Q 1(a)(i)A **Maximum Mark: 1**

RESPONSE 1

$V_H = v\cos\theta$

$V_H = 7.4\cos 30°$

$V_H = \underline{6.41 m/s}$

RESPONSE 2

$= 7.4\cos 80$

$= \underline{6.4 ms^{-1}}$

RESPONSE 3

$V_h = \cos\theta V$

~~= cos…~~

$= \cos 30 \times 7.4$

$= 6.408$

$= 6.41 ms^{-1}$

Q1(a)(i)B **Maximum Mark: 1**

RESPONSE 1

$V_v = \sin\theta v$

$= \sin 30 \times 7.4$

$= 3.7 ms^{-1}$

Q1(a)(ii) **Maximum Mark: 3**

RESPONSE 1

$a = -9.8 \text{ m/s/s}$
$u = 3.7 \text{ m/s}$
$v = 0 \text{ m/s}$
$s = s$
$t = t$

~~$v^2 = u^2 + 2as$~~
~~$0^2 = 3.7^2 + 2 \times -9.8 s$~~
~~$0 = 13.69 - 19.6s$~~
~~$19.6s = 13.69$~~
~~$s = \frac{13.69}{19.6}$~~
~~$s = 0.$~~

$v = u + at$
$0 = 3.7 - 9.8t$
$9.8t = 3.7$
$t = \frac{3.7}{9.8}$
$t = 0.378 \text{ s}$

RESPONSE 2

$v = u + at$
$3.7 = 0 + 9.8t$
$t = 0.38 \text{ s}$

~~s~~
$u = 0$
$v = 3.7$
$a = 9.8$
$t = ?$

RESPONSE 3

$v = \frac{d}{t}$
$t = \frac{d}{v}$
$= \frac{1.5}{3.7}$
$= 0.405 \text{ s}$

Q1(a)(iii) **Maximum Mark: 4**

RESPONSE 1

Final answer Q1(a)(i)B $3{\cdot}7\ ms^{-1}$ Q1(a)(ii) $0{\cdot}378$ s

Space for working and answer

~~t = 0.378 + 0.45~~
~~= 0.828 s~~

a = 9.8 m/s/s
s = s
t = 0.45 s
u = 0 m/s

Total height above ground
s = 0.698 + 1.5
s = 2.198 m

h = 2.198 − 0.992

Second half of journey
s = ut + ½at²
s = 0×0.45 + ½×9.8×0.45²
s = 0 + 4.9 × 0.2025
s = 0.992 m

First half
s = 3.7×0.378 + ½(−9.8)(0.378)²
s = 1.3986 − 0.7001316
s = 0.698 m

h = 1.21 m

RESPONSE 2

Final answer Q1(a)(i)B $3{\cdot}7\ ms^{-1}$

~~s = ut + ½at²~~
~~s = −3.38~~

s = ?
u = 3.7
a = 9.8
t = 0.45

s = ut + ½at²
s = 3.7×0.45 + ½×−9.8×0.45²
s = 0.67 m

h = 0.83 m

RESPONSE 3

t = 0.855 Vh = 6.41
(0.4051045)

d = v×t
= 6.41×0.855
= 5.4805 m

Q1 (b) **Maximum Mark: 2**

RESPONSE 1

The greater the speed, the greater the components of vertical and horizontal velocity ∴ the sponge will reach a greater height and travel a greater horizontal distance in the same timeframe as $d = \frac{v_H}{t}$ and $v^2 = u^2 + 2as$. Therefore the sponge will travel the same distance in a shorter time but will miss the teacher as the height is greater.

RESPONSE 2

Let initial velocity = 8

v.c $= 4\,ms^{-1}$

$s = 0.83$
$u = 4$
$a = 9.8$
$t = ?$

~~$0.83 = 4t + \frac{1}{2} 9.8 t^2$~~

~~$0.2075 = t + 4.9$~~

~~$s = \frac{1}{2}(u+v)t$~~

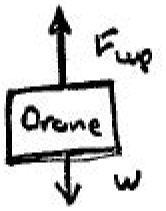
RESPONSE 3

If the ball is thrown at the same angle with a higher velocity, it will reach a higher max height and thus it will travel further in doing so. So the total distance will be greater.

