LIMPOPO

PROVINCIAL GOVERNMENT

REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

JUNE 2024

MARKING GUIDLINES

QUESTION 1

1.1	A / B ✓✓	(2)
1.2	C ✓✓	(2)
1.3	C ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	B ✓✓	(2)
1.7	B ✓✓	(2)
1.8	D ✓✓	(2)
1.9	A ✓✓	(2)
1.10	D ✓✓	(2)
		[20]

QUESTION 2

2.1 The (gravitational) force the Earth exerts on any object on or near its surface.✓✓ (2)

2.2 Weight is a vector quantity ✓ whereas mass is a scalar quantity. ✓ (2)

2.3 Each particle in the universe attracts every other particle with a gravitational force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.✓✓

OR:

Each body in the universe attracts every other body with a gravitational force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.✓✓ (2)

2.4

<table>
<tr><td>OPTION 1:</td><td>OPTION 2:</td></tr>
<tr><td>
$F_{g(Earth)} = \frac{GmM}{r^2}$
$= 945$ N

$F_{g(Planet\ P)} = \frac{GmM_P}{R_P^2}$ ✓
$= \frac{Gm(3M)}{(2R)^2}$ ✓
$= \frac{3}{4}\frac{GmM}{r^2}$
$= \frac{3}{4}(945)$ ✓
= 708,75 N✓ downwards. ✓
</td><td>
$g_P = \frac{GM_P}{R_P^2}$ ✓
$g_P = \frac{(6,67 \times 10^{-11})(3 \times 5,98 \times 10^{24})}{(2 \times 6,38 \times 10^6)^2}$ ✓
$= 7,349316$ m·s^{-2}
$w_E = mg_E$
(945) = m(9,8)

m = 96,42857 kg
$w_P = mg_P$
= (96,42857)(7,349316) ✓
= 708,684 N✓ downwards ✓
</td></tr>
<tr><td colspan="2">OPTION 3:</td></tr>
<tr><td colspan="2">
$w_E = mg_E$
<u>(945) = m(9,8)</u> ✓
m = 96,42857 kg

$g_P = \frac{G(3M_E)}{(2R_E)^2}$ ✓
$= \frac{3 \cdot GM_E}{4(R_E)^2}$
$= \frac{3}{4}\left(\frac{GM}{R^2}\right)$
$= \frac{3}{4}(9,8)$
$= 7,349316$ m·s^{-2}
$w_P = mg_P$
= <u>(96,42857)(7,349316)</u> ✓
= 708,684 N ✓ downwards✓
Range: (708,75 N – 708,684 N)
</td></tr>
</table>

(5)

[11]

QUESTION 3

3.1 When you stop suddenly, your velocity changes rapidly, which means a <u>large acceleration</u>✓ of stopping. <u>By Newton's second Law</u>, this means the force that acts on you is also large – experiencing a <u>large force</u> is what hurts you.✓

OR:

Sudden stop implies *shorter time*✓of contact with the ground. From $F_{net} = \frac{\Delta p}{\Delta t}$, for the same Δp, shorter Δt means greater F_{net}✓, hence greater injury. (2)

3.2.1 The force that opposes the motion of a moving object relative to a surface. ✓✓ (2)

3.2.2

$f_k = \mu_k N$✓

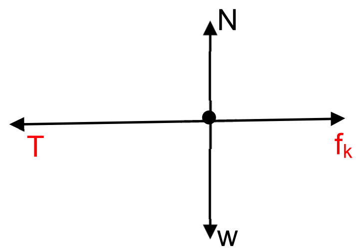
$f_k = \mu_k mg$

$= (0,25)(6)(9,8)$✓

$= 14,70$ N✓

(3)

3.2.3



Accepted labels	
N✓	Normal force/N/F_N
f_k✓	Kinetic friction / frictional force/ f/ F_f
T✓	$F_{rod\ on\ 6\ kg\ block}$/Thrust/$F_C$
w✓	F_g/mg/weight/gravitational force/$F_{Earth\ on\ block}$

