YEAR 12 PHYSICS TERM 2 TEST 1.

1. Find the EMF of a battery which:
   (a) provides 12·0 J of energy to every 2·00 C of charge passing through it.
   (b) does $8{\cdot}00 \times 10^{-17}$ J of work on each electron (charge $1{\cdot}60 \times 10^{-19}$ C) passing between its positive and negative plates:
   (c) does 30·0 J of work in maintaining a current of 2·00 A for 10·0 s. (4)

2. A heating coil is placed into $2{\cdot}00 \times 10^{2}$ g of water at 15·0°C, and connected in series with a battery. The temperature of the water rises to 25·0°C in 7·00 minutes when a current of 2·50 A flow through the coil. Assuming that negligible heat is absorbed by the container, and the specific heat of water is $4{\cdot}19 \times 10^{3}$ J kg^{-1} K^{-1}, calculate:
   (a) the quantity of electrical energy transformed into heat energy.
   (b) the quantity of charge passing any point in the circuit in 7·00 minutes.
   (c) the EMF of the battery. (6)

3. Resistors of 2·00 Ω and 4·00 Ω respectively are joined in series and a potential difference of 12·0 V is maintained between the ends of the arrangement. Calculate the current in each resistor. What currents would flow in each resistor if they were joined in parallel? (6)

4. A cell of EMF 1·50 V and internal resistance 0·100 Ω is connected in series with a coil of 3·00 Ω resistance and an ammeter which reads 0·400 A. A voltmeter is connected so that it will record the potential difference between the terminals of the cell.
   (a) Draw a diagram of this arrangement.
   (b) Calculate the resistance of the ammeter.
   (c) Find the reading of the voltmeter. (5)

5. Two resistors marked $6{\cdot}00\,\Omega$ and $10{\cdot}0\,\Omega$ respectively are joined in parallel and then connected in series with an $8{\cdot}00\,\Omega$ resistor and a battery of EMF $6{\cdot}00\,V$ and internal resistance $0{\cdot}250\,\Omega$. Find the current flowing through the $10{\cdot}0\,\Omega$ resistor and the potential difference between the battery terminals. (6)

6. A wire $4{\cdot}00\,m$ long has a resistance of $2{\cdot}60\,\Omega$. Calculate the resistance of a wire of the same material that is $25{\cdot}0\,m$ long with half the diameter. (3)

TOTAL: $\overline{30}$

YEAR 12 PHYSICS TERM 2 TEST 1.

1. (a) $W = 12.0\,J$

$q = 2.00\,C$

$V = ?$

$V = \frac{W}{q}$

$= \frac{12.0}{2.00}$

$= 6.00\,V.$

$\therefore$ EMF $= 6.00\,V.$ (2)

(b) $V = ?$

$W = 8.00 \times 10^{-17}\,J$

$q = 1.60 \times 10^{-19}$

$V = \frac{W}{q}$

$= \frac{8.00 \times 10^{-17}}{1.60 \times 10^{-19}}$

$= 5.00 \times 10^{2}\,V$

$\therefore$ EMF $= 5.00 \times 10^{2}\,V.$

(1)

(c) $V = ?$

$W = 30.0\,J$

$q = ?$

$I = 2.00\,A$

$t = 10.0\,s.$

$V = \frac{W}{q}$

$= \frac{W}{It}$ (since $I = \frac{q}{t}$.)

$= \frac{30.0}{(2.00)(10.0)}$

$= 1.50\,V$

$\therefore$ EMF $= 1.50\,V.$ (1).

2. $m_w = 0.200\,kg$

$T_2 = 25.0\,°C$

$T_1 = 15.0\,°C.$

$t = 7.00\,mins$

$I = 2.50\,A.$

$c_w = 4.19 \times 10^{3}\,J\,Kg^{-1}\,°K^{-1}$

$R = ?$

EMF $= ?$

(a) Electrical energy = heat energy Q

ie. $Q = m_w c_w \Delta T$

$= (0.200)(4.19 \times 10^{3})(25.0 - 15.0)$

$= 8.38 \times 10^{3}\,J$ (2)

$\therefore$ amount of electrical energy converted to heat $= 8.38 \times 10^{3}\,J.$

