magnetism

12. A toaster (resistance 18.0), a blender (resistance 48.0 Ω) and a coffee maker (resistance 16.0 Ω) are connected in parallel with a 120 V wall outlet.
   a) Draw a diagram illustrating the circuit.
   b) Calculate the equivalent resistance of the three appliances and find the total current in the circuit.
   c) Calculate the current and power electrical power dissipated by each appliance.

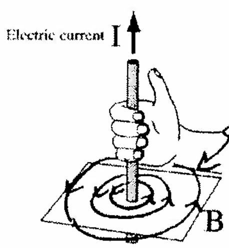
ANS: a) 7.2 Ω b) [redacted] A c) Toaster-6.7 A, 800 W Blender-2.5 A, 300 W, Coffee Maker-7.5 A, 900W

17A

13. a) Discuss the basic principle of electromagnetism discovered by Oersted.

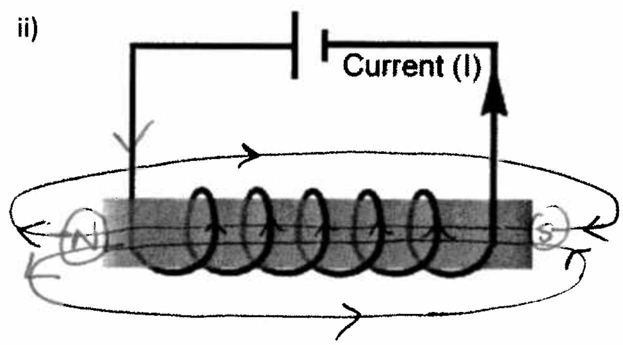
b) Draw the magnetic field associated with each conductor below, assuming positive conventional current is flowing in the direction indicated.

i)



*note- spacing of field lines increases with distance from wire as field becomes weaker

ii)



14. a) What is Faraday's Law of Electromagnetic Induction?
   b) Indicate the direction of the induced current and the associated magnetic field generated in the coils shown below: