NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2015

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours 200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1

1.1 C
1.2 C
1.3 A
1.4 B
1.5 C
1.6 C
1.7 D
1.8 B
1.9 D
1.10 C (2 × 10 = 20)
[20]

QUESTION 2

2.1.1 a = slope of v-t graph OR $\frac{\Delta v}{\Delta t}$ OR v = u + at

$a = \frac{0-4}{35-20}$ 0 = 4 +a(15)

a = -0,27 a = -0,27

a = 0,27 m·s^{-2} West **a = 0,27 m·s^{-2} West** (4)

2.1.2 **0-10 s** (A-B) and **40-50 s** (E-F) (2)

2.1.3 *displacement is a change in position* (2)

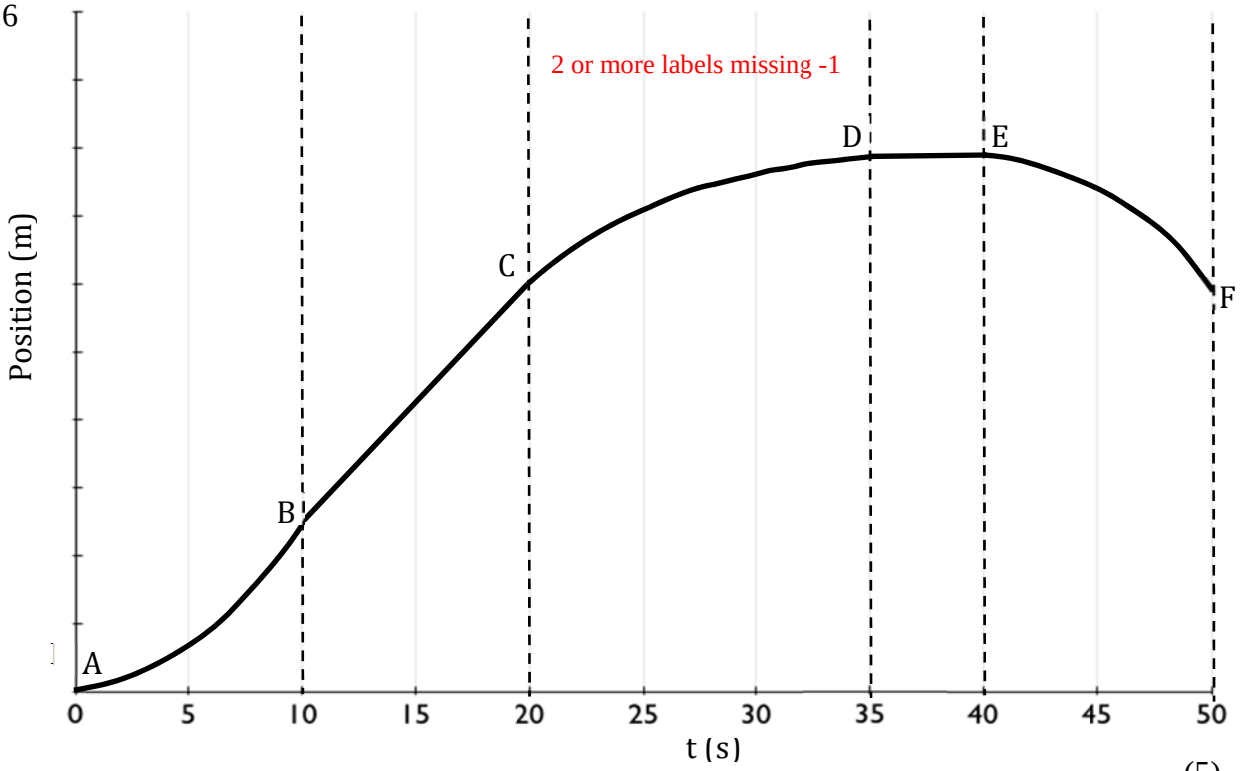
2.1.4 s = area under v-t graph

$s = \frac{1}{2}(10)(4)+(10)(4)+\frac{1}{2}(15)(4)-\frac{1}{2}(10)(3)$

s = 75 m East (4)

2.1.5 No, it will not always be true. Displacement and distance can be equal only if the object travels in a straight line in one direction. (2)

2.1.6



(5)

2.2.1 average speed = $\frac{total\ distance}{total\ time}$

average speed = $\frac{12\ 000}{7{,}6\times60}$

average speed = 26,32 m·s^{-1} (4)

2.2.2 100 km/h = 27,78 m·s^{-1} (2)

2.2.3 No or yes if answer for 2.2.1 > 2.2.2 (coe) (1)

2.2.4 time for 1st 6 km = $\frac{6}{60}$ = 0,1 hrs

time for 2nd 6 km = $\frac{6}{140}$ = 0,04 hrs

average speed = $\frac{total\ distance}{total\ time}$

average speed = $\frac{12}{0{,}1+0{,}04}$

average speed = 84 km/h (or 85,71 km/h if time rounded off) (5)

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QUESTION 3

3.1 *velocity is rate of displacement* OR *velocity is the rate of change of displacement* OR *velocity is rate of change of position* (2)

3.2

$v^2 = u^2 + 2as$	OR	$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$
v^2=0+2(9,8)(95)		$mgh + 0 = 0 + \frac{1}{2}mv^2$
v^2=1862		$(9,8)(95) = \frac{1}{2}v^2$
v = 43,15 m·s^{-1}		**v = 43,15 m·s^{-1}**

(3)

3.3 *acceleration is the rate of change of velocity* (2)

3.4

down positive		up positive
$v^2 = u^2 + 2as$		$v^2 = u^2 + 2as$
0 = 1862 + 2a(5,8)	OR	0 = 1 862 + 2a(–5,8)
a = -160,52		a = 160,52
a = 160,52 m·s^{-2} up		**a = 160,52 m·s^{-2} up**
(a = 160,51 m·s^{-2} up if rounded)		

(4)

3.5

Force of bag / Normal/ F_N

Weight /F_g /w /$F_{gravity}$

$F_{up} > F_{down}$

(-1 for extra forces)

(3)

3.6 $F_{net} = ma$

$F_{bag} - F_g$ = ma

F_{bag} – (80)(9,8) = (80)(160,52) coe

F_{bag} = 13 625,60 N (or 13 625,38 N if no rounding)

OR

$\overrightarrow{F_{bag}} + \overrightarrow{F_g} = m\vec{a}$

F_{bag} + (80)(9,8) = (80)(-160,52) coe

or F_{bag} +(80)(-9,8) = (80)(160,52) coe

F_{bag} = (-)13 625,60 N (or 13 625,38 N if no rounding)

OR

$W_{net} = \Delta E_K = F_{net}(5,8)$ (for both equations)

$0 - \frac{1}{2}(80)(43,15)^2 = F_{net}(5,8)$

$F_{net} = (-)12840,84\ N$

$F_{net} = F_{bag} - F_g$

$F_{bag} = 12840 + (80)(9,8)$

$F_{bag} = 13624,84\ N$

OR

$v = u + at$
0 = 43,15+(-160,52)t
$t = 0{,}27$ s

$F_{net}t = m\Delta v$ (for both equations)
F_{net} (0,27) = 80(0 - 43,15)
$F_{net} = -12785{,}19\ N$

$F_{net} = F_{bag} - F_g$
$F_{bag} = 12785{,}19 + (80)(9{,}8)$
$F_{bag} = 13569{,}19\ N$

OR

$F_{bag}s = \Delta E_K + \Delta E_P$
$F_{bag}(5{,}8) = (0 - \frac{1}{2}(80)(43{,}15)^2) + (0 - (80)(9{,}8)(5{,}8))$
$F_{bag} = (-)13624{,}84\ N$ (5)

3.7 $F_{net}\Delta t = \Delta p$
Airbag increased time to stop
F_{net} decreased

OR

$a = \frac{\Delta v}{\Delta t}\ and\ F = ma$
Airbag increased time to stop
Acceleration decreased so F_{net} decreased (3)
[22]

QUESTION 4

4.1 *Newton's first law states an object continues in a state of rest or uniform velocity unless it is acted upon by a net or resultant force.* (2)

4.2 Firing engine provides a resultant force on rocket
as firing engine pushes gas out of exhaust and gas pushes back on rocket
by Newton III

OR

Firing engine provides a resultant force on rocket
By Newton II
Rocket accelerates (3)

