



NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2009

PHYSICAL SCIENCES: PAPER I

MARKING GUIDELINES

Time: 3 hours

200 marks

These marking guidelines were used as the basis for the official IEB marking session. They were prepared for use by examiners and sub-examiners, all of whom were required to attend a rigorous standardisation meeting to ensure that the guidelines were consistently and fairly interpreted and applied in the marking of candidates' scripts.

At standardisation meetings, decisions are taken regarding the allocation of marks in the interests of fairness to all candidates in the context of an entirely summative assessment.

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, and different interpretations of the application thereof. Hence, the specific mark allocations have been omitted.

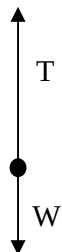
Please note that learners who provided alternate correct responses to those given in the marking guidelines will have been given full credit.

QUESTION 1

1.1

1.1.1 The rocket accelerates uniformly from rest in an upwards direction. (4)

1.1.2



T: (Thrust) Thrust Force of the motor on the rocket/
Force of exhaust gases on rocket
W: (Weight) Force of the Earth on the rocket

(4)

1.2

1.2.1 -10 (1)

$$1.2.2 \quad v = u + a\Delta t$$

$$0 = 12 + (-10) \Delta t$$

$$\therefore \Delta t = 1,2s$$

OR

uses gradient
method

$$-10 = \frac{\Delta v}{\Delta t}$$

$$-10 = \frac{-12}{\Delta t}$$

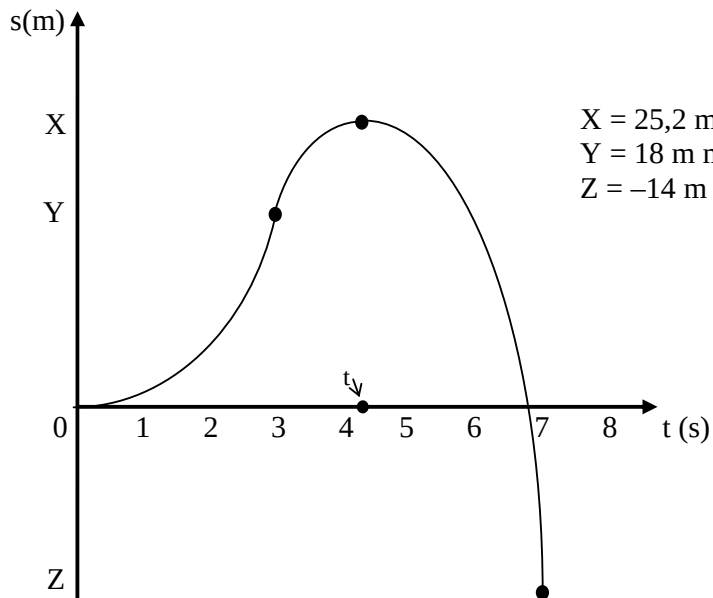
$$\therefore \Delta t = 1,2s$$

$$\therefore t = 3 + 1,2 = 4,2s$$

(6)

1.3

1.3.1



X = 25,2 m method answer
Y = 18 m method answer
Z = -14 m method answer

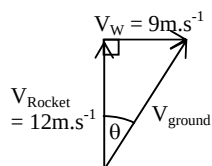
(9)

1.3.2 14 m

(1)

1.4

1.4.1 By calculation



$$V_{ground} = \sqrt{12^2 + 9^2}$$

$$= 15 \text{ m.s}^{-1}$$

$$\tan \theta = \frac{9}{12}$$

$$\theta = 36,87^\circ$$

$$\therefore V_{ground} = 15 \text{ m.s}^{-1} \quad 36,87^\circ$$

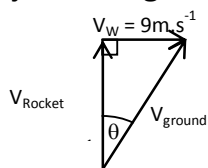
from the vertical

OR
$$\therefore V_{ground} = 15 \text{ m.s}^{-1} \quad 53,13^\circ$$

from the horizontal

(6)

By scale diagram



suitable scale each vector drawn correctly

$$\therefore V_{ground} = 15 \text{ m.s}^{-1} \quad 36,87^\circ \text{ from the vertical}$$

$$\text{OR } \therefore V_{ground} = 15 \text{ m.s}^{-1} \quad 53,13^\circ \text{ from the horizontal}$$

