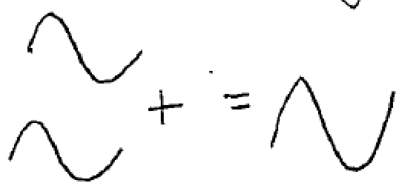
Q8(a)(i)

Maximum Mark: 1

RESPONSE 1

maximas are formed.



RESPONSE 2

These are points in which the waves meet exactly in phase creating maxima and minima

RESPONSE 3

Maxima (bright spots) are produced where two waves meet in phase and combine constructively - where two wave crests combine.

Q8(a)(iii)

Maximum Mark: 2

RESPONSE 1

The bright spots will appear further apart as more diffraction will take place due to the slits being closer together.

$d \sin\theta = m\lambda$

increases (θ) fixed (d) increase (m) constant (λ)

RESPONSE 2

The distance between maximum's are increased due to $d\sin\theta = m\lambda$ where m and λ stay constant

RESPONSE 3

The maxima will be more spread out as ~~[illegible]~~ the gaps are closer to its wavelength meaning ~~[illegible]~~ the light will diffract more.

RESPONSE 4

Smaller d (distance between lines) and since $\sin\theta = \frac{m\lambda}{d}$ if ~~[illegible]~~ λ & m remain the same the θ will increase. Therefore the bright spots will be more spread out.

Q8(a)(iv) **Maximum Mark: 1**

RESPONSE 1

~~[illegible]~~ travels in one direction only.

RESPONSE 2

Coherent means that the waves are in phase i.e. crest to crest, trough to trough

RESPONSE 3

Same phase relationship.

RESPONSE 4

Coherence is when two waves oscillate with a constant phase relationship. i.e. same frequency and speed.

Q8(b) **Maximum Mark: 1**

RESPONSE 1

In grating, the waves pass through while in £5 note only some light goes through

RESPONSE 2

the grating used by the student has ~~the~~ vertical lines. the grating in the note has horizontal and vertical lines.

RESPONSE 3

The grating had lines running vertically, the £5 note may have lines running vertically, horizontally and diagonally.

Q9(a) **Maximum Mark: 2**

RESPONSE 1

$$n = \frac{\sin \theta_1}{\sin \theta_2}$$

$$= \frac{\sin 45}{\sin 22}$$

$$= 1.8875$$

$$= 1.89$$

RESPONSE 2

$$n = \frac{\sin \theta_1}{\sin \theta_2} = \frac{\sin 45}{\sin 22}$$

$$= 1.887\ldots$$

$$= 1.89$$

RESPONSE 3

$$n = \frac{\sin\theta_1}{\sin\theta_2}$$

$$= \frac{\sin 45}{\sin 22}$$

$$\doteq 1.887...$$

$$= 1.89$$

Q9(b)(i) **Maximum Mark: 1**

RESPONSE 1

the term critical angle is the angle in which the angle of incedence would need to be from the middle line to create an angle of refraction of 90°

RESPONSE 2

The angle in which ~~the~~ light will refract at 90° to the normal.

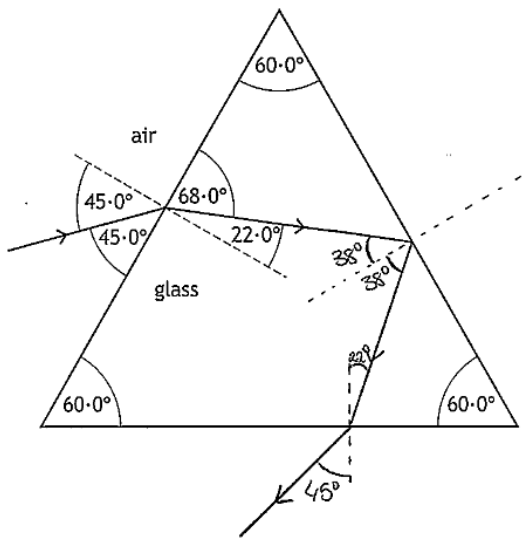
Any higher and total internal reflection will occur.