Q2(a)(iii) **Maximum Mark: 2**

RESPONSE 1

Due to the forces no longer being balanced i.e $F_{upward} \neq$ Weight then the drone will fly vertically upwards at a pace. This can be seen in the diagram.



$F_{up} \neq W$
$\therefore$ accelerates upwards

RESPONSE 2

It accelerates upwards.
It's ~~weight~~ mass has decreased and so has its weight.
$m = 5{\cdot}5kg$ $W = mg = 5{\cdot}5 \times 9{\cdot}8 = 53{\cdot}9N$
And since it still has an upwards force of $66{\cdot}15N$ upwards, there is an unbalanced force of $66{\cdot}15 - 53{\cdot}9 = 12{\cdot}25N$ upwards
resulting in an acceleration upwards of $a = \frac{F}{m} = \frac{12{\cdot}25}{5{\cdot}5} = 2{\cdot}2ms^{-2}$ up

RESPONSE 3

the drone will accelerate upwards because the weight of the drone is less than when it was carrying the package so the upwards force is greater than the weight

Q2(b) **Maximum Mark: 4**

RESPONSE 1

$W = 3 \cdot 4 \times 9 \cdot 8$
$= 33 \cdot 32 \text{ N}$

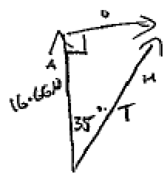
mgsin θ . . $33 \cdot 32 \times \sin 35$
$= 19 \cdot 11156 \ldots$

T for both cables $= 19 \cdot 11$ N

RESPONSE 2

$W = mg$
$= 3 \cdot 4 \times 9 \cdot 8$
$= 33 \cdot 32 \text{ N}$

constant height
∴ Upwards force = 33·32 N
same angle for both drones
∴ Each drone producing upwards force on package of $\frac{33 \cdot 32}{2} = 16 \cdot 66 \text{ N}$



SOHCAHTOA

$\cos\theta = \frac{A}{H}$

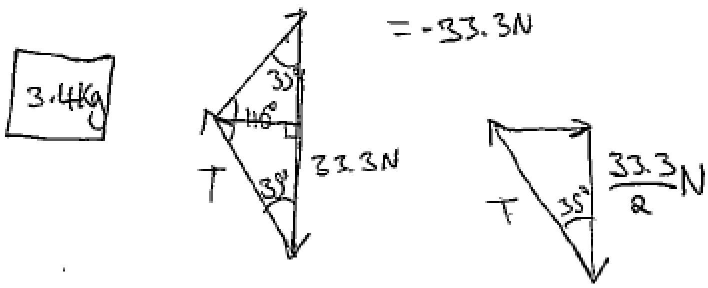
$\cos 35 = \frac{16 \cdot 66}{T}$

$T = \frac{16 \cdot 66}{\cos 35}$

$= 20 \cdot 3 \text{ N}$

RESPONSE 3

$W = mg$
$= 3.4 \times -9.8$
$= -33.3 \text{ N}$



$\cos 35° = \frac{16.65}{T}$

$T = \frac{16.65}{\cos 35°}$

$T = 20.3 \text{ N}$

Q3(a) **Maximum Mark: 2**

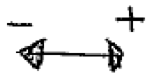
RESPONSE 1

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$
$$(0.75 \times 0.5) + (0.5 \times -0.3) = (0.75 \times 0.02) + (0.5v_2)$$
$$0.225 = 0.015 + 0.5v_2$$
$$0.21 = 0.5v_2$$
$$v_2 = 0.42\,ms^{-1} \rightarrow$$