(6)

1.4.2 $v = \frac{s}{t}$

$$9 = \frac{s}{4}$$

$$\underline{s = 36 \text{ m}}$$

(4)

1.5 Impulse is the product of the net force acting on a body and the time for which it acts.
(Impulse is the change in momentum of a body) (3)

1.6 $\text{N.s} = (\text{kg.m.s}^{-2}).(\text{s}) = \text{kg.m.s}^{-1}$ (3)

1.7 Impulse = $F\Delta t$
 $9 = 6. \Delta t$
 $\Delta t = 1,5 \text{ s}$ (4)

1.8 $\Delta p = m\Delta v$ $v^2 = u^2 + 2as$
 $160 = 1,5 \Delta v$ $0 = 106,67^2 + 2(-10)s$
 $\therefore \Delta v = 106,67 \text{ m.s}^{-1}$ $s = 568,92 \text{ m}$

While the motor acts on the rocket it will accelerate upwards, thereafter it will continue to move upwards for another 568,92m. (Could interfere with flight paths of small planes) (9)

OR

$$\Delta p = m\Delta v$$

$$160 = 1,5 \Delta v$$
 $\therefore \Delta v = 106,67 \text{ m.s}^{-1}$
 $106,67 \text{ m.s}^{-1} \times 3,6 = \underline{384,01 \text{ km.h}^{-1}}$

Operating a rocket at this speed is very dangerous

(9)

1.9

1.9.1 Ratio of the speed of an object to the speed of the surrounding medium.
(Answer can also be shown as a ratio) (2)

1.9.2 $\text{Mach number} = \frac{105}{330} = \underline{0,32}$ (3)

1.9.3 Subsonic. (1)

1.9.4 'Mach-speed' generally refers to objects travelling close to the speed of sound – in this particular case it would not be a relevant comparison. (2)

1.9.5 Clear opinion offered as to what is regarded as a hobby.
An opinion as to whether this is compromised by fingerprinting, etc.
– 2 points of information
Written using good English. (4)

56 marks

QUESTION 2

2.1

2.1.1 $F_{\text{parallel}} = 450 \cos 25^\circ$
 $= 407,84\text{N}$ (2)

2.1.2 407,84N (coe) (1)

2.1.3 $W = Fs$
 $= 407,84 \times 20 \text{ (coe)}$
 $= \underline{8156,8\text{J}}$ (4)

2.1.4 $P = Fv$
 $= 407,84 \times 1 \text{ (coe)}$
 $= \underline{407,84\text{W}}$ (4)

2.1.5 (a) When the motor transfers energy, some is delivered to the T-bar and some is used internally, i.e. 'lost' to internal energy. (2)

(b) – increase the number of windings on the coil in the motor
– increase the strength of the magnets being used
– increase the current strength in the coil (3)

2.2

2.2.1 No, it won't give accurate results.
– responding to the beep of a cell phone every second leaves room for human error
– the experiment was only conducted once
– seeing the marks in the snow may be difficult
– the gradient of the slope is probably not constant (any 2) (3)

2.2.2 Each interval printed on the tape will be longer than the previous amount by the same fixed amount. This shows that the velocity increased by the same amount in each time interval therefore acceleration is uniform. (3)

2.2.3 3 of:

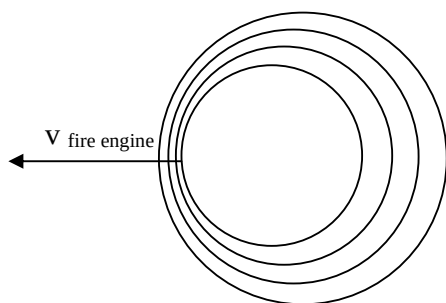
- units for time – s not sec
- displacement should be plotted at 0; 2 m; 4,75 m; 8,25 m, etc.
- the graph plotted of s vs t for an object that is accelerating should be parabolic
- line of best fit should be plotted
- this is a graph of change in displacement against time (3)

