NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2024

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours 200 marks

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QUESTION 1

1.1 B
1.2 A
1.3 B
1.4 D
1.5 D
1.6 C
1.7 A
1.8 C
1.9 C
1.10 B

QUESTION 2

2.1 Acceleration is *the rate of change of velocity.*

2.2 $a = \frac{v-u}{t}$ or gradient of v – t graph

$a = \frac{0,9-0,4}{4}$

a = 0,125 m·s^{-2}

2.3 s = area under curve

s = $\left[\frac{1}{4}(4)(0,5)+(0,4)(4)\right]$

s = 1 + 1,6

s = 2,6 m

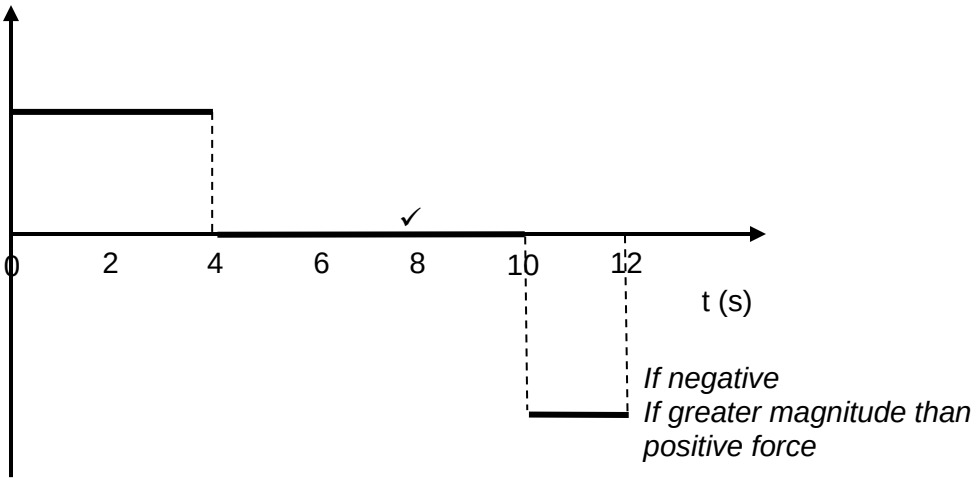
2.4 *When a net force acts on an object, the object accelerates in the direction of the net force. The acceleration is directly proportional to the net force and inversely proportional to the mass of the object.*

OR

The net force acting on an object is equal to the rate of change of momentum.

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2.5



2.6 $F_{net} = \frac{\Delta p}{\Delta t}$

$-0,18 = \frac{m(0-0,9)}{2}$

m = 0,4 kg

OR $F_{net} = ma$

$-0,18 = m\left(\frac{0-0,9}{2}\right)$

m = 0,4 kg

QUESTION 3

3.1 $v^2 = u^2 + 2as$
$0^2 = (8,4)^2 + 2(–9,8)s$
s = 3,6 m

3.2 v = u + at
0 = 8,4 + (-9,8)t
t = 0,86 s

3.3 $s = ut + \frac{1}{2}at^2$

$s = (8,4)(2,25) + \frac{1}{2}(–9,8)(2,25)^2$

Could choose down to be positive throughout.

s = 5,9 m
h = 5,9 m

OR v = u + at
0 = 8,4 + (–9,8)t
t = 0,86 s
t from max height to ground = 2,25 – 0,86 = 1,39 s

displacement from maximum height to the ground:

$s = ut + \frac{1}{2}at^2$

$s = 0 + \frac{1}{2}(–9,8)(1,39)^2$

s = –9,47 m

From start to ground:
s = - 9,47 – (- 3,6) (c.o.e from 3.1)
- s = - 5,9 m
h = 5,9 m

OR v = u + at
0 = 8,4 + (–9,8)t
t = 0,86 s
t symmetrical, so t = 2(0,86) = 1,72 s to reach same point

