MENGO SENIOR SCHOOL

EXAMINATIONS DEPARTMENT

Answer Sheet

Marks grid (For Examiner's use only)

QN	1	2	3	4	5	TOTAL
Marks						

TOTAL MARK SCORED	20/20

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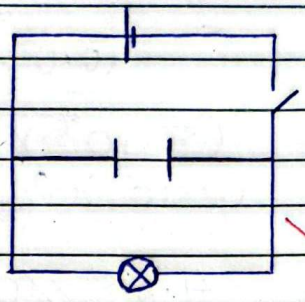
Name: Item 1

Class & Stream: ..... Term: ..... Year: .....

Index Number: ..... Signature: .....

a)



The light dimmed slowly because it was still using energy stored on the capacitor.

When the switch was closed, the bulb received current but the capacitor also charged. Electrons flowed from negative terminal of the power supply to one plate making it negatively charged while electrons also flowed from the other plate to the positive terminal leaving the plate positively charged.

On turning off the spray gun ie opening the switch, electrons flowed from the negatively charged plate through the bulb to the positive plate hence neutralising the charge there.

This flow of electrons brought about the current that made the bulb light a while more until all charge on the capacitor was neutralised.

06

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b) $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0\varepsilon_r r^2}$ ✓

Thus

$8\times10^{-7} = \frac{(2\times10^{-11})(Q_2)(\frac{9\times10^9}{1.07})}{(0.03)^2}$ ✓

05

$Q_2 = \frac{(8\times10^{-7})(0.03)^2}{(2\times10^{-11})(\frac{9\times10^9}{1.07})}$ ✓

$Q_2 = 4.28\times10^{-9}C$

For an even spray, the charge at any point on the car's body should be $4.28\times10^{-9}C$

c) The spray gun is designed to produce tiny droplets of paint and it is connected to an electrostatic generator while the body to be painted is grounded.

Highly pressured paint droplets pass through the nozzle of the gun and get charged positively by friction and also by influence of the generator.

06

The charged droplets then get attracted to the body of the object being sprayed. The droplets trailed along lines of force of the field so as to reach hidden parts of the body which creates uniform coating of paint better than what a hand brush could achieve.

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d) This is because the painter may act as the nearest ground.

The paint mist/droplets are negatively charged according to the scenerio and will therefore hunt for the closest grounded object.

The paint therefore treats the worker's body as a path of least ~~feast~~ resistance hence the paint will reverse direction and target the painter if he is not covered and insulated with gloves, masks, etc.

03

Guide for energy item

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Answer Sheet

Scores grid (For Examiner's use only)

ITEM						TOTAL
SCORE						

TOTAL SCORE	

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Name:..... Item 2 .....

Class & Stream:.....Term:.....Year:.....

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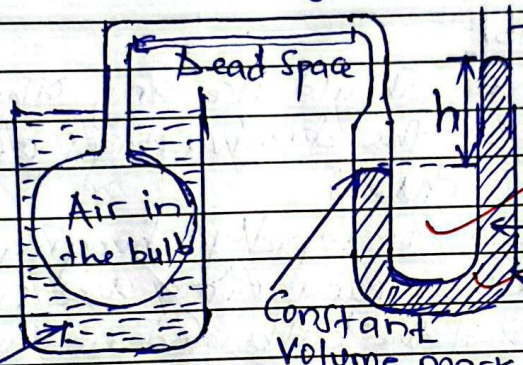
X/20

Part (a)

The best type of thermometer that could be developed is Constant Volume gas thermometer which has a property of variation of pressure of a fixed mass of a gas at constant volume. (07)



(02)

Mercury (Alcohol colored)

flexible rubber tubing.

(clear plastic aquarium tubing)

Bath whose temperature is taken,

Mode of Operation.

The structure above is arranged using the available equivalent materials.

The bulb formed is placed in ice-water mixture at 0°C and left for some time to assume the temperature of the system.

The open limb is adjusted up and down to bring the liquid level in the closed limb to a constant Volume mark.

The difference in the mercury levels in the open and closed limb, h is measured and recorded using a ruler

"Akwana Akira Ayomba"

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The bulb is then placed in steam of pure boiling water and the adjustments are repeated to obtain the new difference in liquid levels h_{100}.
The bulb is finally placed in the room and procedures are repeated to obtain the new difference h_θ.