2.3 2.3.1 0 m.s^{-1} (1)2.3.2 7 m.s^{-1} up the slope (2)2.3.3 8 m.s^{-1} down the slope (2)**30 marks****QUESTION 3**

3.1 The Doppler Effect. (1)

$$\begin{aligned}
 3.2 \quad f' &= \left(\frac{V}{V + v} \right) f \\
 &= \left(\frac{330}{330 + 20} \right) 250 \\
 &= \underline{235,71 \text{ Hz}} \quad (5)
 \end{aligned}$$

3.3



Daniel

shape of pattern
orientation of pattern relative to Daniel (2)

3.4 Speed of sound in air $\ll$ speed of light
 $\therefore$ the velocity of the fire engine (20 m.s^{-1}) produces a noticeable Doppler shift in the frequency of the siren, but is of no consequence when compared with the speed of light. (3)

11 marks**QUESTION 4**

4.1 The universe/ space is expanding. (2)

4.2 4.2.1 explanation 2 (1)

4.2.2 explanation 2 (1)

4.3 Explanation 2: The galaxy is moving with space away from Earth and thus the expanding space is increasing the wavelength of the light waves as they propagate. (3)

7 marks

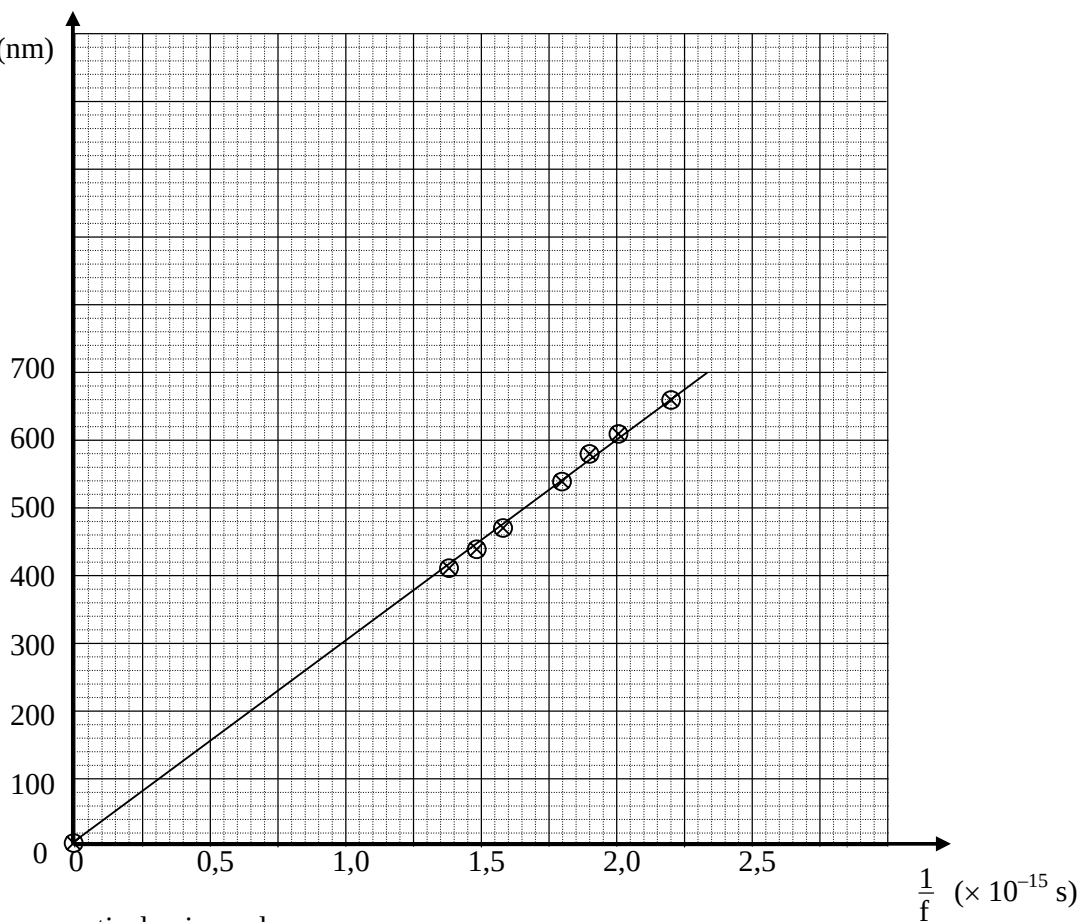
QUESTION 5

5.1 The ability of a wave to spread as it passes through a small aperture or around a sharp edge. (2)

5.2 constructive (1)