RESPONSE 2

$$mu + mu = mv + mv$$
$$(0\cdot75 \times 0\cdot5) + (0\cdot5 \times -0\cdot3) = (0\cdot75 \times 0\cdot02) + 0\cdot5v$$
$$0\cdot5v = 0\cdot225 - 0\cdot015$$
$$0\cdot5v = 0\cdot21$$
$$v = 0\cdot42\,ms^{-1}$$

RESPONSE 3



$$m_xv_x + m_yv_y = m_xv_x + m_yv_y$$
$$(0\cdot75 \times 0\cdot5) + (0\cdot5 \times -0\cdot3) = (0\cdot75 \times 0\cdot02) + (0\cdot5v_y)$$
$$0\cdot225 = 0\cdot015 + 0\cdot5v_y$$
$$0\cdot5v_y = 0\cdot21$$
$$v_y = 0\cdot42\,ms^{-1} \text{ to the right}$$

Q3(b) **Maximum Mark: 3**

RESPONSE 1

$Ft = \Delta p$

$= m_2 v_2 - m_2 u_2$

$= m_2(v_2 - u_2)$

$= 0.5 \times (0.42 - (-0.3))$

$= 0.35\ Ns$

RESPONSE 2

impulse ~~Ft~~ = mV − mu

impulse ~~Ft~~ = $(0.5 \times 0.42) - (0.5 \times 0.3)$

impulse = 0.06 N to the right

RESPONSE 3

~~Ft = 0.5 × 0.3 − 0.5 × 0.42~~

$Ft = 0.5 \times 0.42 - 0.5 \times -0.3$

$= 0.36\ kgms^{-1}$

Q3(c) **Maximum Mark: 2**

RESPONSE 1

Calculate the kinetic energy (total) before the collision and after the collision. If the total kinetic energy before and after the collision is the same, the collision was elastic. If the total kinetic energy after the collision is less than the total kinetic energy before the collision, the collision was inelastic.

RESPONSE 2

Work out the kinetic energy of both cars before and after the collision and compare. If they have the same kinetic energy it ~~is~~ was elastic, if they dont it was inelastic.

RESPONSE 3

before the collision → Calculate the kinetic energy of Vehicle x and Vehicle y Sepretly then add ~~the~~ the kinetic energy of both together.

Then calculate the kinetic energy of the two Vehicles after the collision and add them together.

If kinetic energy before = kinetic energy after, the the collision is elastic

If the kinetic energy before ≠ kinetic energy after, the collision is inelastic

Q5(a) **Maximum Mark: 1**

RESPONSE 1

red shift

RESPONSE 2

(a) State one other piece of evidence that supports the Big Bang theory.

Cosmic microwave background radiation. ~~Cosmic background microwave radiation~~ - Also redshift of light from planets.

RESPONSE 3

(a) State one other piece of evidence that supports the Big Bang theory.

If something is moving away fast. To the observer it shifts to the red end of the spectrum. (Red shift). This is what is observed looking at distand galaxies.

Q5(b)(i) **Maximum Mark: 2**

RESPONSE 1

$$\text{age of universe} = \frac{1}{H_0} = \frac{1}{2 \times 10^{-17}} = 5 \times 10^{16}\ s = 1 \cdot 6 \times 10^{9}\ \text{years}$$

RESPONSE 2

$$\text{age} = \frac{1}{H_0} = 5 \times 10^{16}\ \text{years}$$

Q5(b)(ii) A **Maximum Mark: 1**

RESPONSE 1

~~As~~ This is because the students calculation of hubbles constant is not as accurate as the universally used version.

RESPONSE 2

More advanced ~~telescopes~~ technology has been invented so the value for Ho is more accurate now than in 1929.

RESPONSE 3

~~The recessional velocity can be more accurately measured and time has passed since 1929.~~
The recessional velocity can be measured at greater distances so the gradient has changed.