<u>Notes:</u>
- Mark is awarded for label and arrow.
- Do not penalize for length of arrows
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with dot/body: 3/4
- If arrows missing: 3/4

(4)

3.2.4 When a non-zero net/resultant force on an object, the object will accelerate in the direction of the net force at an acceleration that is directly proportional to the net force and inversely proportional to the mass of the object.✓✓ (2)

3.2.5

POSITIVE MARKING FROM 3.2.2	
For the 3 kg block: **Take to the left as positive**	**For the 6 kg block:**
$F_{net} = ma$ $F_x + (-T) + (-f) = ma$ } Any one✓ (160)(cos30°) - T - μ_kN = 3·a (160) (cos30°) ✓-T -(0,25) [(3)(9,8) + 160 sin30°] ✓= 3a✓ (160) (cos30°) - (6a + 14,70) - 27,35 = 3a 96,51406461 = 9a ∴a = 10,7238 m·s^{-2} a = 10,7238 m·s^{-2}	$F_{net} = ma$ T – f = ma T – 14,70 = 6a✓ T = 6·a + 14,70
T = 6(10,7238) + 14,70✓ = 79,0428 N✓	
NB: Also consider to the right as positive!	

(7)

[20]

QUESTION 4

4.1 **An object which has been given an initial velocity and then it moves under the influence of the gravitational force only.✓✓**

OR:

An object upon which the only force acting is the gravitational force. ✓✓ (2)

4.2.1 16 m·s^{-1} ✓(upwards) (1)

4.2.2 0,4 s ✓ (1)

In these calculations, also consider answers for downward positive!

4.3.1

OPTION 1:	OPTION 2:	OPTION 3:
$x = \frac{8,62 + 10,26}{2}$✓ = 9,44 s✓	$v_f = v_i + a\Delta t$ 0 = 8 + (-9,8)Δt Δt = 0,8163265 s x = 8,62 + 0,82✓ = 9,44 s✓	10,26 – x = x – 8,62✓ 10,26 + 8,62 = x + x x = 9,44 s✓

(2)

4.3.2

OPTION 1:	**OPTION 2:**
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (16)(8{,}22)$ ✓ $+ \frac{1}{2}(-9{,}8)(8{,}22)^2$✓ $\Delta y = -199{,}\ 566$ m $\therefore$the height is 199, 566 m above the ground✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(-64{,}56)^2$ ✓$= (16)^2 + 2(-{,}8)\Delta y$✓ $\Delta y = -199\ 592$ m $\therefore$the height is 199, 592 m above the ground✓
OPTION 3:	**OPTION 4:**
$\Delta y = \frac{1}{2}(v_i + v_f)\Delta t$✓ $= \frac{1}{2}(16 + 1 – 64{,}56)$ ✓$(8{,}22)$ ✓ $= -199{,}\ 582$ m $\therefore$the height is 199, 582 m ✓above the ground	Smaller area $= \frac{1}{2}bh$ $= \frac{1}{2}(1{,}6)(16)$ ✓ $=12{,}8$ m Bigger area $= \frac{1}{2}bh$ $= \frac{1}{2}(8{,}22 – 1{,}6)64{,}56)$✓ $= 213{,}6936$ m ✓ $\therefore$Height $= 213{,}6936 – 12{,}8936$ m ✓ $= 200{,}8936$ m ✓
Range: 199,566 m – 200,8936 m	

(4)

4.3.3

OPTION 1:	**OPTION 2:**
Height $= \frac{1}{2}bh$✓ $= \frac{1}{2}(9{,}44 - 8{,}62)(8)$ ✓ $= 3{,}28$ m $\therefore$the height is 3,28 m ✓ Range: 3,265 m to 3,28 m	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓ $\Delta y = (8)(0{,}82) + \frac{1}{2}(-9{,}8)(0{,}82)^2$✓ $=3{,}265$ m $\therefore$the height is 3,265 m ✓ Range: 3,265 m to 3,28 m
OPTION 3:	**OPTION 4:**
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ ✓ $\Delta y = \left(\frac{8 + 0}{2}\right)(0{,}82)$✓ $= 3{,}28$ m $\therefore$the height is 3,28 m✓ Range: 3,265 m to 3,28 m	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $(0)^2 = (8)^2 + 2(-9{,}8)\Delta y$✓ $\Delta y = 3{,}265$ m $\therefore$the height is 3,265 m✓ Range: 3,265 m to 3,28 m