RESPONSE 3

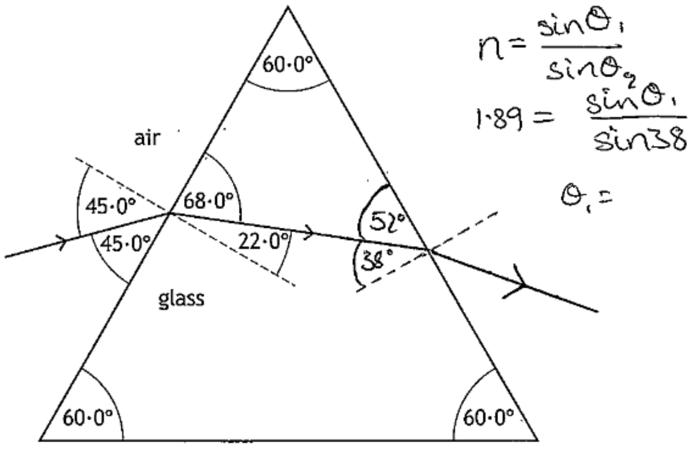
The angle at which the light is refracted at 90°.

Q9(b)(iii) **Maximum Mark: 4**

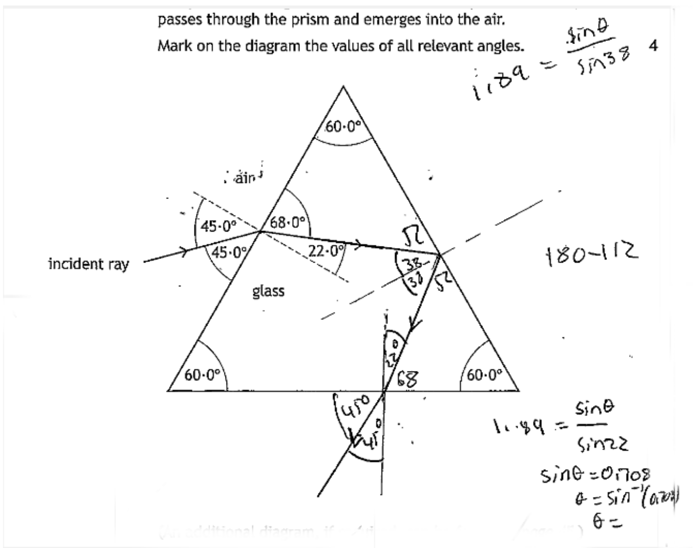
RESPONSE 1



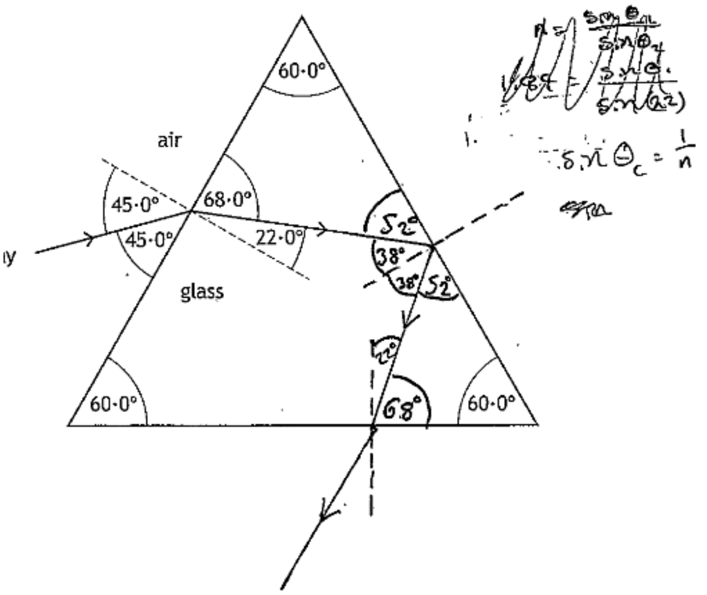
RESPONSE 2



RESPONSE 3



RESPONSE 4



Q9(c) **Maximum Mark: 1**

RESPONSE 1

the spectrum produced by the second prism will be higher up on the screen and will contain less colours (or frequencies of light)

RESPONSE 2

The spectrum would be less refracted, red and violet light would be closer together.

