LIVE: FINAL EXAM PREPARATION P1 — 06 NOVEMBER 2014

Lesson Description

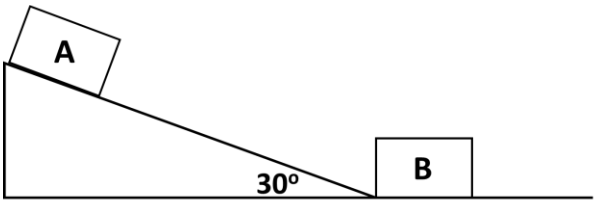
In this lesson we:

- Revise various questions related to topics tested in the various questions in Paper 1.

Exam Questions

Question 1 – Momentum

A brick A, of mass 2,5 kg is at rest on a 1 m long frictionless plane inclined at 30^o to the horizontal. A second brick, B of mass 3,8 kg rests at the bottom of the incline on a flat, rough horizontal surface as shown in the diagram.



1.1. Calculate the speed of brick A at the bottom of the incline when it is released from rest. (4)

1.2. Brick A collides with brick B. The two stick together and begin to move along the flat horizontal surface.

1.2.1. State the principle of conservation of linear momentum (2)

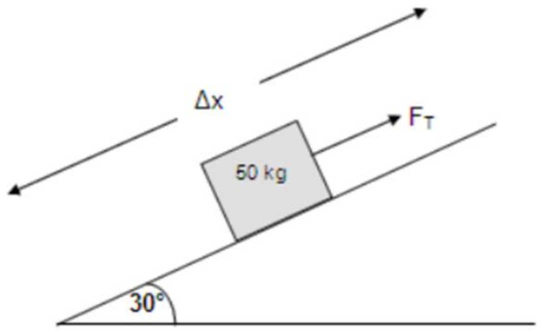
1.2.2. Calculate the speed with which the two bricks move along the horizontal surface. (4)

1.3. The frictional force acting on the two bricks is 5 N. Calculate how far the two bricks will slide before coming to rest. (4)

Question 2

(Adapted from EC Prelim Paper 1 2014)

The diagram below shows a crate of mass 50 kg sliding down a steep slope. The slope makes an angle of 30^o with the horizontal. The motion of the crate as it moves down the slope is controlled by a worker using a rope attached to the crate. The rope is held parallel to the slope. The tension in the rope, F_T, is 300 N and a constant frictional force of 50 N acts on the crate as it slides down the slope.



2.1. Draw a labelled free-body diagram showing the forces parallel to the slope acting on the crate as it moves down the slope (3)

2.2. State the work-energy theorem in words. (2)

2.3. The change in kinetic energy of the crate is 450 J as it slides from the top to the bottom of the slope. Uses the work-energy theorem to calculate the length of the slope, Δx (5)

2.4. Calculate the coeffiecient of kinetic friction on the crate as it moves down the slope. (4)

Question 3

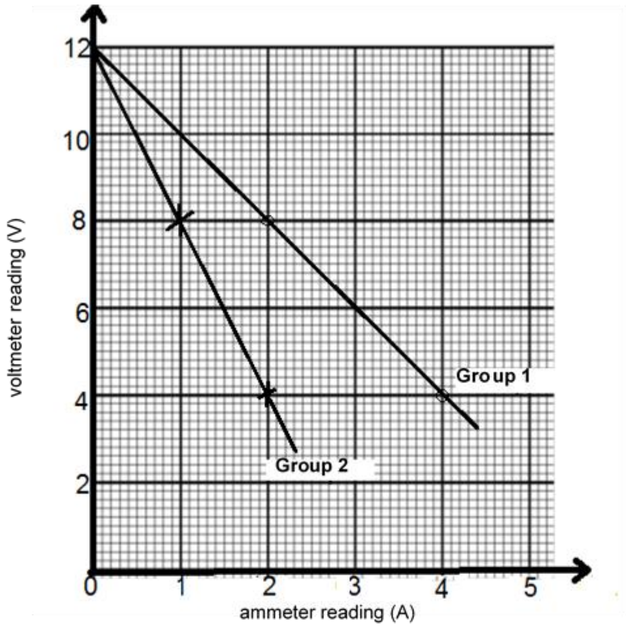
(Adapted from Metro North Common Paper 1 – 2014)

3.1. Grade 12 learners are conducting an experiment to determine the INTERNAL RESISTANCE of a battery. The learners were divided into two groups:

Group **1** used battery 1 with an internal resistance r_1

Group **2** used battery 2 with an internal resistance r_2

The results of each group are shown in the graph below.