(b). $I = \frac{q}{t}$

$\therefore q = It.$

$= (2.50)(7.00 \times 60.0)$

$= 1.05 \times 10^{3}\,C.$

$\therefore$ amount of charge passed one point $= 1.05 \times 10^{3}\,C.$ (2)

(c) $P = \frac{Q}{t} = I^2 R.$

$\Rightarrow R = \frac{Q}{I^2 t}$

$= \frac{8.38 \times 10^{3}}{(2.50)^2 (4.20 \times 10^{2})}$

$= 3.19\,\Omega.$

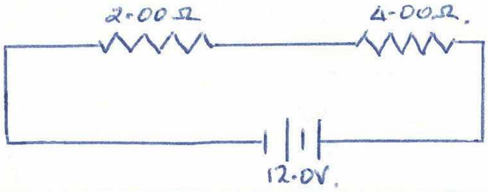
$V = IR$

$= (2.50)(3.19)$

$= 7.98\,V$

$\therefore$ EMF $= 7.98\,V.$ (2)

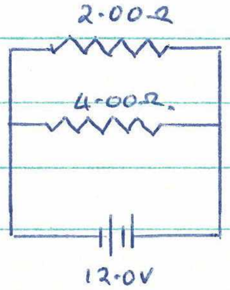
3.



$$R_T = R_1 + R_2$$
$$= (2{\cdot}00 + 4{\cdot}00)\,\Omega$$
$$= 6{\cdot}00\,\Omega.$$

$$\therefore I_T = \frac{V}{R_T}$$
$$= \frac{12{\cdot}0}{6{\cdot}00}$$
$$= 2{\cdot}00\,A.$$

$\therefore$ current in each resistance $= 2{\cdot}00A$. (3)



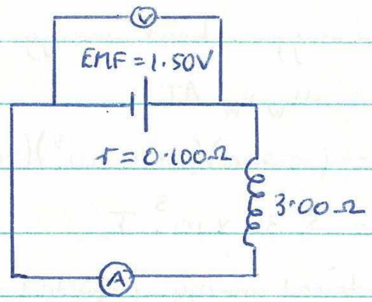
$$V_{2\cdot00\Omega} = V_{4\cdot00\Omega} = 12{\cdot}0\,V.$$

$$\therefore I_{2\cdot00\Omega} = \frac{V_{2\cdot00\Omega}}{R} = \frac{12{\cdot}0}{2{\cdot}00} = 6{\cdot}00\,A.$$

$$I_{4\cdot00\Omega} = \frac{V_{4\cdot00\Omega}}{R} = \frac{12{\cdot}0}{4{\cdot}0} = 3{\cdot}00\,A.$$ (3)

$\therefore$ current in $2{\cdot}00\Omega = 6{\cdot}00A$. $\therefore$ current in $4{\cdot}00\Omega = 3{\cdot}00A$.

4. (a).



(1)

(b) EMF = 1·50V

$r = 0{\cdot}100\,\Omega$

$R_{coil} = 3{\cdot}00\,\Omega.$

$R_{amm.} = ?$

$I = 0{\cdot}400\,A.$

$$EMF = I\,(r + R_{coil} + R_{am}).$$

$$\therefore R_{amm} = \frac{EMF}{I} - (r + R_{coil})$$
$$= \frac{1{\cdot}50}{0{\cdot}400} - (0{\cdot}100 + 3{\cdot}00)$$
$$= 0{\cdot}650\,\Omega.$$

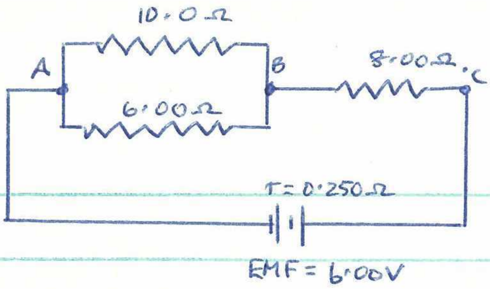
$\therefore$ resistance of ammeter $= 6{\cdot}50 \times 10^{-1}\,\Omega$. (2)

(c) $EMF = Ir + V.$

$$\therefore V = EMF - Ir$$
$$= 1{\cdot}50 - (0{\cdot}400)(0{\cdot}100)$$
$$= 1{\cdot}46\,V.$$

$\therefore$ voltmeter reads $1{\cdot}46\,V$. (2)