RESPONSE 4

Because Hubbles Constant changes a lot

RESPONSE 5

Using Value from data sheet

$$age = \frac{1}{2.3 \times 10^{-18}} = 4.35 \times 10^{17} \text{ years}$$

Student has not finished calculating, they need to take into consideration the days, hours, minutes and seconds

Q5(b)(ii) B

Maximum Mark: 1

RESPONSE 1

the universe.
Gather more information to plot [1] more points to give a more accurate Value for H0.

RESPONSE 2

Draw a more accurate line of best fit.

RESPONSE 3

Include more recessional velocitys at greater distances. To get a more accurate gradient.

RESPONSE 4

value in I) = 5×10^{16}
∴ 5×10^{16} / 365 → ans / 24 → ans / 60
→ ans / 60 = $15 \cdot 9 \times 10^{8}$ years.
The student should follow this process.

Q5(c)

Maximum Mark: 1

RESPONSE 1

Dark Matter.

RESPONSE 2

~~Dark matter~~ Dark energy

RESPONSE 3

The big bang.

Q6(a)(i)

Maximum Mark: 2

RESPONSE 1

~~= 1600 × 1.6~~ $= 1600 \times 1 \cdot 6 \times 10^{-19}$
$= 2 \cdot 56 \times 10^{-16}$
$= 2 \cdot 6 \times 10^{-16}$
⇒ as required.

RESPONSE 2

$W = QV$
$= 1 \cdot 6 \times 10^{-19} \times (1 \cdot 6 \times 10^{3})$
$= 2 \cdot 6 \times 10^{-16}$ J

Q6(a)(ii)

Maximum Mark: 3

RESPONSE 1

$E = \frac{1}{2}mv^2$

$2.6\times10^{-16} = 0.5\times9.11\times10^{-31}v^2$

$v = 2.39\times10^{7}\ ms^{-1}$

$E = \frac{1}{2}mv^2$

$2.6\times10^{-16} = 0.5\times9.11\times10^{-31}v^2$

$v = 2.39\times10^{7}$

RESPONSE 2

$P = mv \quad E_w = E_k = \frac{1}{2}mv^2$

$V = \frac{P}{m}$

$= \frac{2.6\times10^{-16}}{9.11\times10^{-31}}$

$=$

$\frac{1}{2}mv^2 = E_w$

$v^2 = \frac{E_w}{\frac{1}{2}m}$

$= \frac{2.6\times10^{-16}}{0.5\times9.11\times10^{-31}}$

$v^2 = 5.7080\times10^{14}$

$= 5.71\times10^{14}$

$v = \sqrt{5.71\times10^{14}}$

$= 2.38914468.67$

$= 2.4\times10^{7}\ ms^{-1}$

RESPONSE 3

$E_w = E_k$

$2.6\times10^{-16} = \frac{1}{2}mv^2$

$v = \sqrt{\frac{2.6\times10^{-16}}{\frac{1}{2}\times(9.11\times10^{-31})}}$

$= 2.39\times10^{7}\ ms^{-1}$

Q6(b)

Maximum Mark: 2

RESPONSE 1

The electrons will be less spread out upon arrival at the Screen because they will be travelling faster and have less time to spreadout.

RESPONSE 2

The screen will flucresce more frequently. Increasing the voltage increases the current as $I = \frac{V}{R}$ ∴ ~~more~~ the flow of electrons is stronger and more electrons will be able to get through in the same time frame.

RESPONSE 3

The screen glows more brightly. As a higher number of electrons hit the screen as the voltage is greater.

RESPONSE 4

As the voltage has increased the amount of energy will increase making the screen brighter.

$W = QV$

$= 1.6 \times 10^{-19} \times 2.2 \times 10^{3}$

$= 3.52 \times 10^{-16}$ J

Q7(a)

Maximum Mark: 1

RESPONSE 1

The work function of the metal plate is greater than the energy produced by the protons, stopping them from leaving the plate.

RESPONSE 2

The energy provided by the ultra violent light is smaller than that of the work function of the metal.

RESPONSE 3

The frequency of ultraviolet light is not larger than the threshold frequency for gold.