RESPONSE 3

The different colours in the spectrum will be closer together

RESPONSE 4

produces less frequencies of light compared to the first prism

Q10(a) **Maximum Mark: 2**

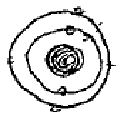
RESPONSE 1

• electrons orbit the nucleus of the atom

• ~~[illegible]~~ outer shells are less attracted to the nucleus.

RESPONSE 2

• Central nucleus containing protons & neutrons.



• Orbiting electron shells.

RESPONSE 3

• Electrons are confined to certain energy levels around the nucleus of the atom

• Electrons ~~[illegible]~~ emit photons of specific ~~[illegible]~~ frequencies to jump down from one energy level to a lower one, trying to reach the ground state.

RESPONSE 4

Shows the energy levels that electrons can exist on.

Shows the nucleus in the middle of the atom.

Q10(b) **Maximum Mark: 3**

RESPONSE 1

$E_3 \to E_1 = (-.136 \times 10^{-19}) - (-5.45 \times 10^{-19})$

$= 4.09 \times 10^{-19}$ J

$E = hf$

$f = \frac{E}{h}$

$= \frac{4.09 \times 10^{-19}}{6.63 \times 10^{-34}}$

$= 6.16892911 \times 10^{14}$

$= 6.17 \times 10^{14}$ Hz

RESPONSE 2

$E = hf$

$f = \frac{E}{h}$

$= \frac{(5.45 - 1.36) \times 10^{-19}}{6.63 \times 10^{-34}}$

$= 6.168... \times 10^{14}$

$= 6.2 \times 10^{14}$ Hz

RESPONSE 3

$E = hf$

$\frac{4.09 \times 10^{-19}}{h} = f$

$f = 6.17 \times 10^{14}$ Hz

Q10(c) **Maximum Mark: 5**

RESPONSE 1

$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$

$= \frac{661 \times 10^{-9} - 656 \times 10^{-9}}{656 \times 10^{-9}}$

$= 7.621 ... \times 10^{-3}$

$= 7.6 \times 10^{-3}$

$z = v/c \quad v = 7.6 \times 10^{-3} \times 3 \times 10^{8}$

$= 2.28 \times 10^{6}$ m s^{-1}

RESPONSE 2

$$z = \frac{\lambda_o - \lambda_r}{\lambda_r}$$

$$= \frac{661 \times 10^{-9} - 656 \times 10^{-9}}{656 \times 10^{-9}}$$

$$= 7.62195122 \times 10^{-3}$$

$$= 7.62 \times 10^{-3}$$

$$z = \frac{v}{c}$$

$$v = zc$$

$$= 7.62 \times 10^{-3} \times 3 \times 10^{8}$$

$$= 2285.366$$

$$= 2.3 \times 10^{6}\ ms^{-1}$$

RESPONSE 3

$$z = \frac{\lambda_o - \lambda_r}{\lambda_r}$$

$$= \frac{661 \times 10^{-9} - 656 \times 10^{-9}}{656 \times 10^{-9}}$$

$$= 0.008$$

$$z = \frac{v}{c}$$

$$0.008 = \frac{v}{3 \times 10^{8}}$$

$$v = 0.008 \times 3 \times 10^{8}$$

$$v = 2.4 \times 10^{6}\ ms^{-1}$$

RESPONSE 4

$$z = \frac{\lambda observed - \lambda rest}{\lambda rest}$$

~~= 656 - 661~~

$$= \frac{661-656}{656}$$

$$= 5/656$$

$$z = \frac{v}{c}$$

$$\frac{5}{656} = \frac{v}{3\times10^8}$$

$$v = 2.29\times10^6$$

Q11(a) **Maximum Mark: 1**

RESPONSE 1

The pushing force of a given cell, i.e. the force that drives the current round the circuit.

