



eduresourceza.com



NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2022

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours

200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1

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

QUESTION 2

2.1 2.1.1 Rate of change of velocity.

2.1.2 F_{friction} $F_{\text{gravitation}}$ forces and labels



2.1.3 (i) $\Delta X_{\text{DART}}(h) = 20t + \frac{1}{2}(-9,8)t^2$

OR $\Delta X_{\text{DART}}(h) = 20(t-1) + \frac{1}{2}(-9,8)(t-1)^2$

(1 mark only as instructions regarding t not followed)

(ii) $\Delta X_{\text{BALL}}(h) = 20(t+1) + \frac{1}{2}(-12)(t+1)^2$

OR $\Delta X_{\text{BALL}}(h) = 20t + \frac{1}{2}(-12)t^2$

2.1.4 (i) $\Delta X_{\text{DART}} = \Delta X_{\text{BALL}}$ (mark for equating/method)

$$20t - 4,9t^2 = 20t + 20 - 6t^2 - 12t - 6$$

$$1,1t^2 + 12t - 14 = 0$$

$$t = 1,06 \text{ s}$$

(ii) $h = 20(1,06) - \frac{1}{2}(9,8)(1,06)^2 = 15,69 \text{ m}$

OR $20t - 20 - 4,9t^2 + 9,8t - 4,9 = 20t - 6t^2$

$$1,1t^2 + 9,8t - 24,9$$

Hence $t = 2,06 \text{ s}$ (time for ball to reach X)

And time for dart to reach X = 1,06 s

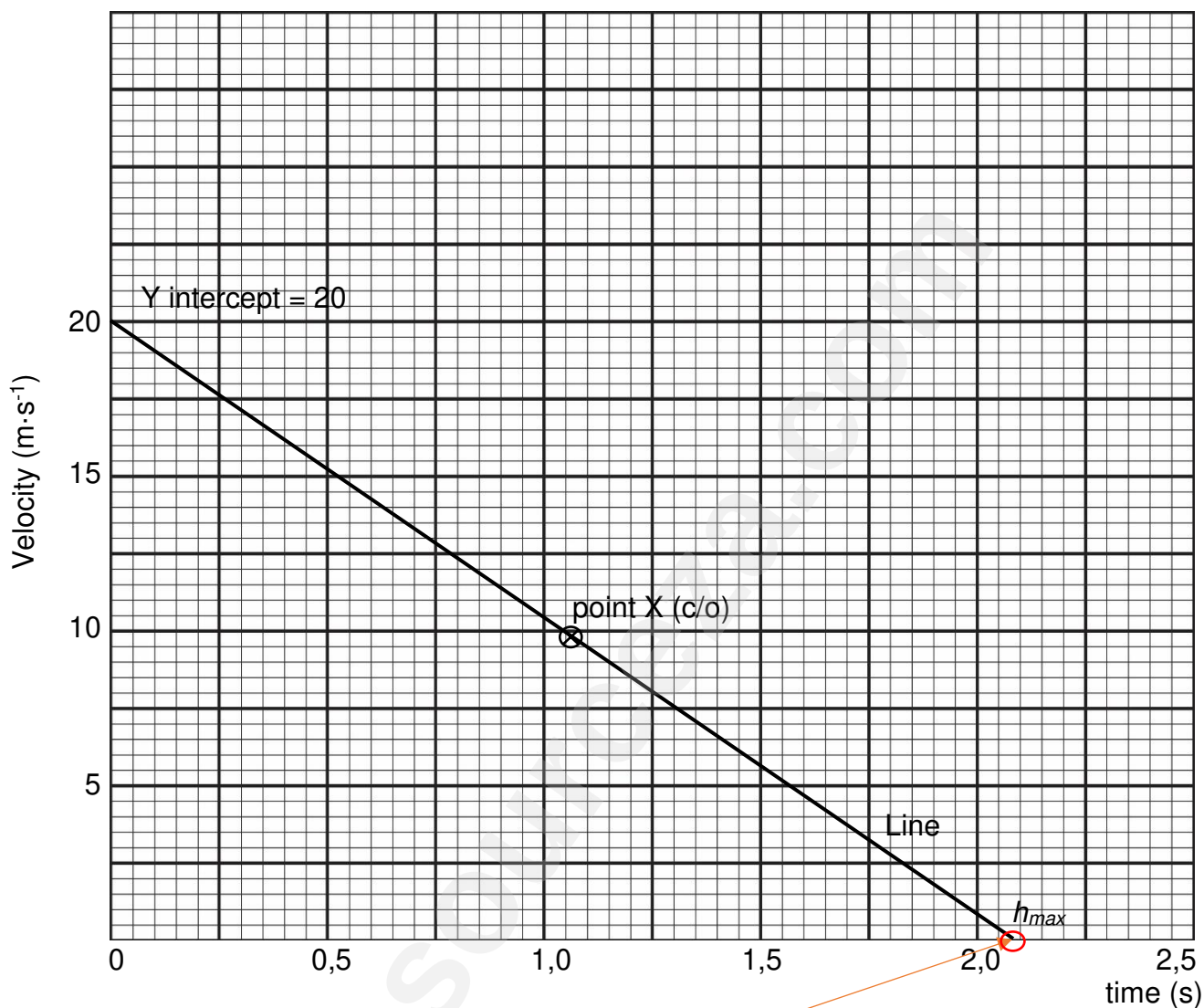
$$h = 20(1,06) - \frac{1}{2}(9,8)(1,06)^2 = 15,69 \text{ m}$$

