INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
MAY 2025

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

No	Answer	Reason
1.1	D	Vertical will be influenced by g but not horizontal
1.2	C	Increasing gradient, constant gradient, decreasing gradient but moving further away
1.3	B	A speed with which it hits the ground, distance up must equal distance down so area up = area down, B max height so speed=0
1.4	C	Air resistance increases until it equals weight (for constant speed). Thus, the resultant force (of resistance and weight) will decrease.
1.5	D	kW.h = $J.s^{-1}$. s = J = N.m = $kg.m.s^{-2}$ m = $kg.m^2s^{-2}$
1.6	B	$p_{before} = p_{after}$, 3m v – m 2v = (3m+m) v_f, v_f = mv / 4m = v/4
1.7	B	I = V/R = 10,5 / 15 = 0,7 A
1.8	A	$\frac{1}{R} = \frac{1}{10} + \frac{1}{30} = \frac{4}{30}$ $R = 7{,}5\ \Omega$
1.9	B	B to C emf and current increase, so Flux will decrease
1.10	A	Biggest difference in energy between orbitals gives highest frequency and thus lowest wavelength. Other drops added in will give 6 possible drops.

QUESTION 2

2.1 A vector has magnitude and direction.

2.2 2.2.1 The time passing before a person actually reacts to what he/she sees.

2.2.2 $\Delta x = ut + \frac{1}{2} at^2$
$16 = 30t + 0$
$t = 0{,}53$ s
OR

$\Delta x = (\frac{v_i+v_f}{2})\Delta t$
$16 = (\frac{30+30}{2})\Delta t$
$\Delta t = 0{,}53$ s

2.2.3 Rate of change of velocity.

2.2.4 $v^2 = u^2 + 2a\Delta x$
$0 = (20)^2 + 2a(24)$
$= 400 + 48a$
$a = -8{,}33\ m.s^{-2}$
$= 8{,}33\ m.s^{-2}$ against movement

2.2.5 $v = u + at$
$0 = 20 + (–8,33)t$
$t = 2,40$ s while braking

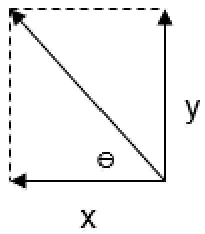
$\Delta x = ut + ½ at^2$
$12 = 20t + 0$
$t = 0,60$ s during reaction time

total time = 2,40 + 0,60 = 3,0 s

2.3.1 y-components:
15 cos 25º OR 15 sin 65º = 13,59 N, up (north)
18 sin 15º OR 18 cos 75º = 4,66 N, down (south)

x-components:
15 sin 25º OR 15 cos 65º = 6,34 N, right (east)
18 cos 15º OR 18 sin 75º = 17,39 N left (west)

Resultant y-comp: 13,59 – 4,66 = 8,93 N North/up
x-comp: 17,39 – 6,34 = 11,05 N west/left



Pyth: $F_R^2 = (8,93)^2 + (11,05)^2$ $\tan \Theta = \dfrac{8,93}{11,05}$

$F_R = \sqrt{202,07}\ N = 14,22$ N $\Theta = 38,94^0$ N of W
OR $51,06^0$ W of N
OR $308,94^0$

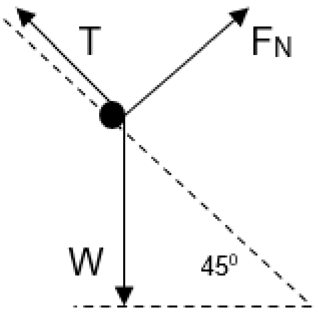
QUESTION 3

3.1 3.1.1 *When object A exerts a force on object B, object B* ***simultaneously*** *exerts an oppositely directed force of equal magnitude on object A.*

3.1.2 force of block on surface – force of surface on block / (P) / Normal force

3.1.3 W = mg = (0,49)(9,8) = 4,80 N

3.1.4

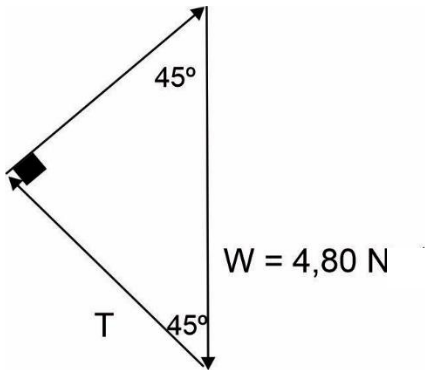


T = Tension in string

W = weight/Gravitational Force **OR** components

F_N = normal force (or P)

3.1.5



$W_{//} = T$

(Sin 45° = cos 45°)

$T = W_{//} = 4{,}80 \sin 45°$

$= 3{,}39$ N (3,40N)

