MATRIC PHYSICAL SCIENCE PAPER 1 2009: MEMORANDUM

SECTION A

QUESTION 1: ONE-WORD/TERM ITEMS

1.1 work function
1.2 kinetic (energy)
1.3 refraction
1.4 magnetic flux
1.5 dielectric [5 x 1 = 5]

QUESTION 2: CORRECTING FALSE STATEMENTS

2.1 ... the reaction to the weight of the 1 kg mass is the force of the 1 kg mass on the Earth. (2)

2.2 Only refraction of light involves light "bending" when it passes into an optically denser medium. Diffraction is due to the bending of a wave around an obstacle or through a narrow gap. (2)]

2.3 If two resistors of 3 Ω and 5 Ω respectively are connected in parallel in a closed circuit (while charge is flowing), the potential difference across the 3 Ω resistor and the potential difference across the 5 Ω resistor will be the same. (2)

2.4 For the "lasing" process to be initiated in a laser, more electrons will be in higher electron energy levels than in lower energy levels. (This is known as population inversion.) (2)

2.5 The wavelength of a "matter wave" – the waves associated with moving particles – is inversely proportional to the momentum of the particle. (2) [5 x 2 = 10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

3.1 D
3.2 C
3.3 D
3.4 A
3.5 D [5 x 2 = 10]

TOTAL SECTION A: 25

SECTION B

QUESTION 4

4.1 $a = \Delta v/\Delta t = (-8 - 0)/(7 - 5) = -8/2 = -4\ m \cdot s^{-2}$ (2)

4.2 0,65 s; 4,0 s; 5,65 s (2)

4.3 Slows down (accelerates negatively, NOT "decelerates" [$-2,6\ m \cdot s^{-2}$]). Stops instantaneously and accelerates (Note: speeds up) in the reverse/negative/backward direction [$-4,0\ m \cdot s^{-2}$]). (3)

4.4 Area under v–t curve for 0 to 5 s is [(½ x 1 x 4) + (2,5 x 4) + (½ x 1,5 x 4)]
= 15 m in a positive direction.
Area under v–t curve for 5 to 8 s is [(½ x 2 x -8) + (1 x -8)] = -16 m in a negative direction. So the car is 1 m back from/behind the start line. (4)

QUESTION 5

5.1 $y = v_i t + ½gt^2 \therefore y = (28,69)(2,92) + ½(-9,8)(2,92)^2 \therefore y = 42,00$ m (3)

Or $v_f^2 = v_i^2 + 2gy \therefore 0 = (28,69)^2 + 2(-9,8)(y) \therefore y = 42,00$ m

5.2 By calculation: $v_f^2 = v_i^2 + 2gy \therefore v_f^2 = 0 + 2(9,8)(42) \therefore v_f = 28,69$ m·s^{-1} (downwards) OR by symmetry we know that the speed at which the ball returns to the point of projection is the same as the speed at which the ball was thrown UP. (2)

5.3 After bouncing, the ball rises to a height of 21 m. Calculate the velocity with which it left the ground (v_i) using $v_f^2 = v_i^2 + 2gy \therefore 0 = v_i^2 + 2(-9,8)(21) \therefore v_i = +20,29$ m·s^{-1}. (4)

5.4 The change in momentum of the ball (mΔv) is caused by the force of the ground on the ball (103 N). The change in momentum of the ball is equal to the impulse (FΔt). Therefore Δt = mΔv/F = [0,4 kg x (-20,29 – 28,69)] / -103 = 0,19 s. (6)

QUESTION 6

6.1 $W_{tot} = W_f + \Delta PE = 5,84 \times 10^6 + 1750 \times 9,8 \times 55 = 6,78 \times 10^6$ J

P = W/t ; t = 570 / (72 x 10 / 36) = 28,5 s $\therefore$ P = 6,78 x10^6 / 28,5 = 2,38 x 10^5 W (3)

6.2 Zero. According to Newton's First Law constant velocity means $F_R = 0$. (2)

6.3 90 km·h^{-1} = (90/36) x 10 = 25 m·s^{-1}; 72 km·h^{-1} = (72/36) x 10 = 20 m·s^{-1}

W_{tot} (by engine) = W_f + ΔKE - ΔPE (in a sense we "get back" the PE, i.e. this is work the engine doesn't have to do!)

