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TRINITYHOUSE HIGH SCHOOL LITTLE FALLS

PHYSICAL SCIENCE: PAPER 1

GRADE 12

PRELIMINARY EXAMINATION

3 SEPTEMBER 2018

Time: 3 hours

Examiner: Mr D Du Toit

Total: 200 marks

Moderator: Mr D Brown

MARKING GUIDELINES

QUESTION 1 MULTIPLE-CHOICE QUESTIONS

1.1 B

1.2 B

1.3 A

1.4 D

1.5 C

1.6 C

1.7 C

1.8 A

1.9 C

1.10 A

[10 x 2 marks = 20]

QUESTION 2 AVERAGE SPEED TRAPPING

2.1 The rate of change ✓ of distance ✓ (2)

2.2 $120/3,6 = 33,33 \text{ m.s}^{-1}$ ✓ (1)

2.3 AB ✓, CD ✓ and EF ✓ (3)

2.4 DE ✓ (1)

2.5 $\Delta y/\Delta x$ ✓ = $(20 - 40) / (500 - 400)$ ✓ = $- 20/100 = - 0,2$
Acceleration is $0,2 \text{ m.s}^{-2}$ ✓ NORTH WEST ✓ (4)

2.6 Area = distance = $(lxb) + (lxb) + (lxb)$ ✓ + $\frac{1}{2} (bxh) + \frac{1}{2} (bxh)$ ✓
= $(30 \times 400) + (10 \times 200) + (20 \times 200) + \frac{1}{2} (100 \times 10) + \frac{1}{2} (100 \times 20)$
= $12000 + 2000 + 4000 + 500 + 1000$
= 19500 m ✓

$v = s/t$ ✓
= $19500 / 600$
= 32.5 m.s^{-1} ✓ < 33.33 (coe Q 2.2) ✓

Therefore he is NOT GUILTY of speeding ✓ (7)

2.7 (4)

- ✓ BC increasing gradient
- ✓ CD straight line
- ✓ DE decreasing gradient
- ✓ EF straight AND shallower than CD

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QUESTION 3 BOUNCING BALL

3.1 A physical quantity ✓ that has both magnitude and direction. ✓ (2)

3.2

3.2.1 20 m.s^{-1} ✓DOWN✓ (2)

3.2.2 15 m.s^{-1} ✓UP✓ (2)

3.3 Inelastic ✓

Magnitude of velocity changes after the ball bounces ✓

Therefore kinetic energy is not conserved ✓ (3)

3.4 $v^2 = u^2 + 2gs$ ✓

$$20^2 = 10^2 + 2(-9,8)s \quad \checkmark$$

$$s = -15,3 \text{ m} \quad \checkmark$$

Therefore the ball was thrown from a height of 15,3 m (3)

3.5 $\text{Impulse} = m(v - u)$ ✓

$$= 0,15(-15 - 20) \quad \checkmark$$

$$= -5,25 \text{ kg.m.s}^{-1}$$

$$= 5,25 \text{ kg.m.s}^{-1} \quad \checkmark \text{UP} \quad \checkmark \quad (4)$$

3.6 $-15,3 \text{ m} + 11,5 \text{ m} = -3,8 \text{ m} = 3,8 \text{ m}$ ✓ DOWN ✓ (2)

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QUESTION 4 WINTER OLYMPICS (1) – SNOW BOARDING HALF PIPE

4.1 In the absence of air resistance or any external forces ✓, the mechanical energy of an object is constant ✓ (2)

4.2 $E_p = mgh$ ✓
 $= 80 \times 9,8 \times 14,3$ ✓
 $= 11211,2 \text{ J}$ ✓ (3)

4.3 $(E_p + E_k)_i = (E_p + E_k)_f$ ✓
 $mgh + 0 = mgh + \frac{1}{2}mv^2$ ✓
 $11211,2 = (80 \times 9,8 \times 6,7) + \frac{1}{2}(80)v^2$ ✓
 $11211,2 = 5252,8 + 40 v^2$
 $5958,4 = 40 v^2$
 $v^2 = 148,96$
 $v = 12,2 \text{ m.s}^{-1}$ ✓ (4)

4.4 $E_p \text{ top} = E_k \text{ bottom}$ if there is no friction ✓
 $mgh = \frac{1}{2}mv^2$ masses cancel out ✓
 Therefore $gh = \frac{1}{2}v^2$ therefore mass doesn't affect the speed. ✓ (3)

4.7 His mass is constant, his velocity is constant so his momentum is constant. His momentum will change when he lands. ✓

