NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2017

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

[20]

QUESTION 2

2.1 Velocity is the rate of change of position OR the rate of displacement OR the rate of change of displacement. (2)

2.2 AB (0 – 3 s); DE (7 – 8 s); FG (9 – 10 s) (3)

2.3 BC (3 – 5 s); EF (8 – 9 s) (2)

2.4 CF (5 – 9 s) (2)

2.5 Acceleration is the rate of change of velocity. (2)

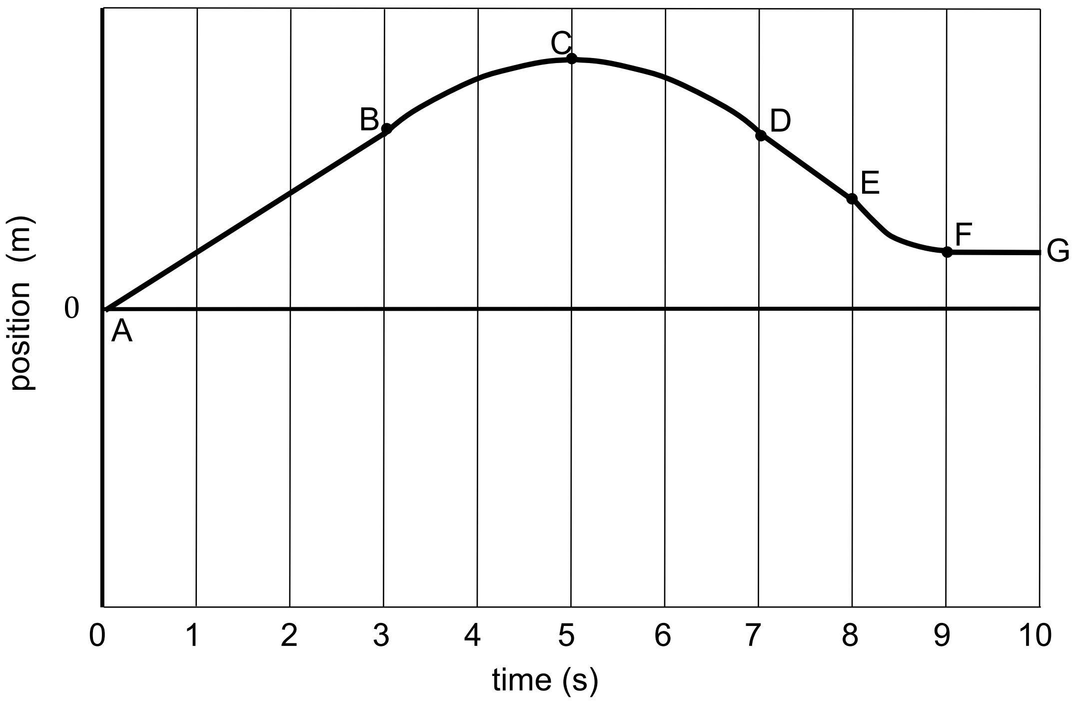
2.6 a = slope of v-t graph OR $\frac{\Delta v}{\Delta t}$ OR $v = u + at$

$a = \frac{-2-2}{7-3}$ $-2 = 2 + a(4)$

a = – 1 a = – 1

a = 1 m·s^{-2} South **a = 1 m·s^{-2} South** (4)

2.7

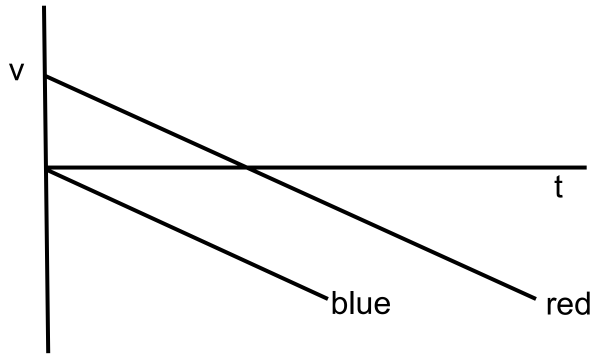


(6)