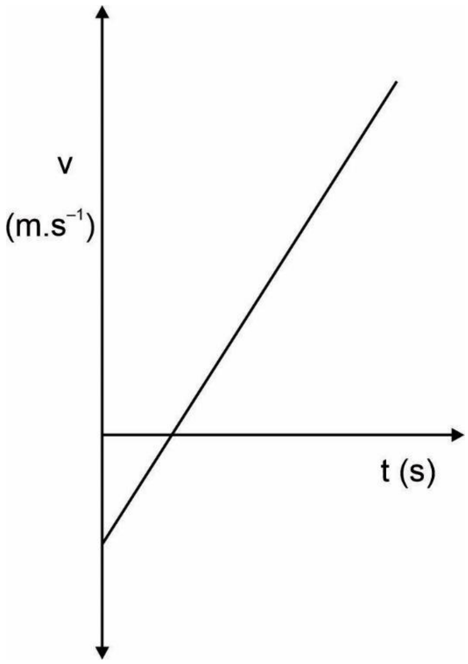
3.1.6 mg = T
m = 3,39 / 9,8 = 0,35 kg

3.1.7 Set of masses: $F_G - T = ma$
$(0{,}35)(9{,}8) - 3{,}2 = 0{,}35\,a$
$a = 0{,}66 \text{ m.s}^{-2}$

block: $T - F_{G//} = ma$
$3{,}2 - F_{G//} = (0{,}49)(0{,}66)$
$F_{G//} = 2{,}877$ N

$\sin \Theta = 2{,}877 / 4{,}8$
$\Theta = 36{,}8°$ (angle of incline)

3.1.8



Starting point
Shape

3.2 3.2.1 *When a net force, F_{net}, is applied to an object of mass, m, it accelerates in the direction of the net force. The acceleration, a, is directly proportional to the net force and inversely proportional to the mass.*

3.2.2 $F_N = F_G + F_A$
$= (30)(9{,}8) + 12 \sin 30^\circ$ [$F_A = 12 \sin 30^\circ$ OR $12 \cos 60^\circ$]
$= 294 + 6$
$= 300$ N

3.2.3 $F_f = \mu_k F_N$
$= (0{,}032)(300)$
$= 9{,}6$ N

3.2.4 Greater than
as static coefficient is bigger than kinetic coefficient of friction.

3.2.5 $F_{Ax} = 12 \sin 60^\circ = 10{,}39$ N OR $12 \cos 30^\circ = 10{,}39$ N
$F_R = ma$
$F_{Ax} - F_f = ma$
$10{,}36 - 9{,}6 = 30a$
$a = \frac{0{,}76}{30} = 0{,}025 = 0{,}03\ m.s^{-2}$ right

QUESTION 4

4.1 The force acting on an object to move it times the distance that it is moving but it must be in the same direction.

4.2 4.2.1 F = ma, so for same mass $a \propto F$
If F varies, a will vary

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

4.2.3 Work done by $F_R = \Delta E_k$
Area under graph = $\frac{1}{2} m \Delta v^2$
$\frac{1}{2}(x)(14) = \frac{1}{2}(8)(0 - 1,5)^2$
$7x = 9,0$
$x = 1,29$ m

4.3 4.3.1 $E_{k\ max} = \frac{1}{2} m v^2$
$= \frac{1}{2}(0,065)(1,6)^2$
$= 0,08$ J (0,0832J)

4.3.2 $v^2 = u^2 + 2a\Delta x$
$0 = (1,6)^2 + 2(-9,8)\Delta x$
$\Delta x = \frac{2,56}{19,6}$
$= 0,13$ m

OR

$E_{pmax} = mgh$
$0,0832 = (0,065)(9,8)h$
$h = 0,13$ m

4.3.3 $v = u + at$
$t = \frac{0-1,6}{-9,8}$ (signs important)
$t = 0,16$ s

4.3.4 distance down = 0,13 + 0,5 = 0,63 m to water surface (coe 4.3.2)
$v^2 = u^2 + 2a\Delta x$
$= 0 + 2(-9,8)(-0,63)$ (signs important)
$= 12,348$
$v = 3,51\ m.s^{-1}$
OR
$v^2 = u^2 + 2a\Delta x$
$= (1,6)^2 + 2(-9,8)(-0,5)$
$= 2,56 + 9,8$
$v_f = 3,52\ m.s^{-1}$

4.3.5 $W_R = \Delta E_k$
$W_R = \frac{1}{2}(0,065)[(0)^2 - (3,51)^2]$
$= -0,40$ J Neg. sign

4.3.6 $W_R = F_R \Delta x$
$-0,40 = F_R(-0,12)$
$F_R = 3,33$ N

4.3.7 $F_{water} = F_G + F_R$

$= (0,065)(9,8) + 3,33$

$= 0,637 + 3,33$

$= 3,97$ N

QUESTION 5

5.1 180 $km.h^{-1}$ = 50 $m.s^{-1}$

5.2 $F\Delta t = m(v - u)$

$F(0,042) = (0,14)(50 - 0)$

$F = 166,67$ N

5.3 Wind resistance / friction acts against movement of ball
Work is done to overcome this wind resistance / friction and the 'lost' kinetic energy is turned into internal energy (heat, sound) of the ball or into kinetic energy of air molecules.

