PART 1: ELECTRICITY

Question 1.

From: Coulombs Law:

'Stationary Objects' = electrostatic Force.

$$F_e = k \frac{Q_1 Q_2}{d^2}$$ where $k = 9 \times 10^9$

$$\frac{(9 \times 10^9 \frac{Nm^2}{C^2} \cdot (8 \times 10^{-6} c) \cdot (5 \times 10^{-6} c))}{(0.09) m^2}$$

$$= \frac{360 \times 10^{-3}}{0.09} N$$

$$F = 4 N.$$

Question 2.

a) From: Finding direction of any charge we use a positive test charge (q^+)

Using: $F_e = qE$

where: Fe (resultant Force)

$: (11.0N - 5.0N) = 6.0N$

$6.0 N = (3.0 \times 10^{-6}) C \times E$

$\therefore E = 2.0 \times 10^6 N/C$ to the right.

b) From: Equation:

$$E = \frac{kQ}{d^2}$$

$$= \frac{11.0N}{(3 \times 10^6) c} = 3.6 \times 10^{-6}$$

↗

$$\therefore 3.6 \times 10^{-6} = \frac{9 \times 10 \frac{Nm^2}{C^2} \times Q}{1 m^2}$$

$$\frac{3.6 \times 10^{-6}}{9 \times 10^{-9}}$$

Charge $Q_2 = 4.0 \times 10^{-4} C$

Thus finding charge Q_1: (F_e: 5N.)

$F_e = qE$

$5.0 N = (3.0 \times 10^{-6}) C \times E$

$$\frac{5.0 N}{(3.0 \times 10^6) c} = E \Rightarrow 5.0 N \times \frac{(3.0 \times 10^6}{1c}$$

$E = 15 \times 10^6 N/C$

Thus:

Equation: $E = \frac{kQ}{d^2}$

$$= \frac{9 \times 10^9 \cdot Q}{1m^2} = 15 \times 10^6 N/C$$

$$Q_1 = 1.67 \times 10^{-3}$$

Ⓒ Given that:

$E = 2.0 \times 10^6 N/C$ & $q^+ = (3.0 \times 10^{-6}) c$

From: $F_e = qE$

$\therefore a = \frac{qE}{m}$

$$a = \frac{(3.0 \times 10^{-6}) c \times 2.0 \times 10^6 N/C}{1.67 \times 10^{-27} kg.}$$

$\therefore a = 3.6 \times 10^{27} N/kg$

But Net Force: 6N (58.84 kg) x 3.6 N

F_{net} = 211.82 N to the right

Question 3.

NOTE: Change in potential energy = change in kinetic energy.

(ie) $\Delta U_e = q\Delta V$ .....(i)

✓ calculating change in potential

$$V = \frac{kQ}{r} \quad .....(ii)$$

substitute equation (i) for (ii)

$$\therefore \Delta U_e = q\left(\frac{kQ}{r(\text{final})} - \frac{kQ}{r(\text{initial})}\right)$$

whereby

$Q = 8.0 \times 10^{-6}$ C. | $r_f = 5m.$

$q^2 = 2.0 \times 10^{-6}$ C | $r_i = 7m.$

✓ calculating WORK | DONE

$$W = 2.0 \times 10^{-6}\left(\frac{9\times10^{9}\ \frac{Nm^2}{C^2} \times Q}{5m.} - \frac{9\times10^{9}\frac{Nm^2}{C^2}\times Q}{7m.}\right)$$

$$w = \left[\frac{72 \times 10^{3}}{5}\ Nm/c - \frac{72\times10^{3}}{7}\ Nm/c\right]$$

$$W = 504{,}000 - 360.000$$

$$W = 2.0\times10^{-6}\cancel{C}\ (144000\ Nm/\cancel{c})$$

$$\therefore \text{WORK DONE} = 28.8 \times 10^{-2}\ J$$

Question 4.

$$V = k\ Q/r$$

$Q_1 = 1.0\ \mu C$; $Q_2 = 4.0\ \mu C$

$$'V(r) = \frac{9.0\times10^{9} \times (1.0 \times 10^{-6})C}{0.5m.}$$

$$= 18\times10^{3}\ J/c$$

$$2.\ V(r) = \frac{9\times10^{9}\ \frac{Nm^2}{C^2} \times (4.0\times10^{-6})^{c}}{1m.}$$

$$\Sigma V = (18+36)$$

$$= 54\ \text{Volts}$$

Question. 5.

$$\varepsilon_r = R_1 + \left(\frac{1}{R_2} + \frac{1}{R_3.}\right)$$

$$\left[\tfrac{1}{6.} + \tfrac{1}{6.}\right] = \tfrac{2}{6} = \tfrac{1}{3}.$$

Finding Ammeter Reading.

$$V = I \cdot R.$$

where $V = 12.0V$; T_R $(3+3)\ \Omega$

Thus: $I = V/R = 12/6$

$$= 2.0\ \text{Ampr.}$$

Question 6.