t remaining (to reach ground) = 2,25 – 1,72 = 0,53 s

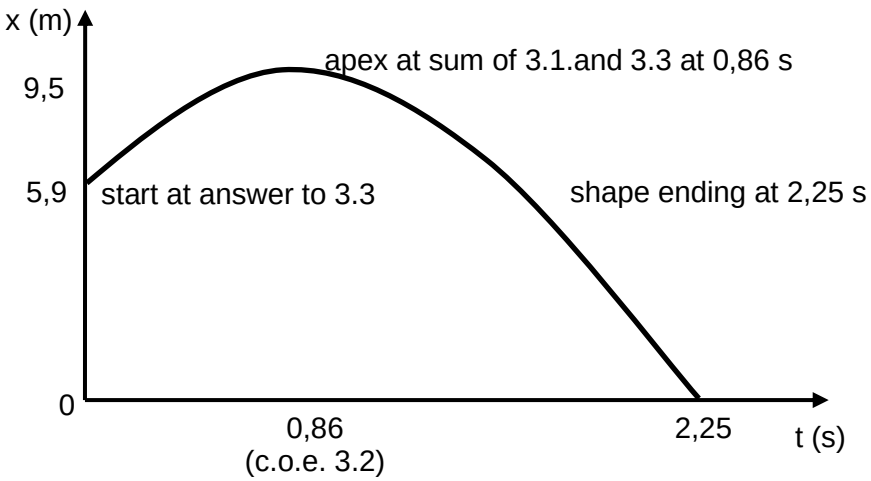
$s = ut + \frac{1}{2}at^2$

$s = (–8,4)(0,53) + \frac{1}{2}(–9,8)(0,53)^2$

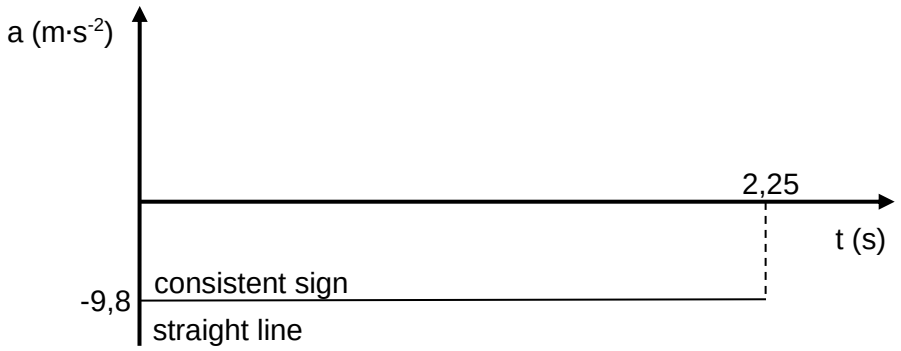
s = –5,9 m
h = 5,9 m

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3.4


x (m)
apex at sum of 3.1.and 3.3 at 0,86 s
9,5
5,9
start at answer to 3.3
shape ending at 2,25 s
0
0,86
(c.o.e. 3.2)
2,25
t (s)

