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PRELIMINARY EXAMINATION 20 AUGUST 2019

PHYSICAL SCIENCES – PAPER 1 (PHYSICS)

Time: 3 hours
Examiner: T. Rodrigues

200 marks
Moderator: S. Pillay

MEMORANDUM

QUESTION 1

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

[20]

QUESTION 1

2.1 The lawn chair. ✓ (1)

2.2 Change in position. ✓✓ (2)

2.3 **25 m** ✓ **east** ✓ (2)

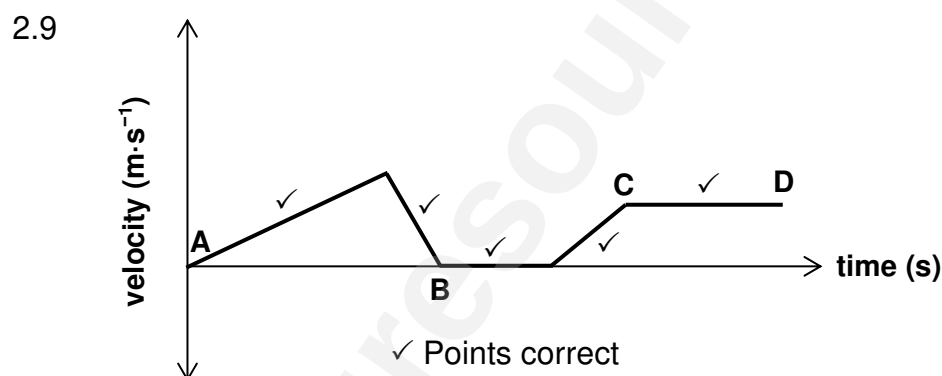
2.4 Average velocity is the rate of change of position (✓) for the entire journey ✓
Instantaneous velocity is the rate of change of position (✓) at a particular moment in time ✓ (3)

2.5 $\vec{v}_{ave} = \frac{\Delta \vec{x}}{\Delta t}$ ✓
 $\vec{v}_{ave} = \frac{(+10)}{(15)}$ ✓
 $\vec{v}_{ave} = \mathbf{0,67 \text{ m} \cdot \text{s}^{-1}}$ ✓ east ✓ (4)

2.6 The gradient (OR gradient of the tangent) ✓ (1)

2.7 West ✓✓ (2)

2.8 $v_f = v_i + a\Delta t$ ✓
 $(0) = v_i + (-0,12)(5)$ ✓✓
 $v_i = \mathbf{0,6 \text{ m} \cdot \text{s}^{-1}}$ ✓ (4)



(6)

[25]

QUESTION 2

3.1 The motion of a projectile, i.e. an object that falls in the absence of air resistance. ✓✓ (2)

3.2 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
 $(-1,6) \checkmark = v_i(1,45) \checkmark + \frac{1}{2}(-9,8)(1,45)^2 \checkmark$
 $v_i = \mathbf{6 \text{ m} \cdot \text{s}^{-1}}$ (4)

3.3 $v_f = v_i + a \Delta t$ ✓
 $(0) = (+6) + (-9,8) \Delta t$ ✓✓
 $\Delta t = \mathbf{0,61 \text{ s}}$ ✓ (4)

3.4 $\mathbf{9,8 \text{ m} \cdot \text{s}^{-2}}$ ✓ **down(wards)** ✓ (2)

3.5 Take upward be positive.

Lift Motion:

$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
 $(+d) = (0) + \frac{1}{2}(+1,8) \Delta t^2$ ✓✓
 $\Delta t = \mathbf{0,45 \text{ s}}$ ✓

Coin Motion:

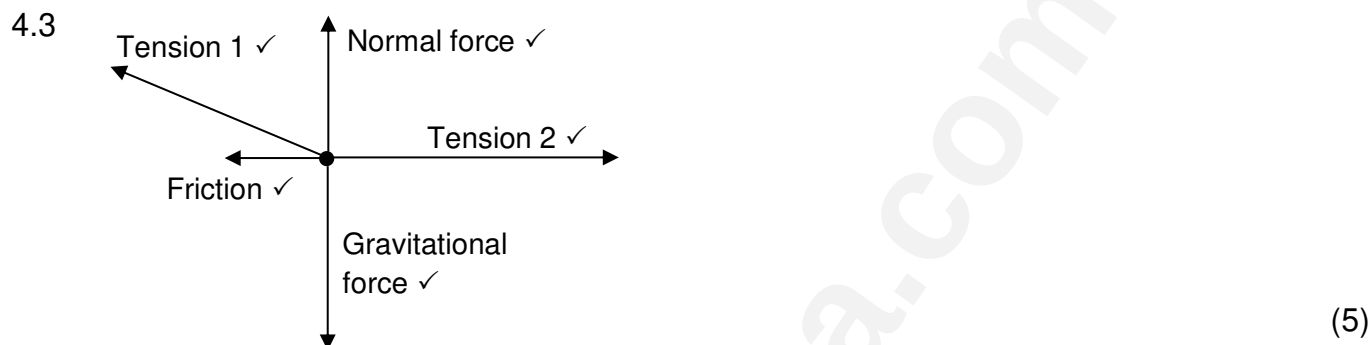
$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓
 $-(1,2 - d) = (0) + \frac{1}{2}(-9,8) \Delta t^2$ ✓✓

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QUESTION 3

4.1 An object continues in a state of rest or uniform (moving with constant) velocity unless it is acted upon by a net or resultant force. ✓✓ (2)

4.2 $F_{T2} = F_{gB} = mg$
 $F_{T2} = (5)(9,8)$ ✓
 $F_{T2} = \mathbf{49\ N}$ ✓ (2)



4.4 $F_N = F_g - F_{T1y}$
 $(78,44) = (m \times 9,8) - (5,4 \cos 70)$ ✓✓
 $m_A = \mathbf{8,19\ kg}$ ✓ (3)

4.5 $F_f + F_{T1x} = F_{T2}$
 $F_f + (5,4 \sin 70) = (49)$ ✓✓
 $F_f = \mathbf{43,93\ N}$ ✓ (3)

4.6 $F_{fs}^{\max} = \mu_s F_N$ ✓
 $(43,93) = \mu_s (78,44)$ ✓
 $\mu_s = \mathbf{0,56}$ ✓ (3)

4.7 $0\ N$ ✓✓ (2)

[20]

QUESTION 4

5.1 When a net force, F_{net} , is applied to an object of mass, m , it accelerates in the direction of the net force. The acceleration, a , is directly proportional to the net force and inversely proportional to the mass. ✓✓ (2)

5.2 For Block X:

$$\vec{F}_{net} = m\vec{a} \quad \checkmark$$

$$\vec{F}_{Y \text{ on } X} + \vec{F}_f + \vec{F}_{g\parallel} = m\vec{a}$$

$$(-0,78) + (+0,6) + (+0,2 \times 9,8 \sin 40) = (0,2)\vec{a} \quad \checkmark \checkmark$$

$$\vec{a} = 5,4 \text{ m} \cdot \text{s}^{-2} \quad \checkmark \text{ down the slope } \checkmark \quad (5)$$

5.3 Yes, as the object is slowing down ✓, meaning the acceleration must be in the opposite direction to the motion ✓. (2)

5.4 For Block Y:

$$\vec{F}_{net} = m\vec{a} \quad \checkmark$$

$$\vec{F} + \vec{F}_{X \text{ on } Y} + \vec{F}_f + \vec{F}_{g\parallel} = m\vec{a}$$

$$\vec{F} + (+0,78) + (+0,6) + (+0,3 \times 9,8 \sin 40) = (0,3)(+5,4) \quad \checkmark \checkmark \checkmark$$

$$\vec{F} = -1,65$$

$$F = 1,65 \text{ N} \quad \checkmark \quad (5)$$

5.5

- As the angle of the slope (θ) is decreased, $\cos \theta$ increases ✓
- Thus, the normal force increases ✓
- From the equation $F_f = \mu F_N$ we get $F_f \propto F_N$ as μ is constant ✓
- Thus, the frictional force also increases ✓