If he lands with straight legs the time for the momentum to change will be shortened

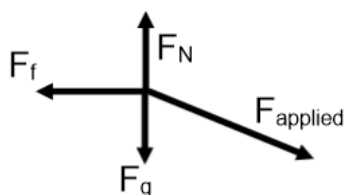
According to the formula $F = m\Delta v / t$ ✓ this will increase the force ✓ exerted on the man's knees

If he bends his knees when landing the time for the momentum to change will be lengthened so according to the same formula it will reduce the force ✓ on his knees. (4)

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QUESTION 5 WINTER OLYMPICS (2) – CURLING

5.1



F_N = Normal force of the surface
 F_{applied} = Applied force on stone
 F_g = Force of Earth on Stone
 F_f = Force of Friction on stone

1 mark per correct labelled force (-1 if arrows not shown) (4)

5.2 $F_{\text{app}x} = F_{\text{app}} \checkmark \cos 20^\circ \checkmark$

$= 11,28 \text{ N} \checkmark$ (3)

5.3 $F_N = mg + 12 \sin 20^\circ \checkmark$

$= (18 \times 9,8) \checkmark + 4,10$

$= 180,50 \text{ N} \checkmark$

$F_{fk} = \mu F_N \checkmark$

$= 0,04 (180,5)$

$= 7,22 \text{ N} \checkmark$ (5)

5.4 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. $\checkmark \checkmark$

OR

The net force acting on an object is equal to the rate of change of momentum. $\checkmark \checkmark$

(2)

5.5 $F_{\text{app}} - F_f = ma \checkmark$

$11,28 - 7,22 = (18) a \checkmark$ (c.o.e. from Q5.2 and Q5.3)

$4,06 = (18) a$

$a = 0,23 \text{ m.s}^{-2} \checkmark$ (3)

5.6 $F_{fk} = \mu F_N$

$= 0,02 (176,4) \checkmark$

$= 3,53 \text{ N} \checkmark$ (there is NO coe here!) (2)

5.7 the work done by a net force on an object $\checkmark$ is equal to the change in the kinetic energy of the object. $\checkmark$ (2)

5.8 $\Delta E_k = F \cdot s \checkmark$

$\frac{1}{2} mv^2 - \frac{1}{2} mu^2 = - 3,53 \times 28 \checkmark$ (coe Q5.6)

$0 - \frac{1}{2} (18)u^2 = - 98,84$ (May use 98,78 if they don't round off)

$- 9 u^2 = - 98,84 \checkmark$ Watch for the signs here

$u^2 = 10,98$

$u = 3,31 \text{ m.s}^{-1} \checkmark$ (4)

5.9 The total linear momentum of an isolated system remains constant (is conserved) $\checkmark\checkmark$ (2)

5.10 $p = mv \checkmark$

$= 17 \times 0,3 \checkmark$

$= 5,1 \text{ kg.m.s}^{-1} \checkmark$ (3)

5.11 $p_i = p_f \checkmark$ taking right as positive

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2 \checkmark$

$(17 \times 0,3) + (18 \times 0) = (17 \times -0,01) + (18 \times v_2) \checkmark$

$5,1 + 0 = (-0,17) + 18 v_2$

$5,1 + 0,17 = 18 v_2$

$v_2 = 0,29 \text{ m.s}^{-1} \checkmark$ (4)

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QUESTION 6 FIELDS

6.1

6.1.1 P – electrostatic force of X on Y ✓

Q – force due to gravitational acceleration/ force of earth on Y ✓ (2)

6.1.2 $F_x = F_T \cos 55 = 0,06 \cos 55 \checkmark = 0,03 \text{ N} \checkmark$ (2)

6.1.3 0,03 N ✓ (1)

6.1.4 The force between two charges is directly proportional to the product of the charges ✓ and inversely proportional to the distance between the charges squared. ✓ (2)

6.1.5

$$F_{X \text{ on } Y} = \frac{kQ_X Q_Y}{r^2} \checkmark = \frac{(9 \times 10^9) \checkmark Q_X (60 \times 10^{-9})}{(0,024)^2 \checkmark} \checkmark = 0,03 \text{ (coe 6.12.)}$$

$$Q_X = 3,2 \times 10^{-8} \text{ C} \checkmark \quad (5)$$

6.1.6 $F_x = F_T \sin 55 = 0,06 \sin 55 = 0,049 \dots \text{ N} \checkmark$

$$F_y = mg$$

$$0,049 \dots = m(9,8) \checkmark$$

$$m = 5,02 \times 10^{-3} \text{ kg} = 5,02 \text{ g} \checkmark \quad (3)$$

6.2

6.2.1

$$\frac{6,5 \times 10^{-12}}{1,6 \times 10^{-19}} \checkmark = 4,06 \times 10^7 \text{ electrons} \checkmark \quad (2)$$