QUESTION 6

6.1 *Every particle with mass 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.*

6.2 F = $\frac{GMm}{R^2}$

$= \frac{(6{,}7\times10^{-11})(5\,972\times10^{24})(5\times10^{14})}{(4\times6\,371\,000)^2}$ second mark for conversion of distance

$= \frac{2{,}00062\times10^{29}}{(25{,}484)^2}$

$= \frac{2{,}00062\times10^{29}}{649{,}43}$

$= 3{,}08\times10^{14}$N

6.3 6.3.1 F = $\frac{kQq}{r^2}$

$= \frac{(9\times10^{9})(3\times10^{-9})(6\times10-9)}{(0{,}045)^2}$

$= \frac{1{,}62\times10^{-7}}{2{,}025\times10^{-3}}$

$= 0{,}80\times10^{-4}$ N west OR 8×10^{-5} N west/left

6.3.2 F = $\frac{kQq}{r^2}$

$= \frac{(9\times10^{9})(3\times10^{-9})(5\times10^{-9})}{(0{,}032)^2}$

$= \frac{1{,}35\times10^{-7}}{1{,}024\times10^{-3}}$

$= 1{,}32\times10^{-4}$ N, south/down

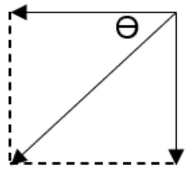
6.3.3 Pyth: $F^2 = (0{,}8\times10^{-4})^2 + (1{,}32\times10^{-4})^2$

$F = \sqrt{2{,}38x10^{-8}}$

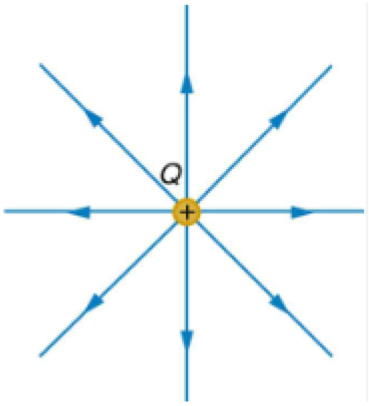
$= 1{,}54\times10^{-4}$ N

Tan $\Theta = 1{,}32\times10^{-4} / 0{,}8\times10^{-4}$

$\Theta = 58{,}8^\circ$ S of W (or $31{,}2^0$ W of S)



6.4



Arrows goes out from charge

Start perpendicular on surface of charge and evenly spread around charge

No, it is not constant but decrease as you move further away.

QUESTION 7

7.1 7.1.1 Alternating current: can use transformers to increase or decrease voltage/used to generate current.

7.1.2 High voltage: when distributing power over long distances high voltage will give low current and thus lower loss of energy due to resistance in wires.

7.2 7.2.1 $6\Omega : 10\Omega = 3 : 5$

$I_6 : I_{10} = 5 : 3$

$X : 0{,}8$

$X = (0{,}8 \div 3) \times 5 = 1{,}33$ A

Total I : $1{,}33 + 0{,}8 = 2{,}13$ A

OR

$V = IR$
$= (0{,}8)(10)$
$= 8$ V

$V = IR$
$8 = I(6)$
$I = 1{,}33$ A

$I_T = 1{,}33 + 0{,}8$
$= 2{,}13$ A

7.2.2 $\frac{1}{R} = \frac{1}{6} + \frac{1}{10}$

$= \frac{16}{60}$

$R = 3{,}75\ \Omega$

7.2.3 $V = IR$
$= (2{,}13)(3)$
$= 6{,}39$ V

7.2.4 $V = IR$
$= (2{,}13)(3{,}75)$
$= 7{,}99$ V

$V = IR$
$= (2{,}13)(7)$
$= 14{,}91$ V

Total $V_{ext} = 14{,}91 + 7{,}99 + 6{,}39 = 29{,}29$ V (e.c.o)

$V_{int} = \text{Emf} - V_{ext} = 30 - 29{,}29 = 0{,}71$ V (e.c.o)