(3)

4.3.4

POSITIVE MARKING FROM QUESTIONS 4.32 and 4.3.3

OPTION 1:

Height of balloon above the ground after 9,44 s: Δy = (16)(9,44) ✓ + 199,592✓
= 350,632 m✓

Distance apart = 350,632✓ – 3,28
= 347,352 m✓

Range: 437,352 m to 437,36 m

OPTION 2:

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\Delta y = (11)(9{,}44) + \frac{1}{2}(0)(9{,}44)^2$ ✓
= 151,04 m

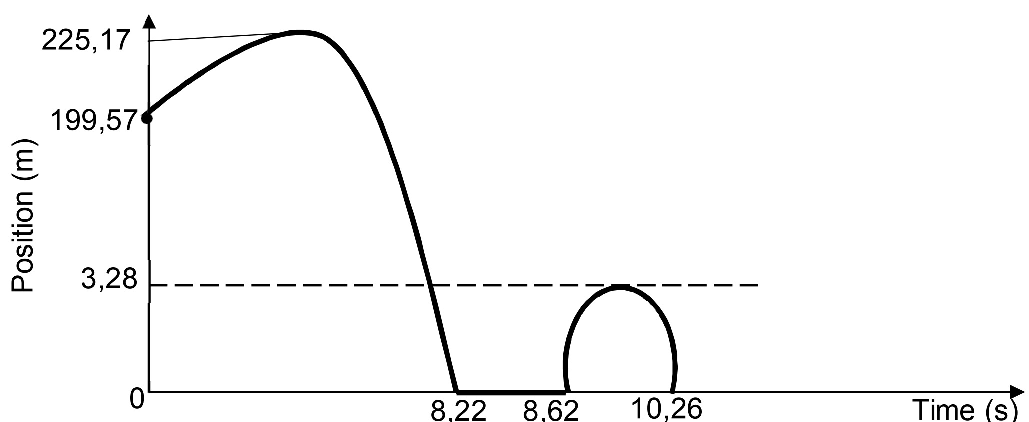
Height above ground = 200,8936 + 151,04✓
= 351,93 m

Distance apart = 351,93 – 3,28 ✓
= 348,65 m ✓

Range: 437,352 m to 437,36 m

(5)

4.4 **POSITIVE MARKING FROM QUESTION 4.3.1 TO QUESTION 4.3.4**



Marking criteria

- Correct shape✓
- Height when the camera is dropped ✓ (199,6 m)
- Time when the camera strikes the ground✓ (8,22 s)
- Time when the camera bounces✓ (8,62 s)
- Total time of motion✓ (10,26 s)

(5)
[23]

QUESTION 5

5.1 A collection of two or more objects that interact with each other.✓✓

OR:

A small part of the universe that we are considering when solving a particular problem.✓✓

OR:

Any object or group of objects that can be separated, in our minds, from the surrounding environment.✓✓

OR:

A collection of objects that can be identified.✓✓ (2)

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

5.3 **Take to the right as positive:**

$\sum P_i = (m_x v_{x_i} + m_y v_{Y_i})$ **If they equated give 3 / 5**

$= (m)(0) + (3m)(v)$ ✓

$= 3mv$✓

$\sum P_f = (m_X + m_Y)v_f$

$= (m + 3m)\left(\frac{75}{100}v\right)$✓

$= (4m)\left(\frac{3}{4}v\right)$

$= 3mv$✓

∴the collision is in agreement with the principle of conservation of linear momentum since $\sum P_i = \sum P_f$✓

(5)