4.3 *The (total linear momentum) of an isolated system / in the absence of external forces remains constant (is conserved)* (2)

4.4 $(p_{total})_{before} = (p_{total})_{after}$

$m(1000) = \frac{2}{3}mv + \frac{1}{3}m(-500)$

$\boldsymbol{v = 1750\ m{\cdot}s^{-1}}$ (5)

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QUESTION 5

5.1 *Kinetic energy is the energy an object has as a result of the object's motion.* (2)

5.2 $E_K = \frac{1}{2}mv^2$
$E_K = \frac{1}{2}(10)(12)^2$
$\boldsymbol{E_K = 720\ J}$ (3)

5.3 *The work done by a net force /net work done on an object is equal to the change in the kinetic energy of the object.* (2)

5.4 $F_f s = \Delta E_k$
$(-54{,}9)(6) = \frac{1}{2}(10)v^2 - 720$ coe
$-329{,}4 = \frac{1}{2}(10)v^2 - 720$
$\boldsymbol{v = 8{,}84\ m{\cdot}s^{-1}}$

OR

$F_f s = \Delta E_k$
$(54{,}9)(6)(\cos 180) = \frac{1}{2}(10)v^2 - 720$ coe
$-329{,}4 = \frac{1}{2}(10)v^2 - 720$
$\boldsymbol{v = 8{,}84\ m{\cdot}s^{-1}}$

OR

$(F = ma$ and $v^2 = u^2 + 2as)$
$-54{,}9 = 10a$ $v^2 = 12^2 + 2(-5{,}49)(6)$ coe
$a = -5{,}49\ m{\cdot}s^{-2}$ $\boldsymbol{v = 8{,}84\ m{\cdot}s^{-1}}$ (4)

5.5 $E_P = mgx \sin(35)$
OR
$E_P = mgx \sin(\theta)$
OR
$E_P = 98\,x \sin(35)$
OR
$E_P = 56{,}21\,x$ (2)

5.6 $E_{K\,at\,B} = E_{P\,at\,C} + W_{Friction}$
$\frac{1}{2}mv^2 = mgx \sin(35°) + (45{,}0)x$
$\frac{1}{2}10(8{,}84)^2$ coe $= (10)(9{,}8)\sin(35°)\,x + 45x$
$390{,}73 = 101{,}21\,x$
$\boldsymbol{x = 3{,}86\ m}$ **($x = 3{,}85$ m if no rounding off)**

OR
$W_{net} = \Delta E_K$ and $F_{net}x = \Delta E_K$
$(-45 - 10(9{,}8)\sin 35)x = 0 - \frac{1}{2}(10)(8{,}84)^2$
$\boldsymbol{x = 3{,}86\ m}$

OR

$W_{net} = \Delta E_K$ and $W_g + W_f = \Delta E_K$

$(10)(9{,}8)x \cos 125 + 45\,x \cos 180 = 0 - \frac{1}{2}(10)(8{,}84)^2$

$\boldsymbol{x = 3{,}86\ m}$

OR

$(F_{net} = ma$ and $v^2 = u^2 + 2as\ )$

$(-45 - (10)(9{,}8)\sin 35) = 10a$ $0 = (8{,}84)^2 + 2(-10{,}121)x$

$a = -10{,}12\ m{\cdot}s^{-2}$ $\boldsymbol{x = 3{,}86\ m}$

OR

$W_f = \Delta E_P + \Delta E_K$

$W_f = mgx \sin 35 + (0 - \frac{1}{2}mv^2$

$45\,x \cos 180 = (10)(9{,}8)x \sin 35 - \frac{1}{2}(10)(8{,}84)^2$

$\boldsymbol{x = 3{,}86\ m}$

OR

$(F_{net}\Delta t = m\Delta v$ and $s = \left(\frac{u+v}{2}\right)t)$

$(-45 - (10)(9{,}8)\sin 35)\Delta t = 10(0 - 8{,}84)$ $x = (\frac{0+8{,}84}{2})(0{,}87)$

$\Delta t = 0{,}87\ s$ $\boldsymbol{x = 3{,}86\ m}$ (5)