= (6,44 x 10^3 x 570) + [½ x1100 ($25^2 – 20^2$)] –1100 x 9,8 x 55

= (3,67 x 10^6) + (1,24 x 10^5) – (5,93 x 10^5)

= 3,20 x 10^6 J (7)

QUESTION 7

7.1 It is the change in pitch/frequency of a sound heard by a listener due to the relative motion of the source and the listener. (2)

7.2 As he slows down the relative speed of their approach decreases and he will notice a drop in the frequency of the siren. (1)

7.3 NB: In the DVD the presenter is focusing on the method, not the complete calculation. Make sure you read the questions carefully. Question 7.3 says, "what <u>change</u> in frequency ….?" This means that you must calculate the frequencies heard BOTH when the ambulance is approaching AND when it is moving away from the cyclist.

Change in frequency (Δf) = $f_{\text{towards}} - f_{\text{away from}}$

$$\therefore \Delta f = \frac{v}{v - v_s}.f_s - \frac{v}{v + v_s}.f_s$$

$$= \left(\frac{330}{330 - 35} - \frac{330}{330 + 35}\right) 400$$

$$= \left(\frac{330}{295} - \frac{330}{365}\right) 400$$

$$= (1,12 - 0,90)\ 400$$

$$= 0,22 \times 400$$

$$\Delta f = 88\ Hz$$

(4)

QUESTION 8 (8 x ½ = 4) (drop odd halves!)

	GREEN	**MAGENTA**	**YELLOW**
CYAN	8.1 green	8.4 blue	8.6 green
BLUE			8.7 black
YELLOW	8.2 green	8.5 red	
RED	8.3 black		8.8 red

QUESTION 9

9.1 Slits A and B are the two sources. (1)

9.2 Between D and G the light from the two sources "overlaps", i.e. interferes; between C and D the area is illuminated by light from slit A only (2)

9.3 At E light from A and B interfere CONSTRUCTIVELY. (2)
At F light from A and B interfere DESTRUCTIVELY.

9.4 *m* = 0; in the equation this will mean that sin θ = 0, i.e. θ = 0°. (2)

9.5 *m* = 2 (the second bright band). (1)

9.6.1 wavefront

9.6.2 diffraction

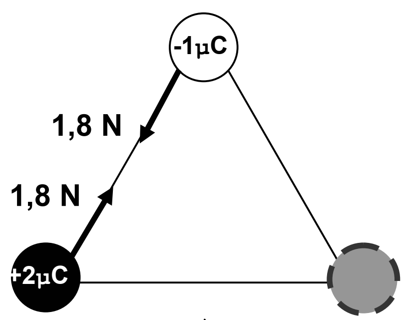
9.6.3 interference

9.6.4 wavelength (4 x 1)

QUESTION 10

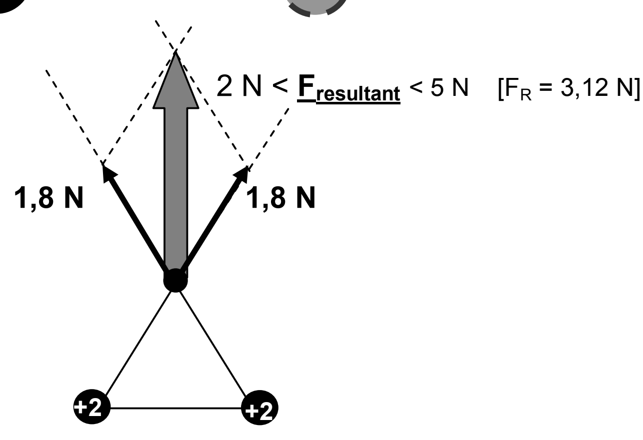
10.1 $\mathbf{F} = \frac{kQ_1Q_2}{r^2} = \frac{-9 \times 10^9 \times (-1 \times 10^{-6})(+2 \times 10^{-6})}{(10^{-1})^2} = \mathbf{1{,}8\,N}$ (3)

10.2



(2)

10.3.1



(2)

10.3.2 $F_R > 2$ N (1)

QUESTION 11

11.1 $C = {}^{Q}/_{V} \therefore Q = CV \therefore Q = 15 \times 10^{-12} \times 3$
$= 4,5 \times 10^{-11}$ C (2)