6.2.2

$$E = \frac{kQ}{r^2} \checkmark = \frac{(9 \times 10^9)(6,5 \times 10^{-12})}{(3)^2} \checkmark = 6,5 \times 10^{-3} \text{ N.C}^{-1} \checkmark$$

(3)

6.2.3 Towards Q $\checkmark$. Electric field lines are directed away from Q $\checkmark$. Q is positively charged $\checkmark$.

(3)

[23]

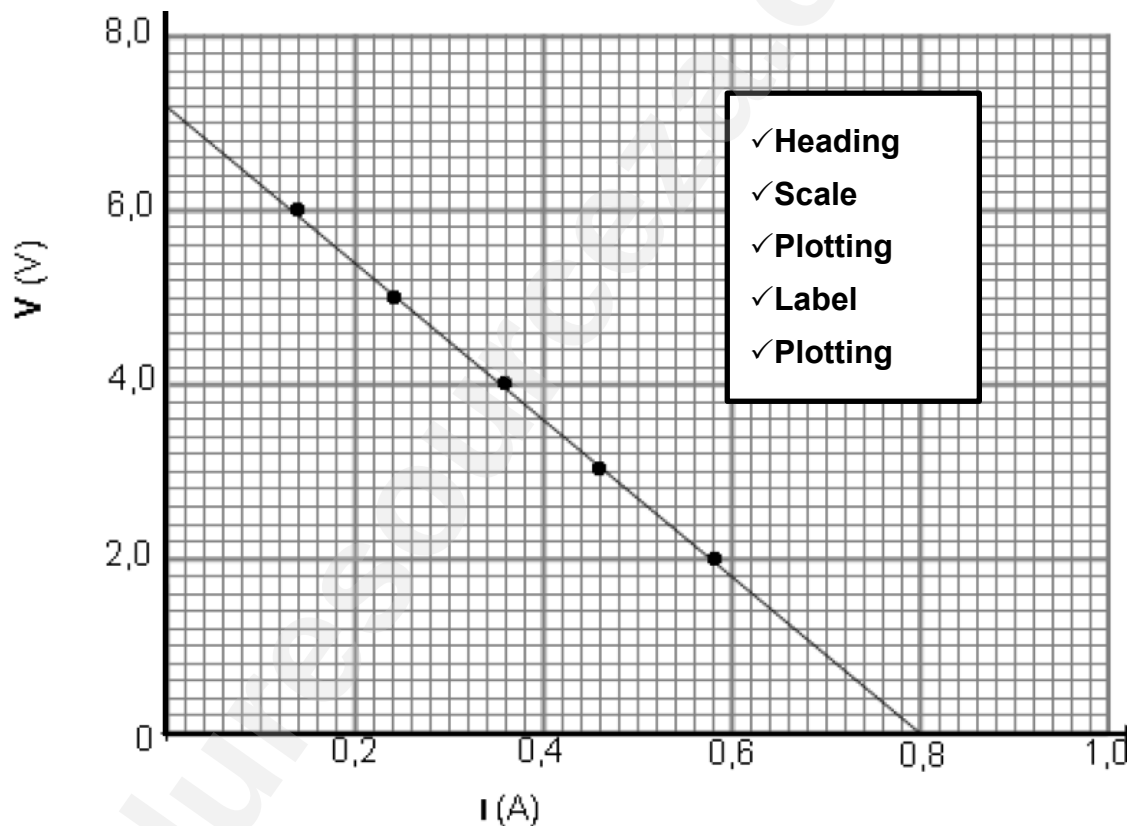
QUESTION 7 ELECTRIC CIRCUITS

7.1

7.1.1 the total energy ✓ supplied per coulomb of charge by the cell ✓ (2)

7.1.2 Temperature ✓ (1)

7.1.3

Graph showing the relationship between voltage and current

(5)

7.1.4 $V_{\text{load}} = -Ir + \text{emf}$ ✓ (1)

7.1.4.1 7.2 V (7.0 V - 7.4 V or the value of the y-intercept) ✓ (1)

7.1.4.2 gradient ✓ $= \frac{\Delta V}{\Delta I} = \frac{0 - 7.2}{0.8 - 0} = -9$ ✓ $r = 9 \Omega$ ✓ (4)

