Delegate Booklet

Course Title: A Level Physics: Understanding our Exams

Course Code: 9PH0-24O3

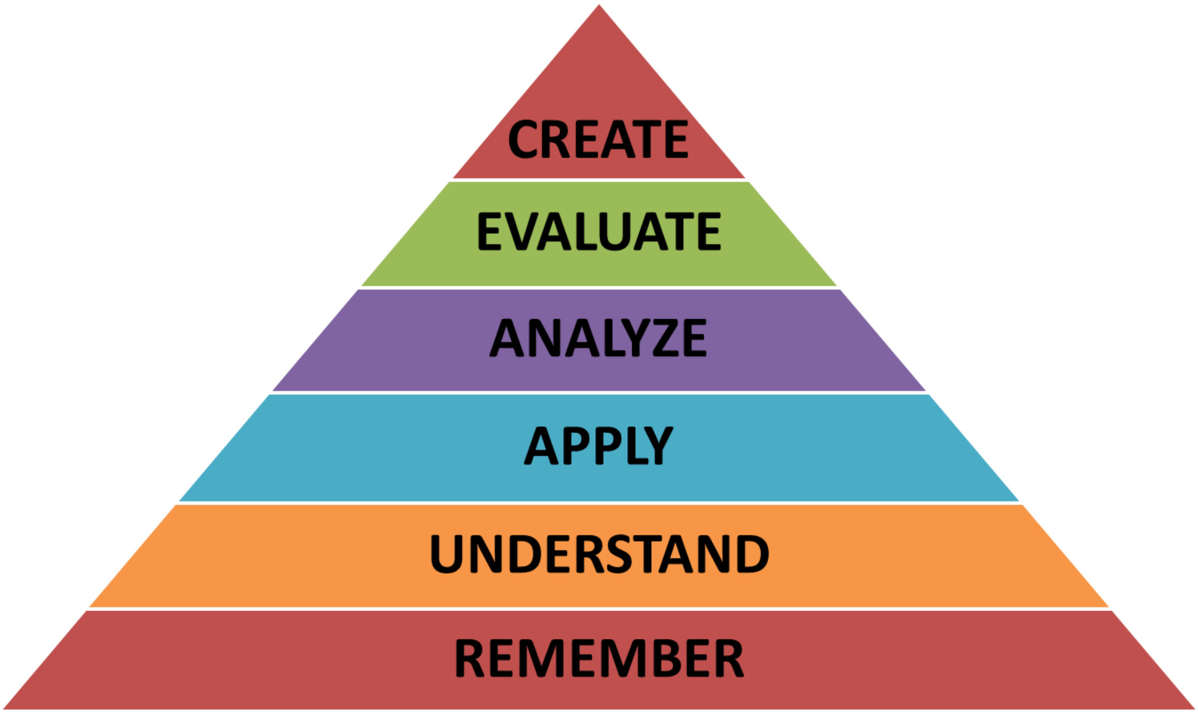
Agenda

- Welcome and Introduction (5 mins)
- The 10-stage process (5 mins)
- Structure of the assessment (35 min)
- Mark schemes (20 min)
- Comfort Break (5 min)
- Applying mark schemes (40 min)
- Advice for students (5 min)
- Questions (5 min)

Aims and Objectives of the Event

- Look at how our question papers are designed to test the specification
- Understand how and why markers are standardised to mark exam papers
- See some example of mark schemes applied to recent exam questions
- Consider some strategies to improve how students respond to exam questions
- Address common issues and FAQs

Activity 1: Command Words and Bloom's Taxonomy



Here are 6 command words from the specification:

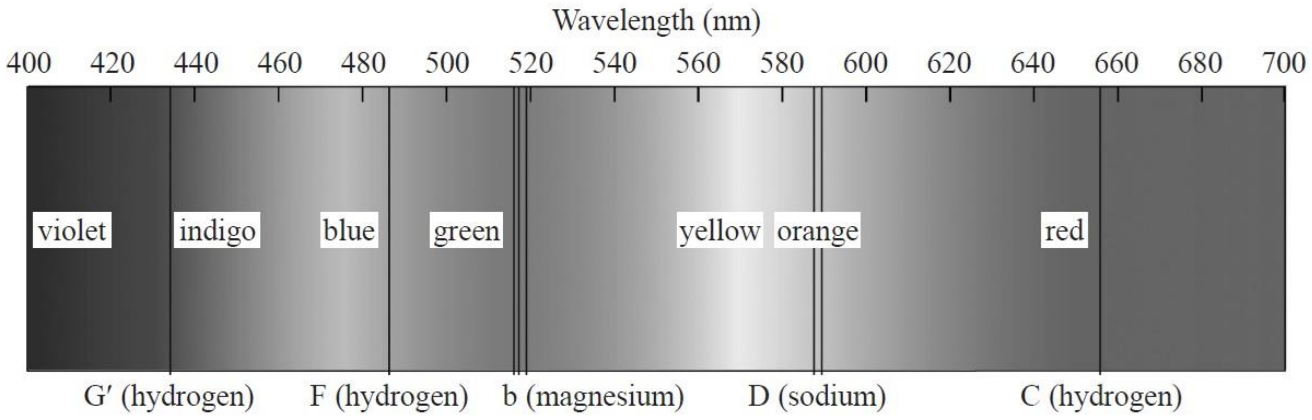
- Assess
- Calculate
- Compare (and contrast)
- Describe
- Devise
- Explain

Link each command word with the appropriate level in Bloom's Taxonomy.

Activity 2: Assessment Objectives

AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures.

(b) A spectrum of the visible light emitted by a particular star is shown.



(Source: © Universal Images Group North America LLC/Alamy Stock Photo)

(i) Light interacts with atoms as it passes through the atmosphere of the star.

Explain how this leads to the formation of the dark lines within the spectrum.

(4)

Mark Scheme:

An explanation that makes reference to the following points:

- Electrons / atoms exist in discrete/fixed/certain energy levels
  Or there are only a certain number of specific differences in energy levels of electrons / atoms
- (Absorbing) a photon causes an electron / atom to move to a higher energy level
  Or (Absorbing) a photon causes an electron / atom to become excited
- Photons are (only) absorbed when the photon energy is equal to the difference between energy levels
- Photon energy depends on frequency/wavelength, so photons of specific frequencies/wavelengths are absorbed, (producing dark lines)

- ***AO2: Apply knowledge and understanding of scientific ideas, processes, techniques and procedures***
  - ***in both a theoretical and practical context***
  - ***and when handling qualitative and quantitative data***

15 A delta particle decays into a proton and a pion.

(ii) The mass of the proton is 939 MeV/c^2 and the mass of the pion is 139 MeV/c^2.

Explain why the sum of the masses of the two particles after the decay is not equal to the mass of the delta particle.

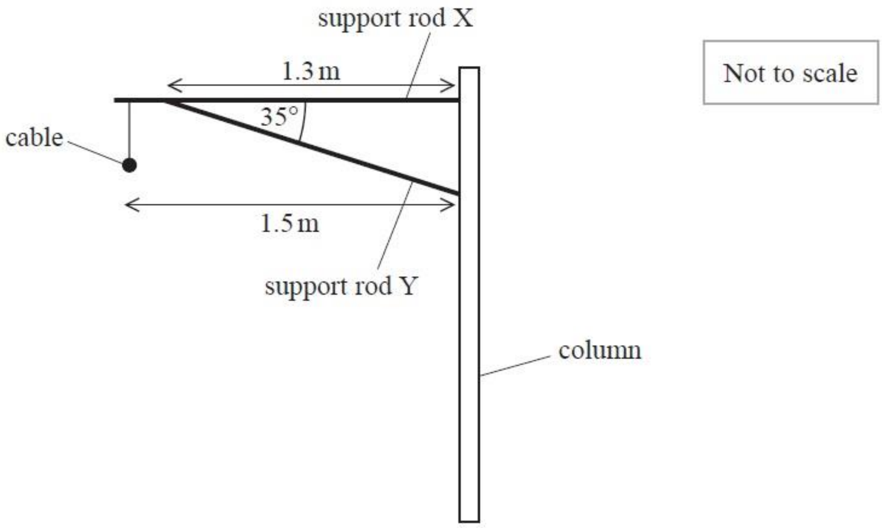
Mark Scheme:

