

Q1(b) Maximum mark: 3**Response A**

$$t = \frac{v}{a}$$
$$t = 1.0918\dots$$
$$t = ?$$
$$u = 10.7$$
$$a = 9.8$$
$$t = \frac{10.7}{9.8}$$
$$t = 1.09 \text{ seconds}$$

Marks**Response B**

$$a = \frac{v - u}{t}$$
$$9.8 = \frac{10.7 - 0}{t}$$
$$t = 1.09 \text{ s}$$

Response C

$$a = \frac{\Delta v}{\Delta t}$$
$$9.8 = \frac{10.7}{\Delta t}$$
$$t = 1.092 \text{ s}$$

Q1(c) Maximum mark: 3**Response A**

$$a = \frac{v-u}{t}$$

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

$$s = 11.89 \times [1 + 1.4] + \frac{1}{2} \times 0 \times t^2$$

$$s = 29.725 \text{ m}$$

Marks**Response B**

$$v = \frac{s}{t}$$

$$10.7 = \frac{s}{2.5}$$

$$s = 27 \text{ m}$$

Q1(d) Maximum Mark: 2**Response A**

EK HIGHER AS SKIER IS GOING
FASTER.

Marks**Response B**

skier has more kinetic energy because they
have less potential energy

Response C

The skier has less kinetic because potential
energy is changed to kinetic energy.

Q2(a) Maximum mark: 4

Response A

Marks

$$\begin{aligned}
 F &= ma \\
 F &= 1.15 \times 10^5 \text{ N} \\
 m &= 1.33 \times 10^5 \text{ kg} \\
 a &=? \\
 a &= \frac{m}{F} \\
 a &= \frac{1.33 \times 10^5}{1.15 \times 10^5} \\
 a &= 1.1565 \dots \\
 a &= 1.16 \text{ m/s}^2
 \end{aligned}
 \qquad
 \begin{aligned}
 F_T &= ma \\
 F_T &=? \\
 m &= 3.56 \times 10^4 \\
 a &= 1.16 \\
 F_T &= 3.56 \times 10^4 \times 1.16 \\
 F_T &= \underline{41180 \text{ N}}
 \end{aligned}$$

Response B

$$\begin{aligned}
 \text{car man} &= 133.1 \times 10^3 \text{ kg} \\
 F &= ma \\
 1.15 \times 10^5 &= 133.1 \times 10^3 \times a \\
 a &= \frac{1.15 \times 10^5}{133.1 \times 10^3} = 0.86 \text{ m/s}^2 \\
 F &= ma \\
 &= 3.56 \times 10^4 \times 0.86 \\
 &= 30.6 \times 10^3 \text{ N}
 \end{aligned}$$

Q2(b)(i) Maximum mark: 3

Response 1

Marks

$$f_0 = f_s \left(\frac{v}{v - v_s} \right)$$

$$f_0 = 531$$

$$f_s = 511$$

$$v = 340$$

$$v_s = ?$$

$$531 = 511 \left(\frac{340}{340 - v_s} \right)$$

$$\frac{531}{511} = \frac{340}{340 - v_s}$$

$$= 1.04$$

$$1.04 = \frac{340}{340 - v_s}$$

$$\frac{340}{1.04} = 340 - v_s$$

$$-v_s = -13.08$$

$$v_s = \underline{13.08 \text{ m/s}}$$

Response 2

$$f_0 = f_s \left[\frac{v}{v \pm v_s} \right]$$

$$531 = 511 \left[\frac{340}{340 + v_s} \right]$$

$$v_s = 340 - 327.193 \dots$$

$$v_s = 12.8 \text{ m/s}$$

Q2(b)(ii) Maximum mark: 2

Response A

The statement is incorrect as the student would be with the screen travelling as one. $\lambda =$ the same and so does v so therefore f does too.

Marks

Response B

this is incorrect because they are moving with the train and therefore there will be no change in the frequency.

Q3(a) Maximum mark: 3**Response A**

$$v^2 = u^2 + 2as$$

$$v^2 = 0^2 + 2 \times -9.8 \times 1.27$$

$$v = \underline{5 \text{ ms}^{-2}}$$

Marks**Response B**

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + 2 \times 9.81 \times 1.27$$

$$v = \underline{5 \text{ m/s}^2}$$

Response C

$$v^2 = u^2 + 2as$$

$$= 0^2 + 2 \times 9.8 \times 1.27$$

$$= \underline{5.0 \text{ ms}^{-1}}$$

Q3(b)**Maximum mark: 3****Response A****Marks**

$$Ft = \Delta p$$
$$Ft = mv - mu$$
$$0.14 = (1.59 \times 10^{-2})v - (1.59 \times 10^{-2}) \times 5$$
$$1.59 \times 10^{-2}v - 0.079 = 0.14$$
$$1.59 \times 10^{-2}v = 0.219$$
$$v = 13.8 \text{ ms}^{-1}$$

Q3(c) Maximum mark: 1

Response A

Energy is lost in collision

Marks

Response B

E_k goes down and E_p goes
up

Response C

In collision E_k gets lost.

