GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2023

MARKING GUIDELINES

PHYSICAL SCIENCES: PHYSICS (PAPER 1) (10841)

12 pages

QUESTION 1

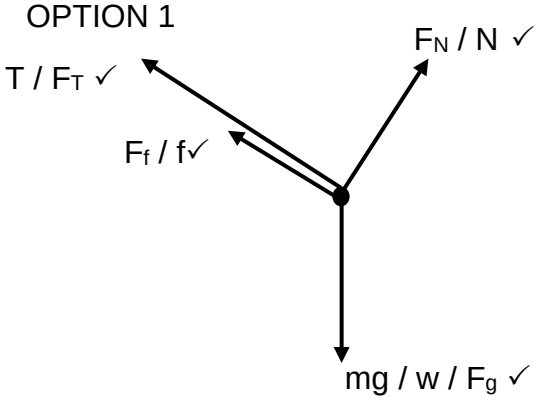
1.1	✓✓	Award marks for all learners. No correct answer.	(2)
1.2	B / C ✓✓		(2)
1.3	C ✓✓		(2)
1.4	B ✓✓		(2)
1.5	✓✓	Mark any and all correct. All statements given are true.	(2)
1.6	A ✓✓		(2)
1.7	D ✓✓		(2)
1.8	D ✓✓		(2)
1.9	C ✓✓		(2)
1.10	✓✓	Award mark for all learners. Out of scope.	(2)

[20]

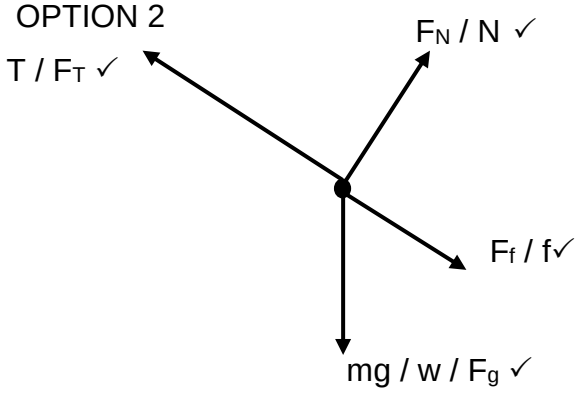
QUESTION 2

2.1 When a net force acts on an object, the object will accelerate in the direction of the force, this acceleration is directly proportional to the force ✓ and inversely proportional to the mass. ✓
OR
The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force. 2 or zero (2)

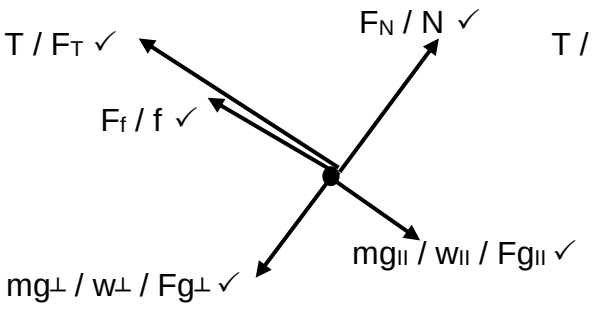
2.2.1 If box seen as moving down:
OPTION 1

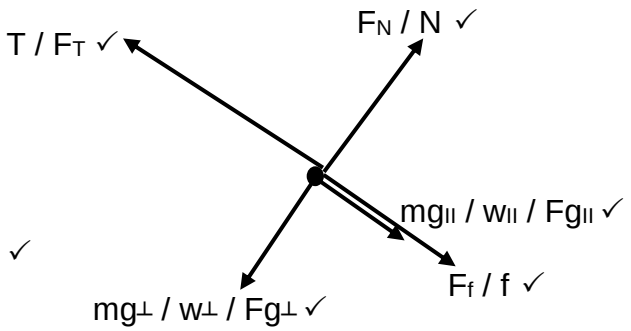


If box seen as moving up
OPTION 2



2.2 2.2.1





(4)