[21]

QUESTION 3

3.1



(3)

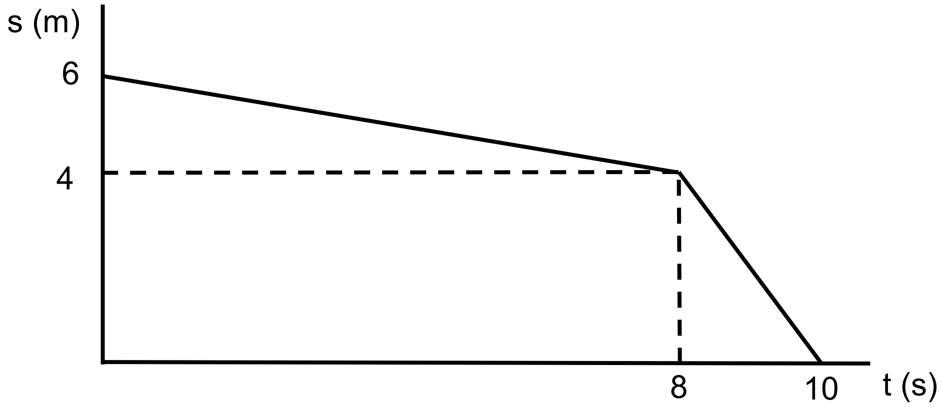
3.2 3.2.1 $s = ut + \frac{1}{2}at^2$

$s = (0,25)(8) + 0$

$s = 2\ \text{m}$

∴ cat is 6 – 2 = 4 m from mouse (3)

3.2.2



(or mirror image in *x*-axis) (3)

3.2.3 *v* = slope of *s* – *t* graph OR $v = \frac{s}{t} = \frac{4}{2}$

$\boldsymbol{v = 2\ \text{m}\cdot\text{s}^{-1}}$ $\boldsymbol{v = 2\ \text{m}\cdot\text{s}^{-1}}$ (2)

3.3 3.3.1 while $a = 20\ \text{m}\cdot\text{s}^{-2}$

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

$s = 0 + \frac{1}{2}20(15)^2$ $v = 0 + 20(15)$

$s = 2\ 250\ \text{m}$ $v = 300\ \text{m}\cdot\text{s}^{-1}$

while *a* = *g*

$v^2 = u^2 + 2as$

$0^2 = 300^2 + 2(-9,8)s$

$s = 4\ 591{,}84\ \text{m}$

max height = 2 250 +4 591,84

max height = 6 841,84 m (6)

3.3.2 Time to max height after rocket runs out of fuel

$v = u + at$

$0 = 300 + (-9,8)t$

$t = 30,61 \text{ s}$

Time to reach the ground from max height

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

$-6\,841,84 = 0 + \frac{1}{2}(-9,8)t^2$

$t = 37,37 \text{ s}$

total $t = 15 + 30,61 + 37,37$

total $t = 82,98$ s

OR

Time to max height after rocket runs out of fuel

$s = \frac{u+v}{2}t$

$4\,591,84 = \frac{300+0}{2}t$

$t = 30,61 \text{ s}$

Time to reach the ground from max height

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

$-6\,841,84 = 0 + \frac{1}{2}(-9,8)t^2$

$t = 37,37 \text{ s}$

total $t = 15 + 30,61 + 37,37$

total $t = 82,98$ s

OR

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

$-2\,250 = 300t + \frac{1}{2}(-9,8)t^2$

$t = 67,98 \text{ s}$

total t = 15 +67,98

total $t = 82,98$ s (5)

3.3.3 as it hits the ground (2)

[24]

QUESTION 4

4.1 4.1.1 Newton's second law. 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.