(4)

5.6 The coefficient of friction ✓ for Block **Y** could be less ✓ than Block **X**.
[One mark only for saying they are made from different materials.] (2)

[20]

QUESTION 5

6.1 Inelastic ✓ because the trolleys stick together ✓. (2)

6.2 **20 cm·s⁻¹** (or **0,2 m·s⁻¹**) ✓ **east** ✓ (2)

6.3 The total linear momentum of an isolated system remains constant (is conserved). ✓✓ (2)

6.4 For Trolleys M and N (isolated system):

$$\Sigma \vec{p}_i = \Sigma \vec{p}_f \quad \checkmark$$

$$m_M \vec{v}_{iM} + m_N \vec{v}_{iN} = (m_M + m_N) \vec{v}_f$$

$$(0,5)(+0,2) + 0 = ((0,5) + m_N)(+0,08) \quad \checkmark \checkmark \checkmark$$

$$m_N = \mathbf{0,75 \text{ kg}} \quad \checkmark \quad (5)$$

6.5 **0,5 s** ✓ (1)

6.6 For Trolley N (nonisolated system):

$$\vec{F}_{net} \Delta t = m(\vec{v}_f - \vec{v}_i) \quad \checkmark$$

$$\vec{F}_{net}(0,5) = (0,75)((+0,08) - (0)) \quad \checkmark \checkmark$$

$$\vec{F}_{net} = +0,12$$

$$F_{\text{on } N} = \mathbf{0,12 \text{ N}} \quad \checkmark \quad (4)$$

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QUESTION 6

7.1 Two point charges in free space or air exert forces on each other. The force is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges. ✓✓ (2)

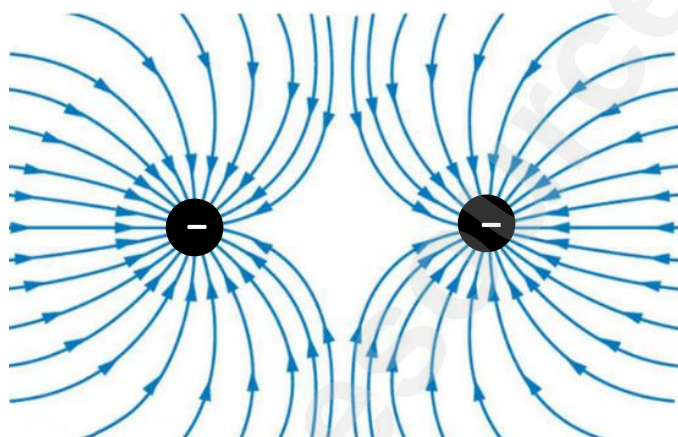
7.2 $F = \frac{kQ_1Q_2}{r^2}$ ✓
 $(4 \times 10^{-3}) = \frac{(9 \times 10^9)Q^2}{(6 \times 10^{-3})^2}$ ✓✓
 $Q = 4 \times 10^{-9} \text{ C}$ ✓ (4)

7.3 The force per unit positive charge. ✓✓ (2)

7.4
 7.4.1. Negative ✓ (1)

7.4.2. $E = \frac{kQ_1}{r^2}$ ✓
 $(4,44 \times 10^5) = \frac{(9 \times 10^9)(4 \times 10^{-9})}{(0,006+d)^2}$ ✓✓
 $d = 3 \times 10^{-3} \text{ m}$ ✓ (4)

7.5



✓ shape
 ✓ direction
 ✓ magnitudes

(3)

[16]

QUESTION 7

8.1 A material's opposition to the flow of electric current. ✓✓ (2)

8.2 $P_{bulb} = I_{bulb} V_{parallel}$ ✓
 $(5) = I_{bulb} (5)$ ✓✓
 $I_{bulb} = 1 \text{ A}$ ✓ (4)

8.3 $I_2 = I_{total} - I_{bulb}$ $R_2 = \frac{V_{parallel}}{I_2}$ ✓
 $I_2 = (1,5) - (1)$ $R_2 = \frac{(5)}{(0,5)}$ ✓
 $I_2 = 0,5 \text{ A}$ ✓ $R_2 = 10 \Omega$ ✓ (4)