2.1.5 $v_f^2 = v_i^2 + 2a\Delta X_{\text{DART}}$ **OR** $v_f = v_i + a\Delta t$

$$v_f^2 = 20^2 + 2(-9,8)(15,69)$$

$$v_f = 9,62 \text{ m}\cdot\text{s}^{-1}$$

2.1.6 Graph showing the relationship between velocity and time for A

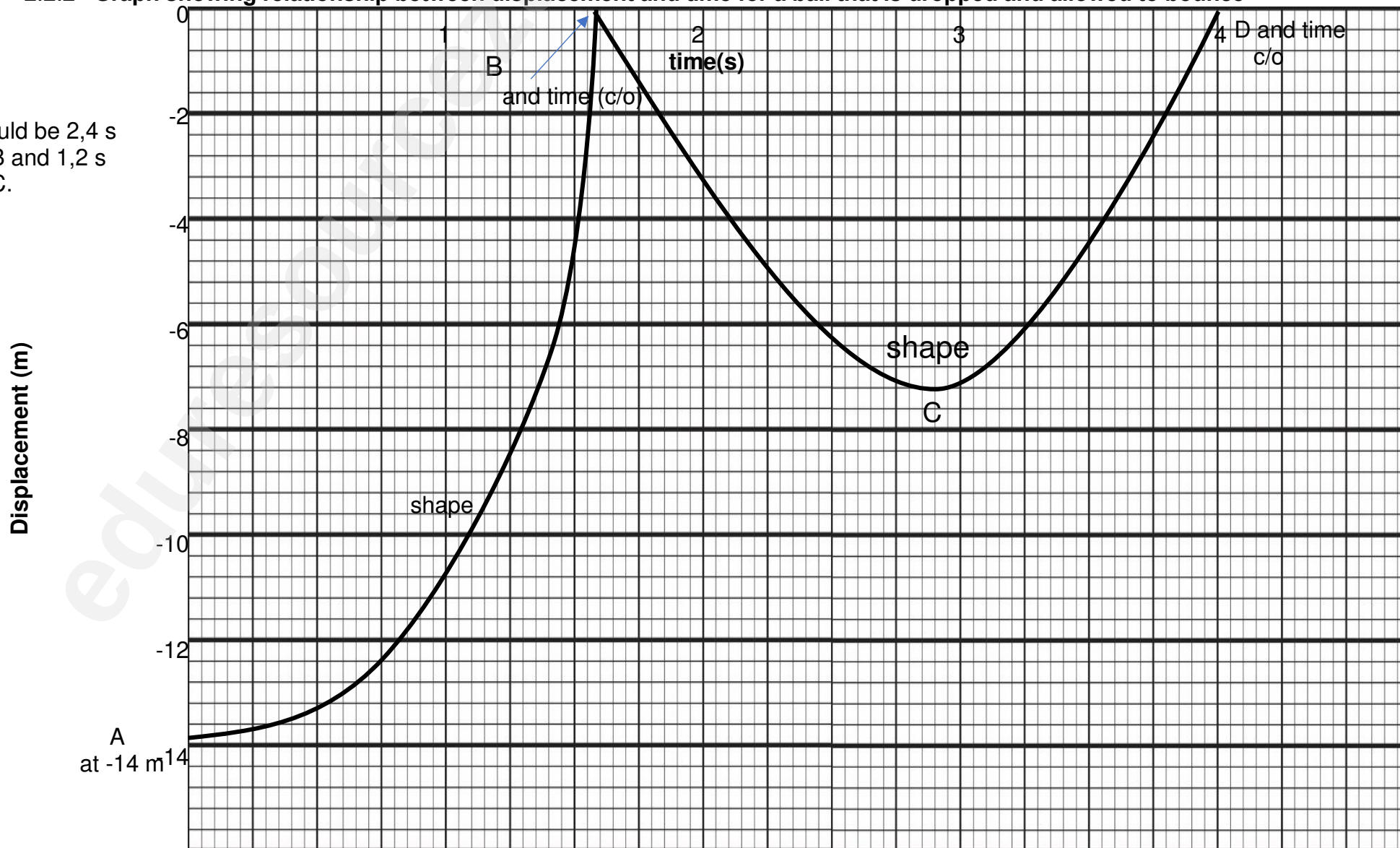


2.1.7 Time at max height = 2,00-2,08 s (c/o from graph) accuracy

$$\begin{aligned}
 2.1.8 \quad \Delta X &= \frac{1}{2} \text{ base} \times \text{height} \\
 &= \frac{1}{2} (\text{time from 2.1.7})(20) \\
 &= 20,7 \text{ m}
 \end{aligned}$$

$$\begin{aligned}
 2.2 \quad 2.2.1 \quad \Delta X &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\
 14 &= \frac{1}{2} (9,8) \Delta t^2 \\
 \Delta t &= 1,69 \text{ s}
 \end{aligned}$$