- Calculates mass difference
  Or states (total) mass of decay products is less than mass of delta particle
- According to $\Delta E = \Delta mc2$
- becomes (extra) *E*k (between decay products)

<u>Example of Calculation</u>
939 + 139 = 1078
1232 – 1078 = 154(MeV/c^2) **Or** 1232 is more than 1078(MeV/c^2)

14 Overhead electricity cables for railway lines are supported by structures like the one shown.

An electric cable of mass 45 kg is suspended from a support rod X. A second support rod Y is attached to X. X and Y are attached at one end to a column.



The masses of support rods X and Y are negligible.

(a) (i) Determine, by taking moments, the force exerted on rod X by rod Y.

(4)

Mark Scheme:

- Attempt to take moments around right hand end of X
  [distance of 1.5 m used with 45 Or 1.3 m used with *T*]
- Use of $W = mg$
- Correct component of *T* or perpendicular distance to *T*
- T = 890 N

<u>Example of calculation</u>
45 kg × 9.81 N kg^{-1} × 1.5 m = T × 1.3 m × sin35
T = 888 N

AO3: Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues,

- ***to make judgements and reach conclusions***
- ***and develop and refine practical design and procedures.***

7 The neon lamp shown is a glass bulb filled with neon gas at low pressure.

(b) When light from the neon lamp is incident upon a metal surface, electrons with a maximum speed of $2.68 \times 10^5\,\mathrm{m\,s^{-1}}$ are emitted from the surface.

The table shows the work functions of some metals.

Metal	Caesium	Potassium	Sodium
Work function / 10^{-19} J	3.36	3.68	3.84

Deduce which metal the light is incident upon.

frequency of light from the neon lamp = 5.56×10^{14} Hz

(4)

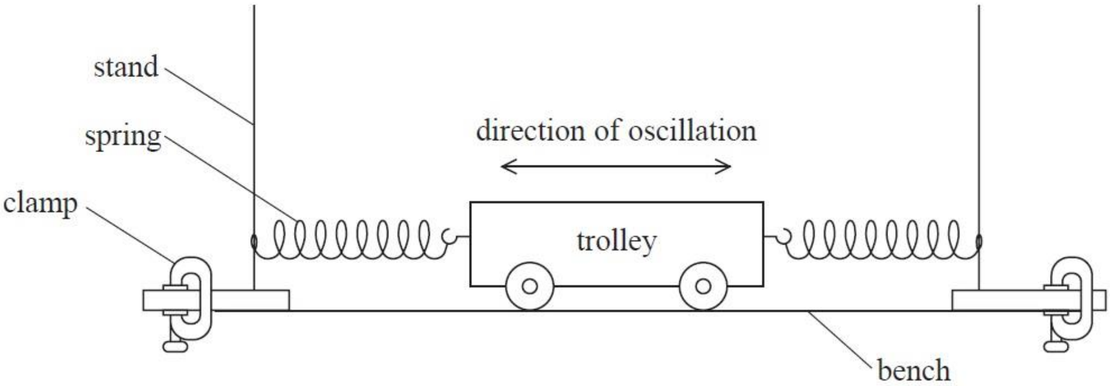
Mark Scheme:

- Use of $E = hf$
- Use of $E\mathrm{k} = \frac{1}{2} mv^2$
- Use of $hf = \phi + \frac{1}{2} mv^2_{max}$
- $\phi = 3.36 \times 10^{-19}$ (J) so metal is caesium