Q3(d) Maximum mark: 2

Response A

$t \uparrow \therefore F \downarrow$

Marks

Response B

t increases so F decreases

Q5(a) Maximum mark: 3

Response A

Marks

$$F = \frac{Gmm}{r^2}$$

$$1.5 \times 10^{39} = \frac{6.67 \times 10^{-11} \times 3.18 \times 10^{30} \times 2.27 \times 10^{30}}{r^2}$$

$$r = 5.5 \times 10^5 \text{ m}$$

Response B

$$F = \frac{GMM}{r^2}$$

$$1.59 \times 10^{39} = \frac{6.67 \times 10^{-11} \times 3.18 \times 10^{30} \times 2.27 \times 10^{30}}{r^2}$$

$$1.59 \times 10^{39} = \frac{4.814 \times 10^{50}}{r^2}$$

$$r = 5.50 \times 10^5 \text{ m}$$

Response C

$$F = \frac{Gmm}{r^2}$$

$$1.59 \times 10^{39} = \frac{6.67 \times 10^{-11} \times 3.18 \times 10^{30} \times 2.27 \times 10^{30}}{r^2}$$

$$1.59 \times 10^{39} = \frac{4.81 \times 10^{50}}{r^2}$$

$$r = 5.50 \times 10^5 \text{ m}$$

Q5(b)(i) Maximum mark: 1

Response A

Crest and trough occupy the same
space at the same time.

Marks

Response B

Crest meets trough and trough meets
trough

Response C

Waves are not in phase

Q6(a)(i) Maximum mark: 3

Response A

Marks

$$\begin{aligned}\Delta E &= E_4 - E_1 \\ &= -0.871 \times 10^{-19} - (-5.45 \times 10^{-19}) \\ &= 4.579 \times 10^{-19} \\ hf &= 4.579 \times 10^{-19} \\ f &= 6.19 \times 10^{14} \text{ Hz}\end{aligned}$$

Response B

$$\begin{aligned}hf &= E_2 - E_1 \\ 6.63 \times 10^{-34} \times f &= 5.45 \times 10^{-19} - 0.871 \times 10^{-19} \\ f &= 6.9 \times 10^{14} \text{ Hz}\end{aligned}$$

Q6(b)**Maximum mark: 3****Response 1****Marks**

$$Z = \frac{v}{c} = \frac{4.51 \times 10^6}{3 \times 10^8} = 0.01500$$

Q6(c) **Maximum mark: 2****Response A**

the vast majority of objects are redshifted away from us, this suggests that everything started as one singularity, supporting the Big Bang theory.

Marks**Response B**

if everything is redshifted that means it is all moving away showing that it was all at one singularity hence the big bang

Response C

As it shows the majority of galaxies are redshifting away from earth showing the universe started with a singularity.

Q7(a)(i) Maximum mark: 1

Response A

To keep the ions decelerating in a straight line

Marks

Response B

So as the ions don't get repelled away from a tube when they're moving towards it.

Q7(a)(ii) Maximum mark: 1

Response A

So as the ions take the same time
to get through every tube.

Marks

Response B

The tubes get longer to give the ions
a bigger accelerating force every time

Q7(b) Maximum mark: 3**Response A**

$$l' = l \sqrt{1 - \frac{v^2}{c^2}}$$

$$l' = 13 \sqrt{1 - \frac{0.5c^2}{c^2}}$$

$$l' = 9.2 \text{ m}$$

Marks**Response B**

$$\lambda' = \lambda \sqrt{1 - \frac{v^2}{c^2}}$$

$$\lambda' = 13 \sqrt{1 - \frac{c^2}{4c^2}}$$

$$\lambda' = 11.258 \text{ m}$$

Q8(a) **Maximum mark: 1**

Response A

UV Photons have enough energy to eject electrons from the Plate. White light Photons do not. Electrons cross from P to Q to make a current.