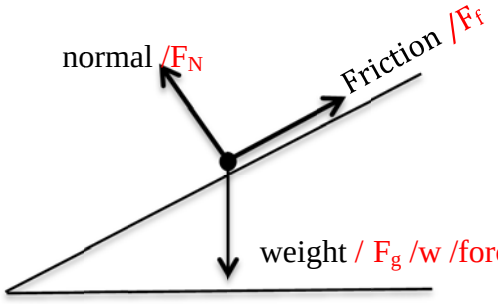
5.7 $F_f = \mu N$

as slope is increased, Normal force decreases

as $N = mg\,cos(\theta)$ OR $cos(\theta)$ decreases as θ increases OR $cos(35) < 1$

so frictional force decreases (3)

5.8



Extra forces -1
Non attachment -1
No arrows -1

(3)

5.9 $F_f = mg\,sin(35°)$

$F_f = 10(9{,}8)\,sin(35°)$

$\boldsymbol{F_f = 56{,}21\ N}$ (3)

5.10 $F_f = \mu F_N$ OR $\mu = \tan\theta$

$56{,}21 = \mu(10)(9{,}8)\cos(35°)$ coe $\mu = \tan 35$

μ = **0,70** μ = **0,70** (3)

5.11 static friction is greater than kinetic friction

OR

Coefficient of static friction greater than coefficient of kinetic friction

OR

While moving, surfaces interact less (2)

[32]

QUESTION 6

6.1 6.1.1 *Every particle in the universe attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between (their centres)* (2)

6.1.2 $F_g = \frac{Gm_1m_2}{r^2}$

$F_g = \frac{(6{,}7\times10^{-11})(96)(1\times10^{13})}{4000^2}$

$\boldsymbol{F_g = 4{,}02\times10^{-3}\ \text{N}}$ (4)

6.1.3 $a_{67} = \frac{F_g}{m}$

$a_{67} = \frac{4{,}02\times10^{-3}}{96}$ coe

$\boldsymbol{a_{67} = 4{,}19\times10^{-5}\ \text{m·s}^{-2}}$

OR

$a_{67} = \frac{GM}{r^2}$

$a_{67} = \frac{(6{,}7\times10^{-11})(1\times10^{13})}{4000^2}$

$\boldsymbol{a_{67} = 4{,}19\times10^{-5}\ \text{m·s}^{-2}}$ or N·kg^{-1} (3)

6.1.4 $a_{67} = \frac{GM}{r^2}$

$a_{new} = \frac{G5M}{(2r)^2}$

$a_{new} = \frac{5}{4}\frac{GM}{r^2}$

$\frac{a_{new}}{a_{67}} = 1{,}25$ OR $\frac{a_{67}}{a_{new}} = 0{,}8$

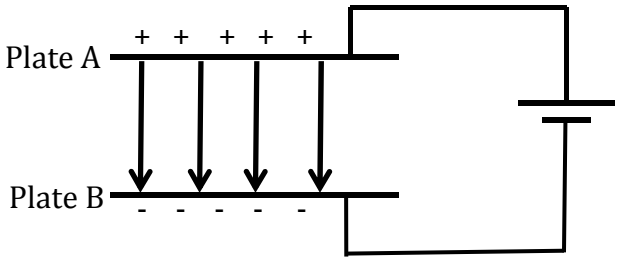
OR $a_{new}: a_{67} = 5:4$ OR $a_{67}: a_{new} = 4:5$ (4)

6.2 6.2.1 $F = Eq$

$F = (4{,}8\times10^{5})(25\times10^{-9})$

$\boldsymbol{F = 0{,}012\ \text{N}}$ (3)

6.2.2 on Answer Booklet



Label plates (with + and –)
Direction
Parallel lines (ignore end effects) (3)

[19]

QUESTION 7

7.1 Cost = $\frac{100}{1000} \times 6 \times 1{,}40$ = **R 0,84** (3)

7.2 $P = \frac{V^2}{R}$

$100 = \frac{240^2}{R}$

$\boldsymbol{R = 576\ \Omega}$ (3)

7.3 no. of bulbs (in parallel) OR resistance OR $\frac{1}{R}$ (2)