2.2.2 Graph showing relationship between displacement and time for a ball that is dropped and allowed to bounce

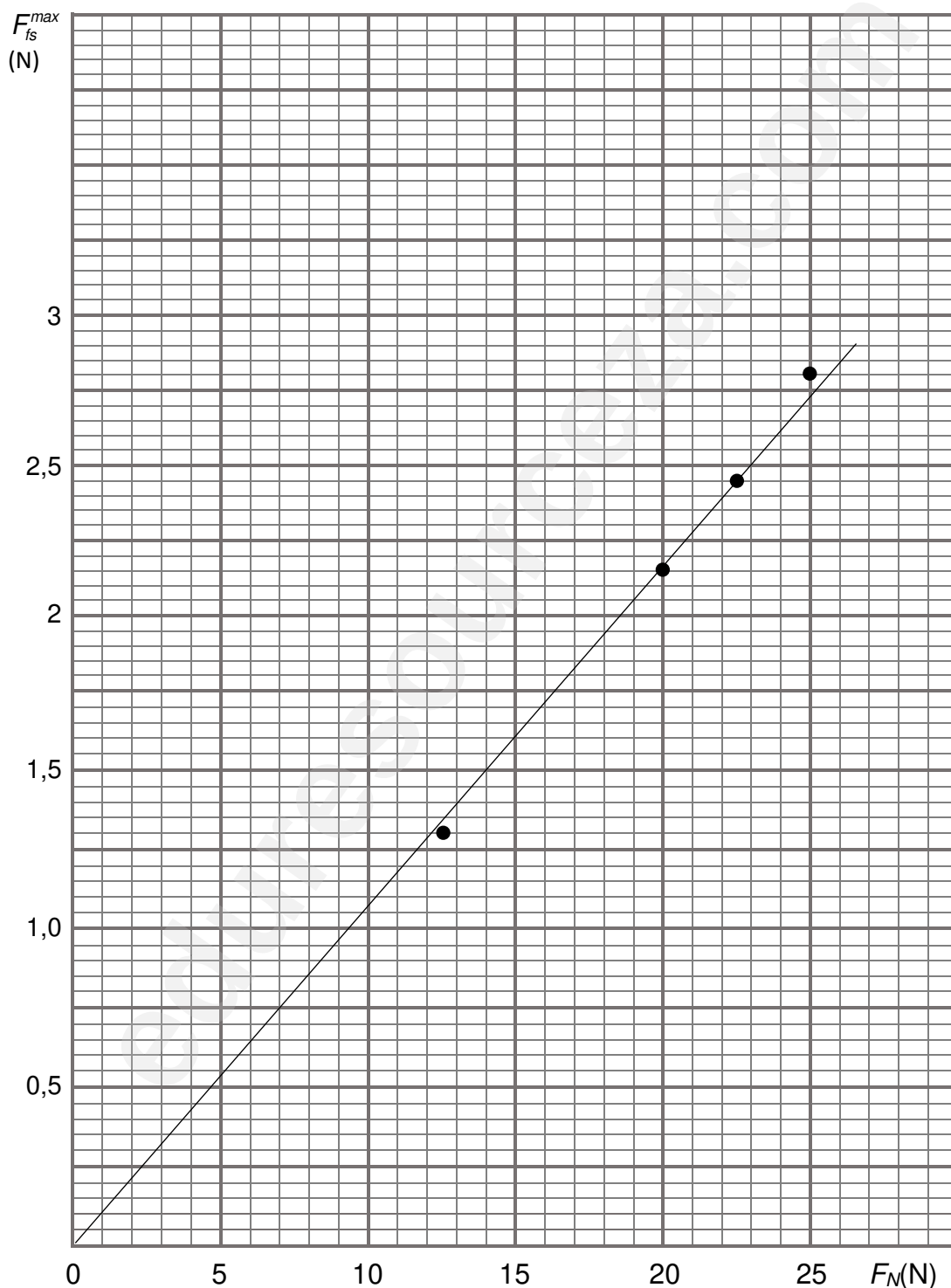


C & D
D should be 2,4 s
after B and 1,2 s
after C.

QUESTION 3

3.1 3.1.1 The perpendicular force exerted on an object by a surface in contact with it.

3.1.2 **Graph showing the relationship between the maximum force of kinetic friction and the normal reaction force for a brick on a surface**



heading

y-axis label and unit

plotting (check a point)

x-axis label and unit

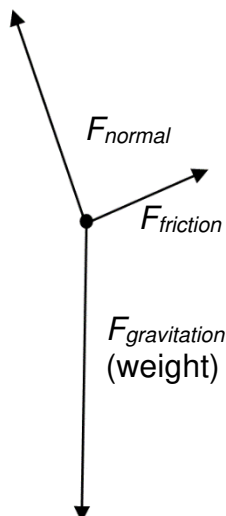
scale

best fit extending line back to axis

3.1.3 Gradient of graph = μ_s method

$$\text{Gradient} = \frac{\Delta y}{\Delta x} = \frac{2,75 - 1,1}{25 - 10} = 0,11$$

3.1.4



3.1.5 $F_N = mg \cos \theta$

3.1.6 $F_{fs}^{\max} = mg \sin \theta$

3.1.7 $\mu_s = \frac{F_{fs}^{\max}}{F_N} = \frac{1,3 \times 9,8 \times \sin \theta}{1,3 \times 9,8 \times \cos \theta}$ (substitution mark)

$$\tan \theta = 0,48$$

$$\theta = 25,64^\circ$$