5.



$$\frac{1}{R_{AB}} = \frac{1}{10.0} + \frac{1}{6.00}$$
$$= \frac{16}{60.0}$$
$$\therefore R_{AB} = 3.75\ \Omega.$$

$$\therefore R_T = 3.75\ \Omega + 8.00\ \Omega$$
$$= 11.75\ \Omega.$$

$$EMF = I(R_T + r)$$
$$\therefore I = \frac{EMF}{(R_T + r)}$$
$$= \frac{6.00}{(11.75 + 0.25)}$$

$$\therefore I_T = 0.500\ A.$$

$$V_{AB} = I_{AB} R_{AB}$$
$$= (0.500)(3.75)$$
$$= 1.88\ V.$$

$$V_{10.0\Omega} = V_{AB} = I_{10.0} \cdot R_{10.0\Omega}.$$
$$\therefore I_{10.0\Omega} = \frac{V_{AB}}{R_{10.0\Omega}}$$
$$= \frac{1.88}{10.0}$$
$$= 0.188\ A.$$

$\therefore$ current in $10.0\ \Omega$ resistor $= 0.188\ A.$ (4)

$$EMF = Ir + V$$
$$\therefore V = EMF - Ir$$
$$= 6.00\ V - (0.500)(0.250)$$
$$= 5.88\ V.$$

$\therefore$ potential across the terminals $= 5.88\ V.$ (2)

6. $$\rho = \frac{R_1 A_1}{\ell_1} = \frac{R_2 A_2}{\ell_2}$$

$R_1 = 2.60\ \Omega$

$\ell_1 = 4.00\ m$

$A_1 = \pi . r_1^2$

$R_2 = ?$

$\ell_2 = 25.0\ m$

$A_2 = \pi(\frac{1}{2} r_1)^2$
$= \frac{1}{4}\pi r_1^2$

$$\therefore \frac{2.60 . \cancel{\pi r_1^2}}{4.00} = \frac{R_2 \frac{1}{4}\cancel{\pi r_1^2}}{25.0}$$

$$\Rightarrow R_2 = \frac{(2.60)(25.0)}{(4.00)(\frac{1}{4})}$$
$$= 65.0\ \Omega.$$ (3)

$\therefore$ resistance of the wire is $65.0\ \Omega.$

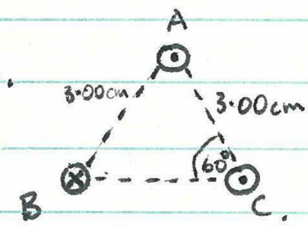
YEAR 12 PHYSICS TERM 2 TEST 2

CONSTANTS: $\mu_0 = 4\pi \times 10^{-7}\ NA^{-2}$ electron mass $= 9.11 \times 10^{-31}$ kg
electron charge $= 1.60 \times 10^{-19}$ C. proton mass $= 1.67 \times 10^{-27}$ kg

1. A galvanometer has a resistance of 20.0 Ω and a full scale deflection when 2.00 mA of current flows.
   (a) Explain how it could be converted to an ammeter.
   (b) Calculate the size of resistor needed to give this ammeter a full-scale reading of 10.0 A. (4)

2. The rectangular coil of dimensions 3.00 cm × 1.00 cm is suspended in a magnetic field of flux density 2.00×10^{-4} T. with the short side parallel to the field. Calculate the total torque exerted on the coil when a current of 10.0 microamperes flows through it. (3)

3. Three resistors of 1.00 megohm, 2.00 megohm and 0.500 megohm respectively are joined in series and carry a current of 4.80 microampere. when connected to a battery with EMF of 17.5 V. Calculate:
   (a) the potential difference across the terminals of the battery, and
   (b) the internal resistance of the battery. (4)

4. 

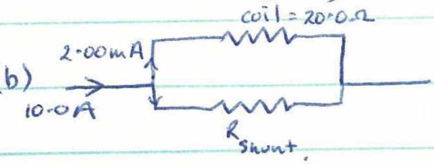
Three wires are arranged vertically at shown at left. A carries 2.00 A, B has 3.00 A and C has 2.00 A. Determine:
   (a) the size and direction of the force on B due to A.
   (b) the resultant force on B. (4)

5. A plane flies horizontally at a place where the earth's magnetic field is 5.00×10^{-4} T at 50.0° dip. The plane's dimensions are: 25.0 m wing tip to wing tip, and 35.0 m nose to tail, and travels at $5.00 \times 10^{2}\ kmh^{-1}$. Calculate
   (a) the induced EMF along the fuselage (nose to tail), and
   (b) the induced EMF between the wings' tips. (4)

TOTAL: 19.