From: $V_1 = I_1 R_1$

Given: $(1/12 + 1/6) = 4\Omega$

1st Resistor:

$$6 \times 4.0\text{Ampr} = \frac{24V}{4} = 6\text{Ampr}$$

2nd Resistor:

$$12\Omega \times 2.0\text{Amp.} = \frac{24\ V}{12}$$

$$= 2\text{Ampr}$$

∴ Total Voltage:

24 Amps + 4amps + 2Amps

8Ampr + 4 = 12 Ω

$V = IR$ ∴ (12×8)

$$V = 96\ \text{Volts}$$

Question 9.

$V = IR$

$I = 2.88V / 12.$ (bulb.) $= 0.24\ A.$

$V_T = (Ir)$

$V = 12 + 0.26 + 0.26.$

$V = 12.52$

Therefore: $0.24A \times 12.52 = 3.00V$

Divide by 2 (2 batteries in series)

$= \underline{\underline{1.5V}}$

Question 10

$P = VI$: $1500\ W = 110V \times I$

$R = P/I^2$: $1500W / (13.6A)^2 = 1500W / 185A$

$I = 1500 / 110. = 13.6\ A.$

$= 1500\ \omega / 185\ A$

$= \underline{\underline{8.1\ \Omega}}$

Question 11.

$P = VI$ $\quad 500,000 = 400,000\ V \times I$

$I = 500,000 / 400,000 = 1.25A.$

$P_{LOST} = I^2R$ $\quad P_{LOST} = (1.25\ A)^2 \times 5.0\ \Omega$

$= 7.8\ W$

$P = VI$ $\quad 500,000 = 10,000\ V \times I$

$I = 500,000 / 10,000V = 50A$

$P_{LOST} = I^2R = (50A)^2 \times 5.0\ \Omega$

$= 12,500\ W$

$12,500\ W / 7.8\ W -$

$= \underline{\underline{1600 \text{ times.}}}$

Question 12

$V = IR$

$P = I^2R$

$R = V/I$

$R = 120\ V / 20A = 6\ \Omega$

$P = (20.0A)^2 \times 6\ \Omega = 2400W$

From:

Efficiency: (Work Output $\div$ W. Inpu

$\frac{2000W}{2400\ W} \times 100\%$

$= \underline{\underline{83\%}}$

Question 15.

Ans: Towards R (to the Left)

Question 16

From: M.M.T

$= 0.20 \times \frac{600}{0.1} \times (2.0 \times 10^{-2})$

$= 0.20 \times 6000 \times 0.02$

$= \underline{\underline{24A}}$

Question 17

a) $r = mv/qB$ .... eq (i)

now:

if $v' = v/2$, $B' = B/2$

hence:

$r' = mv'/qB' = \frac{m(v/2)}{q(B/2)} = mv/qB$ .... eq (ii)

It is clear that the new radius $r' = r$ (old radius)

"REFER TO THE "MISSING WORK PAGE" FOR THE REST OF THE NUMBERS."

PART 2: MECHANICS.

Question 1.

$d = V_i t + \frac{1}{2} a t^2$ $= 5.05$ secs.

Therefore:

Distance $= V \times t$

$= 81 \times 5.05$.

$= \underline{409 m}$

Question 2.

a) $h(t) = \frac{\theta t^2}{2} + V_0 \sin\theta\, t + h_0$

$= 4.9 t^2 + 120 \sin 30° t + 100$

$h(t) = 4.9t^2 + 60t + 100$.

Set $h(t) = 0$ (solve ē Quadratic equation.)

$\swarrow$

$\underline{t = 13.7 s.}$

Question 3

a) Using Pythagorous Theorem:

$(4^2) + (7)^2 = R_2$

$16 m^2/s^2 + 49 m^2/s^2 = R^2$

$\sqrt{65} = \sqrt{R}$

$= 8.06 m/s$

b) Time = $\frac{\text{Distance}}{\text{Average Speed}}$

$= 80/4.$

$= \underline{20s.}$

c) Distance: Speed x Time

: $7 m/s \times 20 s$.

$= \underline{140 m.}$

Question 4.

$V_{pg} = V_{pa} + V_{ag}$.

$V_{pa} = 300 km/h$ N

$V_{ag} = 50.0 km/h$. NE

$V_{pg} = ?$

$V_{agx} = V_{ag} \sin 45°$

$= (50.0) \sin 45°$.