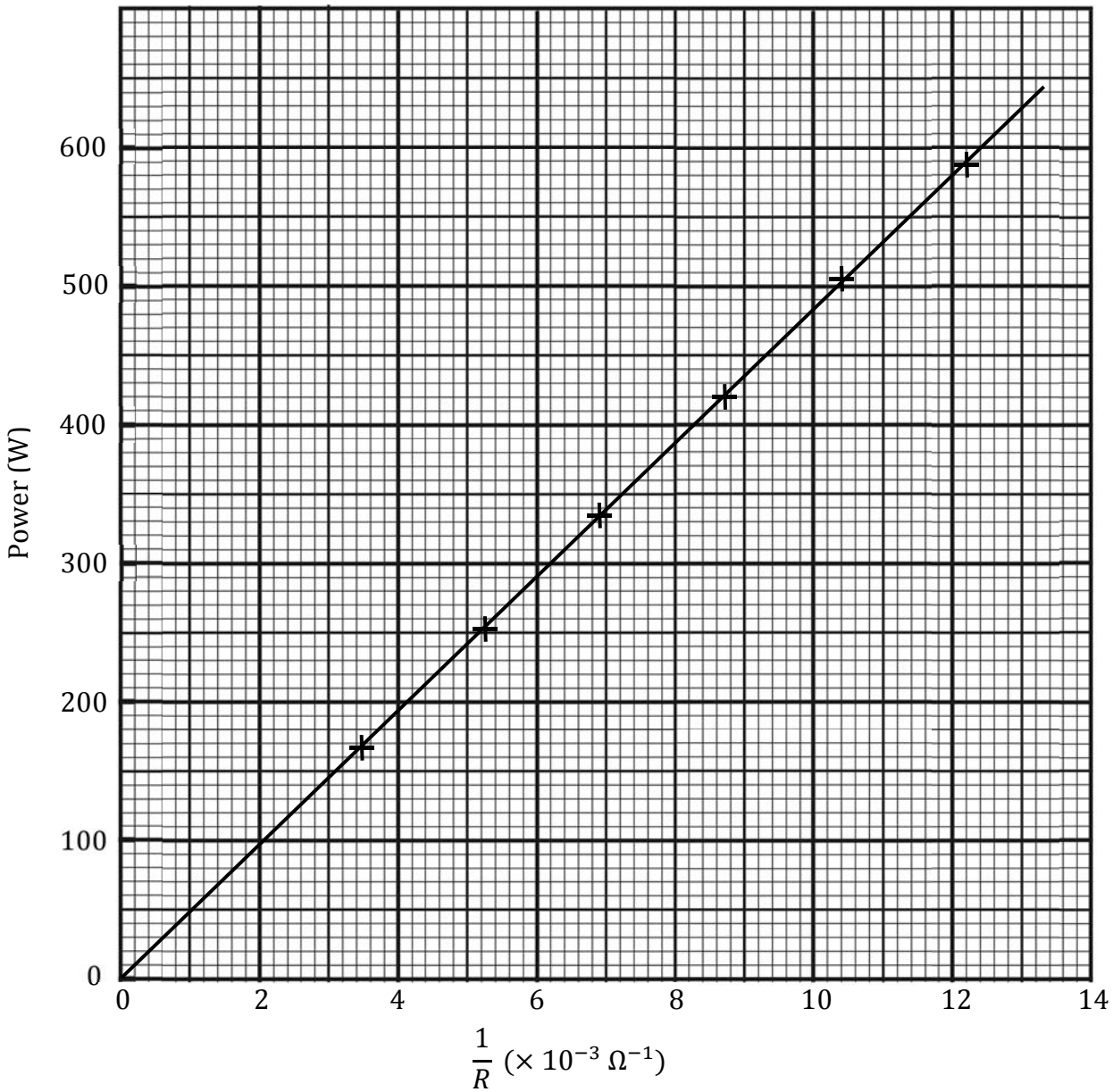
7.4 more pathways / branches, makes it easier for charge to flow (2)

7.5 7.5.1 5,21

7.5.2 10,42 (if $\times 10^{-3}$ included in both answers then max 1/2) (2)

7.6 Graph – On Answer Booklet

Graph to show Power vs $\frac{1}{R}$



Heading
y-axis title and unit
y-axis scale (plotted points > $\frac{1}{2}$ graph paper, scale must be in sensible multiples)
plotted points (all 6 points plotted within half small block)
line of best fit (with a ruler) (6)

