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GRADE 12
TIME: 3 HOURS

PHYSICAL SCIENCE PRELIMINARY EXAM
PAPER 1 PHYSICS

6 SEPTEMBER 2019
MARKS 200

MEMORANDUM:

QUESTION 1: (MULTIPLE CHOICE)

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

TOTAL QUESTION 1: [20]

QUESTION 2:

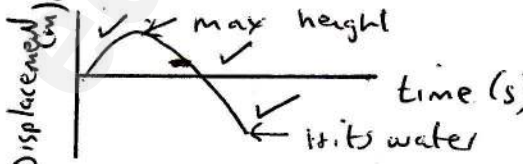
2.1.1 Displacement: Change in position ✓ (accept any valid answer as per SAGS) (1)

2.1.2 Velocity: Rate of displacement. ✓ (accept any valid answer as per SAGS) (2)

2.1.3 $V_f = V_i + g\Delta t = 0 + (9.8)(4) = 39.2 \text{ m.s}^{-1}$ ✓ (3)

2.1.4 $\Delta x = V_i\Delta t + \frac{1}{2}g\Delta t^2 = \frac{1}{2}(9.8)(4)^2 = 78.4 \text{ m}$ ✓ (2)

2.2.1 $V_f^2 = V_i^2 + 2a\Delta x$
 $\Delta x = (V_f^2 - V_i^2)/2a = 3.27 \text{ m}$ ✓
 Height above river = $3.27 + 78.4 = 81.67 \text{ m}$ ✓ (3)

2.2.2  (3)

2.2.3 $E_p = mgh = (5 \times 10^3)(9.8)(78.4) = 3841600 \text{ J}$ ✓
 $t = W/P = E_p/P = 3841600/2000 = 1920.8 \text{ s}$ ✓
 Time in minutes = $1920.8/60 = 32.01 \text{ minutes}$ ✓ (4)

TOTAL QUESTION 2: [18]

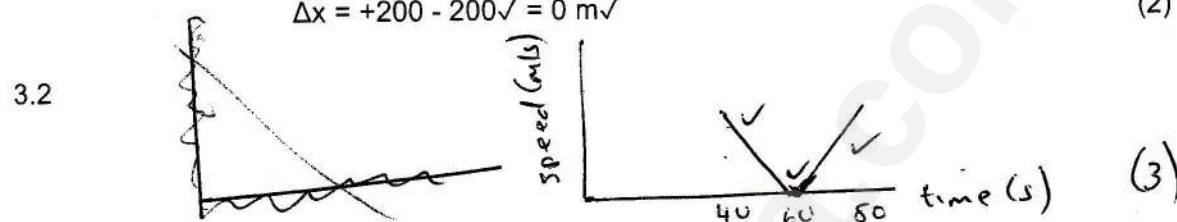
QUESTION 3:

3.1.1(a) B-C ✓ (1)

3.1.1(b) D-E ✓ (1)

3.1.2(a) $a = \text{gradient} = (0-20)/(60-40) = -1 \text{ m.s}^{-2}$ ✓ (2)

3.1.2(b) $\Delta x = \text{some of areas under curve}$
 $\Delta x = +200 - 200 = 0 \text{ m}$ ✓ (2)



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

3.3.2(a) $W_{\text{net}} = F_{\text{net}} \Delta x \cos \theta = 90 \times 10 \times 1 = 900 \text{ J}$ ✓
 $W_{\text{net}} = E_{\text{kf}} - E_{\text{ki}}$
 $E_{\text{kf}} = 900 + \frac{1}{2}(8)(20)^2$ ✓
 $E_{\text{kf}} = 900 + 1600 = 2500 \text{ J}$ ✓ (3)

3.3.2(b) $E_k = \frac{1}{2}mv^2$
 $v^2 = 2(2500)/8$ ✓
 $v = 25 \text{ m.s}^{-1}$ ✓ in direction object was moving at 80 s ✓ (3)

3.3.3 $W_{\text{net}} = F_{\text{net}} \Delta x \cos \theta = 90 \times 10 \times -1 = -900 \text{ J}$ ✓
 $E_{\text{kf}} = -900 + 1600 = 700 \text{ J}$ ✓
 $v^2 = 2(700)/8$
 $V = 13.23 \text{ m.s}^{-1}$ ✓ (3)

TOTAL QUESTION 3: [20]

QUESTION 4:

4.1.1 In an isolated system the total linear momentum remains constant. ✓✓ (2)

4.1.2 $p_{\text{before}} = p_{\text{after}}$
 $(55)(10) + (65)(6) = (120)v$ ✓
 $v = 7.83 \text{ m.s}^{-1}$ ✓ in original direction (4)