<u>Example of calculation</u>

$E = hf = 6.63 \times 10^{-34}$ J s $\times$ 5.56×10^{14} J
$\therefore E = 3.69 \times 10^{-19}$ J
Max $E_k = \frac{1}{2} mv^2$
$= 0.5 \times 9.11 \times 10^{-31}$ kg $\times$ (2.68 × 105 m s^{-1})^2
$= 3.27 \times 10^{-20}$ J
$\therefore \phi = 3.69 \times 10^{-19}$ J $- 3.27 \times 10^{-20}$ J
$\phi = 3.36 \times 10^{-19}$ J

6 A student investigated the horizontal oscillations of a trolley between two springs, using the apparatus shown.



The student displaced the trolley from its equilibrium position. She then released the trolley and started a stopwatch. She stopped the stopwatch when the trolley had completed one oscillation.

(a) Describe how the method used by the student could be improved to determine a more accurate value of the time period.

(4)

Mark Scheme:

- Time a number of (complete) oscillations and divide this time by the number of (complete) oscillations
- Repeat measurement (of time) **and** determine a mean value
- Use a (fiducial) marker (so easier to see when trolley passes a particular point)
- Time from the mid-point of the oscillation
  Or Wait for oscillation to settle before starting to time

[Allow 1 mark for reference to using light gates and a data logger if no other marks awarded]

Activity 3: Applying Mark Schemes

Marking Example A

14 The fuel used in a camping stove is butane, which is stored in a canister as shown.

Some of the butane in the canister is in a liquid state, and some is a gas.

(b) The pressure inside the canister is 220 kPa and the temperature of the gas is 21 °C.

(i) The canister is in the shape of a cylinder of length 0.23 m and radius 0.11 m.

Calculate the number of molecules of butane gas in the canister.

Assume the volume of liquid butane inside the canister is negligible.

(4)

Mark Scheme:

- Use of $V = \pi r^2 l$
- Use of $pV = NkT$
- Conversion of ^{o}C to K
- $N = 4.7 \times 10^{23}$

<u>Example of calculation</u>

$V = \pi \times 0.112\ (\text{m})^2 \times 0.23(\text{m}) = 8.74 \times 10^{-3}\ \text{m}^3$

$T = 21\ ^{o}\text{C} + 273 = 294\ \text{K}$

$2.2 \times 10^5\ \text{Pa} \times 8.7 \times 10^{-3}\ \text{m}^3 = N \times 1.38 \times 10^{-23} \text{J K}^{-1} \times 294\ \text{K}$

$N = 4.74 \times 10^{23}$

Response 1:

(b) The pressure inside the canister is 220 kPa and the temperature of the gas is 21 °C.

(i) The canister is in the shape of a cylinder of length 0.23 m and radius 0.11 m. A

Calculate the number of molecules of butane gas in the canister.

Assume the volume of liquid butane inside the canister is negligible.

(4)

$pV = NkT$

$(220 \times 10^3) \times \frac{4}{3}\pi r^3 h = N \times 1.38 \times 10^{-23} \times (21 + 273)$

$N = \frac{pV}{kT}$

$= \frac{(220 \times 10^3) \times \frac{4}{3}\pi\, 0.11^3 \times 0.23}{1.38 \times 10^{-23} \times (21 + 273)}$

$= 2.2 \times 10^{22}$ molecules

Number of molecules of butane gas = 2.2×10^{22}

Response 2:

(b) The pressure inside the canister is 220 kPa and the temperature of the gas is 21 °C.

(i) The canister is in the shape of a cylinder of length 0.23 m and radius 0.11 m.

Calculate the number of molecules of butane gas in the canister.

Assume the volume of liquid butane inside the canister is negligible.