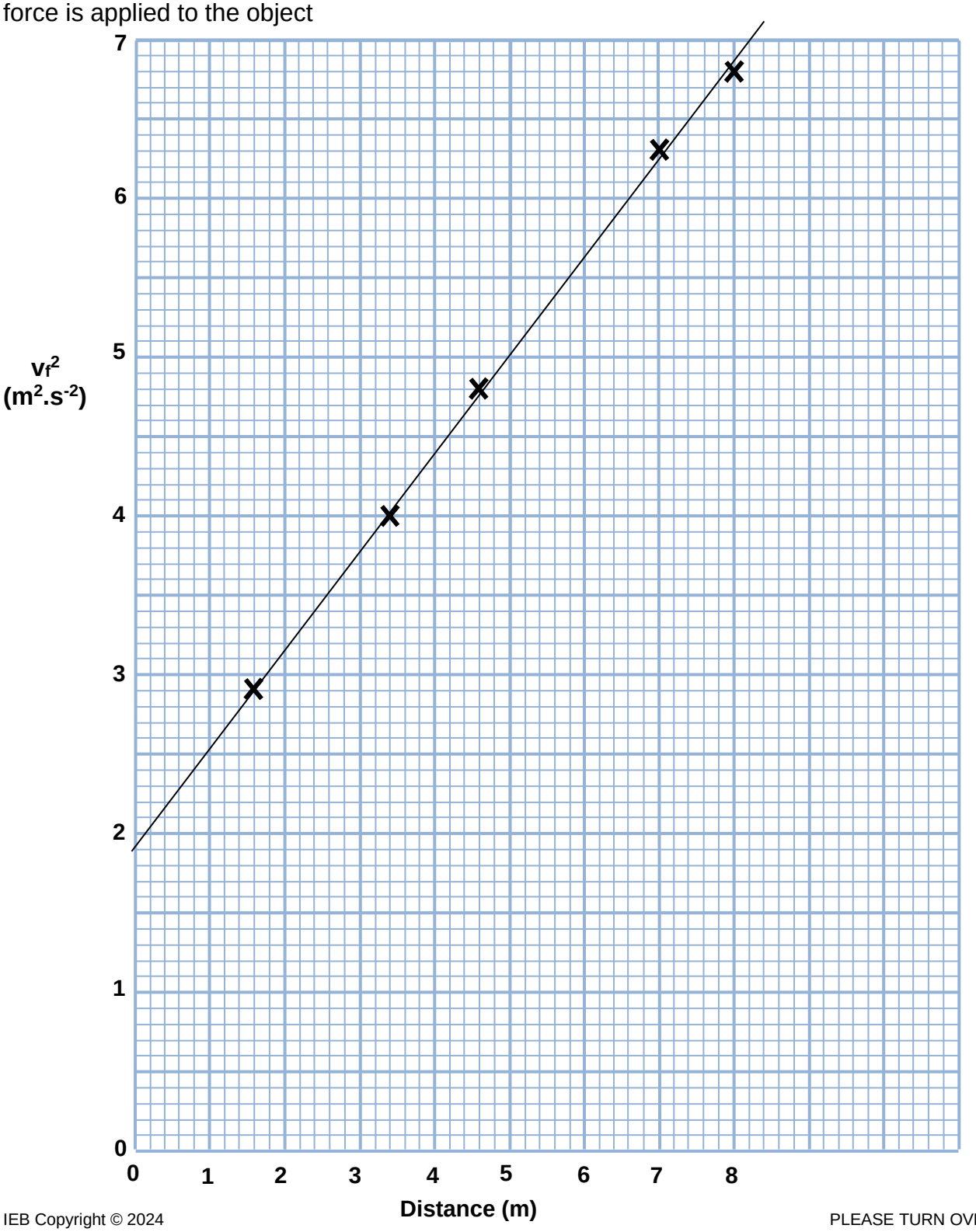
3.5


a (m·s-2)
2,25
t (s)
consistent sign
-9,8
straight line

QUESTION 4

4.1 Heading
y-axis label + unit
x-axis label + unit
scale (plotted points $> \frac{1}{2}$ graph paper)
plotted points
line of best fit

Graph of the final velocity squared ($\mathbf{v_f^2}$) of the object vs the distance over which that the force is applied to the object



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4.2 $\text{gradient} = \frac{\Delta y}{\Delta x}$

$\text{gradient} = \frac{\text{values from y-axis}}{\text{values from x-axis}}$ *(–1 if points not indicated on graph)*

(values must be from LOBF on graph – not data points)

gradient = 0,62 (m·s^{-2}) (accept 0,60 – 0,64)

4.3 $v_f^2 = 2as + v_i^2$

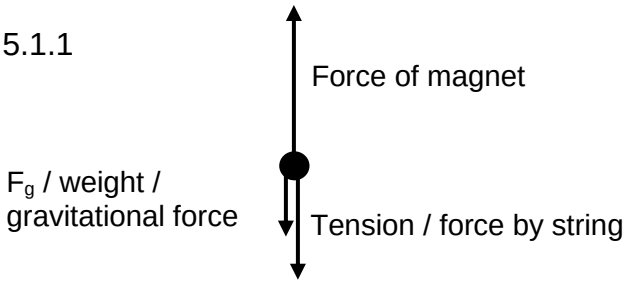
2a = gradient
a = 0,31 m·s^{-2} (c.o.e from 4.2)

4.4 v_i^2 read off y-intercept. ~~(range 1,8 – 2,0)~~
$\sqrt{\text{value}}$
v_i = 1,38 m·s^{-1} ~~(range 1,34 – 1,41)~~

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QUESTION 5

5.1 5.1.1



5.1.2 $F_{net} = 0 = F_{tension} + F_g = F_{magnet}$ *(as vectors)*

$F_{tension} + F_g = F_{magnet}$ *(as scalars)*

$F_{tension} + (0,002)(9,8) = 0,24$

$\mathbf{F_{tension} = 0,22\ N}$

5.1.3 Yes

The tension was maintaining equilibrium, so when the tension is removed, the net force acting on the paper clip will be equal to the magnitude of the tension.

OR $F_{tension} + F_g = F_{magnet}$ *(as scalars)*

= 0,24 – 0,0196

= 0,22 N which is equal to the tension

5.1.4 Force due to magnet is not uniform / force increases closer to the magnet.

Equations of motion are for constant acceleration only.

5.2 5.2.1 The total linear momentum of an isolated system remains constant.