4.2.1 No. ✓ momentum is product of mass and velocity of an object. ✓ This means that the object has kinetic energy since $E_k = \frac{1}{2}mv^2$ ✓ (3)

4.2.2 Yes. ✓ When a body is stationary it has zero momentum✓ but can possess potential energy (3)

4.2.3 Yes. ✓ They fell from the same height. Gravitational acceleration is constant, therefore final velocity is the same. Their masses are equal therefore momentum is equal✓ (2)

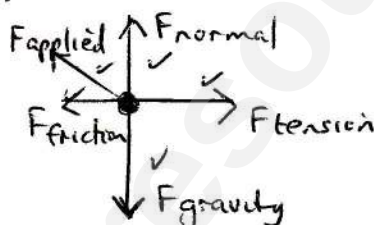
4.2.4 The same. They both have the same initial and final velocity (final = 0 m/s) And their masses are the same✓
 $\Delta p = m\Delta v$ (2)

4.2.5 Force on Quinlan > force on Ethan✓
 $F = \Delta p / \Delta t$
 Δt on Quinlan < Δt on Ethan✓ (2)

TOTAL QUESTION 4: [18]

QUESTION 5:

5.1 The net force acting on an object is equal to the rate of change in momentum of the object. ✓✓ (2)

5.2  (5)

5.3.1 $F_g = mg = 5 \times 9.8 = 49 \text{ N}$ ✓
 $F_{\text{NORMAL}} = F_g - F_{\text{vertical component of applied force}} = 49 - 5\sin 30 = 46.5 \text{ N}$ ✓ (4)

5.3.2 $F_{kf} = \mu F_{\text{NORMAL}} = 0.2 \times 46.5 = 9.3 \text{ N}$ ✓ (2)

5.3.3 5 kg: $F_{\text{net}} = F_{\text{tension}} - F_{\text{friction}} - F_{\text{horizontal component of applied force}}$
 $(5)a = F_{\text{tension}} - 9.3 - 5\cos 30$ ✓ equation 1

12 kg: $F_{\text{net}} = F_{\text{gravity}} - F_{\text{tension}}$
 $(12)a = 12(9.8) - F_{\text{tension}}$ ✓ equation 2

$17a = 117.6 - 9.3 - 4.33$ ✓ = 103.97✓
 $a = 6.12 \text{ m.s}^{-2}$ ✓ right (5)

TOTAL QUESTION 5: [18]

QUESTION 6:

6.1 time = distance/speed

1st 10 km: $10/25 = 0.4$ hours

2nd 10 km: $10/80 = 0.125$ hours ✓

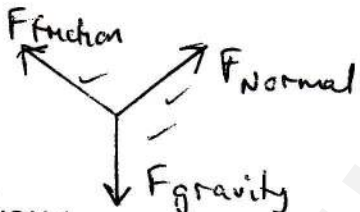
3rd 10 km: $10/100 = 0.1$ hours

$$\text{Average speed} = 30/0.625 \checkmark = 48 \text{ km.h}^{-1} \checkmark \quad (3)$$

6.2.1 Force that opposes the motion of an object and acts parallel to the surface with which the object is in contact. ✓✓ (2)

6.2.2 $90 \text{ km.h}^{-1} = 25 \text{ m.s}^{-1} \checkmark$
 $V_f = V_i + a\Delta t = 25 + (-0.5)(15) \checkmark = 17.5 \text{ m.s}^{-1} \checkmark \quad (3)$

6.2.3 $F_{\text{friction}} = F_{\text{net}} = ma = (500)(-0.5) \checkmark = 250 \text{ N} \checkmark \quad (2)$

6.2.4  (3)

6.2.5 OPTION 1:

$$\text{Distance BC} = \text{opp}/\sin 30 = 20/0.5 = 40 \text{ m} \checkmark$$

$$E_{\text{m(at B)}} - W_{\text{friction (down slope)}} = E_{\text{m(at C)}}$$

$$(mgh + \frac{1}{2}mv^2)_B + 250(40)\cos 180 = (0 + \frac{1}{2}mv^2)_C$$

$$(500)(9.8)(20) \checkmark + \frac{1}{2}(500)(17.5)^2 \checkmark - 10000 \checkmark = \frac{1}{2}(500)v^2 \checkmark$$

$$v = 25.66 \text{ m.s}^{-1} \checkmark \text{ down the slope} \checkmark \quad (7)$$