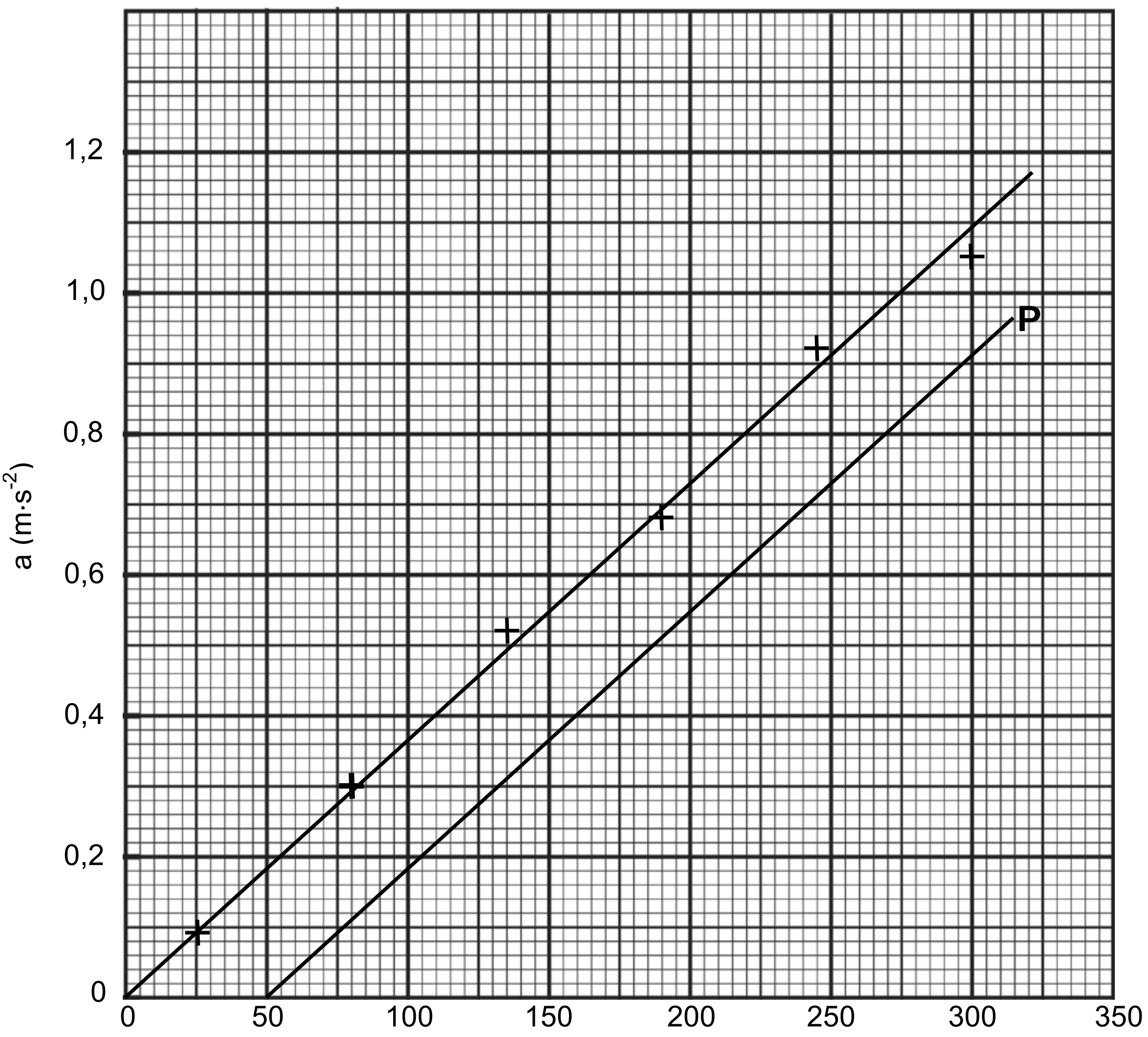
OR

Newton's second law. The net force acting on an object is equal to the rate of change of momentum. (3)

4.1.2 acceleration (2)

4.1.3

Graph to show acceleration vs force



Graph – on answer sheet
Heading
y-axis title and unit
y-axis scale (plotted points > $\frac{1}{2}$ graph paper)
plotted points
line of best fit (6)