3.2 3.2.1 $F_{hX} = X \cos 25^\circ$

3.2.2 The net force is the single force that has the same effect as the original forces acting together.

3.2.3 $F_{\text{net}(3 \text{ kg})} = X \cos 25^\circ - F_{\text{due to } 6 \text{ kg}} - F_f$ (all or nothing)

3.2.4 $F_{\text{net}(6 \text{ kg})} = F_{\text{due to } 3 \text{ kg}} - F_f$

3.2.5 $3(1,5) = X \cos 25^\circ - 2 - F_{\text{due to } 6 \text{ kg}}$
(application of $F_{\text{net}} = ma$)

$$6(1,5) = F_{\text{due to } 3 \text{ kg}} - 2$$

$$F_{\text{due to } 6 \text{ kg}} = 11 \text{ N}$$

$$4,5 = 0,91 X - 2 - 11$$

$$X = 19,23 \text{ N (19,31 N)}$$

QUESTION 4

4.1 4.1.1 The energy an object has as a result of its motion.

$$\begin{aligned}
 4.1.2 \quad E_k &= \frac{1}{2}mv^2 \\
 &= \frac{1}{2}(40)(0,5)^2 \\
 &= 5 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 4.1.3 \quad E_p + E_{k \text{ at } A} + W_f &= E_p + E_{k \text{ at } B} \\
 40(9,8)(20) + 5 \text{ (c/o)} + W_f &= \frac{1}{2}(40)(19,24)^2 \\
 W_f &= -441,45 \text{ J}
 \end{aligned}$$