Marks

Q8(b)(ii) Maximum Mark: 2

Response A

Marks

$$W = QV$$

$$W = 12 \times 1.6 \times 10^{-19} \quad V = 12$$

$$= 1.92 \times 10^{-19} \text{ J} \quad Q = 1.6 \times 10^{-19}$$

$$= 1.92 \times 10^{-18} \text{ J}$$

Q9(a)(i) Maximum mark: 2

Response A

$$F = 19.5 \times \sin 14^\circ$$
$$= 4.72$$
$$F_{\text{RES}} = 2 \times 4.72 = 9.44 \text{ N}$$

Marks

Response B

$$F_T = 2 \times 19.5 \sin 14 = 9 \text{ N}$$

Q9(a)(ii) Maximum mark: 1

Response A

Marks

THE SIDEWAYS FORCE FROM ONE WIRE IS BALANCED
BY THE SIDEWAYS FORCE FROM THE OTHER WIRE

Q9(b)(i) Maximum mark: 5

Response A

Marks

$$I = \frac{P}{A}$$
$$11800 = \frac{P}{1.42 \times 10^{-5}}$$
$$P = 0.16756$$
$$P = \frac{E}{t}$$
$$0.16756 = \frac{2.1}{t}$$
$$t = 12.5 \text{ s}$$

Q9(b)(ii) Maximum mark: 3

Response A

$$6.3 \times 0.3^2 = 0.567$$

$$3.5 \times 0.4^2 = 0.56$$

$$2.3 \times 0.5^2 = 0.575$$

$$1.6 \times 0.6^2 = 0.576$$

As the results are all similar
the LED acts as a point
source.

Marks

Response B

d	I	$I d^2$
0.30	6.3	0.567
0.40	3.5	0.56
0.50	2.3	0.575
0.60	1.6	0.576

$$4 \overline{) 2.278}$$

$$\underline{0.5695}$$

$$I d^2 = 0.5695$$

so LED is a point source

Q9(b)(iii)A **Maximum mark: 1**

Response A

A semiconductor with other
chemicals added to it.

Marks

Q9(b)(iii)B

Maximum mark: 3

Response A

Marks

The forward biased LED emits light because electrons move from the conduction band. They then drop energy levels and fill slots in the valence band available. The energy released is in the form of light energy.

Response B

Electrons in the n-type fall into gaps in the band of the p-type and energy is released in the form of photons.

Q10(a)(i)B **Maximum mark: 2****Response A****Marks**

$$\frac{14.5 - 13.0}{5} = \underline{0.3}$$
$$\underline{13.9 \pm 0.3}$$

Q10(b) Maximum mark: 1

Response A

Marks

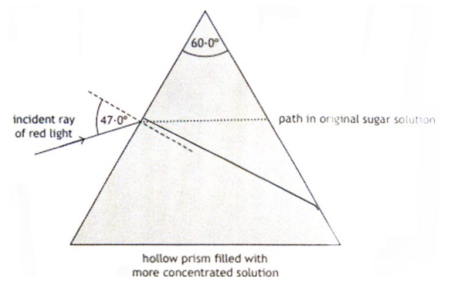
The central maxima is wide because the path difference is 0 therefore meaning the wavelengths stay the same.

Response B

this is because the white light, when pass straight through the grating, will not diffract because path difference is 0 as it is $= m\lambda$, where $m=0$ (central maximum)