5.4

Inelastic✓

$E_k = \frac{1}{2}mv^2$✓

$E_{K_i} = \frac{1}{2}m_x v_{xi}^2 + \frac{1}{2}m_y v_{yi}^2$

$= \frac{1}{2}(m)(0)^2 + \frac{1}{2}(3m)v^2$✓

$= \frac{3}{2}mv^2$

$E_{K_f} = \frac{1}{2}(m_x + m_y)v_f^2$

$= \frac{1}{2}(m + 3m)\left(\frac{3}{4}v\right)^2$ ✓

$= \frac{9}{8}mv^2$

$\therefore$ The collision is inelastic since $E_{K_i} \neq E_{K_f}$ ✓

(5)
[14]

QUESTION 6

6.1 The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant.✓✓ (2)

6.2

$\sum E_{\text{mech at top}} = \sum E_{\text{mech at bottom}}$
$(E_P + E_K)_{top} = (E_P + E_K)_{bottom}$
$\left(mgh + \frac{1}{2}mv^2\right)_{top} = \left(mgh + \frac{1}{2}mv^2\right)_{bottom}$
} Any one✓

$\underline{(2,4)(9,8)(35) + \frac{1}{2}(2,4)(2,2)^2}$✓ $= \underline{(2,4)(9,8)(0) + \frac{1}{2}(2,4)}(v^2)$ ✓

$829,008 = (1,2)v^2$

$v^2 = 690,84$

$v = 26,284\ m{\cdot}s^{-1}$

The speed is $26,284\ m{\cdot}s^{-1}$✓($26,284\ m{\cdot}s^{-1}$)

(4)

Also consider calculation based on $W_{nc} = \Delta E_k + \Delta E_p = 0$

6.3

POSITIVE MARKING FROM QUESTION 6.2

OPTION 1:

$W_{nc} = \Delta E_k + \Delta E_p$
$W_f = \frac{1}{2}m(v_f^2 - v_i^2) + mg(h_f - h_i)$ } Any one✓

$= \frac{1}{2}(2,4)(0^2 - 26,284^2)$✓ $+ (2,4)(9,8)(0 - 0,20)$ ✓

$= -829,0183872 - 4,704$

$= -833,7224$ J

∴ The work done by the frictional force is -833,7224 J✓(-833,72 J)

Range: -833,47 to -833,72 J

OPTION 2:

$W_{net} = \Delta E_k$
$W_f + W_w = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$W_f + mg\Delta y\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } Any one✓

$W_f + (2,4)(0,20)(9,8)(\cos 0°)$✓ $= \frac{1}{2}(2,4)(0)^2 - \frac{1}{2}(2,4)(26,284)^2$✓

$W_f + 4,704 = -829,0183872$

$W_f = -833,7224$ J

∴ The work done by the frictional force is -833,7224 J✓(-833,72 J)

Range: -833,47 to -833,72 J

OPTION 3:

$W_{net} = \Delta E_k$
$F_{net}\Delta\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ } Any one✓

$F_{net}\underline{(0,20)(\cos 180°)} = \underline{\frac{1}{2}(2,4)(0)^2 - \frac{1}{2}(2,4)(26,284)^2}$✓

Fnet(-0,20) = -829,0183872

Fnet = 4 145,091936

$f + (-w) = F_{net}$

$f - mg = F_{net}$

$f - (2,4)(9,8) = 4\ 145,091936$

$f = 4\ 168,611936$

$W_f = f\Delta y\cos\theta$

$W_f = (4,\ 168,\ 611936)(0,20)(\cos 180°)$✓

$W_f = -833,7224$ J

∴ The work done by the frictional force is -833,7224 J✓(-833,72 J)

Range: -833,47 to -833,72 J (4)

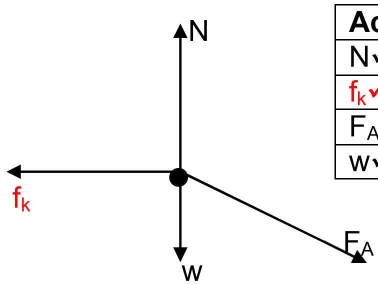
[10]