(4)

~~$pV = \frac{1}{3} Nm\langle c^2 \rangle$~~

~~$(220 \times 10^3)(0.23)(0.11)(\pi(0.11)^2) = \frac{1}{3} N($~~

~~$pV = Nk$~~ $pV = NkT$

$(220 \times 10^3)(0.23)(\pi(0.11)^2) = N(1.38 \times 10^{-23})(21)$

$N = \frac{(220 \times 10^3)(0.23)(\pi(0.11)^2)}{(1.38 \times 10^{-23})(21)}$ ~~293~~

$= 6.64 \times 10^{24}$ molecules (3sf)

Number of molecules of butane gas = 6.6×10^{24}

Response 3:

(b) The pressure inside the canister is 220 kPa and the temperature of the gas is 21 °C.

(i) The canister is in the shape of a cylinder of length 0.23 m and radius 0.11 m.

Calculate the number of molecules of butane gas in the canister.

Assume the volume of liquid butane inside the canister is negligible.

(4)

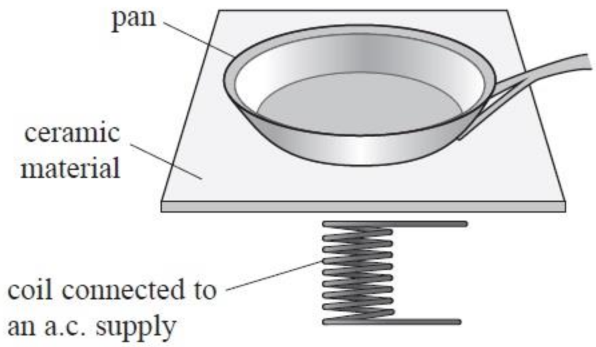
$PV = NkT$ $P = 220\times10^3$ Pa, $T = 21+273$, $V = 0.23\times\pi(0.11)^2 = 8.74\times10^{-3}$ m

$N = \frac{PV}{kT} = \frac{(220\times10^3)(8.74\times10^{-3})}{(1.38\times10^{-23})(21+273)} = 4.74\times10^{23}$ molecules (3s.f.)

Number of molecules of butane gas = 4.74×10^{23} (3s.f.)

Marking Example B

11 An induction hob consists of a coil beneath a sheet of ceramic material. The coil is connected to an alternating current (a.c.) supply as shown.



(a) A steel pan containing water is placed on the induction hob.

Explain why the pan becomes hot when the supply is switched on.

(4)

Mark Scheme:

An explanation that makes reference to the following points:

- current (in coil) produces a magnetic field/flux
- (a.c.) leads to changing (magnetic) field/flux through pan
- induces an emf in pan
- leads to current (in pan because it is an electrical conductor)

MP4 dependent on MP2,; MP2, MP3 and MP 4 must relate to the pan

Response 1:

(a) A steel pan containing water is placed on the induction hob.

Explain why the pan becomes hot when the supply is switched on.

(4)

• ~~at~~ a.c Supply generates a Changing magnetic field which Causes a Change in flux linkage

• Through faradays law, this induces an emf through the coil $\epsilon = \frac{d(N\phi)}{dt}$

• Therefore a current flows through the coil

• The current causes the temperature of the coil to rise, in turn the ceramic material conducts heat allowing the Pan to get hotter.

Response 2:

(a) A steel pan containing water is placed on the induction hob.

Explain why the pan becomes hot when the supply is switched on.

(4)

Because when the supply turns on the alternating current creates a changing magnetic field. This magnetic field cuts through the steel pan meaning a current is induced ~~depending on how the frequency of the AC supply~~ the plate ~~can~~ will get hotter as current increases.

Response 3:

(a) A steel pan containing water is placed on the induction hob.

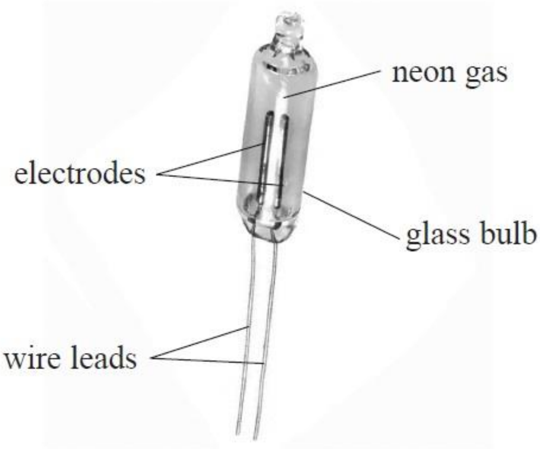
Explain why the pan becomes hot when the supply is switched on.

