5 Memorandum: Maths in physics

1.1 B $W_{net} = F_{net}\Delta x cos\theta$ F_{net} and θ constant therefore $W_{net} \propto \Delta x$

1.2 A K = 0 at biggest height and K will be largest at the bottom when $h = 0$ therefore B and C can not be the answer

E_{mech} is conserved (no air friction)

$$E_{mech\ i} = E_{mech\ f}$$
$$E_{mech\ i} = E_K + E_p$$
$$E_{mech\ i} = K + mgh$$
$$K = -mg\ h\ +\ E_{mech\ i} \qquad \text{(Straight line : } y = mx + c)$$

gradient y-intercept

1.3 B

Option 1:
Choose the equation
and rewrite to isolate a:

$$F_{net} = ma$$
$$a = \frac{F_{net}}{m}$$

Substitute the new values
and compare with the original:

$$a_{new} = \frac{F_{net}}{2m}$$
$$= \frac{1}{2}\frac{F_{net}}{m}$$
$$= \frac{1}{2}a$$

Option 2:
Choose the equation
and rewrite to isolate a:

$$F_{net} = ma$$
$$a = \frac{F_{net}}{m}$$
$$a \propto \frac{1}{m}$$

When m increase with factor 2,
a will decrease with factor 2

$$a_{new} = \frac{1}{2}a$$

1.4 B

$$W_{net} = \Delta E_k = \frac{1}{2}m(v_f^2 - v_i^2)$$

Substitute the values for both situations and compare them:

$$W_{old} = \frac{1}{2}m((2v)^2 - v^2)$$
$$= \frac{1}{2}m(4v^2 - v^2)$$
$$= \frac{1}{2}m(3v^2)$$
$$= 3\,[\frac{1}{2}mv^2]$$

$$W_{new} = \frac{1}{2}m(v^2 - 0)$$
$$= \frac{1}{2}mv^2$$

$$W_{old} = 3\,W_{new}$$
$$W_{new} = \frac{1}{3}W_{old}$$

1.5 C $K = \frac{1}{2}mv^2$ with $m =$ constant therfore $K \propto v^2$ (parabola)

E_{mech} is conserved (no air friction)
K + U = constant

$$E_{mech\ i} = E_{mech\ f} \qquad \text{Freefall}$$
$$E_{mech\ i} = K + U$$
$$E_{mech\ i} = \frac{1}{2}mv^2 + U$$
$$U = -\frac{1}{2}mv^2 + E_{mech\ i}$$

Negative constant (upside down) — parabola — y-intercept

1.6a

$$F_g = mg$$
$$gradient = \frac{F_g}{m} = g$$
$$g = \frac{49 - 0}{10 - 0} = 4{,}9\ m \cdot s^{-2}$$

1.6b

Option 1:

$$g = 9{,}8 m \cdot s^{-2}$$
$$g_X = 4{,}9 = \frac{9{,}8}{2} = \frac{g}{2}$$
$$g = \frac{GM}{r^2}$$
$$g \propto M$$

g decreases with factor 2,
therfore M decreases with factor 2

$$M_X = \frac{1}{2}M_{earth}$$

Option 2:

$$g_X = 4{,}9 = \frac{9{,}8}{2} = \frac{g}{2}$$
$$g = \frac{GM}{r^2}$$

Rewrite to isolate M:

$$M_{earth} = \frac{gr^2}{G}$$
$$M_X = \frac{(\frac{g}{2})r^2}{G} = \frac{1}{2}M_{earth}$$

1.7a

$$\text{Impulse} = \Delta p$$
$$= p_f - p_i$$
$$= -2 - 6 \qquad \text{(read } p_i \text{ and } p_f \text{ from the graph)}$$
$$= -8$$
$$= 8\ N \cdot s,\ west$$

1.7b

$$\text{Impulse} = F_{net}\Delta t$$
$$-8 = F_{net}(3) \qquad \text{(read } \Delta t \text{ from the graph)}$$
$$F_{net} = -2{,}67$$
$$= 2{,}67\ N,\ west$$