RESPONSE 2

Energy per volt

(Energy given to 1 unit volt)

RESPONSE 3

the maximum theriectical Voltage of a circuit.

RESPONSE 4

The energy given to each coulomb of charge passing through the supply

Q11(b)

Maximum Mark: 3

RESPONSE 1

internal resistance = m

$m = \frac{\Delta y}{\Delta x}$

$= \frac{110}{30}$

$= -3.6$

resistance can't be negative

⇒ internal resistance = 3.6 Ω

RESPONSE 2

$m = (-r)$

$m = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{670\times10^{-3} - 600\times10^{-3}}{0 - 20}$

$= \frac{0.07}{-20}$

$= -3.5\times10^{-3}$

Internal resistance = 3.5×10^{-3} Ω

RESPONSE 3

$E = V + Ir$

$E = 670\times10^{-3}$ V

$r = \frac{E - V}{I}$

$r = \frac{670\times10^{-3} - 200\times10^{-3}}{130\times10^{-6}}$

$r = 3615$ Ω

Q11(c) **Maximum Mark: 1**

RESPONSE 1

~~In photons~~ The battery is not of a high enough voltage to give the electrons in the n-type material enough energy to jump from the valence to the conduction band ~~in~~ which, in turn, prevents any transition from the conduction to valence bands in the p-type semiconductor ∴ preventing the emission of photons. The band gap is bigger in the blue LED than in the red as blue light requires a higher frequency of photon and ∴ bigger energy gap. The battery does not provide enough energy for electrons to jump the gap in this LED.

RESPONSE 2

Electrons in the conduction band are not supplied with sufficient energy to cross the gradient from the n-type to p-type material and hence cannot fall into the valence band of the p-type semiconductor

RESPONSE 3

Electrons in conduction band do not have enough energy to move across depletion layer to p-type

Q12(a)(ii) **Maximum Mark: 3**

RESPONSE 1

Period 4
Timebase 0·5

$T = 1/f$
$f = 0{\cdot}5$

RESPONSE 2

$$\text{frequency} = \frac{1}{0{\cdot}5 \times 2{\cdot}5} = 0{\cdot}8\,\text{Hz}$$

RESPONSE 3

$$f = \frac{1}{T} \quad f = \frac{1}{4 \times 0{\cdot}5}$$

$$f = \frac{1}{2} \quad f = 0{\cdot}5\ \underline{\text{Hz}}$$

Q12(a)(iii)

Maximum Mark: 2

RESPONSE 1

This is because the red LED is in forward bias, and can only allow current to flow from one direction (positive direction) whereas the green LED is in reverse bias and can only get a flow of current from the (negative) direction.

RESPONSE 2

The red LED is connected in forward bias but the green LED is in reverse bias therefore the current needs to be travelling in different directions for each of them to operate

RESPONSE 3

LEDs are diodes and only conduct when forward biased. Since the LEDs are connected in opposite directions, they light up on opposite halves of the wave.

RESPONSE 4

red light is electrons, green protons.