7.7 Power is inversely proportional to resistance
(or power is directly proportional to the inverse of resistance)
straight line graph or linear or constant gradient
line through the origin (3)

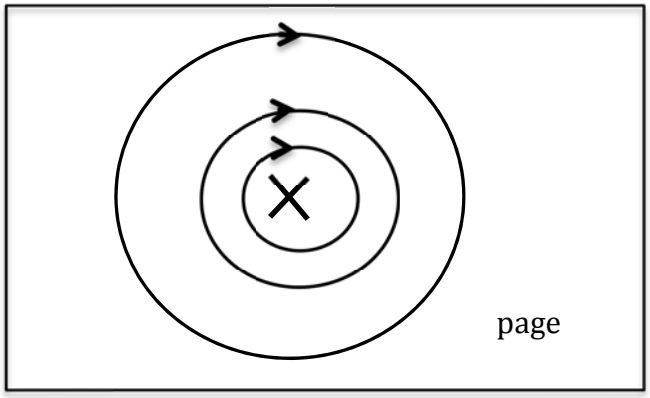
7.8 Gradient = $\frac{\Delta y}{\Delta x}$
Gradient = $\frac{values\ from\ y\text{-}axis}{values\ from\ x\text{-}axis}$ (-1 if not shown on graph)

Gradient = 48 203,4 (allow 45790 – 50610) (4)

7.9 P on y-axis, $\frac{1}{R}$ on x-axis means gradient is V^2
V^2 = 48 203, 4 coe
V = 219,6 V (allow 214 – 225) (3)
[28]

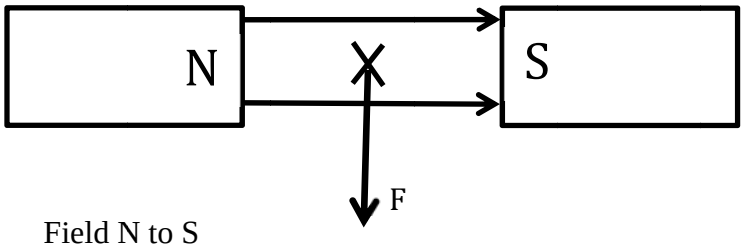
QUESTION 8

8.1 8.1.1 On Answer Booklet



Concentric circles
Direction (2)

8.1.2 On Answer Booklet



Field N to S
Field line parallel
Force direction
Force labelled and acting on wire (4)

8.1.3 magnetic field due to current interacts with magnetic field due to magnet (2)

8.1.4 wire parallel to field lines (2)

8.2 8.2.1 electrical energy to mechanical (kinetic) energy (2)

8.2.2 split ring commutator (2)

8.2.3 change the direction of the current in the coil every half rotation to that ensure the coil continues rotating (in the same direction)
(NO coe allowed) (2)

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

- As the cone moves, coil moves relative to magnet
- the coil experiences a change of flux
- so emf is induced in the coil (4)

[22]

QUESTION 9

9.1 9.1.1 Photoelectric effect (2)

9.1.2 UV light has a larger frequency than visible light
frequency of UV light greater than threshold frequency
UV can eject electrons

OR

UV light has a larger energy than visible light
energy of UV light greater than work function
UV can eject electrons (3)

9.2 9.2.1 *Work function is the <u>minimum</u> amount of energy needed to emit an electron from the surface of a metal.* (2)

9.2.2 $W_0 = hf_0$
$3{,}36 \times 10^{-19} = 6{,}6 \times 10^{-34} f_0$
$\boldsymbol{f_0 = 5{,}09 \times 10^{14}\ Hz}$ (3)

9.2.3 $c = f\lambda$
$3 \times 10^8 = f\ 400 \times 10^{-9}$
$f = 7{,}5 \times 10^{14}$ Hz

$hf = W_0 + E_{K\,max}$
$(6{,}6 \times 10^{-34})(7{,}5 \times 10^{14}) = 3{,}36 \times 10^{-19} + E_{K\,max}$
$\boldsymbol{E_{K\,max} = 1{,}59 \times 10^{-19}\ J}$ (4)
[14]

Total: 200 marks