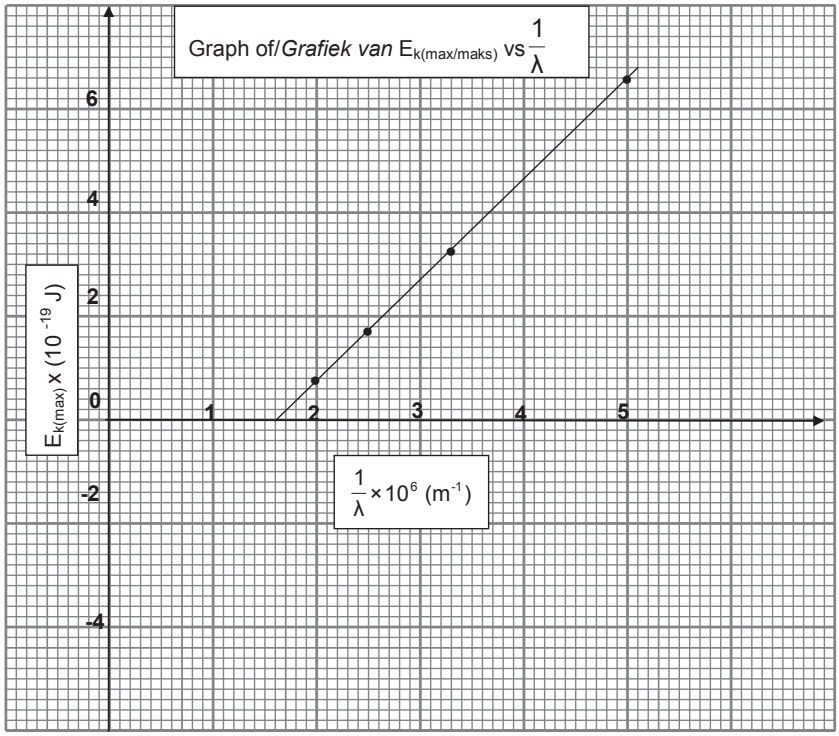
1.7c $2{,}67\ N,\ east$

QUESTION 11/*VRAAG 11*

11.1 It is the process whereby electrons are ejected from a metal surface when light (of suitable frequency) is incident on it. ✓✓

(2)

11.2



11.3.1

<u>OPTION 1/OPSIE 1</u>

$\frac{1}{\lambda} = 1{,}6 \times 10^6\ m^{-1}$ ✓

$f_o = c\frac{1}{\lambda}$ ✓

$= (3 \times 10^8)(1{,}6 \times 10^6)$ ✓

$= 4{,}8 \times 10^{14}$ Hz✓ (**Accept** 4,8 x 10^{14} Hz to/*to* 5,1 x 10^{14} Hz)

<u>OPTION 2/OPSIE 2</u>

By extrapolation: y-intercept = $-W_o$

$W_o = hf_o$ ✓

$3{,}2 \times 10^{-19}$✓ $= (6{,}63 \times 10^{-34})f_o$ ✓

$f_o = 4{,}8 \times 10^{14}$ Hz✓ (**Accept** 4,8 x 10^{14} Hz to/*tot* 4,83 x 10^{14} Hz)

<u>OPTION 3/OPSIE 3</u> (Any points from the graph)

$E = W_o + E_{k(max)}$

$\frac{hc}{\lambda_0} = hf_0 + E_{k(max)}$ ✓

$(6{,}63 \times 10^{-34})(3 \times 10^8)(1{,}6 \times 10^6) = (6{,}63 \times 10^{-34})f_0 + 0$

$f_o = 4{,}8 \times 10^{14\ Hz.}$

(4)

11.3.2

OPTION 1/*OPSIE 1*

hc = Gradient/ *Helling* ✓

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

$= \frac{6,6 \times 10^{-19}}{(5 - 1,6) \times 10^{6}}$ ✓

$= 1,941 \times 10^{-25}$ (J·m)

$h = \frac{\text{gradient / helling}}{c}$

$h = \frac{1,941 \times 10^{-25}}{3 \times 10^{8}}$ ✓

$= 6,47 \times 10^{-34}$ J·s ✓

OPTION 2/*OPSIE 2*

W_0 = y intercept/*afsnit* } ✓
$= 3,2 \times 10^{-19}$ J

Accept
$3,2 \times 10^{-19}$ J to $3,4 \times 10^{-19}$J)

$W_o = hf_o$
$3,2 \times 10^{-19}$ ✓ = h(4,8 x 10^{14}) ✓
h = 6,66 x 10^{-34} J·s ✓