4.1.4 The product of the net force and the time over which it acts.

$$\begin{aligned}
 4.1.5 \quad F_{net}\Delta t &= \Delta p \\
 F_{net} 1,4 &= mv_f - mv_i \\
 &= 40(0 - 19,24) \\
 F_{net} &= 549,71 \text{ N left}
 \end{aligned}$$

4.2 4.2.1 The total linear momentum of an isolated system remains constant.

$$\begin{aligned}
 4.2.2 \quad m_t v_{it} + m_{board} v_{i \text{ board}} &= (m_t + m_{board})v_f \\
 45(1,5) + 5(-3,0) &= 50 v_f \\
 v_f &= 1,05 \text{ m}\cdot\text{s}^{-1} \text{ right}
 \end{aligned}$$

QUESTION 5

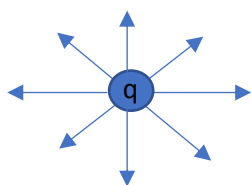
$$\begin{aligned}
 5.1 \quad 5.1.1 \quad F &= G \frac{m_1 m_2}{r^2} \\
 &= \frac{6,7 \times 10^{-11} \times 7,16 \times 10^{22} \times 5,97 \times 10^{24}}{(3,84 \times 10^8)^2} \text{ (conversion to } m) \\
 F &= 1,94 \times 10^{20} \text{ N (attraction)}
 \end{aligned}$$

$$\begin{aligned}
 5.1.2 \quad g &= \frac{GM}{r^2} \\
 4,9 &= \frac{6,7 \times 10^{-11} \times 5,97 \times 10^{24}}{r^2} \\
 r &= 9,03 \times 10^6 \text{ m}
 \end{aligned}$$

$$\begin{aligned}
 \text{Height above surface} &= 9,03 \times 10^6 - 6,38 \times 10^6 \text{ (method)} \\
 &= 2,65 \times 10^6 \text{ m}
 \end{aligned}$$

5.2 5.2.1 The force per unit positive charge.

5.2.2

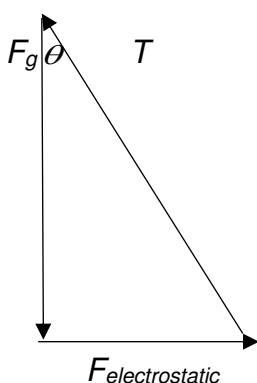


(shape/radial direction)

$$5.2.3 \quad q = \frac{F}{E} = \frac{0,07}{3 \times 10^5} = 2,33 \times 10^{-7} \text{C positive}$$

5.2.4 zero N (0)

5.2.5



$$(i) \quad T^2 = ((0,004)(9,8))^2 + 0,07^2$$

$$T = 0,08 \text{ N}$$

(ii) mark given for sketch

$$\tan \theta = \frac{0,07}{0,004 \times 9,8} \quad \text{hence } \theta = 60,75^\circ$$

QUESTION 6

6.1 6.1.1 The maximum amount of energy per coulomb of (positive) charge supplied by the cell.

6.1.2 10 V

$$6.1.3 \quad I = \frac{emf}{R+r} \\ = \frac{10}{60 + 5} = 0,15 \text{ A}$$

$$6.1.4 \quad V_2 = RI = 30 (0,15 \text{ c/o}) = 4,50 \text{ V} (4,62 \text{ V})$$

6.1.5 Increase

6.1.6 less than

6.1.7 When S_2 is closed the voltmeter is connected across zero resistance (short circuit)

and no work is done when charge moves through zero resistance

$V=RI$ and since $R=0$ $V=0$ or V decreases

OR

When S_2 is closed NO CURRENT flows through R_2 because it is a short circuit (or current takes the path with negligible resistance)

Thus $V = RI = 0$

6.2 6.2.1 It means that 1 500 J of energy is transferred per second.

