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Brescia House School

PHYSICS (P1) 2021: MEMO

July 2021

QUESTION 1: MULTIPLE CHOICE QUESTIONS

- | | | |
|------|---|-----|
| 1.1 | C | (2) |
| 1.2 | A | (2) |
| 1.3 | C | (2) |
| 1.4 | D | (2) |
| 1.5 | A | (2) |
| 1.6 | A | (2) |
| 1.7 | B | (2) |
| 1.8 | C | (2) |
| 1.9 | B | (2) |
| 1.10 | C | (2) |

QUESTION 2. KINEMATICS

[44]

$$\begin{aligned}
 2.1.1 \quad v &= \frac{\Delta x}{\Delta t} \checkmark \\
 &= \frac{12\,000}{8 \times 60} \checkmark \\
 &= 25 \text{ m} \cdot \text{s}^{-1} \checkmark
 \end{aligned}
 \tag{4}$$

$$\begin{aligned}
 2.1.2 \text{ a) } 30 \text{ km} \cdot \text{h}^{-1} &= \frac{30}{3,6} = 8,33 \text{ m} \cdot \text{s}^{-2} \checkmark \\
 a &= \frac{v_f - v_i}{\Delta t} \checkmark \\
 &= \frac{32 - 8,33}{15} \checkmark \\
 &= 1,58 \text{ m} \cdot \text{s}^{-2} \checkmark
 \end{aligned}
 \tag{4}$$

2.1.2 b) ALTERNATIVE 1

$$\begin{aligned}
 \Delta x &= v_i + \frac{1}{2} a \Delta t^2 \checkmark \\
 &= (8,33)(15) + \frac{1}{2} (1,58)(15)^2 \checkmark \\
 &= 302,7 \text{ m}
 \end{aligned}$$

ALTERNATIVE 2

$$\begin{aligned}
 \Delta x &= \frac{1}{2} (v_i + v_f) \Delta t \checkmark \\
 &= \frac{1}{2} (8,33 + 32)(15) \checkmark \\
 &= 302,48 \text{ m} \checkmark
 \end{aligned}
 \tag{3}$$

2.1.2 c) Remaining distance = $12\,000 - 302,45$ ($302,48$) = $11\,697,55$ ($11\,697,52$) m ✓

$$\Delta t = \frac{\Delta x}{v} \checkmark = \frac{11\,697,55}{32} = 365,55 \checkmark \text{ [correct method]}$$

$$\text{Time} = 365,55 + 15 = 380,55 \text{ s} \checkmark \text{ (6,34 minutes)} \tag{4}$$

2.1.3 Average velocity = rate of change in displacement ✓ which is a vector quantity. ✓

There is no scale to determine displacement (from X to Y) and/or there is no indication of North, South, East or West. ✓

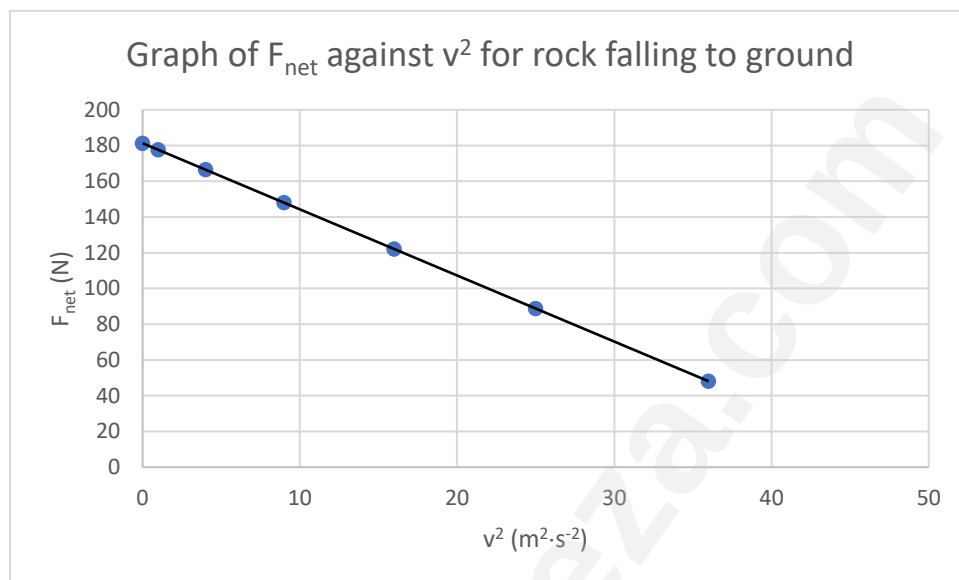
(3)