5.2.2 $Pbefore_{total} = Pafter_{total}$ OR $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$(0,16)(0,4) + (0,06)(-0,85) = (0,16)(0) + (0,06)v_2$

$\mathbf{v_2 = 0,22\ m{\cdot}s^{-1}}$ **to the right**

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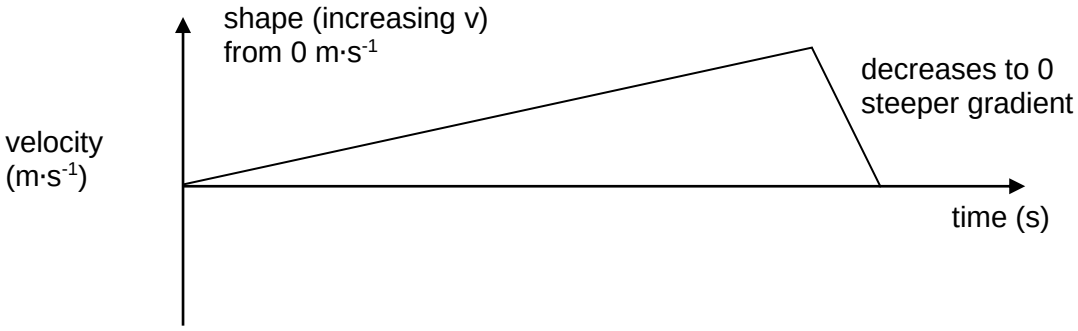
QUESTION 6

6.1 $W = F.s.\cos\theta$
$W = (55)(2).\cos 15°$
$W = 106,25$ J

6.2 *The force that opposes the motion of an object.*

6.3 $F_{fk} = \mu F_N$
$F_{fk} = (0,3)(12 \times 9,8 + 55.\sin 15°)$
$F_{fk} = 39,55$N

6.4



6.5 The same as
The component of the force parallel to the displacement is the same for both scenarios.
OR
There is the same angle between the same force and the same displacement in each case.

QUESTION 7

7.1 Equal to Newton's third law

7.2 *The work done by a net force on an object is equal to the change in the kinetic energy of the object.*

7.3 $F_{net} \cdot s = \Delta E_K = \frac{1}{2}mv_f^2 - mv_i^2$

$(F_{net})(44,6) = \frac{1}{2}(0,2)(0)^2 - \frac{1}{2}(0,2)(25)^2$

F_{net} = - 1,4 N

F_f = 1,4 N

7.4 *The product of the net force and the contact time.*

7.5 If the force is applied for a longer time / the contact time is increased, the change in momentum will be greater. $F_{net}.\Delta t = m.\Delta v$

7.6 $t_{ball} = \frac{s}{v}$

$t_{ball} = \frac{15}{14}$

$t_{ball} = 1,07s$

Player:

$s = ut + \frac{1}{2}at^2$ (both equations)

$6 = 0 + \frac{1}{2}$ (a) $(1,07 - 0,25)^2$

a = 17,78 m·s^{-2} (**a = 17,85 m·s^{-2}** if rounding)

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QUESTION 8

8.1 8.1.1 *Every particle with mass in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.*

8.1.2 $F = \frac{GM_1M_2}{r^2}$

$$F = \frac{\left(6,7\times10^{-11}\right)\left(3,3\times10^{23}\right)\left(1,99\times10^{30}\right)}{\left(46\times10^{9}\right)^2}$$

F = 2,08 × 10^{22} N

8.1.3 $g = \frac{GM}{r^2}$

$$g = \frac{\left(6,7\times10^{-11}\right)\left(3,3\times10^{23}\right)}{\left(2,441\times10^{6}\right)^2}$$

g = 3,71 m·s^{-2} OR **g = 3,71 N·kg^{-1}**

8.2 8.2.1 Electric field is *the force per unit positive charge.*

8.2.2 $E = \frac{kQ}{r^2}$

$$E = \frac{\left(9\times10^{9}\right)\left(12\times10^{-9}\right)}{\left(6\times10^{-2}\right)^2}$$ conversions

E = 30 000 N·C^{-1} away from the 12 nC charge / towards X / away from Y / to the left

8.2.3 Towards **X**
P is closer to the sphere with greater magnitude of positive charge

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QUESTION 9

9.1 *Current through a conductor is directly proportional to the potential difference across the conductor at constant temperature.*

9.2 $V_2 = IR$
$V_2 = (0,8)(13,7)$
$V_2 = 10,96$ V

9.3 $$\frac{1}{R_P} = \frac{1}{R_{bulb}} + \frac{1}{R_R}$$
$$\frac{1}{R_P} = \frac{1}{24} + \frac{1}{16}$$
$R_P = 9,6\ \Omega$