(4)

- The AC supply ~~[illegible]~~ throughout the coil induces a magnetic field, in which the ~~[illegible]~~ emf is proportional to the rate of change of flux linkage.
- The AC causes a change in flux linkage.
- The magnetic field induces an emf in the pan, despite no electricity passing through the ceramic material, as a result the changing magnetic field induces an emf, in the pan, which produces a current in the pan.
- the pan heats up due to the high resistance of the pan.

Marking Example C

7 The neon lamp shown is a glass bulb filled with neon gas at low pressure.



(Source: https://media.digikey.com/Photos/Visual%20Communications%20Company%20VCC/A1A.JPG)

*(a) When in use, the neon gas between the electrodes emits electromagnetic radiation.

Explain why this happens when there is an electric current between the electrodes.

(6)

Mark Scheme:

IC1 The electric current is a movement of electrons (between the electrodes)
[Accept "charge carriers" for "electrons"]

IC2 The electrons collide with neon atoms
[Accept "interact" for "collide"]

IC3 Energy is transferred to the neon atoms (in the collisions)

IC4 Electrons in the neon (atoms) are promoted to higher energy states
Or electrons in neon (atoms) are excited

IC5 (After a short time) electrons in the neon (atoms) return to their normal/ground state
Or electrons in neon (atoms) de-excite

IC6 When an electron returns to a lower energy state it emits a photon (of electromagnetic radiation)

IC points	IC mark	Max linkage mark available	Max final mark
6	4	2	**6**
5	3	2	**5**
4	3	1	**4**
3	2	1	**3**
2	2	0	**2**
1	1	0	**1**
0	0	0	**0**

Response 1:

*(a) When in use, the neon gas between the electrodes emits electromagnetic radiation.

Explain why this happens when there is an electric current between the electrodes.

(6)

The electrodes will produces a potential difference between them. So charge carries will go from one electrode to the other when a current flows. Current flowing will produce heat which will give the neon gas more energy. If the energy provided by this heat is big enough it will cause electrons to move up to higher energy levels (excitation). ~~If this~~ Eventually the electrons will de-excite and move back down to a lower energy level. When this ~~Happens~~ happens the energy ~~excession~~ difference from the higher level to lower level is released from the electron as a discreet packet of electro- ~~mag~~ magnetic radiation (photon). The Energy is directly proportional to the frequency of radiation emmitted.

Response 2:

*(a) When in use, the neon gas between the electrodes emits electromagnetic radiation.

Explain why this happens when there is an electric current between the electrodes.

(6)

electrons emit electromagnetic radiation when they fall ~~betw~~ down discrete energy levels. (~~dexcited~~ deexcitation). The ~~current between the electrodes provides~~ As current travels through the wire and heats it up, ~~the resistance of the the~~ the number of charge carriers released increases which means resistence increases and ∴ ~~V~~ potential difference increases. Electrons absorb energy and ~~jump up~~ are excited to higher discrete energy levels and then ~~fall to~~ deexcite while emitting electromagnetic radiation. Electrons have discrete energy levels

$pV = NkT$

Response 3:

*(a) When in use, the neon gas between the electrodes emits electromagnetic radiation.

Explain why this happens when there is an electric current between the electrodes.

(6)

The current causes the electrons in the Neon atoms to excite and go to a higher energy level and when they fall back down they release energy in the form of photons. The frequency of the light is proportional to its energy. $E = hf$. Only certain the energy is equal to the difference in energy levels and because there are a limited no of discrete energy levels only certain energy changes are possible hence only certain wavelengths of light are released. Hence when the current excites the electrons in the neon gas certain wavelengths of electromagnetic radiation are released