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

Gradient $= \frac{\text{values from } y\text{-axis}}{\text{values from } x\text{-axis}}$ (values must be from LOBF on graph)

Gradient $= 3{,}54 \times 10^{-3}$ m·s^{-2}·mN^{-1} or g^{-1}

(allow $3{,}19 \times 10^{-3} - 3{,}89 \times 10^{-3}$)

OR

Gradient = 3,54 m·s^{-2}·N^{-1} or kg^{-1}

(allow 3,19 – 3,89) (4)

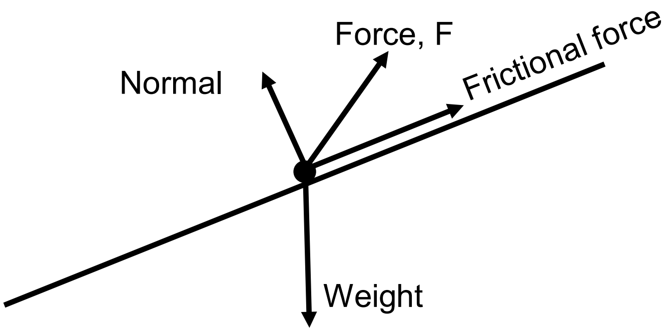
4.1.5 $F_{net} = ma$; $F - \text{Friction} = ma$; $a = \frac{1}{m}F$

$\frac{1}{m} = 3{,}54 \times 10^{-3}$ OR $\frac{1}{m} = 3{,}54$

***m* = 282 g** ***m* = 0,282 kg** (3)

4.1.6 Sketch line parallel to line of best fit and *x* intercept 50 mN (line labelled P on graph). (2)

4.2 4.2.1



(4)

4.2.2 $w_{\parallel plane} = mg\sin 35°$

$w_{\parallel plane} = 150(9{,}8)\ \sin 35°$

$\boldsymbol{w_{\parallel plane} = 843{,}16\ \text{N}}$ (3)

4.2.3 $F_f + F\cos 40° = 843{,}16$

$F_f + 100\cos 40° = 843{,}16$

$\boldsymbol{F_f = 766{,}55\ \text{N}}$ (4)

4.2.4 ⊥: $F_N + F\sin 40° = mg\cos 35°$

||: $mg\sin 35° = F_f + F\cos 40°$

$mg\sin 35° = \mu F_N + F\cos 40°$

$mg\sin 35° = \mu(mg\cos 35° - F\sin 40°) + F\cos 40°$

$mg(\sin 35° - \mu\cos 35°) = F(\cos 40° - \mu\sin 40°)$

$150(9{,}8)(\sin 35° - 0{,}7\cos 35°) = F(\cos 40° - 0{,}7\sin 40°)$

$\boldsymbol{F = 0{,}79\ \text{N}}$ (4)

[35]

QUESTION 5

5.1 5.1.1 Frictional force is the force that opposes the motion of an object. (2)

5.1.2 $E_K = \frac{1}{2}mv^2$

$E_K = \frac{1}{2}(2)(1,5)^2$

$\boldsymbol{E_K = 2,25}$ **J** (3)

5.1.3 $W = Fs$

$W = (26)(0,7)$

$\boldsymbol{W = 18,2}$ **J** (3)

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

5.1.5 $W = \Delta E_k$

$-18,2 = 2,25 - \frac{1}{2}(2)v_1^2$ coe

$\boldsymbol{v_1 = 4,52}$ **m·s**$^{-1}$

OR

$F_{net} = ma$ for both equations

$-26 = 2a$

$a = -13$ m·s^{-2}

$v^2 = u^2 + 2as$

$1,5^2 = u^2 + 2(-13)(0,7)$

$u = 4,52$ m·s^{-1} (4)

5.2 5.2.1 In the absence of air resistance or any external forces, the mechanical energy of an object is constant. (2)

5.2.2 crate: $\frac{1}{2}mv^2 = mgh$

$\frac{1}{2}(1,2)v^2 = (1,2)(9,8)(0,65)$

$\boldsymbol{v = 3,57}$ **m·s**$^{-1}$ (4)