9.4 $$A_2 = \frac{I_{TOTAL}}{(R_1 + R_2)} \times R_1$$

$$A_2 = \frac{(0,8)}{(24 + 16)} \times 24$$

I = 0,48 A

OR $V_{parallel} = I_{parallel} \times R_{parallel}$
$V = (0,8)(9,6)$ (c.o.e from 9.3)
$V = 7,68$ V

$$A_2 = \frac{V_{parallel}}{R_R}$$
$$I = \frac{7,68}{16}$$
I = 0,48 A

9.5 $P = I^2R$
$P = (0,8 - 0,48)^2\ (24)$ (c.o.e from 9.4)
P = 2,46 W

OR $P = VI$
$P = (7,68)\ (0,8 - 0,48)$ (c.o.e from 9.4)
P = 2,46 W

OR $$P = \frac{V^2}{R}$$
$$P = \frac{(7,68)^2}{24}$$
P = 2,46 W

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9.6 $V = \varepsilon - Ir$
$10,96 + 7,68 = 20 - (0,8)r$ (c.o.e. from Q 9.2)
$r = 1,7\ \Omega$

OR

$emf = I(R_{ext} + r)$
$20 = (0,8)(9,6 + 13,7 + r)$ (c.o.e. from Q 9.3)
$r = 1,7\ \Omega$

9.7 9.7.1 DECREASE

9.7.2 INCREASE (less current) fewer 'lost volts' (Ir)

9.7.3 INCREASE greater voltage across bulb

QUESTION 10

10.1 10.1.1 *The induced current flows in a direction so as to set up a magnetic field to oppose the change in magnetic flux.*

10.1.2 North

10.1.3 Coil moves away from the magnet.
Reading on ammeter.

10.1.4 Coil moves / swings towards the magnet
Relative movement induces magnetic field / causes coil to be repelled.
Coil will swing back and forth/oscillate.

10.2 10.2.1 Step-up. More turns on secondary coil than primary coil.

10.2.2 $\frac{V_S}{V_P} = \frac{N_S}{N_P}$

$\frac{V_S}{48} = \frac{414}{92}$

$V_S = 216\ V$

10.2.3 Change in flux needed in the primary coil to induce an emf in the secondary coil. Only change in flux around AC, not DC.

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QUESTION 11

11.1 Threshold (cut-off) frequency (f_0) is *the minimum frequency of incident radiation at which electrons will be emitted from a particular metal.*

11.2 $W_0 = hf_0$

$$\left(4,3\times1,6\times10^{-19}\right)=\left(6,6\times10^{-34}\right)f_0$$

$$f_0=\frac{\left(4,3\times1,6\times10^{-19}\right)}{\left(6,6\times10^{-34}\right)}$$

$$f_0=\frac{\left(6,88\times10^{-19}\right)}{\left(6,6\times10^{-34}\right)}$$

$f_0 = 1,04 \times 10^{15}$ Hz

OR $W_0 = hf_0$

$$\left(4,3\right)=\frac{\left(6,6\times10^{-34}\right)}{\left(1,6\times10^{-19}\right)}\ f_0$$

$$f_0=\frac{\left(4,3\times1,6\times10^{-19}\right)}{\left(6,6\times10^{-34}\right)}$$

$$f_0=\frac{\left(4,3\right)}{4,125\times10^{-15}}$$

$f_0 = 1,04 \times 10^{15}$ Hz

11.3 $hf = W_0 + E_{K(max)}$

$(6,6 \times 10^{-34})(18 \times 10^{14}) = 6,88 \times 10^{-19} + E_{K(max)}$

$E_{K(max)} = 5 \times 10^{-19}$J

OR
$hf = W_0 + E_{K(max)}$

$$\frac{\left(6,6\times10^{-34}\right)}{\left(1,6\times10^{-19}\right)}\left(18\times10^{14}\right)=4,3+\ E_{K(max)}$$

$E_{K(max)}$ = 3,125 eV (=3,13 eV)

11.4 11.4.1 STAY THE SAME

11.4.2 INCREASE

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11.5 $c = f\lambda$

$\left(3\times10^{8}\right) = f\left(200\times10^{-9}\right)$

$f = 15 \times 10^{14}$ Hz

This frequency is greater than f_0 so electrons will be emitted.

OR $E = \frac{hc}{\lambda}$

$= \frac{(6{,}6\times10^{-34})(3\times10^{8})}{(200\times10^{-9})}$

$= 9{,}9 \times 10^{-19}\ J$

This energy is greater than the work function of aluminium ($6{,}88 \times 10^{-19}\ J$), so electrons will be emitted.

Total: 200 marks

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