1. (a) Place a resistance of a lower value in parallel with the coil so that most of the current going through this shunt resistance.

(b)



Since the two resistors are in parallel:

$$V_{coil} = V_{shunt}$$

$$\Rightarrow I_c R_c = I_s R_s$$

But $I_c + I_s = I_T$

$$\therefore I_c R_c = (I_T - I_c) R_s$$

$$\therefore R_s = \frac{I_c R_c}{(I_T - I_c)}$$

$$= \frac{(2.00\times10^{-3})(20.0)}{(10.0 - 2.00\times10^{-3})}$$

$$= 4.00\times10^{-3}\ \Omega.$$

$\therefore$ shunt resistance should be $4.00\times10^{-3}\ \Omega$. (4)

2. Force on one side is: $F = IlB$

$$= (10.0\times10^{-6})(3.00\times10^{-2})(2.00\times10^{-4})$$

$$= 6.00\times10^{-11}\ N.$$

The torque produced by this is:

$$M = F \times d$$

$$= (6.00\times10^{-11})(0.5\times10^{-2})$$

$$= 3.00\times10^{-13}\ Nm.$$

Since there are 2 such moments acting as a couple, the total torque is: 6.00×10^{-13} Nm. (3)

3. (a) $R_T = R_1 + R_2 + R_3$

$$= (1.00\times10^{6}) + (2.00\times10^{6}) + (0.500\times10^{6})\ \Omega$$

$$= 3.50\times10^{6}\ \Omega.$$

$$\therefore V = IR$$

$$= (4.80\times10^{-6})(3.50\times10^{6})$$

$$= 16.8\ V$$

$\therefore$ potential difference across the terminals $= 16.8$ V.

(b) $EMF = V + Ir$

$$\therefore r = \frac{EMF - V}{I}$$

$$= \frac{17.5 - 16.8}{4.80 \times 10^{-6}}$$

$$= 1.46 \times 10^{5}\ \Omega.$$

$\therefore$ internal resistance of the battery $= 1.46 \times 10^{5}\ \Omega$. (4)

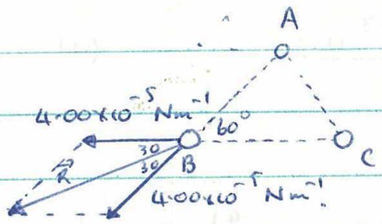
4. (a) $$\frac{F}{\ell} = \frac{\mu_0}{2\pi} \cdot \frac{I_1 I_2}{d}$$

$$= \frac{4\pi \times 10^{-7}}{2\pi} \cdot \frac{(2.00)(3.00)}{(3.00 \times 10^{-2})}$$

$$= 4.00 \times 10^{-5}\ N\,m^{-1}.$$

$\therefore$ resultant force on the wire B due to A is 4.00×10^{-5} N for each metre of length away from A.

(b) $F_{\text{due to C}} = F_{\text{due to A}}$



$$\vec{R} = \sqrt{(4.00 \times 10^{-5})^2 + (4.00 \times 10^{-5})^2 - 2(4.00 \times 10^{-5})^2 \cos 120^{\circ}}$$

$$= \sqrt{4.8 \times 10^{-9}}$$

$$= 6.93 \times 10^{-5}\ N\,m^{-1} \text{ of length.}$$

$\therefore \vec{R} = 6.93 \times 10^{-5}\ N\,m^{-1}$ of length at 30° to $\overline{AB}$. (4)

5. (a) Since the plane is flying horizontally, it is cutting across the vertical component of the earth's field, But the fuselage is travelling in such a way that its motion is not perpendicularly cutting across the field. $\therefore$ EMF (nose to tail) = 0.00 V.