Q12(b)

Maximum Mark: 5

Final answer (a)(i) 3V

RESPONSE 1

$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{3}{\sqrt{2}} = 2.1v$

$V = IR \quad I = \frac{V}{R_t} = \frac{2.1}{150} = 0.014A$

$V = IR$
$= 0.014 \times 82$
$= 1.15V$

RESPONSE 2

$\frac{V_{peak}}{\sqrt{2}} = V_{rms}$

$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) V_s$

$V_1 = \left(\frac{82}{82+68}\right) 3$

$= 1.64V$

$\frac{1.64}{\sqrt{2}} = V_{rms}$

$V = 1.16V$

RESPONSE 3

$V_{peak} = 3V$

$3 = \sqrt{2} V_{rms}$ for whole circuit

$V_{rms} = 2.12V$

~~V = IR~~
~~2.12~~

$V_1 = \left(\frac{R_1}{R_1 + R_2}\right) V_S$

$= \left(\frac{68}{68+82}\right) 2.12$

$= 0.96V$

RESPONSE 4

Peak v = 3v

r.m.s of supply $= \frac{3}{\sqrt{2}} = 2.12$ v

$I = \frac{V}{r} = \frac{2.12}{150} = 0.014$ A

$V = Ir = 0.014 \times 82$

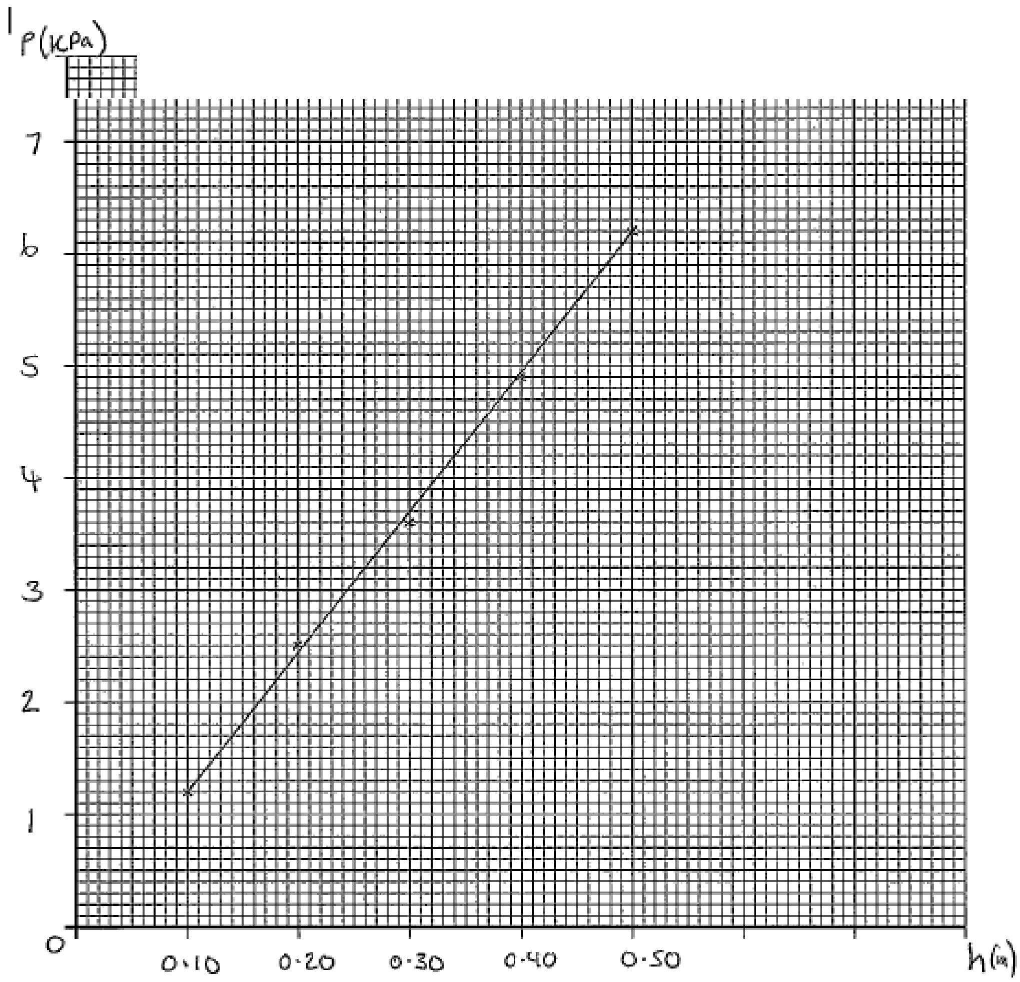
$V_{rms} = 1.15$ v

Q13(b)