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

5.2.4 $(p_{total})_{before} = (p_{total})_{after}$

$0,4v_b + 0 = (0,4)(-0,36) + 1,2(3,57)$

$\boldsymbol{v_b = 10,35}$ **m·s**$^{-1}$ (4)

[26]

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 $F_1 = \frac{Gm_1m_2}{r^2}$

$F_1 = \frac{(6,7\times10^{-11})(700)(5,8\times10^{24})}{(7,4\times10^6)^2}$

$\mathbf{F_1 = 4\ 967,49\ N}$ (3)

6.1.3 $F_2 = \frac{G\left(\frac{1}{2}m_1\right)m_2}{(1,8r)^2}$

$F_2 = \frac{0,5}{(1,8)^2}F_1$

$\mathbf{\frac{F_2}{F_1} = 0,15}$ (3)

6.2 6.2.1 $s = ut + \frac{1}{2}at^2$

$0,6 = 0 + \frac{1}{2}a(3,3)^2$

$\mathbf{a = 0,11\ m\cdot s^{-2}}$ (3)

6.2.2 $ma = \frac{kqQ}{r^2}$

$(0,020)(0,11) = \frac{(9\times10^9)(1\times10^{-9})Q}{(0,6)^2}$

$\mathbf{Q = 8,8\times10^{-5}\ C}$

OR

$F_{net} = ma$	$E = \frac{F}{q}$	$E = \frac{kQ}{r^2}$ for all equations
$F_{net} = (0,020)(0,11)$	$E = \frac{0,0022}{1\times10^{-9}}$	$2,2\times10^6 = \frac{(9\times10^9)Q}{(0,6)^2}$
$F_{net} = 0,0022\ N$	$E = 2,2\times10^6$	$Q = 8,8\times10^{-5}$ **C** (4)

6.2.3 Acceleration is not constant. Electric field and hence force depends on distance from charge *Q*. (3)

[18]

QUESTION 7

7.1 7.1.1 The current through a conductor is directly proportional to the potential difference across the conductor at constant temperature (or constant resistance). (2)

7.1.2 $V = RI$

$12 = 8I$

$\boldsymbol{I = 1{,}5\ \text{A}}$ (3)

7.1.3 $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R_P} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12}$

$\boldsymbol{R_P = 2{,}18\ \Omega}$ (3)

7.1.4 $V = RI$

$12 = 2{,}18I$

$\boldsymbol{I = 5{,}5\ \text{A}}$

OR

$4\Omega : I = 3\ \text{A}$

$8\Omega : I = 1{,}5\ \text{A}$

$12\Omega : I = 1\ \text{A}$

$\boldsymbol{I = 5{,}5\ \text{A}}$ (3)

7.1.5 $V = emf - Ir$

$12 = 16{,}5 - 5{,}5r$

$\boldsymbol{r = 0{,}82\ \Omega}$ (3)

7.2 7.2.1 Power is the rate at which work is done.
OR the rate at which energy is transferred. (2)

7.2.2 $P = \frac{V^2}{R}$

$P = \frac{220^2}{50}$

$\boldsymbol{P = 968\ \text{W}}$ (3)

7.2.3 cost = kW $\times$ time $\times$ unit cost

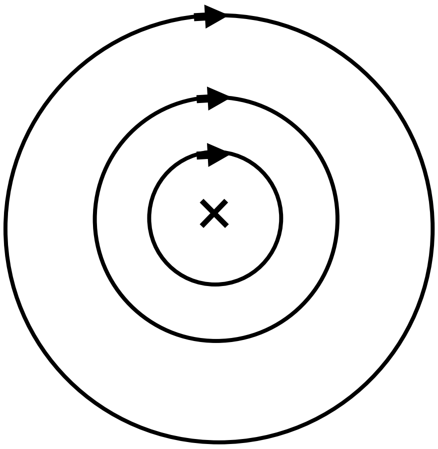
$80 = (0{,}968)t(1{,}24)$

$\boldsymbol{t = 66{,}65\ \text{hours}}$ (66 hours 39 min; 3998,93 min; 239936 s) (4)