(b) $V = B\ell v$ $\qquad v = 5.00 \times 10^{2}\ km\,h^{-1} = 1.39 \times 10^{2}\ ms^{-1}$

$$= (5.00 \times 10^{-4} \cos 40^{\circ})(25.0)(1.39 \times 10^{2})$$

$$= 1.33\ V.$$

$\therefore$ EMF across wing tips = 1.33 V. (4)

1. The wavelength of the red line in the visible (Balmer) series of the hydrogen spectrum is 6563 Å. What is the difference in energy between the two levels responsible for this line?
(Planck's constant: $h = 6 \cdot 62 \times 10^{-34}$ Js). (3)

2. If γ rays of wavelength $2 \cdot 90 \times 10^{-10}$ m fall on a metallic surface, what would be the maximum velocity of the photo electrons emitted?
($m_{electron} = 9 \cdot 11 \times 10^{-31}$ kg) (3)

3. $1 \cdot 60 \times 10^{-18}$ J electrons are shot through a gas and are found by experiment to retain $4 \cdot 80 \times 10^{-19}$ J and $9 \cdot 60 \times 10^{-19}$ J of energy.
(a) Draw a diagram to show the energy levels to which the gas atoms were excited, and hence determine the energies of the photons that would be emitted. (3)
(b) What frequencies of radiation would be emitted? (3)
(c) What would happen if an $8 \cdot 00 \times 10^{-19}$ J electron collided with an atom of this gas? (3)

4. How does Bohr's model of the atom explain the emission of energy by atoms? (2)

5. The lowest energy levels of an atom are: ground state, $2 \cdot 41 \times 10^{-19}$ J, $5 \cdot 21 \times 10^{-19}$ J and $7 \cdot 39 \times 10^{-19}$ J.
(a) The atoms are bombarded with electrons of energy $7 \cdot 10 \times 10^{-19}$ J. What will be the energies of the photons emitted? (3)
(b) If the atom is bombarded with electrons of $8 \cdot 65 \times 10^{-19}$ J energy, what would be the velocity of the electron scattered from the atom if the energy transferred is used to ionize the atom. (3)

TOTAL: $\overline{23}$

Year 12 Physics. Term 2 Test 2

1. $\lambda = 6.563 \times 10^{-7}$ m

$\Delta E = ?$

$c = \nu\lambda$

$\therefore \nu = \frac{c}{\lambda}$

$= \frac{3.00\times10^{8}}{6.563\times10^{-7}}$

$= 4.57\times10^{14}$ hz.

$\therefore \Delta E = h\nu$

$= (6.62\times10^{-34})(4.57\times10^{14})$

$= 3.03\times10^{-19}$ J.

$\therefore$ difference in energy levels $= 3.03\times10^{-19}$ J. (3)

2. $\lambda = 2.90\times10^{-10}$ m

$E = ?$

$v = ?$

$c = \nu\lambda$

$\therefore \nu = \frac{c}{\lambda}$

$= \frac{3.00\times10^{8}}{2.90\times10^{-10}}$

$= 1.034\times10^{18}$ hz.

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

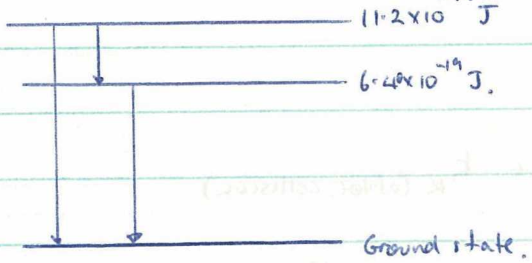
$\Rightarrow v = \sqrt{\frac{2h\nu}{m}}$

$= \sqrt{\frac{2(6.62\times10^{-34})(1.034\times10^{18})}{9.11\times10^{-31}}}$

$= 3.88\times10^{7}\ ms^{-1}$.

$\therefore$ velocity of photoelectrons $= 3.88\times10^{7}\ ms^{-1}$. (3)

3. (a)



The possible energies of the photons are:

11.2×10^{-19} J, 6.40×10^{-19} J, 4.80×10^{-19} J

Incident electron has $E_K = 16.0\times10^{-19}$ J.

$\therefore$ energig levels possible are:

(1) $(16.0\times10^{-19} - 4.80\times10^{-19}) = 11.2\times10^{-19}$ J.

(2) $(16.0\times10^{-19} - 9.60\times10^{-19}) = 6.40\times10^{-19}$ J. (3)

(b) $E = h\nu$

$\therefore \nu_1 = \frac{E}{h}$
$= \frac{11.2\times10^{-19}}{6.62\times10^{-34}}$
$= 1.69\times10^{15}$ hz.