Maximum Mark: (i) 3, (ii) 2,(iii) 2

RESPONSE 1

(i)



(ii)

$(0.10, 1.2)$ $(0.50, 6.2)$ in kPa
x_1, y_1, x_2, y_2

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6.2\times10^3 - 1.2\times10^3}{6.50 - 0.10}$

$= 12500$ P/m

(iii)

$\frac{P}{h} = 12500$ ~~1200~~

$\rho = ?$

$P = \rho g h$

$\frac{P}{h} = \rho g$

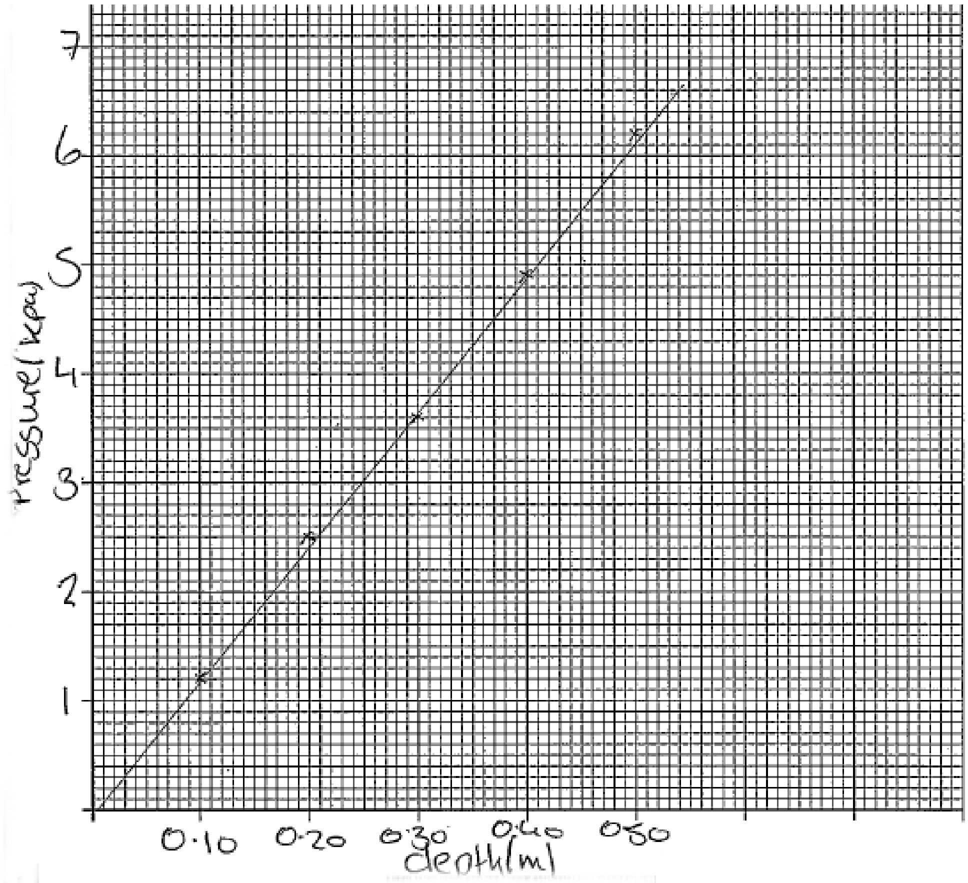
$1200 = \rho \times 9.8$

$\rho = 1275.5$

$\rho = 1276$ kg^{-3}

RESPONSE 2

(i)



(ii)

(ii) Calculate the gradient of your graph.