11.2 $N_e = (4,5 \times 10^{-11}\text{ C}) / (1,6 \times 10^{-19}\text{ C/e}^-) = 2,81 \times 10^8$ electrons (2)

11.3 If the gap (d) is the same for both and the materials are the same (i.e. the same dielectric), then the only way to double the capacitance of the second capacitor is to double the area of the plates; A is twice as big for the 30 pF capacitor. (1)

QUESTION 12

12.1 The potential difference across a conductor is proportional to the current flowing through, provided the temperature remains constant. (3)

12.2 Nichrome wire does not obey Ohm's Law. (1)

12.3 It enables the experimenter to vary the current in the circuit. (1)

12.4 Plot *V* (dependent variable) on the y-axis, because *V* depends on *I,* which the experimenter varies (independent variable). (2)

12.5.1 resistance (1)

12.5.2 The four values of V/I are 1,25; 1,22; 1,23; 1,21. The average of these numbers will be very close to the average slope (i.e. the straight line closest to most of the plotted points).
Average = (1,25 + 1,22 + 1,23 + 1,21)/4 = 1,23. (1)

12.5.3 Yes, as indicated by the straight line on the V–I graph; must control for temperature. (2)

12.6 If a 500 mm length of 0,1 mm diameter wire has a resistance of 1,23 Ω, then a piece with the same diameter and twice the length will have a resistance of about 2,46 Ω. (1)

12.7 Same length but double the diameter, i.e. about a quarter of the resistance or ± 0,3 Ω. (The greater the cross-sectional area, the less resistance the conductor offers to charge moving through it.) (2)

QUESTION 13

13.1.1 $R_{tot} = 24/3 = 8\ \Omega$; $(r_{int} + R_{series}) = 1\ \Omega + 3\ \Omega = 4\ \Omega \therefore R_{parallel} = 4\ \Omega$
${}^{1}/_{Rp} = {}^{1}/_{12} + {}^{1}/_{R} = {}^{1}/_{4} \therefore {}^{1}/_{R} = {}^{1}/_{4} - {}^{1}/_{12} \therefore R = 6\ \Omega$ (4)

13.1.2 V_1 : 3 A x 4 Ω = 12 V (3)

13.1.3 V_2 : 24 V – (3 A x 1 Ω) = 21 V (3)

13.1.4 A_2 : 12 V / 12 Ω) = 1 A (current divides in ratio 2 : 1 in 6 Ω and 12 Ω resistors. (3)

13.1.5 $E/t = P = i^2R = 3^2 \times 1 = 9$ W. (Power dissipated in the battery.) (3)

13.2.1 decrease (1)

13.2.2 decrease (1)

13.2.3 decrease (1)

13.2.4 decrease (1)

13.3 As the battery gets older (runs down) the internal resistance of the battery increases. Therefore the total resistance in the circuit increases and hence the current strength decreases. Thus all voltmeter readings also decrease. (1)

QUESTION 14

14.1.1 down (1)

14.1.2 out (1)

14.2 Diagram II (1)

14.3.1 rms or root mean square (current) (1)

14.3.2 $I_{max} = \sqrt{2} \times I_{rms} = 1,414 \times 24 = 33,9$ A (2)

14.3.3 33,9 x 2 = 67,8 A (1)
14.3.4 Peak-to-peak current (1)
14.3.5 No. There is no information given on the frequency of the AC when we measure AC current and AC potential difference. (1)

QUESTION 15

15.1 Photoelectric effect (1)

15.2 $E = hf$ and $c = f\lambda$; hence $E = {}^{hc}/_{\lambda}$
The energy of a single photon of yellow light ($\lambda = 590 \times 10^{-9}$ m) can be calculated (see information sheet for values of h and c) from $E_{yellow} = {}^{hc}/_{\lambda(yellow)} = 3,37 \times 10^{-19}$ J. Since $3,37 \times 10^{-19}$ J < the work function for zinc ($W_0 = 6,89 \times 10^{-19}$ J) yellow light will NOT remove electrons from zinc. (5)

15.3 If the energy of yellow light photons is LESS than the work function of zinc, it will NOT liberate photoelectrons, no matter how many of those photons there are (i.e. the number of photons per second determines the light intensity).. (1)

TOTAL FOR SECTION B: 125

GRAND TOTAL: 150