IF OPTION 1 of question 2.2.1 is done: boxes move to the right

2.2.2

For the 12 kg box:	For the 70 kg box:
Fnet = ma	Fnet = ma
T – FgII = ma ✓	FgII – Ff – T = ma
T – 12(9,8)sin50 ✓= 12a✓	70(9,8)sin30✓ – 0,2(70)9,8cos30✓ – T = 70a✓
T = 12a + 12(9,8)sin50 ……1	70(9,8)sin30 – 0,2(70)9,8cos30 – 70a = T ….2

✓ for equating

$12a + 12(9,8)\sin 50 = 70(9,8)\sin 30 – 0,2(70)9,8\cos 30 – 70a$

$a = 1,64\ m.s^{-2}$ ✓ answer

(8)

IF OPTION 2 of question 2.2.1 is done: boxes move to the left

2.2.2

For the 12 kg box:	For the 70 kg box:
Fnet = ma	Fnet = ma
FgII – T = ma ✓	– FgII – Ff + T = ma
12(9,8)sin50✓ – T = 12a✓	T – 70(9,8)sin30✓ – 0,2(70)9,8cos30✓ = 70a✓
12(9,8)sin50 – 12a = T ……1	T = 70(9,8)sin30 + 0,2(70)9,8cos30 + 70a ….2

✓ for equating

$12(9,8)\sin 50 – 12a = 70(9,8)\sin 30 + 0,2(70)9,8\cos 30 + 70a$

$a = -4,53\ m.s^{-2}$ ✓ answer

(8)

2.3 INCREASES. ✓

If the angle of the slope decreases the NORMAL FORCE INCREASES ✓

and since $F_f \propto F_N$, ✓ the friction force increases.

(3)

[17]

QUESTION 3

3.1 A projectile is a (moving) object which has been given an initial velocity which then moves under the influence of the gravitational force (gravity) only.✓✓
(if the learner defines free fall then no marks) mark within context There was a change in the guideline for 2021 (2)

3.2 3.2.1 **OPTION 1: (UP POSITIVE)**

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
0 = (+7,27)² + 2 (–9,8)Δy ✓ (opposite signs)
Δy = 2,7 m (2,697 m)
Max height = 2,7 + 1,3 ✓
= 4 m (3,997 m) ✓

OPTION 2: (DOWN POSITIVE)

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
0 =(– 7,27)² + 2 (+9,8) Δy ✓ (opposite signs)
Δy = – 2,70 m
Δy = 2,70 m (2,697 m) (answer must be positive)
Max height = 2,70 + 1,3 ✓
= 4 m (3,997 m) ✓ (4)

3.2.2 **OPTION 1: (UP POSITIVE)**

$\Delta y = v_i t + \frac{1}{2}at^2$ ✓
(+1,9) = (+7,27) t + ½ (– 9,8) t² ✓ (opposite signs)
t = 1,14 s ✓ or ~~t = 0,339 s (too small)~~

✓ formula
✓ substitution
✓ answer

OPTION 2: (UP POSITIVE)

Time to maximum height:
$v_f = v_i + at$
0 = 7,27 + (–9,8)Δt
Δt = 0,742 s

Time from maximum height to balcony:
$v_f^2 = v_i^2 + 2a\Delta y$
= 0^2 + 2(–9,8) 0,797
v_f = 3,952 m.s^{-1}
$v_f = v_i + at$ ✓
– 3,952 = 0 + (–9,8)Δt ✓
Δt = 0,403 s

Total time: = 0,742 + 0,403
= 1,145 s ✓

✓ formula that calculates the answer
✓ substitution
✓ answer

(3)

OPTION 3: (DOWN POSITIVE)

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

(–1,9) = (– 7,27) t + ½ (+9,8) t² ✓ (opposite signs)

t = 1,14 s ✓ or ~~t = 0,339 s (too small)~~

OPTION 4: (DOWN POSITIVE)

Time to maximum height:

$v_f = v_i + at$

0 = – 7,27 + (9,8)Δt

Δt = 0,742 s

Time from top to balcony:

$v_f^2 = v_i^2 + 2a\Delta y$

$= 0^2 + 2(+9,8)\ 0,797$

$v_f = 3,952\ m.s^{-1}$

$v_f = v_i + at$ ✓

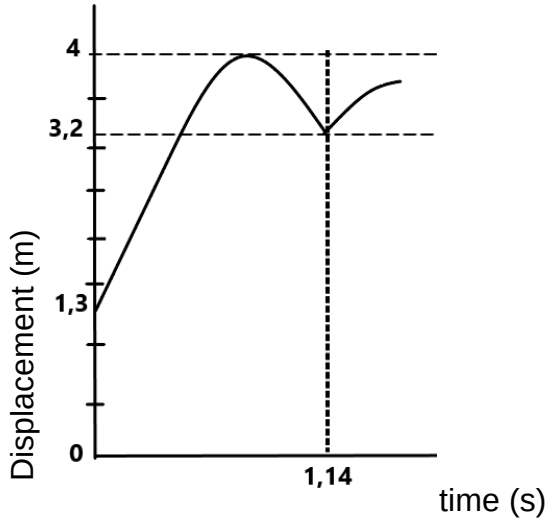
3,952 = 0 + (+9,8)Δt ✓

Δt = 0,403 s

Total time: = 0,742 + 0,403

= 1,145 s ✓

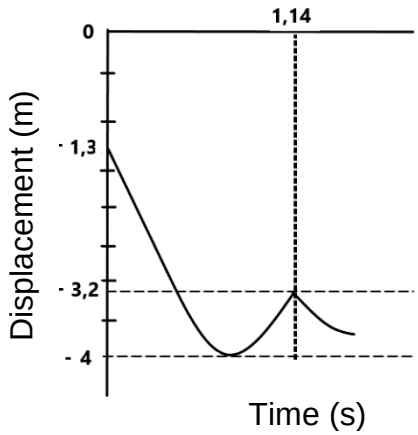
3.3 **OPTION 1: UP POSITIVE**



Marking guidelines:

- ✓ Height from which ball is thrown (1,3 m)
- ✓ Maximum height that ball reached (4 m) positive marking
- ✓ Height of the balcony (3,2 m)
- ✓ The time it takes to bounce on the balcony (1,14 s) positive marking
- ✓ Shape – no straight lines must be a parabola

OPTION 2: DOWN POSITIVE



(5)

[14]

QUESTION 4

4.1 The product of the resultant/net force acting on an object and the time the net force acts on the object. ✓✓
DO NOT ACCEPT change in momentum (2)

4.2 Impulse = Area under the graph
= ½ b x h
= ½ x (15 x 10^{-3}) x 64,13 ✓
= 0,481 N.s ✓ accept kg.m.s^{-1} (2)

4.3 positive marking from 4.2
0,481 kg.m.s^{-1} ✓ upwards/up ✓ (2)

4.4 positive marking from 4.2 can use up as + or down as +
$F_{net}\Delta t = \Delta p$ ✓
$0,481 = m (v_f - v_i)$
0,481 ✓ = 0,05 (v_f – (– 5,42) ✓
v_f = 4,2 m.s^{-1} ✓ (upwards) (4)

4.5 INCREASE, ✓
The <u>change in momentum</u> will be <u>constant</u>✓
The hard ball will <u>take less time</u> to bounce off the force sensor, ✓
<u>The force is inversely proportional to the time</u>, the force will increase as the time of contact will decrease. (3)
[13]

QUESTION 5

5.1 $P_{avg} = Fv_{avg}$ ✓

57,6 = F x 1,2 ✓

F = 48 N ✓ (3)

5.2 The <u>net work done</u> on an object by a net force is <u>equal to the change in the object's kinetic energy</u>
OR
The <u>work done</u> on an object <u>by a net force</u> is <u>equal to the change in the object's kinetic energy</u>. ✓✓ (2)

5.3

<u>Marking guideline:</u>
✓ Formula
✓ Kinetic energy substitution
✓ Potential energy substitution
✓ Substitution for the work done by the frictional force
✓ $\frac{1,6}{\sin 32^o}$
✓ answer range of 4,34 – 4,77 m.s^{-1}
Ignore direction