8.4 $V_1 = I_{total} R_1$ $V_{total} = V_{||} + V_1$
 $V_1 = (1,5)(2)$ ✓ $V_{total} = (5) + (3)$ ✓
 $V_1 = 3 \text{ V}$ ✓ $V_{total} = 8 \text{ V}$ ✓

OR

$R_{||} = \frac{V_{||}}{I_{total}}$ $R_{total} = R_{||} + R_1$ $V_{total} = I_{total} R_{total}$
 $R_{||} = \frac{(5)}{(1,5)}$ $R_{total} = (3,3333) + (2)$ $V_{total} = (1,5)(5,3333)$ ✓
 $R_{||} = 3,3333 \Omega$ ✓ $R_{total} = 5,3333 \Omega$ ✓ $V_{total} = 8 \text{ V}$ ✓ (4)

8.5 The total energy supplied per coulomb of charge by the cell. ✓✓ (2)

8.6 $emf = I_{total} (R_{total} + r)$ ✓
 $emf = (1,5)((5,3333) + (1))$ ✓✓
 $emf = 9,5 \text{ V}$ ✓ (4)

8.7 • From the equation $emf = I_{total} (R_{total} + r)$, we get the relationship $I_{total} \propto \frac{1}{(R_{total} + r)}$ as the emf is constant ✓
 • Removing the bulb from the circuit increases the total resistance ✓ (and thus $R_{total} + r$ increases)
 • Therefore, the total current decreases ✓
 • From the equation $P_{internal} = I_{total}^2 r$, we get the relationship $P \propto I_{total}^2$ as the internal resistance, r , is constant ✓
 • As the total current decreases, so does the power developed by the internal resistance of the battery ✓
 • This is why the temperature decreases (5)

[25]

QUESTION 8

- 9.1 No current ✓
There is no change in magnetic field strength (magnetic flux density) ✓
and therefore there is no change in magnetic flux ✓ (3)
- 9.2
- 9.2.1 The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux. ✓✓ (2)
- 9.2.2 South ✓ (1)
- 9.2.3 A to B ✓✓ (2)
- 9.3 Rotate the magnet faster ✓✓ (2)
- 9.4
- According to Faraday's law ✓
 - the faster the magnet is rotated, the greater the rate of change of magnetic flux (or the smaller the time) ✓
 - Since the emf is directly proportional to the rate of change in magnetic flux (✓)
 - This will increase the induced emf ✓
 - Therefore increasing the power developed by the bulb (✓) (4)

[14]

QUESTION 9

- 10.1 The process that occurs when light shines on a metal and electrons are ejected. ✓✓ (2)
- 10.2 Title ✓
 x -axis scale ✓
 x -axis label ✓
 Data points plotted correctly ✓✓
 Line of best fit ✓
 Line NOT extrapolated (-1) (6)
- 10.3 The minimum frequency of incident radiation at which electrons will be emitted from a particular metal. ✓✓ (2)
- 10.4 $9,1 (\pm 0,3) \times 10^{14} \text{ Hz}$ ✓✓ (2)
- 10.5 $W_0 = hf_0$ ✓
 $W_0 = (6,6 \times 10^{-34})(9,1 \times 10^{14})$ ✓
 $W_0 = 6 \times 10^{-19} \text{ J}$ ✓ (coe from 10.4) (3)
- 10.6 Equation ✓✓
 Gradient = h ✓
 Intercept = $-W_0$ ✓ (4)
- 10.7 Same gradient ✓
 Bigger x -intercept ✓ (2)
- 10.8 Read kinetic energy off graph: $E_K^{\max}$ in eV ✓
 $E_K^{\max} = \frac{1}{2}mv^2$ ✓
 $(E_K^{\max} \text{ in eV} \times 1,6 \times 10^{-19}) \checkmark = \frac{1}{2}(9,1 \times 10^{-34})v^2 \checkmark$
 $v = \text{in m} \cdot \text{s}^{-1} \checkmark$ (5)

[26]

Total: 200 Marks