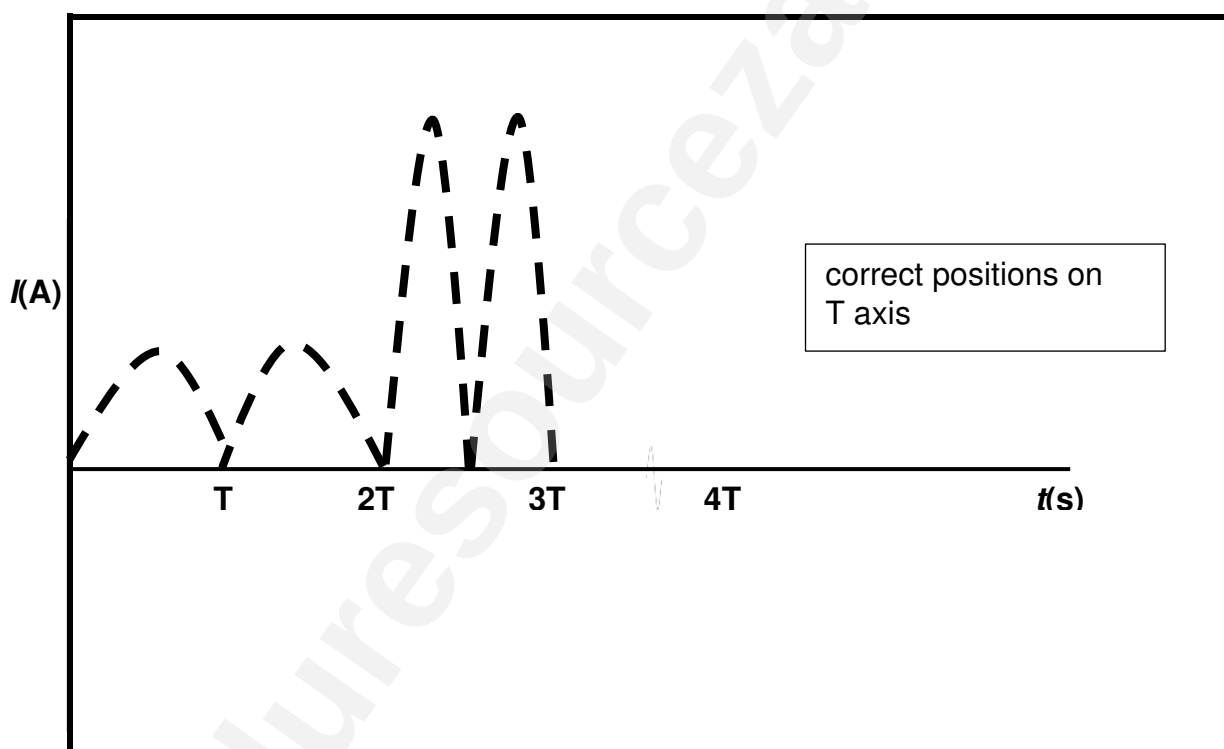
$$6.2.2 \quad I = \frac{P}{V} \text{ hence } I_{total} = \frac{1\,500}{220} + \frac{1\,800}{220} = 15,0 \text{ A}$$

$$6.2.3 \quad R = \frac{V^2}{P}$$

- V is the same for both
- Hence if P is smaller R will be higher (noting that it has to do with power)
- Hence kettle has higher R

QUESTION 7

- 7.1 Kinetic/mechanical to electrical
- 7.2 A to B
- 7.3 Flemmings right hand dynamo rule **OR** Lenz's Law and RH solenoid rule.
- 7.4 North
- 7.5 Moved coil faster (or higher pitch sound)
- 7.6 Current that changes direction (polarity) every half turn
- 7.7 Full-wave rectifier
- 7.8



QUESTION 8

$$8.1 \quad 8.1.1 \quad \lambda = \frac{c}{f} = \frac{3 \times 10^8}{7,81 \times 10^{14}} \\ = 3,84 \times 10^{-7} \text{ m or } 384 \text{ nm}$$

8.1.2

**384 nm correct relative position**

8.1.3 Transition 2

- 8.1.4
- Shorter wavelength (higher f) means greater energy photon.
 - The greater the photon energy, the bigger the energy difference between levels.

8.2 8.2.1 The process that occurs when light strikes a metal and electrons are emitted.

8.2.2 $4,50 \times 10^{-19} \text{ J}$

8.2.3

$$W_0 = hf_0$$

$$4,5 \times 10^{-19} = 6,6 \times 10^{-34} \times f_0$$

$$f_0 = 6,82 \times 10^{14} \text{ Hz}$$

8.2.4

$$hf = hf_0 + \frac{1}{2}mv^2$$

$$6,6 \times 10^{-34} (6 \times 10^{15}) = 4,5 \times 10^{-19} + \frac{1}{2} (9,1 \times 10^{-31}) v^2$$

$$v = 2,78 \times 10^6 \text{ m} \cdot \text{s}^{-1}$$

Total: 200 marks