(6)

OPTION 1: if learner takes v_i as 1,2 m.s^{-1}

$$W_{nc} = \Delta E_k + \Delta E_p$$

$$f\Delta x\cos\theta = (\frac{1}{2}mv_f^2 - mv_i^2) + (mgh_f - mgh_i) \quad \checkmark \text{ formula}$$

$$[(0,25)(41,554)]\cos 180^o \checkmark (\frac{1,6}{\sin 32^o}) \checkmark = \frac{1}{2}(5)v_f^2 - \frac{1}{2}(5)(1,2^2) \checkmark + 0 - (5)(9,8)(1,6) \checkmark$$

$$v_f = 4,37 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 2: if learner takes v_i as 1,2 m.s^{-1}

$$W_{net} = \Delta E_k \quad \checkmark \text{ formula}$$

$$f\Delta x\cos\theta + mg\Delta x\cos\theta + N\Delta x\cos\theta = (\frac{1}{2}mv_f^2 - mv_i^2)$$

$$[(0,25)(41,554)]\cos 180^o \checkmark (\frac{1,6}{\sin 32^o}) \checkmark + (5)(9,8)\cos(90-32) \checkmark + 0 = \frac{1}{2}(5)v_f^2 - \frac{1}{2}(5)(1,2^2) \checkmark$$

$$v_f = 4,37 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 3: if learner takes v_i as 0 m.s^{-1}

$$W_{nc} = \Delta E_k + \Delta E_p$$

$$f\Delta x\cos\theta = (\frac{1}{2}mv_f^2 - mv_i^2) + (mgh_f - mgh_i) \quad \checkmark \text{ formula}$$

$$[(0,25)(41,554)]\cos 180^o \checkmark (\frac{1,6}{\sin 32^o}) \checkmark = \frac{1}{2}(5)v_f^2 \quad \checkmark - 0 + 0 - (5)(9,8)(1,6) \checkmark$$

$$v_f = 4,34 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 4: if learner takes v_i as 0 m.s^{-1}

$$W_{net} = \Delta E_k \quad \checkmark \text{ formula}$$

$$f\Delta x\cos\theta + mg\Delta x\cos\theta + N\Delta x\cos\theta = (\frac{1}{2}mv_f^2 - mv_i^2)$$

$$[(0,25)(41,554)]\cos 180^o \checkmark (\frac{1,6}{\sin 32^o}) \checkmark + (5)(9,8)(\frac{1,6}{\sin 32^o})\cos(90-32) \checkmark + 0 = \frac{1}{2}(5)v_f^2 - 0 \checkmark$$

$$v_f = 4,34 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 5: if learner takes v_i as 0 m.s^{-1} and F is included

$$W_{nc} = \Delta E_k + \Delta E_p \quad \checkmark \text{ formula}$$

$$F\Delta x\cos\theta + f\Delta x\cos\theta = (\frac{1}{2}mv_f^2 - mv_i^2) + (mgh_f - mgh_i)$$

$$48(\frac{1,6}{\sin 32^o})\cos 0 + [(0,25)(41,554)]\cos 180^o \checkmark (\frac{1,6}{\sin 32^o}) \checkmark = \frac{1}{2}(5)v_f^2 \quad \checkmark - 0 + 0 - (5)(9,8)(1,6) \checkmark$$

$$v_f = 8,76 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

OPTION 6: if learner takes v_i as 1,2 m.s^{-1} and F is included

$$W_{nc} = \Delta E_k + \Delta E_p$$

$$F\Delta x\cos\theta + f\Delta x\cos\theta = (\frac{1}{2}mv_f^2 - mv_i^2) + (mgh_f - mgh_i) \quad \checkmark \text{ formula}$$

$$48(\frac{1,6}{\sin 32^o})\cos(0) + [(0,25)(41,554)]\cos 180^o \checkmark (\frac{1,6}{\sin 32^o}) \checkmark = \frac{1}{2}(5)v_f^2 - \frac{1}{2}(5)(1,2^2) \checkmark + 0 - (5)(9,8)(1,6) \checkmark$$

$$v_f = 8.84 \text{ m} \cdot \text{s}^{-1} \quad \checkmark$$

QUESTION 6

6.1 The (apparent) change in frequency/pitch of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ (2)

Marking criteria: If any of the underlined words/phrases in the correct context is omitted deduct 1 mark.