Accept
6,66 x10^{-34} J·s to 7,08 x10^{-34}J·s)

(4)

OPTION 3/*OPSIE 3*
(Points from the graph

$\frac{hc}{\lambda} = W_0 + K_{max} = 3,2 \times 10^{-19}$ ✓ $+ 6,6 \times 10^{-19}$ ✓

$h = \frac{9,8 \times 10^{-19}}{(3 \times 10^{8})(5 \times 10^{6})}$ ✓ $= 6,53 \times 10^{-34}$ ✓ J·s

OR/*OF*

$\frac{hc}{\lambda} = W_0 + K_{max} = 3,2 \times 10^{-19}$ ✓ $+ 3,3 \times 10^{-19}$ ✓

$h = \frac{6,5 \times 10^{-19}}{(3 \times 10^{8})(3,3 \times 10^{6})}$ ✓ $= 6,57 \times 10^{-34}$ J·s

OR/*OF*

$\frac{hc}{\lambda} = W_0 + K_{max} = 3,2 \times 10^{-19}$ ✓ $+ 1,7 \times 10^{-19}$

$h = \frac{4,7 \times 10^{-19}}{(3 \times 10^{8})(2,5 \times 10^{6})}$ ✓ $= 6,27 \times 10^{-34}$ J·s

OR/*OF*

$\frac{hc}{\lambda} = W_0 + K_{max} = 3,2 \times 10^{-19}$ ✓ $+ 0,7 \times 10^{-19}$ ✓

$h = \frac{3,9 \times 10^{-19}}{(3 \times 10^{8})(2 \times 10^{6})}$ ✓ $= 6,5 \times 10^{-34}$ J·s

OPTION 4/*OPSIE 4*

$W_o = \frac{hc}{\lambda_o}$ or / of $W_o = hc\frac{1}{\lambda_o}$

$3,2 \times 10^{-19}$ ✓= h(3 x 10^{8})(1,6 x 10^{6})✓
h = 6,66 x 10^{-34} J·s ✓

(4)
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QUESTION 11 / *VRAAG 11*

11.1 The energy transferred to / work done on ✓ each coulomb (of charge) / per C charge ✓ passing through the battery.

Die lading oorgedra / arbeid verrig op✓ elke coulomb (lading) / per C lading ✓ wat deur die battery beweeg. (2)

11.2 Gradient / *helling* $= \frac{3,8 - 0,5}{9 - 0}$ ✓✓

$= 0,37\ (V^{-1})$ ✓

Note / *Aantekening*:
• Accept any correct values from graph to calculate the gradient.
• *Aanvaar enige korrekte waarde vanaf grafiek om helling te bereken.*

(3)

11.3 $\frac{1}{emf}$ ✓ (1)

11.4 11.4.1 **POSITIVE MARKING FROM QUESTION *11.2* / *POSITIEWE NASIEN VAN VRAAG 11.2***

OPTION 1 /*OPSIE 1*	**OPTION 2 / *OPSIE 2***
$\frac{1}{emf} = 0,37$ ✓ ε (emf) = 2,70 V ✓ **Range/*Aanvaar*:** 2,67 – 2,70 V	emf = 2(0) + 2r emf = 0,26(9) + 0,26r 0 = - 2,34 + 1,74r r = 1,34 Ω ε = 2(0) + 2r = 2(1,34) = 2,67 V ✓

(2)

11.4.2 **POSITIVE MARKING FROM QUESTION 11.2 AND 11.3.1 / *POSITIEWE NASIEN VAN VRAAG 11.2 EN 11.3.1***

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***
Emf = I(R + r) y = mx + c: $\frac{1}{I} = \frac{1}{emf}R + \frac{r}{emf}$ y intercept/ af snit= $\frac{r}{emf}$ 0,5 ✓ = $\frac{r}{2,70}$ ✓ R = 1,35 Ω ✓ Range / *aanvaar*: 1,34 - 1,35 Ω	Any two equation using values from the graph / *Enige twee vergelykings waar waardes van grafiek gebruik is*: emf = 2(0) + 2r ✓ emf = 0,26(9) + 0,26r ✓ 0 = - 2,34 + 1,74r r = 1,34 Ω ✓

(3)
[11]