[23]

QUESTION 8

8.1 8.1.1



Current direction
Concentric circles
Magnetic field direction

(3)

8.1.2 into page (2)

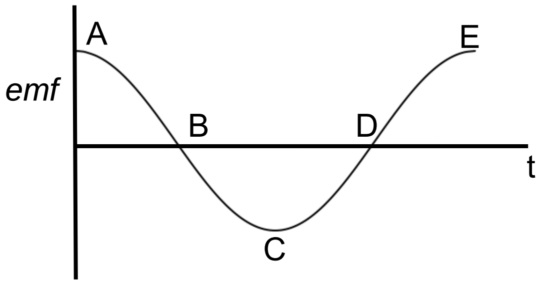
8.1.3 use a.c. or current continuously changes direction
∴ force on current carrying conductorchanges direction
∴ vibrates (3)

8.2 8.2.1 mechanical energy → electrical energy (2)

8.2.2 yes, there are slip rings or no split rings (2)

8.2.3 The *emf* induced is directly proportional to the rate of change of magnetic flux (flux linkage) (2)

8.2.4



OR negative of graph

shape
max *emf* for A
B and D at zero (3)

8.2.5 at point C, $\frac{\Delta\phi}{\Delta t}$ = maximum
∴ *emf* is a maximum

OR

at point C, $\frac{\Delta\phi}{\Delta t}$ = maximum
Polarity of C is opposite as coil has rotated 180° relative to A (2)

[19]

QUESTION 9

9.1 3 (2)

9.2 $\Delta E = hf$

$(13,6 - 3,4)(1,6 \times 10^{-19}) = 6,6 \times 10^{-34} f$

$(10,2)(1,6 \times 10^{-19}) = 6,6 \times 10^{-34} f$

$\boldsymbol{f = 2,47 \times 10^{15}}$ **Hz** (4)

9.3 9.3.1 $E = \dfrac{hc}{\lambda}$

$E = \dfrac{(6,6 \times 10^{-34})(3 \times 10^{8})}{655 \times 10^{-9}}$

$E = 3,02 \times 10^{-19}$ J

$\boldsymbol{E = 1,89}$ **eV**

OR

$c = f\lambda$ (for both formulae)

$3 \times 10^{8} = f(655 \times 10^{-9})$

$f = 4,58 \times 10^{14}$ Hz

$E = hf$

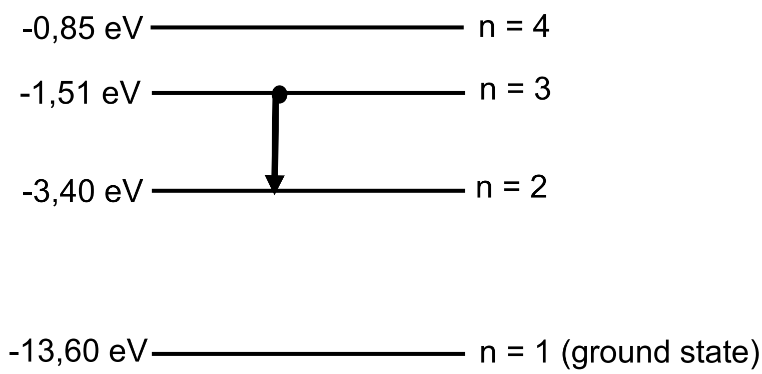
$E = (6,6 \times 10^{-34})(4,58 \times 10^{14})$

$E = 3,02 \times 10^{-19}$ J

$\boldsymbol{E = 1,89}$ **eV** (4)

9.3.2 $n = 3 \rightarrow n = 2$

Direction



(2)

9.4 A free electron has energy of zero. Electrons will gain energy as they move up a level

OR

A free electron has energy of zero so an electron releases energy as it moves to a lower level (2)

[14]

Total: 200 marks