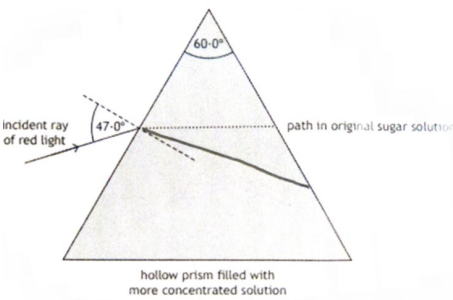
Q12(b) Maximum mark: 1

Response A

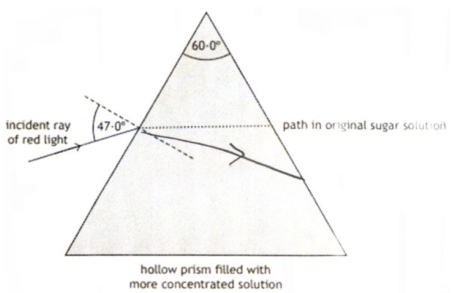


Marks

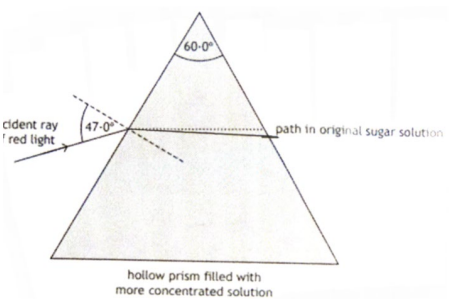
Response B



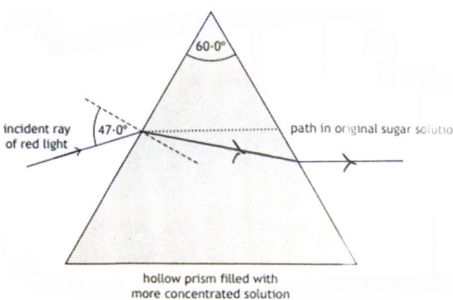
Response C



Response D



Response E



Q12(c) Maximum mark: 2

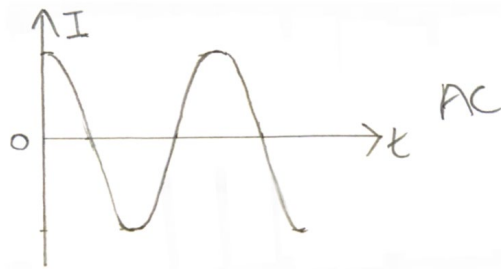
Response A

The red light's wavelength is greater than that of green light within the spectrum.

Marks

Response B

Green light is more refractive due to its shorter wavelength. Red light has longer wavelength so its less refractive

Q13(a) Maximum mark: 1**Response A****Marks****Response B**

alternating current changes
direction. direct current flows in
the same one direction all the time

Response C

AC CHANGES DIRECTION WITH TIME

Q13(b)(ii) Maximum mark: 3**Response A**

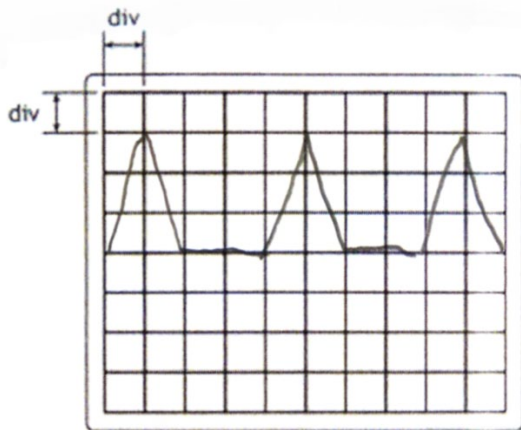
$$T = \frac{1}{f}$$
$$f = ? \quad f = \frac{1}{0.4}$$
$$T = 0.4 \quad f = 2.5 \text{ Hz}$$
$$f = \frac{1}{T}$$

Marks**Response B**

$$4 = T$$
$$T = \frac{1}{f}$$
$$4 = \frac{1}{f}$$
$$f = 0.25 \text{ Hz}$$

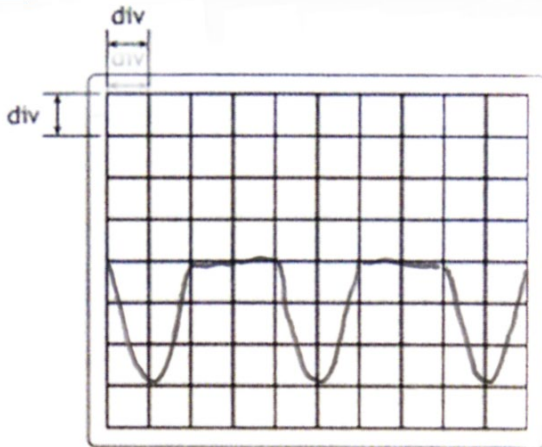
Q13(c) Maximum mark: 2

Response A



Marks

Response B



Q14(a) Maximum Mark: 3

Response A

Make (V) and (A) readings by
changing resistance.
Draw a graph.

The gradient of the graph
gives r .

Marks

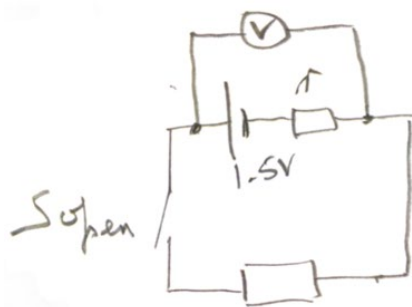
Q14(b)(i) Maximum mark: 1

Response A

1.5 J of energy is passed through 1
coulomb of charge in the circuit.

Marks

Response B



EMF 1.5V is
the voltmeter
reading

Q14(c) Maximum mark: 3**Response A**

voltmeter reading goes up.
Voltmeter reading is TPD
 $EMF = TPD + \text{lost volts}$
EMF doesn't change and lost volts
goes down so TPD goes up.

Marks**Response B**

Voltmeter reading decreases because
current is less as resistance is
less.

Q15(a) Maximum mark: 2**Response A**

The velocity of the ball will increase meaning the frictional force on the ball will increase. The frictional force on the ball will continue to increase until it is equal with weight, then it will no longer increase meaning terminal velocity will be reached.

Marks**Response B**

The forces acting on the ball bearing become balanced, so no unbalanced force acts on ball bearing so it doesn't accelerate but reaches terminal velocity.