Space for working and answer

$(0.4, 4.9)$ — x_1, y_1

$(0.5, 6.2)$ — x_2, y_2

$m = \frac{y_2 - y_1}{x_2 - x_1}$

$= \frac{6.2 - 4.9}{0.5 - 0.4}$

$= 16$

(iii)

$P = \rho g h$

$\rho g h = P$

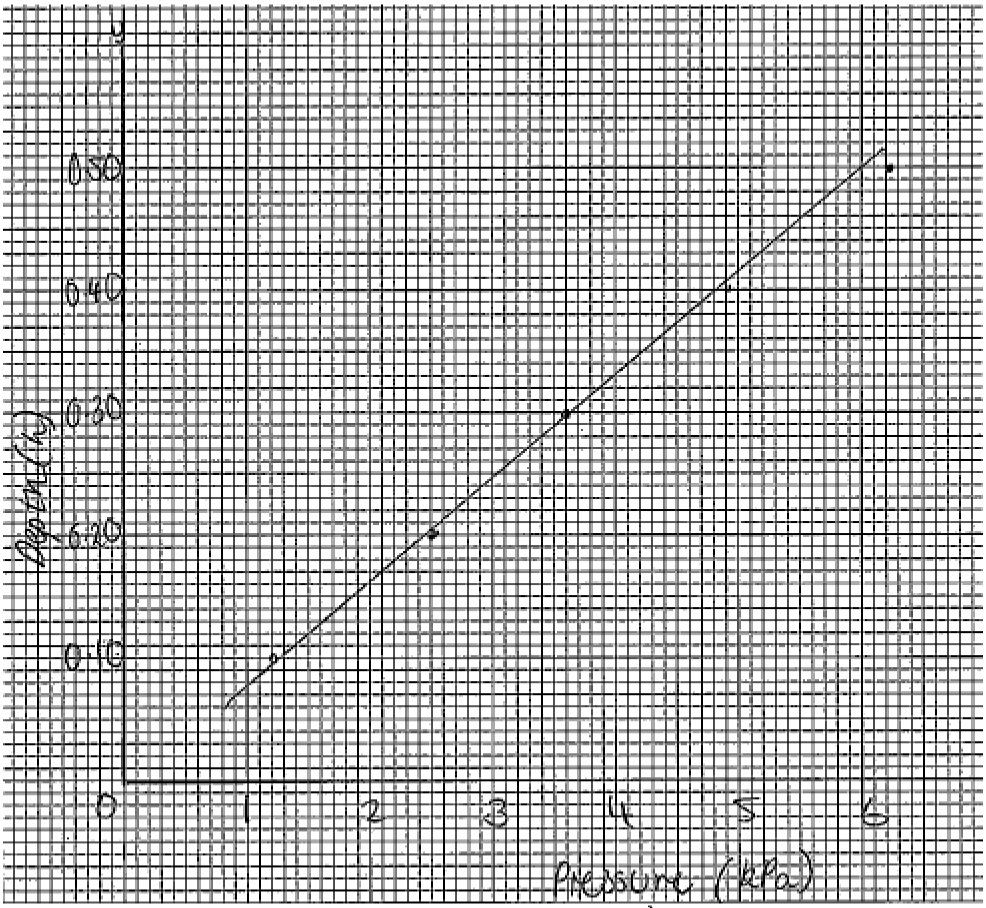
$\rho = \frac{P}{gh}$

$= \frac{4.9 \times 10^3}{9.8 \times 0.4}$

$= 1250$ kgm^{-3}

RESPONSE 3

(i)



(ii)

(1.2, 0.10) (2.5, 0.20)

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

$m = \frac{0.20 - 0.10}{2.5 - 1.2}$

$m = 0.08$

(iii)