5.3 $660 \text{ nm} = 660 \times 10^{-9} \text{ m} (= 6,60 \times 10^{-7} \text{ m})$ (1)

5.4 λ (nm)



vertical axis: scale

plotting of points: (check 2 random points)

line: through origin good attempt made at best-fit through points

(5)

5.5 frequency is inversely proportional to wavelength (1)

5.6 method shown : $\Delta\lambda / \Delta 1/f$

answer: $\approx 3,0 \times 10^8$ (if $\Delta\lambda$ in m)

$\approx 3,0 \times 10^{17}$ (if $\Delta\lambda$ in nm) (3)

5.7 Speed of light in a vacuum (1)

5.8 if $c = f \times \lambda$. 1 mark

if $3,0 \times 10^8 = f \times \lambda$ 2 marks (2)

16 marks

QUESTION 6

6.1

6.1.1 A, C, B, D (4)

- 6.1.2 – a statement rather than a question
 – does it make a prediction about the effect of the core material on the strength of the magnetic field?
 – is it testable? (3)

6.1.3 any feasible suggestion that indicates the presence of a field and enables their strengths to be compared.
 For example **counting the number** of paper clips that can be lifted OR determining the **mass** of iron filings that can be lifted, etc. (2)

6.1.4 material used for the core (1)

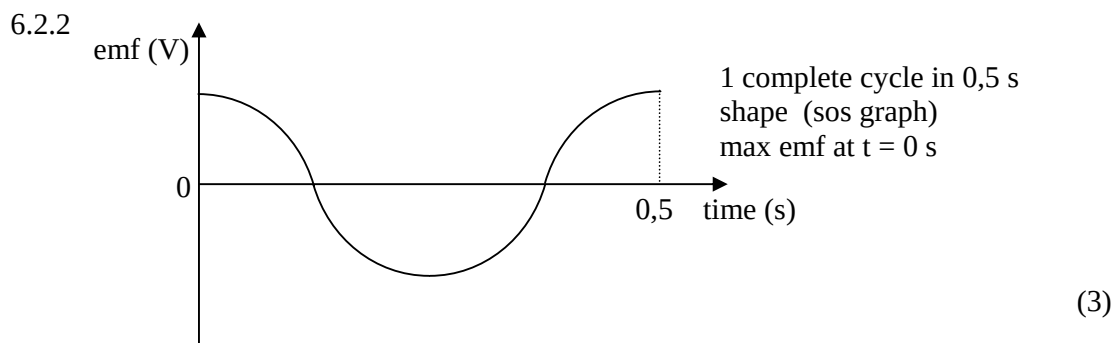
6.1.5 number of paper clips lifted, etc. (link to 6.1.3) (1)

- 6.1.6 No.
Able to identify important variables needing control.
 – emf of power supply;
 – number of windings around core;
 – Recognises important defects in the design;
 – not a 'fair test';
 – experiments should be repeated to verify results. (5)

6.1.7 Any 2 suitable suggestions
 (use same power supply; use same number of windings on each core etc) (2)

6.2

- 6.2.1 – The rotating magnet produces a changing magnetic field/magnetic flux.
 – This magnetic flux interacts with the particles in the wire inducing an emf. (4)

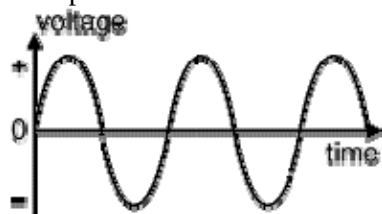


- 6.2.3 two of:
 – increase speed of magnet's rotation
 – increase number of coils of wire
 – bring the magnet closer to the coil
 – use a stronger magnet (2)