2.2.1 $F_{\text{net}} = F_g (=mg)$ ✓ at $v = 0 \text{ m}\cdot\text{s}^{-1}$ ✓ (before air resistance builds up).

$$180 = m(9,8) \quad m = 18,37 \text{ kg} \quad \checkmark \quad (3)$$

2.2.2 a) 1, 4, 9, 25, 36 ✓ (1)

b)



- ✓ Title
- ✓ Axes labelled with correct SI units
- ✓ v^2 plotted on the x-axis
- ✓ two points plotted correctly
- ✓ straight line graph – drawn with a ruler. (6)

c) As the square of velocity increases, F_{net} decreases in a linear relationship (straight line). ✓✓

$$\text{OR } F_{\text{net}} = \frac{(48,1 - 180)}{36} \checkmark v^2 + 180 \checkmark = -3,66 v^2 + 180 \quad (2)$$

2.3.1

- ✓ ball accelerates (uniformly) downwards
- ✓ hits the ground at 3,0 s and leaves the ground at 3,5 s
- ✓ rises to maximum height at 5,44 s slowing down (negative uniform acceleration) (3)

2.3.2 $m = \frac{\Delta y}{\Delta x} \checkmark = \frac{31,4-2}{3} \checkmark = 9,8 \text{ m}\cdot\text{s}^{-2} \checkmark$ (3)

2.3.3 ALTERNATIVE 1

Area under the graph $\checkmark = \frac{1}{2} (3)(31,4 - 2) \checkmark + (2)(3) \checkmark$
 $= 50,1 \text{ m} \checkmark$

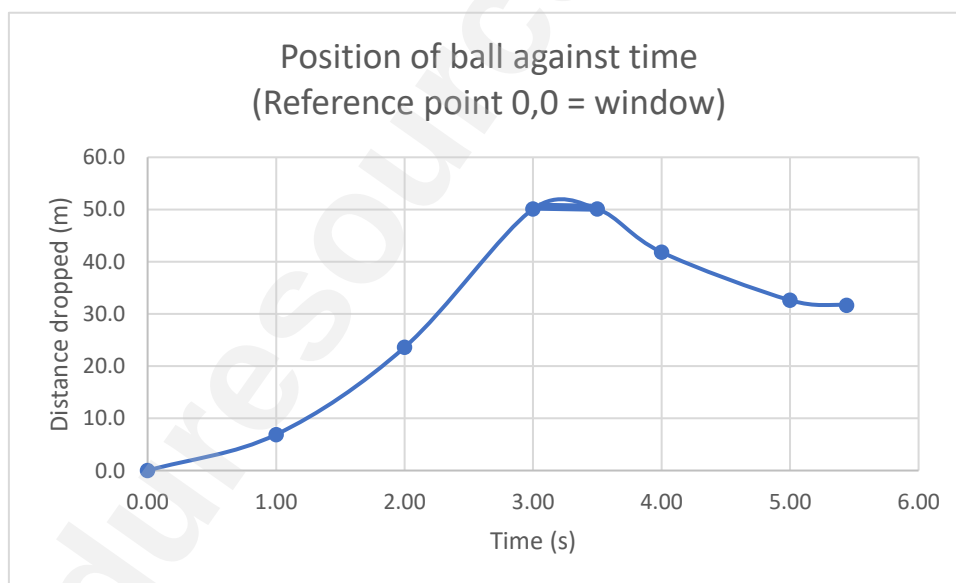
ALTERNATIVE 2

$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark = (2)(3) \checkmark + \frac{1}{2} (9,8)(3)^2 \checkmark = 50,1 \text{ m} \checkmark$

