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MARK SCHEME

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This document consists of **8** printed pages.

Question	Answer	Marks
1(a)	units of F : kg ms^{-2}	C1
	units of ρ : kg m^{-3} and units of v : ms^{-1}	C1
	units of K : $\text{kg ms}^{-2} / [\text{kg m}^{-3} (\text{ms}^{-1})^2]$ $= \text{m}^2$	A1
1(b)(i)	$K\rho = 1.5 / 33^2$	C1
	$= 1.38 \times 10^{-3}$	A1
	$F_D = 1.38 \times 10^{-3} \times 25^2$ or $F_D / 1.5 = 25^2 / 33^2$ $F_D = 0.86 \text{ N}$	
1(b)(ii)	$a = (1.5 - 0.86) / (1.5 / 9.81)$ or $a = 9.81 - [0.86 / (1.5 / 9.81)]$	C1
	$a = 4.2 \text{ ms}^{-2}$	A1
1(c)	initial acceleration is $g/9.81 (\text{ms}^{-2})$ /acceleration of free fall	B1
	acceleration decreases	B1
	final acceleration is zero	B1

Question	Answer	Marks
2(a)	$30 \text{ ms}^{-1} = 108 \text{ km h}^{-1}$ or $100 \text{ km h}^{-1} = 28 \text{ ms}^{-1}$ and so exceeds speed limit	B1
2(b)	acceleration = gradient or $\Delta v / (\Delta t)$ or $(v - u) / t$	C1
	e.g. acceleration = $(24 - 20) / 12$ [other points on graph line may be used] $= 0.33 \text{ ms}^{-2}$	A1
2(c)	distance travelled by Q = $\frac{1}{2} \times 12 \times 30$ (= 180 m)	C1
	distance travelled by P = $\frac{1}{2} \times (20 + 24) \times 12$ (= 264 m)	C1
	distance between cars = $264 - 180$ $= 84 \text{ m}$	A1
2(d)	$30 - 24 = 6 \text{ ms}^{-1}$ 'extra' time $T = 84 / 6$ (= 14 s) or $180 + 30T = 264 + 24T$ 'extra' time $T = 84 / 6$ (= 14 s)	C1
	$t = 12 + 14 = 26 \text{ s}$	A1

Question	Answer	Marks
3(a)(i)	in a stationary wave energy is not transferred or in a progressive wave energy is transferred	B1
3(a)(ii)	in a stationary wave (adjacent) particles are in phase or in a progressive wave (adjacent) particles are out of phase/have a phase difference/not in phase	B1
3(b)(i)	(position where) maximum amplitude	B1
3(b)(ii)	distance = 0.10 m	B1
3(b)(iii)	1. $\lambda = 0.60/1.5$ = 0.40 m	A1
	2. $v = f\lambda$	C1
	$f = 340/0.40$ = 850 Hz	A1
3(b)(iv)	$\lambda = 2 \times 0.60$ or $\lambda = 3 \times 0.40$ or $f = 850/3$	C1
	$f = 280$ (283) Hz	A1

Question	Answer	Marks
4(a)	(strain =) extension / <u>original</u> length	B1
4(b)(i)	$E = \sigma / \varepsilon$	C1
	maximum stress = $2.1 \times 10^{11} \times 4.0 \times 10^{-4}$ $= 8.4 \times 10^7 \text{ Pa}$	A1
4(b)(ii)	$\sigma = F/A$	C1
	minimum area = $8.0 \times 10^3 / 8.4 \times 10^7$ $= 9.5 \times 10^{-5} \text{ m}^2$	A1

Question	Answer	Marks
5(a)	$I_1 + I_2 = I_3$ [any subject]	B1
5(b)	$E_1 + E_3 = I_1 R_1 + I_3 R_3 + I_3 R_4$ [any subject]	B1
5(c)	$E_1 - E_2 = I_1 R_1 - I_2 R_2$ [any subject]	B1

Question	Answer	Marks
6(a)	force <u>per</u> unit positive charge	B1
6(b)(i)	$E_K = \frac{1}{2}mv^2$	C1
	$2.4 \times 10^{-16} = \frac{1}{2} \times 1.7 \times 10^{-27} \times v^2$	A1
	$v = 5.3 \times 10^5 \text{ ms}^{-1}$	
6(b)(ii)	work done = $2.4 \times 10^{-16} \text{ J}$	A1
6(b)(iii)	$W = Fs$	C1
	$F = 2.4 \times 10^{-16} / 15 \times 10^{-3}$	A1
	$= 1.6 \times 10^{-14} \text{ N}$	
6(b)(iv)	$V = Fd / Q$ or $V = W / Q$ or $E = V/d$ and $E = F/Q$	C1
	$V = (1.6 \times 10^{-14} \times 15 \times 10^{-3}) / 1.6 \times 10^{-19}$ or $2.4 \times 10^{-16} / 1.6 \times 10^{-19}$	C1
	$= 1500 \text{ V}$	A1
6(b)(v)	straight line with positive gradient starting at the origin and going as far as $x = 15 \text{ mm}$	B1

Question	Answer	Marks
7(a)	(the ohm is) volt / ampere	B1
7(b)(i)	$R = \rho L / A$	C1
	ratio = $[\rho L / (\pi d^2 / 4)] / [0.028 \rho \times 7.0 L / \{\pi (14d)^2 / 4\}] = 1000$ or ratio = $14^2 / (0.028 \times 7) = 1000$	A1
7(b)(ii)	same current (in connecting and filament wires) and the lamp/filament (wire) has greater resistance	B1
7(b)(iii)	$P = V^2 / R$ or $P = VI$ or $P = I^2 R$	C1
	(for filament wire) $R = 12^2 / 6.0$ or $R = 6.0 / 0.50^2$ or $R = 12 / 0.50$	C1
	(for filament wire) $R = 24 \Omega$	A1
	(for connecting wire) $R = 24 / 1000$ $= 2.4 \times 10^{-2} \Omega$	
7(b)(iv)	resistance of connecting wire increases	B1
	current in circuit/lamp/filament (wire) decreases or potential difference across lamp/filament (wire) decreases	M1
	(so) resistance of lamp/filament (wire) decreases	A1

Question	Answer	Marks
8(a)	(quark structure is) up, down, down/udd	B1
	up/u has charge $+\frac{2}{3}(e)$, down/d has charge $-\frac{1}{3}(e)$	C1
	$+\frac{2}{3}e - \frac{1}{3}e - \frac{1}{3}e = 0$	A1
8(b)	charge: p $+1.6(0) \times 10^{-19}$ (C) or $+e$ β^- $-1.6(0) \times 10^{-19}$ (C) or $-e$ $\bar{\nu}$ zero/0	B1
	mass: p 1.67×10^{-27} (kg)/ 1.7×10^{-27} (kg) β^- $9.1(1) \times 10^{-31}$ (kg) $\bar{\nu}$ very small/zero/0	B1