6.2 6.2.1 A ✓ (1)

6.2.2 C ✓ (1)

6.2.3 The frequency of the waves reaching the observer decreases. ✓
OR
The wavelength increases. (1)

6.3
$$f_L = \frac{v \pm v_L}{v \pm v_S} \times fs \ \checkmark$$

$$f_L = \frac{340 \ \checkmark}{(340+25)\checkmark} \times 900 \ \checkmark$$

$$=838{,}356 \text{ Hz} \ \checkmark$$ (5)

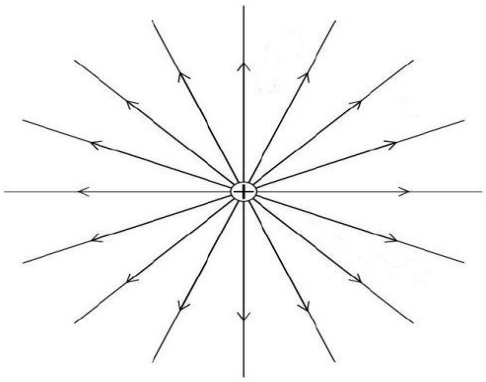
6.4 The observed wavelength of the spectral lines of the hydrogen atom from the nearby star is LONGER ✓ than the wavelength of the hydrogen atom on the sun. The wavelength is RED SHIFTED ✓and therefore the nearby star is moving AWAY from the sun. ✓ (3)

[13]