7.2

$$7.2.1 \quad P = VI \checkmark \quad 100 = 20I \checkmark \quad I = 5 \text{ A} \checkmark \quad (3)$$

$$7.2.2 \quad P = \frac{V^2}{R} \checkmark \quad 150 = \frac{20^2}{R} \checkmark \quad R = 2,67 \, \Omega \checkmark \quad (3)$$

$$7.2.3 \quad P = VI \quad 150 = 20I \quad I = 7,5 \text{ A} \checkmark$$

$$I_{\text{tot}} = 7,5 + 5 = 12,5 \text{ A} \checkmark$$

$$R = \frac{V}{I} = \frac{20}{12,5} = 1,6 \, \Omega \checkmark$$

$$\text{emf} = I(R_{\text{ext}} + r) \checkmark$$

$$24 = 12,5(1,6 + r)$$

$$r = 0,32 \, \Omega \checkmark \quad (5)$$

OR

Calculate R_y and work out R_{ext} using resistors in parallel.

$$7.2.4 \quad \text{A voltmeter} \checkmark \quad (1)$$

7.2.5 Device Z should be a voltmeter because it has a very high resistance and will draw very little current. $\checkmark$

The current through X and Y will remain the same $\checkmark$ hence the device can operate as rated.

It is connected in parallel (1 marks only) (2)

[28]

QUESTION 8 ELECTRODYNAMICS

8.1

8.1.1 B to A ✓ (1)

8.1.2 The magnetic field due to current ✓ interacts with the magnetic field due to the magnets ✓ (2)

8.2

8.2.1 Electrical energy to mechanical energy ✓ (1)

8.2.2 ABCD ✓ (1)

8.2.3 The split ring commutator ✓. It reverses the direction of the current every half a revolution ✓. This ensures that the coil continues rotating (in the same direction) ✓ (3)

8.2.4 Anticlockwise ✓ (1)

8.2.5 The current flowing in BC is parallel to the permanent magnetic field ✓. According to the equation: $F = IB\ell\sin\theta$ ✓, $\theta = 0$ and therefore $F = 0$ ✓ (3)

8.3

8.3.1 the emf induced is directly proportional ✓ to the rate of change of magnetic flux (flux linkage) ✓ (2)

8.3.2 ac generator ✓. The slip ring commutator allows for current to flow in both directions in the external circuit ✓ (2)

8.3.3 Any ONE of the following ✓ (1)

1) Turn the coil faster in the magnetic field

2) Increase the number of turns in the coil

3) Use stronger magnets

4) Increase the cross-sectional area of the coil

8.3.4 For emf to be induced there needs to be a *change* in magnetic flux ✓. When the coil is not rotating magnetic flux is constant and no emf is induced ✓ (2)

8.3.5 ✓ Cosine graph (shape)

✓ Starts at max positive emf

✓ One full cycle

✓ Axes labels correct

(4)

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QUESTION 9 PHOTONS AND ELECTRONS

- 9.1 the minimum amount of energy ✓ needed to emit an electron from the surface of a metal ✓ (2)

9.2

$$E = W_0 + E_k^{max} \checkmark$$

$$\frac{hc}{\lambda} \checkmark = 3,36 \times 10^{-19} + 2,32 \times 10^{-19} \checkmark$$

$$\frac{(6,6 \times 10^{-34})(3 \times 10^8) \checkmark}{\lambda} = 3,36 \times 10^{-19} + 2,32 \times 10^{-19}$$

$$\lambda = 3,49 \times 10^{-7} \text{ m } \checkmark$$

(5)

9.3

$$E = W_0 + E_k^{max}$$

$$\frac{(6,6 \times 10^{-34})(3 \times 10^8)}{3,49 \times 10^{-7}} \checkmark \text{ coe from 9.2} = 3,65 \times 10^{-19} + E_k^{max} \checkmark$$

$$E_k^{max} = 2,03 \times 10^{-19} \text{ J } \checkmark = 1,27 \text{ eV } \checkmark \quad (4)$$

9.4

- 9.4.1 Increasing the intensity does not change the energy/ frequency/ wavelength of the incident photons ✓ The energy of a photon remains unchanged (for the same frequency) ✓ (2)

- 9.4.2 Increases ✓ (1)

- 9.4.3 More photons strike the surface of the metal per unit time ✓, hence more (photo) electrons ejected per unit time (leading to increase in current) ✓ (2)

[16]