$\nu_2 = \frac{E}{h}$
$= \frac{6.40\times10^{-19}}{6.62\times10^{-34}}$
$= 9.67\times10^{14}$ hz.

$\nu_3 = \frac{E}{h}$
$= \frac{4.80\times10^{-19}}{6.62\times10^{-34}}$
$= 7.25\times10^{14}$ hz.

(3)

$\therefore$ possible frequencies emitted $= 1.69\times10^{15}$ hz, 9.67×10^{14} hz, 7.25×10^{14} hz.

(c) If the electron has 8.00×10^{-19} J, then only one photon would be emitted – that caused by an electron transition from 6.40×10^{-19} J level to ground state.

$\therefore$ a photon of frequency 9.67×10^{14} hz would be observed.

The energy of the scattered electron would be $(8.00\times10^{-19} - 6.40\times10^{-19})$ J
$= 1.60\times10^{-19}$ J. (3)

4. Bohr's model assumes that electrons can exist in distinct energy levels. When electrons are given energy, they move from their ground state to a higher energy level. On returning to their ground state, they release their energy as a photon. (2)

5. (a) Possible photon energies are: (1) 5.21×10^{-19} J.
(2) 2.41×10^{-19} J
(3) 2.80×10^{-19} J. (3)

(b) $E_{ionization} = 7.39\times10^{-19}$ J.
$E_{electron} = 8.65\times10^{-19}$ J.

$\therefore E_{electron} = E_{ionization} + E_{K\,(after\ collision)}$

$\therefore E_K = 8.65\times10^{-19}\text{ J} - 7.39\times10^{-19}\text{ J}$
$= 1.26\times10^{-19}$ J.

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

$\therefore v = \sqrt{\frac{2E_K}{m}}$ (3)

$= \sqrt{\frac{2(1.26\times10^{-19})}{9.11\times10^{-31}}}$ $\therefore$ scattered electrons velocity

YEAR 12 PHYSICS TERM 2 TEST 4 W-84

1. (a) Explain fully how a photoelectric cell works. (3)
   (b) Why does the photoelectric effect support the quantum theory of light? (2)
   (c) Draw a graph showing the kinetic energy of the ejected photoelectrons versus the frequency of the incident light. (2)

2. The threshold frequency of zinc is $9{\cdot}70 \times 10^{14}$ hz.
   (a) What is the work function of zinc? (2)
   (b) Explain what is meant by the term "work function". (2)
   (c) If light of wavelength $6{\cdot}67 \times 10^{-8}$ m is incident on the zinc surface, what is the maximum E_k of the photoelectrons? ($h = 6{\cdot}62 \times 10^{-34}$ Js, $c = 3{\cdot}00 \times 10^{8}$ ms^{-1}). (2)

3. What is an isotope? (1)

4. Define "half-life". (1)

5. 6·30 moles of radioactive substance "X" has a decay rate of 3,500 counts/min. It emits β particles and has a half-life of 6·00 hours.
   (a) Is it necessary to seal the substance in an expensive lead container? Explain. (2)
   (b) After 24·0 hours, how many radioactive atoms would remain, and what decay rate would they show? (1 mole = $6{\cdot}023 \times 10^{23}$ atoms) (3)

6. (a) What is "transmutation"? (1)
   (b) Radioactive phosphorous ($^{30}_{15}P$) decays by emitting a positron and becomes stable silicon (Si). Write an equation for this change. (2)
   (c) How many protons, neutrons and electrons does one atom of stable silicon have? (1)
   (d) Why does a nucleus emit radiation? (2)

YEAR 12 PHYSICS TERM 2 TEST 4

1. (a) Explain fully how a photoelectric cell works. (3)
   (b) Why does the photoelectric effect support the quantum theory of light? (2)
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2. The threshold frequency of zinc is 9.70×10^{14} Hz.
   (a) What is the work function of zinc? (2)
   (b) Explain what is meant by the term "work function". (2)
   (c) If light of wavelength 6.67×10^{-8} m is incident on the zinc surface, what is the maximum E_k of the photoelectrons? ($h = 6.62 \times 10^{-34}$ Js, $c = 3.00 \times 10^{8}$ ms^{-1}) (2)