ALTERNATIVE 3

$\Delta x = \frac{v_f^2 - v_i^2}{2a} \checkmark = \frac{31,4^2 - 2^2}{2(9,8)} \checkmark = 50,1 \text{ m} \checkmark$ (4)

2.3.4



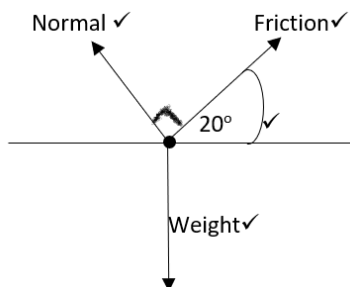
- ✓ Curve upwards for 3 s
- ✓ Maximum displacement = 50,1 m (down)
- ✓ Curves downward (as ball bounces up)
- ✓ From 3,0 – 3,5 s the graph should run parallel to x-axis.

QUESTION 3. NEWTON'S LAWS AND APPLICATIONS**24 marks**

3.1.1 Mass – amount of matter ✓ in an object

Weight – gravitational force that the earth exerts ✓ on an object. (2)

3.1.2



(4)

3.1.3 $F_{g\perp} = mg \cos \theta$ ✓ (method)

$$= (45)(9,8) \cos 20^\circ \quad \checkmark$$

$$= 414,4 \text{ N} \quad \checkmark$$

(3)

3.1.4 $F_f = \mu_s F_N$ ✓

$$= (0,3)(414,4) \quad \checkmark \quad [\text{c.o.e. 3.1.3}]$$

$$= 124,32 \text{ N} \quad \checkmark$$

(3)

3.1.5 $F_{\text{net}} = F_{g\parallel} - F_f$ ✓

$$= mg \sin \theta - 124,32 \quad [\text{c.o.e. 3.1.4}]$$

$$= (45)(9,8) \sin 20^\circ - 124,32$$

$$= 26,51 \text{ N down the slope.} \quad \checkmark$$

(3)

3.1.6 When the sled slides down the slope, kinetic friction opposes its motion.

$$F_f = \mu_k F_N \quad \checkmark$$

$$= (0,2)(414,4) \quad [\text{c.o.e. 3.1.3}]$$

$$= 82,88 \text{ N} \quad \checkmark$$

$$F_{\text{net}} = 150,83 - 82,88 - 67,95 \text{ N} \quad \checkmark$$

$$a = \frac{F_{\text{net}}}{m} \quad \checkmark$$

$$= \frac{67,95}{45}$$

$$= 1,51 \text{ m} \cdot \text{s}^{-2} \text{ down} \quad \checkmark$$

[Maximum 2/5 if F_f = static friction force]

(5)

3.2

- ✓ The pencil has inertia.
- ✓ Therefore, it resists a change in its state of rest or of motion.
- ✓ It continues moving forward at constant speed until the side of the recess stops it.
- ✓ Newton's 1st Law

(4)

QUESTION 4. MOMENTUM, IMPULSE, WORK, ENERGY AND POWER. 29 marks

4.1.1 (Linear) momentum is the product of mass and velocity of an object. ✓✓ (2)