RESPONSE 4

Ultraviolet cannot make the gold leaf deflect because it is not of a sufficiently high frequency.

Q7(b)(i)

Maximum Mark: 1

RESPONSE 1

6.94 Joules of energy, is the minimum amount of energy required for photoelectric emission to occur.

RESPONSE 2

The energy taken to discharge a photoelectron

RESPONSE 3

The minimum energy required by an a photon to cause photoemission of an electron from the metal plate.

Q7(b)(ii)

Maximum Mark: 2

RESPONSE 1

The frequency of UV light is still the same and therefore there is no effect on the maximum kinetic energy

RESPONSE 2

this has no effect on the maximum kinetic energy of the photoelectrons because irradiance only affects how many photoelectrons are emitted, not their kinetic energy. The only way to change this is to change the frequency of the light emitted from the source by changing the source of light.

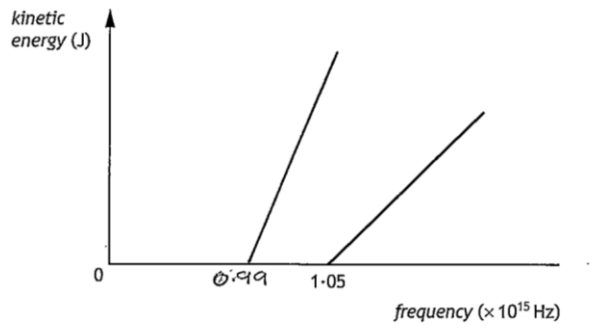
RESPONSE 3

Decreases current but does not have any effect on Ek as $E_k = hf - hf_o$ and if the frequency of the light remains the same and the metals work function then the maximum kinetic energy of the electron will not change.

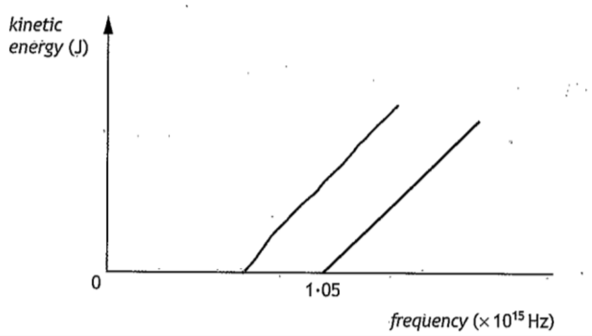
Q7(c)

Maximum Mark: 2

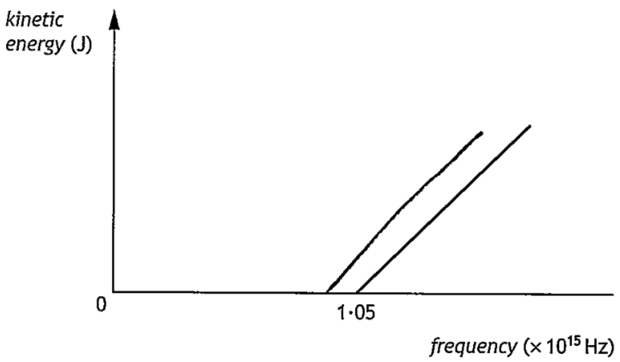
RESPONSE 1



RESPONSE 2



RESPONSE 3



Q7(d)

Maximum Mark: 1

RESPONSE 1

• A photon is a bundle of energy and to eject an electron from a metal surface energy is required (a certain amount. ie. Work function)

One photon ejects one electron (above fo).

Increasing irradience increases no. of electrons emitted (per second)

RESPONSE 2

It isn't due to ionisation as a positive plate would also discharge. It isn't due to waves as total energy hitting plate isn't what causes photoemission since light of any frequency would cause photoemission if incident for a period of time, which isn't the case. Therefore light must be made up of discrete particles called photons which have their own ~~energy~~ energies.

RESPONSE 3

This is because the photons of light exist on energy levels, and through absorbing energy from a photon they can move up energy levels and fly off.