QUESTION 7

7.1 A force for which the work done in moving an object between two points is independent of the path taken.✓✓ (2)

7.2 Non-conservative force. ✓ (1)

7.3



Accepted labels	
N✓	Normal force/ F_N/$F_{surface\ on\ lawn\ mower}$
f_k✓	Kinetic friction/f/F_f
F_A✓	Applied force/$F_{applied}$
w✓	F_g/mg/weight/gravitational force/$F_{Earth\ on\ lawn\ mower}$

Notes:

- Mark is awarded for label and arrow.
- Do not penalize for length of arrows
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with dot/body: 3/4
- If arrows missing: 3/4

(4)

7.4 Normal force/Gravitational force✓ (1)

7.5

OPTION 1	OPTION 2
$W_{net} = \Delta E_K$ } Any one✓ $W_N + W_w + W_F + W_{F_A} = E_{K_f} - E_{K_i}$ $0 + 0 + f \cdot \Delta x \cdot \cos\theta + W_{F_A} = 0 - 0$ $(35)(20)(\cos 180°) + W_{F_A} = 0$✓ $-700 + W_{F_A} = 0$ $\therefore W_{F_A} = 700$ J $P = \frac{W}{\Delta t}$✓ $= \frac{700}{2,5 \times 60}$✓ $= 4,6667$ W✓(4,67 W) OPTION 3 Calculations may also be based on: $W_{nc} = \Delta E_k + \Delta E_p$	$W_{net} = \Delta E_K$ } Any one✓ $W_N + W_w + W_F + W_{F_A} = E_{K_f} - E_{K_i}$ $0 + 0 + f \cdot \Delta x \cdot \cos\theta + W_{F_A} = 0 - 0$ $(35)(20)(\cos 180°) + W_{F_A} = 0$✓ $-700 + W_{F_A} = 0$ $\therefore W_{F_A} = 700$ J $W_{F_A} = F_A \Delta x \cos\theta$ $700 = F_A(20)\cos 0°$ $F_A = 35$ N $P_{ave} = Fv_{ave}$✓ $= F\left(\frac{\Delta x}{\Delta t}\right)$ $= (35)\left(\frac{20}{2,5 \times 20}\right)$✓ $= 4,6667$ W✓(4,67 W)

(5)

[13]

QUESTION 8

8.1 The rate at which work is done or energy is expended\transferred.✓✓ (2)

8.2

OPTION 1:	OPTION 2:
Work done, $W = E_P$ $W = mgh$ $W = (4500)(9,8)(100)$✓ $W = 4,41 \times 10^6$ J $P = \frac{W}{\Delta t}$✓ $2\ 300$✓ $= \frac{441\ 0000}{\Delta t}$✓ $\Delta t = 1\ 917,\ 391304$ s $\Delta t = 31,96$ min✓	$F_{net} = ma$ $F_{pump} + (-w) = 0$ $F_{pump} = mg$ $=(4500)(9,8)$ ✓ $F_{pump} = 44100$ N $P_{ave} = Fv_{ave}$ ✓ 2300 ✓$= (44100)\left(\frac{\Delta y}{\Delta t}\right)$ $2300 = (44100)\left(\frac{100}{\Delta t}\right)$✓ $\Delta t = 1\ 917,\ 391304$ s $\Delta t = 31,96$ min✓

(5)
[7]

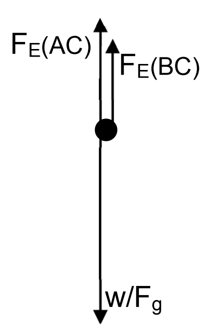
QUESTION 9			
9.1.1	The apparent change in frequency (or pitch) of sound detected by the listener✓ because the sound source and the listener have different velocities relative to the medium of sound propagation.✓ OR The apparent change in frequency (or pitch) of sound detected by the listener✓ as a result of the relative motion between the sound source and the listener.✓		(2)
9.1.2	$f_{learner} = 500,0$ Hz ✓ No relative motion between the learner and the train.✓ OR Dopper effect was not observed.✓		(2)
9.1.3	OPTION 1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ $= \left(\frac{340 - 0}{340 + 10}\right)$✓$(500,0)$✓ $= \left(\frac{340}{350}\right)(500,0)$ $= 485,7143$ Hz	OPTION 2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ $= \left(\frac{340 - 0}{340 + 10}\right)$✓$(500,0)$✓ $= \left(\frac{340}{350}\right)(500,0)$ $= 485,7143$ Hz	