$V_{int} = IR_{int}$

$R_{int} = \frac{0{,}71}{2{,}13} = 0{,}33\ \Omega$

OR

Emf $= I(R + r)$

$30 = 2{,}13\ (3{,}75 + 10 + r)$ subs

$r = 0{,}33\ \Omega$

7.3.1 Potential difference is the *work done per unit positive charge*

7.3.2 12 V and 12,1V accepted
Read from the Y-intercept of graph
As the current is then 0 A

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

$= \frac{10,0 - 12,0}{0,8 - 0}$ (coordinates marked on the line)

$= -2,50$ (–2,40 to –2,60 allowed)

7.3.4 $Emf = V_{ext} + IR_{int}$

$V_{ext} = -\,IR_{int} + Emf$

$y = m\,x + c$

$-\,2,50 = -\,R_{int}$

gradient = internal R = 2,50 Ω

QUESTION 8

8.1 8.1.1 period T = 0,02 s
f = 1 / T = 1/ 0,02 = 50 Hz

8.1.2 parallel

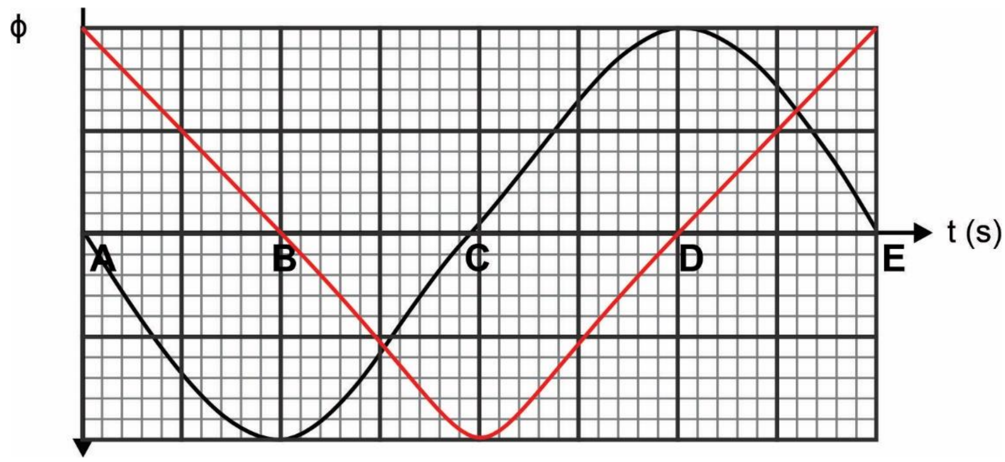
8.1.3 Frequency halved – wavelength doubled
Time for 1 wavelength/ period is doubled
current halved – max and min amplitude halved

8.1.4 sliprings

8.1.5 Faraday's Law: *the emf induced is directly proportional to the rate of change of magnetic flux (flux linkage).*

8.1.6 Magnetic Flux Linkage: is *the product of the number of turns on the coil and the flux through the coil* (*N*Φ).

8.1.7



Starting point, going down
Zero at B and D
Max value at C

8.2.1 Concentric circles (min 3)
Separation increases with distance from wire
Correct direction, anticlockwise

8.2.2 arrow from B towards A
Magnetic fields due to currents influence each other / Cancelling each other out between the two wires / field weaker in the middle
Stronger fields on outside push wires closer together

QUESTION 9

9.1 Electrons are attracted by the positive nucleus of the atom which must be broken.

9.2 Work function (*Wo*) is *the minimum amount of energy needed to emit an electron from the surface of a metal.*

9.3 9.3.1 <u>Wave theory</u>: light has a continuous transferring of energy

Thus, with long enough time, eventually e^- will gain enough energy to be emitted.

Also, more intense light, more energy available–so e^- should be emitted sooner.

This do not happen.

9.3.2 Particle theory: light consists of 'packets'/quanta of energy, called photons

Where each photon has a specific limited energy according to its frequency/wavelength

9.4 9.4.1

$$W = hf_0$$
$$= (6{,}6 \times 10^{-34})(1{,}85 \times 10^{15})$$
$$= 12{,}21 \times 10^{-19}\ J$$
$$= 1{,}22 \times 10^{-18}\ J$$

9.4.2

$$hf = W + E_k$$
$$(6{,}6 \times 10^{-34})\left(\frac{3x10^{8}}{145x10^{-9}}\right) = 1{,}22 \times 10^{-18} + \tfrac{1}{2}(9{,}1 \times 10^{-31})v^2$$
$$0{,}137 \times 10^{-17} - 0{,}122 \times 10^{-17} = 4{,}55 \times 10^{-31}\ v^2$$
$$0{,}015 \times 10^{-17} = 4{,}55 \times 10^{-31}\ v^2$$
$$v^2 = 3{,}198 \times 10^{11}$$
$$v = 5{,}66 \times 10^{5}\ m.s^{-1}$$

Total: 200 marks