$= 35.4$. km/h

$\vec{V}_{pgx} = \vec{V}_{agx}$

$\downarrow$ = ~~35.4 km/h~~.

$V_{agx} = V_{ag} \cos 45$.

$= (500) \cos 45°$

$= 35.4$ km/h.

$\vec{V}_{pgy} = \vec{V}_{pa} + V_{agy}$

$= 300 + 35.4$.

$= 335 km/h$

$V_{pg} = \sqrt{V_{pgx}^2 + V_{pgy}^2}$

$\sqrt{(35.4)^2 + (33.5)^2}$

$= 337 km/h$.

$\underline{\vec{V}_{pg} = 337 km/h, 84.0° N of East}$

Question 5

a) Acceleration of the fridge:

$a = F/m$

$= \frac{594 - 48}{158}$

$= \underline{0.671\ m/s^2}$

b. Speed after 1.44s:

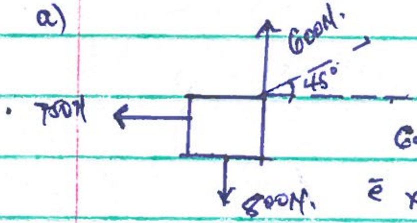
$V = at$

$V = 0.671 \times 1.44$

$= \underline{0.966\ m/s}$

Question 6

a)



600 N is distributed along ē x axis & y axis.

Thus:

Netforce along the X axis

$300\sqrt{2} - 750$

$= 174.20\ N.$

Netforce along the Y axis

$300\sqrt{2} - 500$

$= 424.20 - 500$

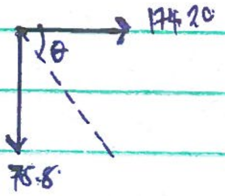
$= \underline{-75.8\ N.}$

∴ Resultant Force:

$\sqrt{(174.20)^2 + (75.8)^2}$

$= \underline{\text{Approximately } 190 \text{ Newtons}}$

b)



$\tan\theta = \frac{-78.8}{174.20}$

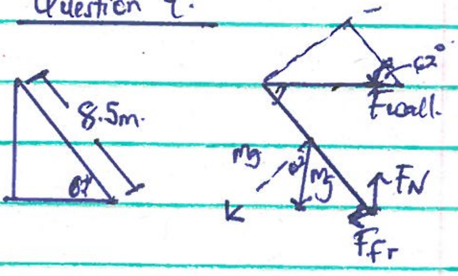
$= -23.5°$ (South East)

From:

Accelaration: $\frac{\text{Netforce}}{\text{Mass}} = 190/780.$

$= \underline{25\ m/s}$

Question 9.



$F_{w\perp}(8.5) = mg \perp (4.25)$

$F_{w\perp} = mg \frac{(\cos 62)(4.25)}{8.5} =$

$\frac{(16)(9.8)(\cos 62)(4.25)}{8.5}$

$= 36.8\ N.$

$\sin 62 = \frac{F_{w\perp}}{F_{wall}} \rightarrow F_{wall} = \frac{F_{w\perp}}{\sin 62} = \frac{36.8}{\sin 62}$

$= 41.7\ N.$

$\therefore \underline{F_{fr} = F_{wall} = 41.7\ N.}$

Question 11:-

m: mass of pickup truck

M: mass of dump truck

V_1 = Initial speed of Pickup truck (north

U_1 = Initial speed of dump truck (east)

V = final speed of the trucks stuck together

North.

$mv_1 = (m + M) v \sin \theta$

$(2080)(32.6) = (2080 + 18400) v \sin \theta$

(i) $67808 = 20480 v \sin \theta$

East.

$Mu_1 = (m + M) v \cos \theta$

$(18400)(12.4) = 20480 v \sin \theta$

(ii) $228160 = 20480 v \cos \theta$

Divide equation (i) & (ii)

$0.2972 = \tan \theta$

$\theta = 16.6°$ N of E

Equation (i)

$67008 = 20480 v \sin 16.6°$

$V = 11.6 m/s$

Question 12

$F_{down} = M \times g$

a) $= 999.60N.$

$999.60N \times 2.29m.$

$= 2289.08J.$ $(2.30 \times 10^3 J)$

$Work = 2.30 \times 10^3 J$

b) $\frac{2289.08}{1.325}$

$Power = 1.734 \times 10^8$

$Power = 1.934 \times 10^3 \text{ Watts}$

Question 13.

a) $KE = \frac{1}{2} m v^2$

$m = 56.2\,kg$

$v = 12.8\,m/s$

$= 4603.9\,J$

b) $P.E = mgh$

$m = 56.2\,kg$

$g = 9.8\,m/s$

$h = 19.5\,m$

$P.E = 10{,}703\,J$

c) From:

Mechanical Energy (bottom) = Mechanical Energy (top)

$PE + KE$

$10{,}703 + 4603.9$

$= 15343.7\,J$

↙

$15343.7\,J = \frac{1}{2} \times 56.2 \times v^2$

$= 23.4\,m/s$

Question 14.

a) Orbital Radius -

From:

$P^2/_{r^3} = 4\times\pi^2/_G \div M$

$r^3 = G \times M \times P^2/_4 \div \pi^2$

$r^3 = 10 \times 598 \times 10^{24} \times (24)^2/_4 \div \pi^2$

$\sqrt[3]{r^3} = \sqrt{7.455 \times 10^{22}}$

$r = 4.225 \times 10^{7}\,m$

b)

$$\frac{(4.225\times10^{7}) \times 2 \times \pi}{60 \times 60}$$

$= 3{,}073\,m/s\ (3.07\times10^{3})$

c) Acceleration

$A = \text{speed}^2/_r$

$A = G \times m \times r$

$= \frac{9.8 \times 5.98 \times 10^{24}}{3.07\times10^{-3}}$ ~~3.07×10^{-3}~~

$A = .$

$A = 0.223\,m/s$

Question 15:

$$V_e = \sqrt{2gR}$$

$$= \sqrt{2GM/R}$$

$$= \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 6.46 \times 10^{23}}{3.39 \times 10^{6}}}$$

$$= 5.04 \times 103\ m/s$$

MISSING QUESTIONS:

Question. 8.

Calculating Internal Resistance:

From: $e = I(r+R)$

$12 = 4(r + 2{\cdot}80)$

$12 - 2{\cdot}50 = 4r$

$r = 2{\cdot}38$ Ohm

Question 12.

From:

$|F| = qvB$

$= 1{\cdot}6\,10 \times 2{\cdot}1 \times 10 \times 125$

$|F| = 4{\cdot}2 \times 10$

Question 20.

Using Faradays Law:

$$emf = -N\frac{\Delta\Phi}{\Delta t}$$

$$= \frac{-170(4.0\times10^{-2})(0.30)}{0.20}$$

$$= -1.0\times10^{1}$$

Question 14.

a) The electron beam will be deflected upwards towards the positive charged plates

b) The beam of electrons will deflect downwards towards the negatively charged plates

Question 18.

From: $BA \cos\theta$

$B = 2{\cdot}0 \times 10^{-3}$ T.

$\theta = 0^\circ$

Thus:

$\Phi = B\pi r^2 \cos\theta$

Getting r:

$3{\cdot}14 \times r^2 = 0{\cdot}05$

$3{\cdot}14r^2 = 0{\cdot}05$

$r = 0{\cdot}13$ m

Therefor:

$= 2.0 \times 10^{-3}\, 3{\cdot}14\,(0{\cdot}13)^2 \cos\theta$

$= 1{\cdot}0 \times 10^{-4}$ Wb

Question 21.

a) Wire: 10cm (0.01m)
Speed: 2m/s
$\Phi = 0.500$ T.

$|\vec{v}| = v$

From:

$emf = LVB$

$= 0.1 \times 2m/s \times 0.500$

$= 0.10V$

b) The Induced emf will be Increased to 4.

c) X

Question 22.

Because the magnetic field of the bar Magnet moves from North to South, the current will move from Y to X and the end B will be the South pole

Question 24.

$V_P = 120$
$V_s = 16V$
$P_1 = 300$

From: $\frac{V_P}{V_s} = \frac{300}{X?}$

$\frac{300 \times 16}{120}$

$= 39.7$

= Approx = 40 turns

PART B

Question 2

(b) Using: SOHCAHTOA

$\tan \theta = \frac{Opp}{Adj}$

$\tan 30° = 100m$

? X x.

= 173m

(c) $v = u + at$

= 120+17 (13.7)

= 128 m/s

Question 8

$\Sigma t = 0 = (T_2)(1.5m) - (3.35N)(0.35m) - (80.5N)(0.75m)$

$- (300N)(1.05m)$

$\Sigma t = 0 = (T_2)(1.5m) - 124.25\,Nm - 37.875\,Nm - 185\,Nm$

$T_2 = 318\,N$.

Question 10

(a) M = 1300 kg

u = 11m/s

V = 0m/s

From:

= change In Velocity × Mass

= (v−u) × M

= 1300 × 11.

= 14500 kg·m/s

b) From:

$F \cdot t = m \cdot \Delta v$

where t = 0.14s

0.14F = (1300·11)

$F = 1.4 \times 10^4\,N \cdot s$

(c) Magnitude of the force

F = Mass X Accelaration

F = 1300 × (−78.6)

F = −102,180N.