	$\Delta f = 500,0 - 485,71431$✓ $= 14,2857$ Hz $\% \Delta f = \frac{14,2857}{500,0} \times 100$ $= 2,86\ \%$✓	$\% \Delta f = \frac{485,7143}{500,0} \times 100$ $= 97,14286\ \%$ $\%\Delta f = 100 - 97,14286$✓ $= 2,86\ \%$✓	(5)
9.2	$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $\left(f_s + \frac{8,7}{100} f_s\right) = \left(\frac{343 + 0}{343 - v_s}\right) f_s$ $f_s\left(1 + \frac{8,7}{100}\right)$ ✓$= \frac{343 \cdot f_s}{343 - v_s}$✓ $f_s\ (1,087) = \frac{343}{343 - v_s} f_s$ $(1,087)(343 - v_s) = 343$ $343 - v_s = 315,5474$ $343 - 315,5474 = v_s$ $v_s = 27,4526\ m \cdot s^{-1}$✓$(27,45\ m \cdot s^{-1})$		(3)
			[12]

QUESTION 10

10.1.1 The magnitude of the electrostatic force exerted by one stationary point charge (Q_1) on another stationary point charge (Q2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them.✓✓
(if the word point is omitted, … square of the distance between their centers) (2)

10.1.2



Accepted labels	
$F_{E(BC)}$✓	Electrostatic force / coulomb's force
$F_{E(AC)}$✓	Electrostatic force / coulomb's force
w✓	F_g/mg/weight/gravitational force

Notes:
- Mark is awarded for label and arrow.
- Do not penalize for length of arrows
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with dot/body: 2/3
- If arrows missing: 2/3

(3)

10.1.3

$F_{net,y} = 0$

$F_E(AC) + F_E(BC) + (F_C^g) = 0$

$F = \frac{KQ_1Q_2}{r^2}$ ✓

$\frac{KQ_CQ_B}{r_{BC}^2} + \frac{KQ_CQ_A}{r_{AC}^2} - mg = \underline{0}$ ✓

$\frac{(9 \times 10^9)(8 \times 10^{-6})(3 \times 10^{-6})}{(1,0)^2} + \frac{(9 \times 10^9)(8 \times 10^{-6})Q_A}{(1,5)^2}$ ✓ $-(0,03)(9,8)$ ✓ $= 0$

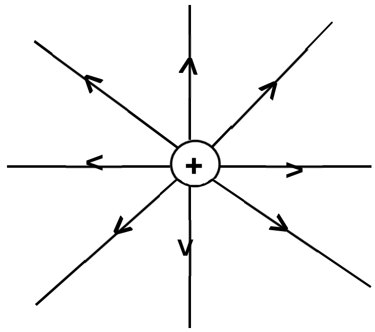
$0,216 + 32\,000 \cdot Q_A - 0,294 = 0$

$32\,000 \cdot Q_A = 0,078$

$Q_A = -2,4375 \times 10^{-6}$ C ✓ ($-2,4375 \times 10^{-6}$ C) (5)

10.2.1 The electrostatic force experienced per unit positive charge placed at that point.✓✓ (2)

10.2.2



- Shape✓
- Direction✓

(2)

10.2.3

$n = \frac{Q}{e}$ or $n = \frac{Q}{q_e}$

$3,2 \times 10^{10} = \frac{Q}{-1,6 \times 10^{-19}}$✓

$Q = -5,12 \times 10^{-19}$ C

$Q_M = -5,12 \times 10^{-19} + 2,4 \times 10^{-19}$✓

$= -2,72 \times 10^{-19}$ C

$E = \frac{KQ}{r^2}$✓

$= \frac{(9 \times 10^9)(2,72 \times 10^{-9})}{(0,125)^2}$✓

$= 1\ 566,72$ N·C^{-1}✓($1\ 567 \times 10^3$ N·C^{-1}), towards sphere M ✓

(6)

[20]

Grand total: [150]