4.1.2 Constant (uniform) acceleration; constant increase in momentum. ✓ (1)

4.1.3 Constant velocity; constant momentum. ✓ (1)

4.1.4 The net force on an object is directly proportional to the rate of change of its momentum. ✓✓

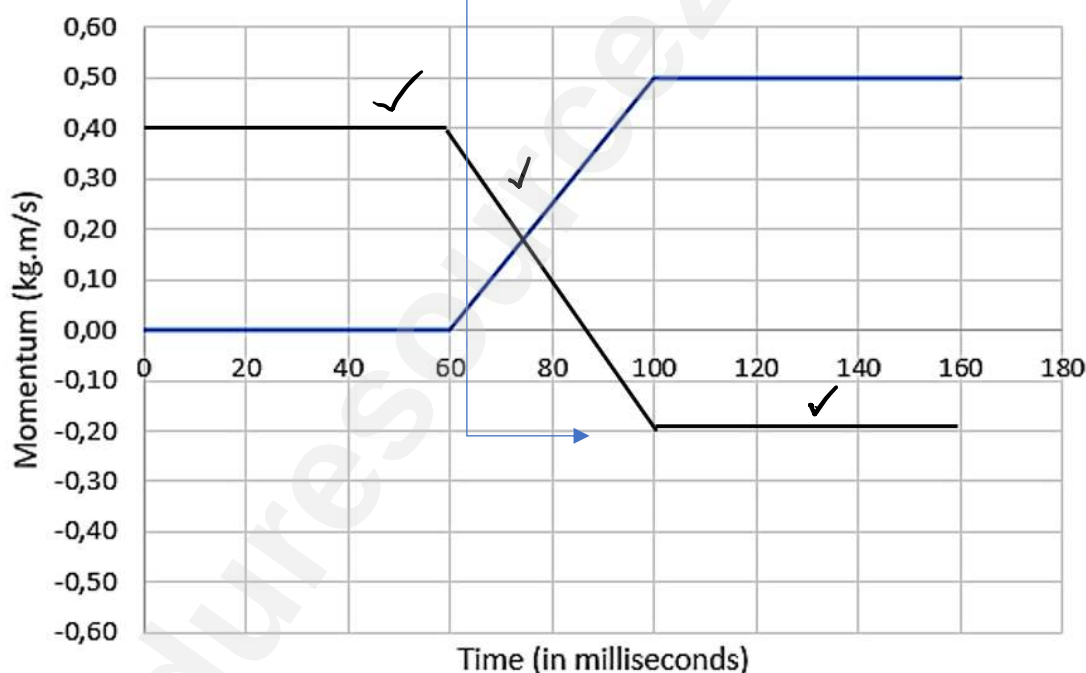
OR The acceleration of an object is in the direction of the net force and is directly proportional to the net force. The acceleration is inversely proportional to its mass. (2)

4.1.5 $F_{net} = \frac{\Delta p}{\Delta t} \checkmark = \frac{(0,5-0)\checkmark}{(100-60)\times 10^{-3}\checkmark} = 12,5 \text{ N} \checkmark$ (4)

4.1.6 $\Delta p_Y = -\Delta p_X$

$(0,5 - 0) = -(p - 0,4)$

$p = -0,1 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$ (4)



4.2.1 Work done by a net force on an object is equal to the change in kinetic energy of the object. ✓✓ (2)

4.2.2 $W_{net} = \Delta E_K \checkmark$

$= \frac{1}{2} 6000(50^2 - 0) \checkmark$

$= 7\,500\,000 \text{ J} \checkmark$ (3)

4.2.3 ALTERNATIVE 1

$$a = \frac{\Delta v}{\Delta t} = \frac{50}{4} = 12,5 \text{ m}\cdot\text{s}^{-2} \checkmark$$

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$= 0 + \frac{1}{2} (12,5)(4)^2$$

$$= 100 \text{ m} \checkmark$$

ALTERNATIVE 2

$$\Delta x = \frac{1}{2} (v_i + v_f) \Delta t \checkmark = \frac{1}{2} (0 + 50)(4) \checkmark = 100 \text{ m} \checkmark$$

Type equation here.