$P = \rho g h$

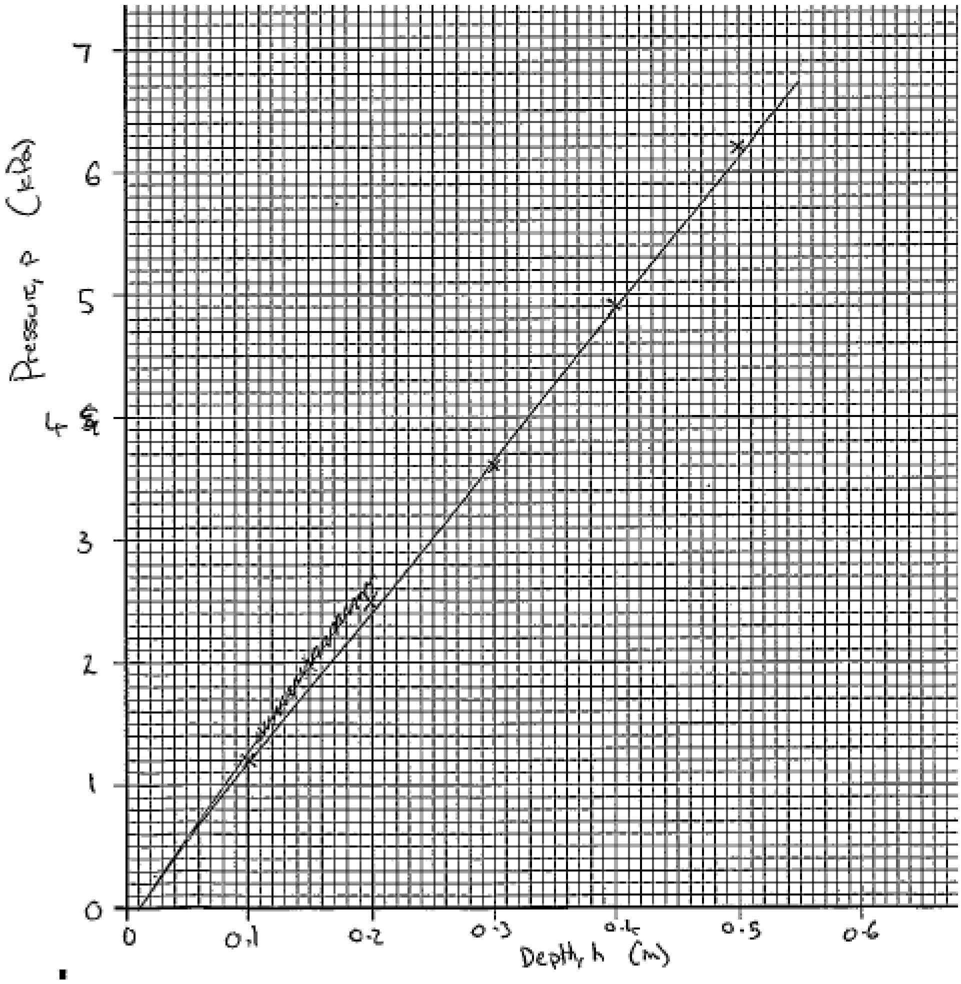
$1.2 = \rho \times 9.8 \times 0.10$

$1.2 = 0.98\rho$

$\rho = 1.22 \text{ kgm}^{-3}$.

RESPONSE 4

(i)



(ii)

...e for working and answer

$m = \frac{y_2 - y_1}{x_2 - x_1}$

(0.4, 4.9)

(0.33, 4)

$= \frac{4.9 \times 10^3 - 4 \times 10^3}{0.4 - 0.3}$

~~$= \frac{4.9 - 4}{0.4 - 0.33}$~~

$= 13{,}000\ \text{Pa m}^{-1}$

(iii)

$P = \rho g h$

$\frac{P}{h} \times g = \rho$

$13{,}000 \times 9.8 = \rho$

$\rho = 127{,}000\ \text{kg m}^{-3}$