6.3

6.3.1 (a) step-down (1)

(b)



(2)

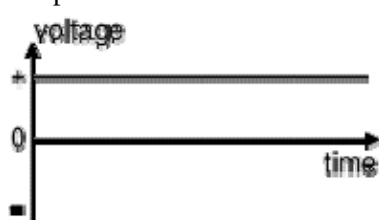
6.3.2 (a) Alternating voltage is changed to direct voltage – no change in polarity of terminals (which is applied in one direction only). (2)

(b)

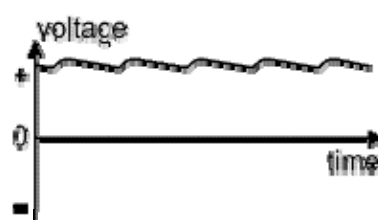
diode(s) (1)

6.3.3 (a) capacitor (1)

(b)



If this is given: 1 mark only



If this is given: 2 marks (2)

27 marks

QUESTION 7

7.1

7.1.1 Radio waves

7.1.2 Gamma rays or x-rays

7.1.3 Infrared (3)

7.2 Photons of UV light are absorbed by the fluorescent ink. Energy is radiated by the ink in the visible region of light. (3)

7.3 sunburn; skin cancer (2)

7.4 flesh; bone; metal (in this order) (3)

7.5

7.5.1 (a) green

(b) red & blue (3)

7.5.2 (a) black

(b) green paint absorbs red light ∴ no light is reflected (3)

7.6

7.6.1 D (2)

7.6.2 A (2)

21 marks**QUESTION 8**

8.1 A negatively charged plate was repelling particles ∴ the particles must be negatively charged. (Zinc plate must be losing electrons whereas the positive plate would attract electrons so no such effect is noticed) (2)

8.2 8.2.1 intensity of light (NOT brightness)
frequency/wavelength of light (NOT colour) (2)

$$\begin{aligned}
 8.2.2 \quad E &= \frac{hc}{\lambda} \\
 &= \frac{6,6 \times 10^{-34} \times 3,0 \times 10^8}{440 \times 10^{-9}} \text{ conv. subs} \\
 &= \underline{4,5 \times 10^{-19} \text{ J} = 2,81 \text{ eV}} \quad (6)
 \end{aligned}$$

8.2.3 Intensity of red and blue light does not affect the kinetic energy of the photoelectrons.

$$E = w_f + \frac{1}{2}mv^2 \quad \therefore \frac{1}{2}mv^2 = E - w_f$$

$$E = hf \quad f_{\text{blue}} > f_{\text{red}} \therefore E_{\text{blue}} > E_{\text{red}}$$

since w_f is constant (same metal being used)

$$\therefore \frac{1}{2}mv^2 \text{ for blue light} > \frac{1}{2}mv^2 \text{ for red light} \quad (6)$$

OR

- Intensity of red and blue light does not affect the kinetic energy of the photoelectrons.
- Only the frequency of the light affects the kinetic energy.
- The photon of light is absorbed by a (valence) electron in the metal. If the energy of this electron is greater than the work function of the metal, the electron will be emitted. It will have kinetic energy = energy of the photon – the work function of the metal.
- Because blue light has a higher frequency than red light, its photons have higher energy than those of red light. The electrons emitted when blue light is shone on the metal will therefore have greater kinetic energy. (6)

8.3 8.3.1 caesium (1)

8.3.2 smallest value for w_f therefore more electrons are ejected per unit time. (2)

8.3.3 $2,75 \text{ eV} = 4,4 \times 10^{-19} \text{ J}$
 $E = w = hf_o$
 $4,4 \times 10^{-19} = 6,6 \times 10^{-34} \times f_o$
 $f_o = 6,67 \times 10^{14} \text{ Hz}$ (5)

24 marks

QUESTION 9

9.1

	1 mark	2 marks
(a)	a relevant comment	a relevant comment that addresses the question
(b)	1 point of information	2 points of information
(c)	1 point that clearly counters (b)	2 points that clearly counter (b)
(d)	a relevant comment	a well constructed argument
		Total: (8)

8 marks

Total: 200 marks