ALTERNATIVE 3

$$F_{\text{net}} = ma$$

$$= 6000(12,5) = 7500 \text{ N left}$$

$$W_{\text{net}} = F_{\text{net}} \cdot X$$

$$X = 100 \text{ m}$$

(3)

$$4.2.4 \quad F_{\text{net}} = \frac{W_{\text{net}}}{\Delta x} \checkmark = \frac{7\,500\,000}{100} = 75\,000 \text{ N} \checkmark \quad [\text{c.o.e}]$$

$$F_{\text{net}} = F_{\text{applied}} - F_{\text{friction}} \checkmark \text{ (method)}$$

$$75\,000 = F_{\text{applied}} - 10\,000$$

$$F_{\text{applied}} = 85\,000 \text{ N} \checkmark \quad (4)$$

4.2.5 Power output = 20% of Power input

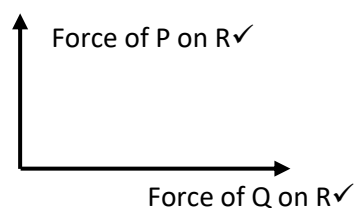
$$\text{Power input} = \frac{100}{20} \text{ Power output} \checkmark = \frac{100}{20} \times \frac{85\,000 \times 100}{4} \checkmark = 10\,625\,000 \text{ W} \checkmark \quad (3)$$

QUESTION 5: FIELDS

19 marks

5.1 The force between two charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them. ✓✓ (2)

5.2.1



(2)

5.2.2 $F_{Q \text{ on } R} = (2,4 \times 10^{-5}) \cos 30^\circ \checkmark = 2,08 \times 10^{-5} \text{ N repulsion}$

$$F = \frac{k q_1 q_2}{r^2} \checkmark$$

$$q_2 = \frac{F r^2}{k q_1} = \frac{2,08 \times 10^{-5} \times (2,5 \times 10^{-2})^2}{9 \times 10^9 \times 4,8 \times 10^{-9}} \checkmark = 3,01 \times 10^{-10} \text{ C} \checkmark = 30,1 \text{ nC} \quad (4)$$

5.2.3 $F_{P \text{ on } R} = (2,4 \times 10^{-5}) \sin 30^\circ \checkmark = 1,2 \times 10^{-5} \text{ N attraction}$

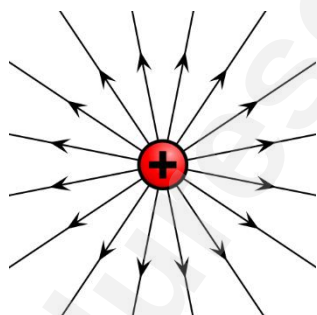
$$F = \frac{k q_1 q_2}{r^2}$$

$$r^2 = \frac{k q_1 q_2}{F} = \frac{9 \times 10^9 \times (2,5 \times 10^{-9}) \times (4,8 \times 10^{-9})}{1,2 \times 10^{-5}} \checkmark$$

$$r = \sqrt{\frac{9 \times 10^9 \times (2,5 \times 10^{-9}) \times (4,8 \times 10^{-9})}{1,2 \times 10^{-5}}} \checkmark = 9,49 \times 10^{-2} \text{ m} = 9,49 \text{ cm} \checkmark \quad (4)$$

5.3 The electric field at a point is the force per unit positive charge. ✓✓ (2)

5.4.1



- ✓ Straight lines radiating from positive charge.
 - ✓ Symmetrical pattern.
- Lines must touch the positive charge. (2)

5.4.2 There are 4 times ✓ more lines around **X** than there are around **Y**. ✓ (2)

5.4.3 **XP > XQ** or further away from **X** (closer to **Y**) ✓ (1)

QUESTION 6: ELECTRIC CIRCUITS

28 marks

6.1.1 The current through a conductor is directly proportional to the potential difference across the conductor provided that the temperature remains constant. ✓✓ (2)

6.1.2 a) Yes. ✓ The graph is a straight line ✓ through the origin ✓ which confirms that current is directly proportional to the potential difference across the conductor. (3)