The temperature of the room is then determined from

$$\theta = \frac{h_\theta - h_0}{h_{100} - h_0} \times 100^\circ C$$ (04)

Part (b)

The reasons why he should use any other thermometers is due to the disadvantages of the one developed which include;

- It cannot respond to rapidly changing temperatures.
- It is accompanied by many errors due neglection of thermal expansion of the bulb and un uniformity in capillary tube. (03)
- It is bulky and so hard to work with.
- It does not give direct readings.

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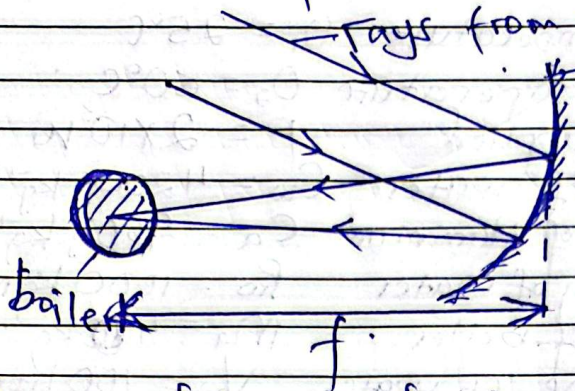
Part (C)

The best position from the mirror where the boiler should be placed is;



It should be placed 20cm from the mirror. This is because when rays of energy move from the Sun at infinity, after reflection the rays converge through the principal focus of the mirror. According to the scenario, radius of curvature of the mirror is 40cm. (04)

And from $f = \frac{r}{2} \Rightarrow f = \frac{40}{2} = 20\,cm$

and therefore the reflected energy is concentrated at 20cm from the mirror.

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Part (d)

Time taken to boil the water using the electrical heater.

from the Item.

Initial temperature $\theta_1 = 25°C$

final temperature $\theta_2 = 80°C$.

Power Supplied $P = 2 \times 10^3 W$.

S.H.C of water $C_w = 4200 J kg^{-1} K^{-1}$

S.H.C of Aluminium $C_a = 900 J kg^{-1} K^{-1}$

density of water $\rho_w = 1000 kg m^{-3}$

Mass of boiler $m_a = 40 kg$.

Volume of water $V_w = 100$ litres.

time taken $t = ??$

Mass of water $m_w = \rho_w \times V_w$

But $V_w = \left(\frac{100}{1000}\right) m^3$.

$V_w = 0.1 m^3$ of water

$\therefore m_w = (1000 \times 0.1)$

$= 100 kg$.

So Electrical energy Supplied = Heat energy absorbed by water and boiler (Assuming no heat losses to the Surroundings at the moment)

$Pt = m_w C_w \Delta\theta + m_a C_a \Delta\theta$

$t = \frac{(m_w C_w + m_a C_a)(\theta_2 - \theta_1)}{P}$ (OR)

$t = \frac{(100 \times 4200 + 40 \times 900)(80 - 25)}{2 \times 10^3}$

$t = 12540 s$ approximately equal to 3 hours and 29 minutes.

$\therefore$ It will take 3 hours and 29 minutes to boil.

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Scores grid (For Examiner's use only)

ITEM						TOTAL
SCORE						

TOTAL SCORE	

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Name: Item 3

Class & Stream: Term: Year:

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a) $S = \frac{u^2}{2a} + vt$

$[L.H.S] = [S] = L$

$[R.H.S] = \frac{[u^2]}{2[a]} + [v][t]$

$= \frac{(LT^{-1})^2}{LT^{-2}} + LT^{-1} \cdot T$

$= \frac{L^2T^{-2}}{LT^{-2}} + L$

$= L + L$

$= 2L$ (4)

Since the dimensions on the L.H.S are equal to the dimensions on the R.H.S, then the equation is dimensionally consistent.

200 m. x.

Car X Car Y

Let X be the distance Car Y travels before it is overtaken by car X.

$S = ut + \frac{1}{2}at^2$

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Car X

$200 + x = 0 \times t + \frac{1}{2} \times 3t^2$

$200 + x = 1.5t^2$ ---- (1)

Car Y

$x = 0 \times t + \frac{1}{2} \times 2t^2$

$x = t^2$ ---- (2)

$200 + t^2 = 1.5t^2$

$200 = 1.5t^2 - t^2$

$200 = 0.5t^2$

$t^2 = 400$

$t = 20$ s

Therefore, car X overtakes car Y after 20 s. The director therefore loses the bet.