QUESTION 7

7.1 Electric field at a point is <u>the force experienced per unit positive charge</u> at that point. ✓✓ (2)

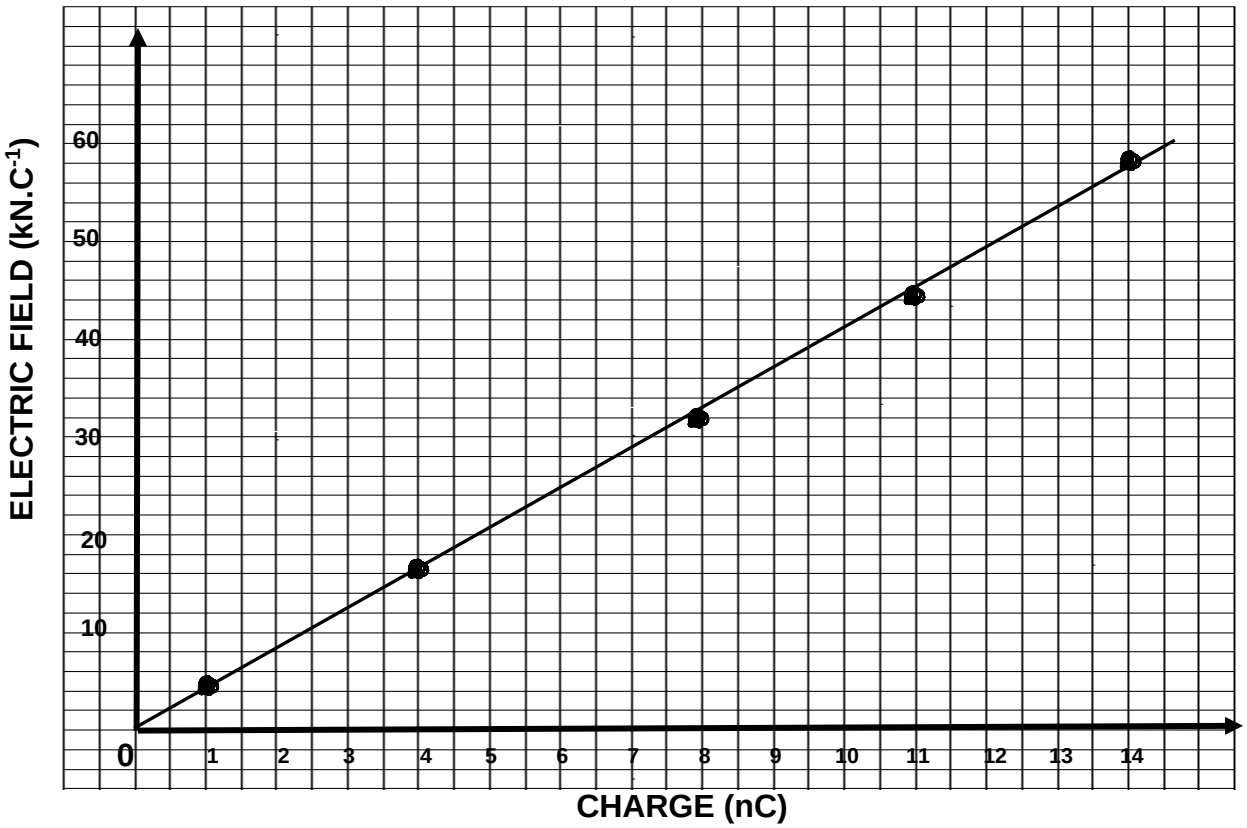
7.2



<u>Marking guidelines:</u>
✓ Direction
✓ Evenly spaced/not touching

(2)

7.3 **Graph of E vs Q**



(4)

<u>Marking Guideline:</u>
✓ Scale on both axes correct
✓ 3 points plotted correctly
✓ 5 points plotted correctly
✓ Line of best fit (must go through the origin)
if no Labels for both X and Y axes – penalise with one mark
if axes are swopped around -1

7.4 7.4.1 The (fixed) distance ✓ (1)

7.4.2 Electric field ✓ (1)

7.4.3 **OPTION 1**

$$\text{Gradient} = \frac{\Delta y}{\Delta x}$$

$$\frac{k}{r^2} = \frac{\Delta E}{\Delta Q} \checkmark$$

$$r = \sqrt{\frac{k \times \Delta Q}{\Delta E}} =$$

$$\sqrt{\frac{9\times10^{9} \times [12\times10^{-9} - 2\times10^{-9}]}{48\times10^{3} - 8\times10^{3}]}}$$

$= 0{,}047\ m$ ✓

- ✓ Formula / gradient
- ✓ y-value (any one)
- ✓ x-value (any one)
- ✓ 9×10^9
- ✓ answer

OPTION 2

$$E = \frac{kQ}{r^2} \checkmark$$

$$10 \times 10^{-10} \checkmark = \frac{9x10^{9} \checkmark (40x10^{3}) \checkmark}{r^2}$$

$$r = 0{,}047\ m \checkmark$$

(5)
[15]

QUESTION 8

8.1 6 V ✓ (1)

8.2 When a charge of <u>0,75</u> <u>Coulomb (C)</u>✓ travels in the circuit <u>in one second</u>. ✓

OR

Total of 0,75 <u>Coulombs (C) per unit time</u>

OR

The <u>rate</u> at which <u>0,75 Coulomb (C) flows</u> (2)

8.3 8.3.1 **OPTION 1:**

$\mathcal{E} = I\,(R + r)$✓

$6 = 0{,}75(R + 0{,}4)$ ✓

$R = 7{,}6\ \Omega$ ✓

(3)

OPTION 2:

$R = \frac{V}{I}$ ✓

$= \frac{(6-0,3)}{0,75}$ ✓

$= 7,6\ \Omega$ ✓

8.3.2 **OPTION 1:**

$R_P = R_{ex} - R_s$

$= 7,6 - 4$ ✓

$= 3,6\ \Omega$

$\frac{1}{R_p} = \frac{1}{R} + \frac{1}{R_3+R_1}$

$\frac{1}{3,6} = \frac{1}{R} + \frac{1}{3+1}$ ✓

$R = 36\ \Omega$ ✓

OPTION 2:

$R_{ext} = R_{//} + R_s$

$7,6$ ✓ $= \left(\frac{4R}{4+R} + 4\right)$ ✓

$7,6\ (4 + R) = 4R + 4(4 + R)$

$R = 36\ \Omega$ ✓

OPTION 3:

$I_{//(1+3)} = \frac{V_{//}}{R_{(1+3)}}$

$= \frac{2,7}{4}$

$= 0,675A$

$I_R = 0,75 - 0,675$ ✓

$= 0,075\ A$

$R = \frac{V_R}{I_R}$

$= \frac{2,7}{0,075}$ ✓

$R = 36\ \Omega$ ✓ (3)

8.4 INCREASES ✓

R_{ex} decreases ✓
I increases (because I $\propto R$). ✓
According to P = I^2R will increase because P$\propto I^2$ ✓

OR

R_{ex} decreases ✓
V over the resistor increases. ✓
According to P=$\frac{V^2}{R}$ will increase because P$\propto V^2$ ✓ (4)

8.5 8.5.1 4,5 V ✓ (1)

8.5.2 gradient = - r = $\frac{\Delta y}{\Delta x}$

$= \frac{1,5 - 4,5}{5 - 0}$ ✓ ✓

$= -0,6$
$\therefore$ r = 0,6 Ω ✓ (3)
[17]

QUESTION 9

9.1 AC (generator) ✓
It has two slip rings (AC). ✓✓
There is a handle to turn the coil/no power supply
OR
Sliprings for AC. ✓✓✓ (3)

9.2 B to A ✓ (1)

9.3 9.3.1 One and a half turns. ✓✓ OR 1 ½ OR 1,5 (2)

9.3.2 The rms current is the alternating current which dissipates/produces the same amount of energy as an equivalent direct current (DC). ✓✓ (2)

9.3.3 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓

$= \frac{15}{\sqrt{2}}$ ✓

$= 10,61A$

$P_{ave} = I_{rms}^2 R$ ✓

$= 10,61^2 \times 30$ ✓

$= 3377,16$ W ✓ (3375 W) (5)

9.4 $P_{ave} = V_{rms}I_{rms}$

2 200 = $240I_{rms}$ ✓ if subscripts are omitted, subtract one mark

I_{rms} = 9,167 A

$I_{max} = I_{rms}\sqrt{2}$ ✓ formula mark goes for formula calculating the answer

I_{max} = (9,167) × ($\sqrt{2}$) ✓

= 12,96 A ✓ (4)

[17]

QUESTION 10

10.1 The process whereby electrons are ejected from a metal surface when light of a suitable frequency is incident on that surface. ✓✓ (2)

10.2 The frequency of the red light must be lower ✓ than the threshold frequency ✓ for the phototube metal surface. (must be a comparison for both marks)

OR

The red light does not have enough energy to eject electrons from the phototube metal surface. ($E_{red\ light} < W_0$ metal surface) ✓✓ (2)

OR

the wavelength of the light is higher than the threshold wavelength.

10.3 10.3.1 INCREASES. ✓ (1)

10.3.2 INCREASES. ✓

If the intensity of the light increases, the number of photons per unit time / per second of light striking the phototube increases ✓.

This increases the number of electrons ejected per unit time / per second ✓ and therefore the reading on the ammeter increases. (3)

10.4

$$E = W_0 + Ek_{max} \checkmark$$

$$h\frac{c}{\lambda} = W_0 + Ek_{max}$$

$$\frac{(6{,}63\times10^{-34}\times3\times10^{8})}{(390\times10^{-9})} \checkmark = 3{,}52\times10^{-19} \checkmark + \frac{1}{2}(9{,}11\times10^{-31})v^2 \checkmark$$

$$5{,}108\times10^{-19} - 3{,}52\times10^{-19} = \frac{1}{2}(9{,}11\times10^{-31})v^2$$

$$v = \sqrt{\frac{1{,}588\times10^{-19}}{\frac{1}{2}(9{,}1\times10^{-31})}} = 5{,}89\times10^{5}\ m{\cdot}s^{-1} \checkmark$$

if frequency is calculated and then substituted – accept two step question (5)

[13]

TOTAL: 150