6.1.2 b) $m = \frac{\Delta y}{\Delta x} = \frac{11,3-0}{50-0} = 0,224$ ✓

$$R_{\text{circuit}} = (0,224)^{-1} = 4,46 \, \Omega \quad (2)$$

6.1.3 $R_{//} = \frac{R \times R}{R+R} = \frac{R}{2}$ ✓

$$R_{\text{circuit}} = R + \frac{1}{2} R \quad \checkmark = 4,46$$

$$R = \frac{2}{3} (4,46) \quad \checkmark = 2,97 \, \Omega \quad \checkmark \quad (4)$$

6.1.4 $\text{emf} = I (R_{\text{circuit}} + r)$ ✓

$$6 = I (4,46 + 1,5) \quad \checkmark$$

$$I = 1,01 \, \text{A} \quad \checkmark \quad (3)$$

6.2.1 The emf of a battery is the total energy per unit charge required to move charge through the battery. ✓✓ (2)

6.2.2 In series: $R_s = 2 + 3 = 5 \, \Omega$ ✓

$$\text{emf} = (0,97)(5 + r) \quad \checkmark = 4,85 + 0,97r$$

On parallel: $R_{//} = \frac{2 \times 3}{2+3} = 1,2 \, \Omega$ ✓

$$\text{emf} = (2,5)(1,2 + r) \quad \checkmark = 3,0 + 2,5 r$$

The emf remains constant.

$$\text{Therefore } 4,85 + 0,97r = 3,0 + 2,5 r \quad \checkmark$$

$$r = 1,21 \, \Omega$$

$$\text{emf} = 4,85 + 0,97(1,21) = 6,02 \, \text{V} \quad \checkmark \quad (7)$$

6.2.3 ALTERNATIVE 1

$$V_{//} = IR_{//} = 2,5 \times 1,2 = 3 \, \text{V} \quad \checkmark$$

$$P = \frac{V^2}{R} \quad \checkmark = \frac{3^2}{2} \quad \checkmark = 4,5 \, \text{W} \quad \checkmark$$

ALTERNATIVE 2

Current through $2,0 \, \Omega = \frac{3}{5} \times 2,5 = 1,5 \, \text{A}$ ✓ or calculate pd across $2,0 \, \Omega$, then I

$$P = I^2 R \quad \checkmark$$

$$= (1,5)^2 (2) \quad \checkmark$$

$$= 4,5 \, \text{W} \quad \checkmark \quad (4)$$

QUESTION 7: ELECTRODYNAMICS**22 marks**

7.1.1 A current carrying conductor sets up a magnetic field around it. This magnetic field interacts with the magnetic field of the permanent magnets. ✓

When the conductor carries current at 90° to the magnetic field, the conductor experiences maximum force (due to the interaction of the two magnetic fields). ✓ (2)

7.1.2 Anti-clockwise ✓✓ (2)

7.1.3 ANY TWO OF THE FOLLOWING:

- Increase the current.
- Increase the strength of the magnetic field (use stronger magnets) (move the magnets closer together).
- Add more loops (per unit length) of the coil. (2)

7.2.1 Lenz's law: The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux. ✓✓ (2)

7.2.2 ✓ When the switch closes, an increasing magnetic field is set up in the coil.

- ✓ The change in magnetic flux induces current in the copper ring.
- ✓ The current in the copper ring sets up a magnetic field which opposes the increase in magnetic field of the coil (Lenz's law).
- ✓ The two opposing magnetic fields repel each other, and the ring jumps up. (4)

7.2.3 Yes. ✓ The pole of the magnetic field produced by the coil is reversed ✓ therefore the current in the ring is also reversed ✓ and it is still repelled by the coil. ✓ (4)