OPTION 2:

$$F_{\text{net}} = F_{\text{parallel component of gravity}} - F_{\text{friction}} \\ = mg\cos 30 - 250 \checkmark = 2200 \text{ N} \checkmark$$

$$\text{Distance BC} = \text{opp}/\sin 30 = 20/0.5 = 40 \text{ m} \checkmark$$

$$a = 2200/500 \checkmark = 4.4 \text{ m.s}^{-2} \checkmark$$

$$V_f^2 = V_i^2 + 2a\Delta x = (17.5)^2 + 2(4.4)(40) \checkmark$$

$$V_f = 25.66 \text{ m.s}^{-1} \checkmark \text{ down the slope} \checkmark$$

TOTAL QUESTION 6: [20]

QUESTION 7:

7.1.1 Every object in the universe exerts an attractive force on every other object. This force is directly proportional to the product of the objects masses and inversely proportional to the square of the distance between the two centres. ✓✓ (2)

7.1.2 $F = G(m_1 m_2) / r^2$
 $r^2 = ((6.7 \times 10^{-11})(6 \times 10^{24})(200)) / 1.9 \times 10^3 \checkmark$
 $r = 6.50 \times 10^6 \text{ m} \checkmark$
 Distance above surface = $6.50 \times 10^6 - 6.40 \times 10^6 = 0.10 \times 10^6 \text{ m} = 100 \text{ km} \checkmark$ (3)

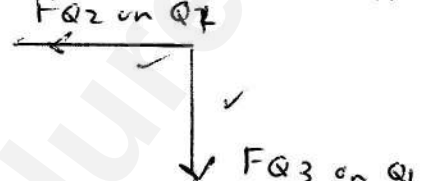
7.1.3 $F_{\text{net}} = ma = (200)(0.8) = 160 \text{ N} \checkmark$
 $F_{\text{net}} = F_{\text{rocket}} - F_{\text{earth on rocket}}$
 $F_{\text{rocket}} = 160 \checkmark + 1900 \checkmark = 2060 \text{ N} \checkmark \text{ away from earth}$ (4)

7.1.4 No ✓
 As the distance increases the force earth has on rocket decreases ✓ and hence the net force will increase ✓ resulting in an increased acceleration of the satellite (3)

7.2 $E_{\text{m on x}} = kQ/r^2 = (9 \times 10^9)(6 \times 10^{-9}) / (35 \times 10^{-3})^2 \checkmark = 4.41 \times 10^4 \text{ N.C}^{-1} \checkmark \text{ away from M}$
 $E_{\text{n on x}} = kQ/r^2 = (9 \times 10^9)(9 \times 10^{-9}) / (10 \times 10^{-3})^2 \checkmark = 81 \times 10^4 \text{ N.C}^{-1} \checkmark \text{ towards N}$
 Resultant field = $81 \times 10^4 - 4.41 \times 10^4 \checkmark = 76.59 \times 10^4 \text{ N.C}^{-1} \checkmark \text{ towards N} \checkmark$ (7)

7.3.1 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 two charges ✓✓ (2)

7.3.2 $F = k(Q_1 Q_2) / r^2 = ((9 \times 10^9)(4 \times 10^{-6})(4 \times 10^{-6})) / (3 \times 10^{-6})^2 \checkmark = 16 \times 10^3 \text{ N} \checkmark$ (3)

7.3.3  (2)

7.3.4 $F_{\text{resultant}}^2 = (16 \times 10^3)^2 + (16 \times 10^3)^2 \checkmark$
 $F_{\text{resultant}} = 22627.42 \text{ N} \checkmark \text{ Bearing } 225^\circ \checkmark$ (3)

TOTAL QUESTION 7: [29]

QUESTION 8:

- 8.1.1 Total energy supplied per coulomb of charge by the cell ✓✓ (2)
(accept any valid description)
- 8.1.2 Rate of flow of charge. ✓✓ (2)
- 8.1.3 $P = I^2 R$ ✓
 $I^2 = 5/5$ ✓
 $I = 1 \text{ A}$ ✓ (3)
- 8.1.4 $\text{Emf} = IR + Ir$
 $12 = (1)(R) + (1)(1)$ ✓
 $R_T = 11 \Omega$ and $V_{\text{ext}} = 11 \text{ V}$ ✓
 $V_{\text{across device}} = 1 \times 5 = 5 \text{ V}$
 $V_{\text{across parallel resistors}} = 11 - 5 = 6 \text{ V}$ ✓
 $I_{(3+9\Omega)} = 6/12 = 0.5 \text{ A}$, therefore current $R_{(4+R_x\Omega)} = 0.5 \text{ A}$ ✓
 $R_{(4+R_x\Omega)} = 6/0.5 = 12 \Omega$ ✓
 $R_x = 12 - 4 = 8 \Omega$ ✓ (6)
- 8.1.5 When the starter motor is connected in parallel to the headlamps the overall current increases which results in the "lost" volts increasing (emf and internal resistance are constant). This means the voltage for the load decreases. Since $P = V^2/R$ the power and hence the brightness of the bulbs will dim slightly. ✓✓ (2)
or
The starter motor has a very very low resistance in comparison to the light bulbs and hence draws a high current leaving less current available for the headlamps.
 $P = VI$ (low current results in low power and hence dim lights)
- 8.1.6 $P = VI = 240 \times 9.5 = 2280 \text{ W} = 2.28 \text{ kW}$ ✓
 $\text{kWh} = 2.28 \times 0.5 = 1.14 \text{ kWh}$ ✓
Cost for 30 minutes = $R1.70 \times 1.14 = R1.94$ ✓ (5)
- 8.2.1 A. ✓ this is a series circuit therefore current is constant. $P = I^2 R$
Resistance of A > Resistance of B ✓ (2)
- 8.2.2 This is a parallel circuit therefore Potential difference is constant
 $P = V^2/R$ Therefore B (lower resistance) will burn brighter ✓✓ (2)
- 8.2.3 Circuit Y has a higher total current than circuit X. Therefore bulbs will burn more brightly in Circuit Y. (accept any valid explanation) ✓✓ (2)

TOTAL QUESTION 8: [26]

QUESTION 9:

9.1.1 A current is induced in it and current has a magnetic field associated with it✓✓ (2)

9.1.2 North ✓ (1)

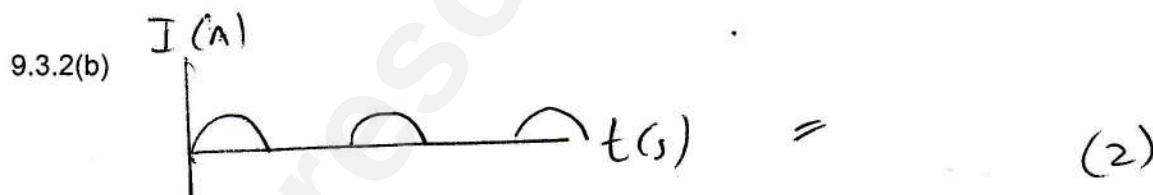
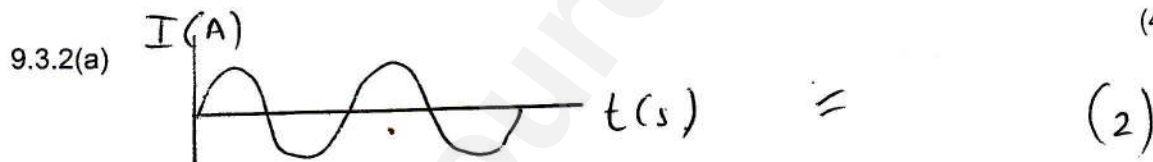
9.1.3  ✓ (1)

9.1.4 Lenz's Law ✓ The induced current flows in a direction so as to set up a magnetic field that opposes the change in magnetic flux.✓✓ (3)

9.2.1 The Emf induced is directly proportional to the rate of change in magnetic flux (linkage)✓✓ (2)

9.2.2 Slip rings. ✓ Maintain contact between the coil and the brushes which are connected to the external circuit and prevent the coils from tangling.✓✓ (3)

9.3.1 Francoise only achieves half wave rectification ✓
Current can flow as follows: M-1-O-R-P-3-N✓
Diode 2 is connected the wrong way✓ around so current cannot flow in this direction✓ (4)



TOTAL QUESTION 9: [20]

QUESTION 10:

- 10.1 Alternating current in the primary coil will induce a constantly changing magnetic flux. which will induce a current in the secondary coil. ✓✓ (2)
- 10.2 No ✓✓ (2)
- 10.3 Soft iron core ✓ strengthens magnetic field linkage✓ (2)
- 10.4 $P = 65 \text{ W}$
 $I = 65/220\checkmark - 0.30 \text{ A}\checkmark$ (2)
- 10.5 $V_p/V_s = N_p/N_s = 220/20 = 11:1\checkmark\checkmark$ (2)
- 10.3 Step down

TOTAL QUESTION 10: [11]