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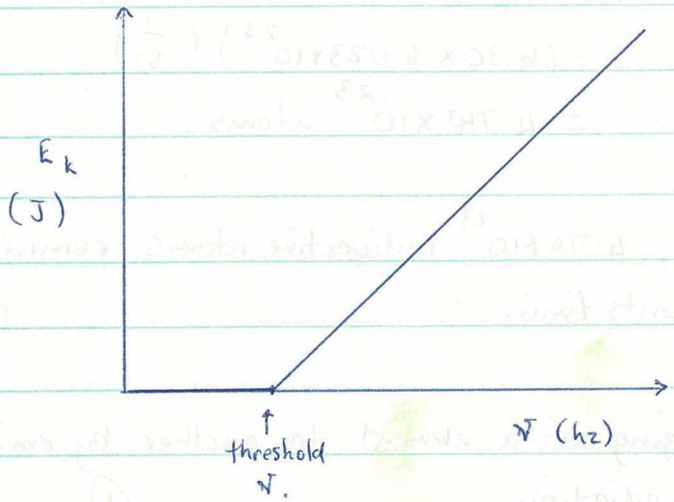
   (c) How many protons, neutrons and electrons does one atom of stable silicon have? (1)
   (d) Why does a nucleus emit radiation? (2)

1. (a) Light of a certain energy ($E = h\nu$) is incident on a metallic surface. Some energy is used to remove the electrons from the surface, and the excess is shown as the E_k of the photoelectrons as it moves to the collector plate. If the collector plate is positive, it will attract these e^{-}'s across, and so a current is formed. If the frequency of light is less than the threshold ν, no current occurs. If the collector is made sufficiently −ve with respect to the emitter, then the electrons are repelled and no current exists. This is the cut-off voltage. 3

(b) If light was a wave, then the photoelectric effect would occur for all ν's of light, but it is found that it only occurs for distinct ν's for a particular surface. Therefore the light is thought to be packets or quanta of energy. 2

(c)



2

2. (a) $E = h\nu_0 = \phi$

$\therefore \phi = (6.62\times10^{-34})(9.70\times10^{14})$

$= 6.42\times10^{-19}$ J.

$\therefore$ work function of zinc $= 6.42\times10^{-19}$ J. 2

(b) work function: the amount of energy used in getting an electron in the metal off the surface. 2

(c) $E = h\nu = \phi + E_k$

i.e. $\frac{hc}{\lambda} = \phi + E_k$

$\Rightarrow E_k = (-6.42\times10^{-19}) + \frac{(6.62\times10^{-34})(3.00\times10^{8})}{6.67\times10^{-8}}$

$= (-6.42\times10^{-19}) + 2.98\times10^{-18}$ 2

$= 2.34\times10^{-18}$ J. $\therefore$ max $E_k = 2.34\times10^{-18}$ J.

3. Isotope: atom with same proton number but different neutron number when compared to the "normal" atom. 1

4. Half-life: the time taken for the decay rate of a substance to decrease to half of its original level. 1

5. (a) No since β particles won't penetrate 1-2 mm of aluminium so it is easier to store it in cheaper aluminium. 2

(b) $N_0 = 3{,}500$ counts/min

$n = 4$.

$N = ?$

$N = N_0 \, 2^{\frac{1}{n}}$

$= (3500)\, 2^{\frac{1}{4}}$

$= 220$ counts / min (2 sig. figures).

$N_0 = 6.30$ moles

$n = 4$

$N = ?$

$N = N_0 \, 2^{\frac{1}{n}}$

$= (6.30 \times 6.023 \times 10^{23})\left(\frac{1}{16}\right)$

$= 2.37 \times 10^{23}$ atoms.

∴ after 4 half lives, 2.37×10^{23} radioactive atoms remain giving a count of 220 counts/min. 3.

6. (a) Transmutation: the changing of a element to another by emitting part of its nucleus as radiation. 1

(b) $^{30}_{15}P \longrightarrow {}^{30}_{14}Si + {}^{0}_{+1}e$ 2

(c). 14 protons, 16 neutrons, 14 electrons. 1

(d) The nucleus is unstable and emits the radiation to remove energy from itself. Then the nucleus becomes stable. 2

TOTAL: /26.