7.3.1 $\frac{N_P}{N_S} = \frac{V_P}{V_S}$ ✓

$$\frac{N_P}{12\,000} = \frac{5}{200} \checkmark$$

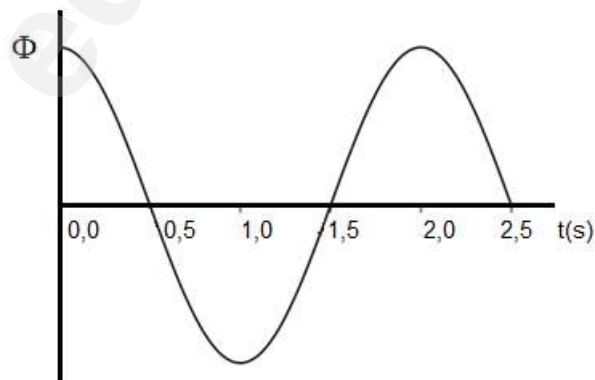
$$N_P = \frac{12\,000 \times 5}{200} = 3\,00 \checkmark \quad (3)$$

7.3.2 $V_S I_S = V_P I_P$ ✓

$$(200) I_S = (5)(16) \checkmark$$

$$I_S = 0,4 \text{ A} \checkmark \quad (3)$$

7.3.3



- ✓ Out of phase by 90°
- ✓ Starts at maximum (positive) (2)

QUESTION 8. PHOTONS AND ELECTRONS**14 marks**

8.1.1 Threshold frequency is the minimum frequency of incident radiation at which electrons are emitted from a particular metal. ✓✓ (2)

8.1.2 $W_0 = hf_0$ ✓ (method)
 $= 6,6 \times 10^{-34} \times 4,85 \times 10^{14}$
 $= 3,2 \times 10^{-19} \text{ J}$ ✓ (2)

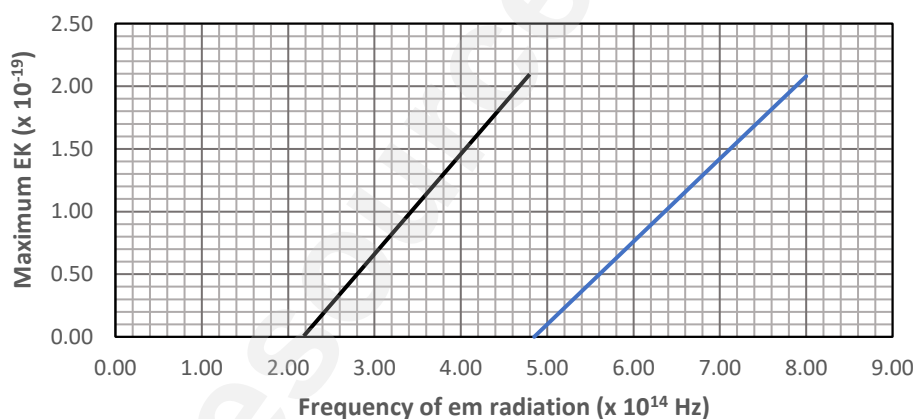
8.1.3 f_0 of second metal $= \frac{1}{2} \times 4,85 \times 10^{14} = 2,43 \times 10^{14} \text{ Hz}$ ✓

OR

$W_0 = 1,6 \times 10^{-19} = 6,6 \times 10^{-34} \times f_0$
 $f_0 = 2,43 \times 10^{14} \text{ Hz}$ ✓ (1)

8.1.4

**Maximum kinetic energy of photoelectrons
against frequency of em radiation**



- ✓ Parallel to the original graph
- ✓ Correct position of $2,43 \times 10^{14} \text{ Hz}$ [c.o.e. 8.1.3] (2)

8.2.1 $E = hf = \frac{hc}{\lambda}$ ✓
 $= \frac{6,6 \times 10^{-34} \times 3 \times 10^8}{492,1 \times 10^{-9}}$ ✓
 $= 4,02 \times 10^{-19} \text{ J}$ ✓ (3)

8.2.2 When an electron in an energised atom falls (drops) from a higher energy level to a lower energy level, light (em radiation in the visible spectrum) is radiated. ✓ (2)

8.2.3 Each element has a unique number of protons (and therefore electrons). ✓ These electrons fall to lower energy levels giving out a unique combination of frequencies (wavelengths) ✓ therefore each has a unique spectrum. (2)