Distance travelled by the car X.

$s = 0 \times t + \frac{1}{2} \times 3 \times 20^2 + 200$

$= 1.5 \times 400 + 200$

$= 800$ m.

Hence the car X travels 800 m before catching Y.

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The drone camera is launched.

$$\text{Range} = \frac{u^2 \sin 2\theta}{g}$$

$$= \frac{4u^2 \sin(60 \times 2)}{9.81}$$

$$\text{Range} = 141.2477 \text{ m}$$ (6)

The co-producers' prediction is not true, since the real distance that must be moved by the point overtaking Y is 800m.

The distance between = $800 - 141.2477$

$= 658.7522$ m.

Item 4

MECHANICS ITEM GUIDE (out of 20)

TASK A

Dimensional analysis (~~3 Scores~~) (04 scores)

$$m = \frac{k\rho v^6}{g^3}$$

Dimensions: $[\rho]=ML^{-3}$; $[v]=LT^{-1}$; $[g]=LT^{-2}$ ✓

$[RHS] = [LHS] = \frac{ML^{-3} \times L^6T^{-6}}{L^3T^{-6}} = M$ ✓ (02)

- Hence the equation is dimensionally consistent. ✓ (02)
- From the formula, $\mathbf{m \propto v^6}$. Therefore a small increase in velocity, v of water greatly increases mass, m of the stones carried. ✓

TASK B

Bridge equilibrium ~~(4 marks)~~ (08 scores)

$tan\theta = \frac{4}{4}$ *implies that* $\theta = 45^0$ ✓

Sum of clockwise moments = Sum anti clockwise moments

$100 \times 2 + 300 \times 3 = (T \sin 45) \times 4$

$T = 388.9087\ N.$ ✓

Since 388.9087 N >350 N, the rope snaps;

Reaction force at the hinge **~~hinge:~~**

$R_X = T\cos 45^0$

$R_X = 388.9087\cos 45^0$ ✓

$R_X = 274.999N$

$R_Y + T\sin\theta = 100 + 300$

But T=388.9087 and $\theta = 45^0$

Implies $R_Y = 124.9447N$ ✓

Resultant reaction, $R = \sqrt{RX^2 + RY^2}$;

$$R = \sqrt{(274.999)^2 + (124.9447)^2}$$ ✓

$R = 302.0524N$; this goes beyond 300N. Hence the rope breaks ✓

Direction of reaction at the hinge;

$\tan\alpha = \frac{124.9447}{274.999}$; implies $\alpha = 24.4^0$ ✓

Direction is $N65.6^0E$ Or 24.4^0 above the positive horizontal (X) axis.

Judgement: Basing on the conclusions made, the rope breaks in either case. Therefore the bridge is not stable and will fall. ✓

TASK C

Toolbox (~~5 marks~~) (04 scores)

Resultant force; F_R

$\Sigma Fx=(5+25cos70^0-30cos50^0-20cos60^0)=-15.7331N$ ✓

$\Sigma Fy=(0+25sin70^0+30sin50^0-20sin60^0)=29.1531N$ ✓

Resultant force, $F_R=\sqrt{(-15.7331)^2+(29.1531)^2}=33.1275N.$

Acceleration$=\frac{33.1275}{6}=5.5213\ ms^{-2}.$ ✓

Since magnitude of acceleration exceeds 5.0 ms^{-2}, the box comes out of the mud.

Motorcycle case (4 marks)

$50km/h=13.8889m/s$

At the instant the van meets the motorcycle;

$S_1=13.8889t$ also $S_2=0\times t+\frac{1}{2}\times 2.8t^2$ ✓

At catch up, $S_1=S_2$

Implies; $13.8889t=0.5\times 2.8t^2.$

t=9.9206 s. *(this is the time at catchup)*

distance travelled by the motorcycle at catchup $=13.8889\times 9.9206=137.7862m$

Speed of motorist: $v=u+at\Longrightarrow v=0+2.8\times 9.9206=27.7777\ m/s\approx 100$ km/h.

Therefore it exceeds the 80 km/h limit.