3.1.1. Explain why the voltmeter reading across the battery decreases as the current increases. Use appropriate equation(s) in physics in your explanation. (3)

3.1.2. Which group, **1** or **2**, used a battery with greater internal resistance? (1)

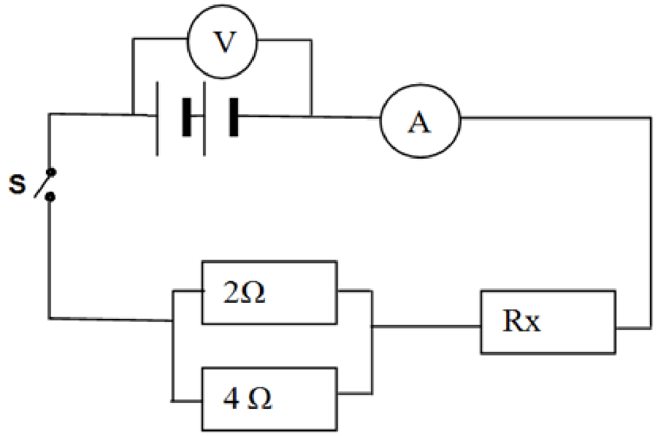
3.1.3. Use the graph to determine the:

a) emf of the battery used by learners in group 2. (1)

b) internal resistance of the battery used by learners in group 1 (3)

3.1.4. If the internal resistance of the battery was negligible, draw a sketch graph to show the shape of the graph when voltmeter reading is plotted against ammeter reading. (2)

3.2. Three resistors, 2 Ω, 4 Ω and $\mathbf{R_x}$ are connected to a battery as shown in the circuit diagram below. When the switch **S** is open the reading on the voltmeter is 10 V. When the switch **S** is closed the reading on the voltmeter is 8 V and the reading on the ammeter is 1 A.



3.2.1. Write down Ohm's law in words (2)

Calculate the:

3.2.2. resistance of the unknown R_x (7)

3.2.3. internal resistance of the battery (3)

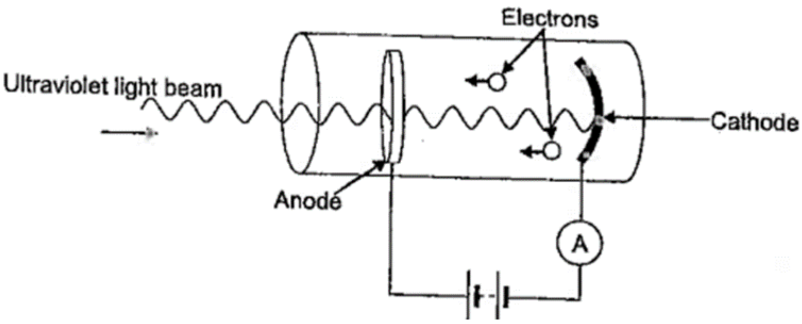
After a while, the 2Ω resistor gets hotter than the 4 Ω resistor

3.2.4. Explain this observation. (3)

Question 4

(Adapted from KZN Prelim Paper 1 – 2014)

The photo-electric effect has many practical applications. A photocell, such as the one below used in burglar alarm systems, is one such application.



The largest wavelengths of monochromatic light that will cause the ejection of photoelectrons in the above photocell is 229 nm. When a person interrupts the beam, the sudden drop in current activates a switch, which sets off the alarm.

4.1. Calculate the frequency of the monochromatic light of wavelength 229 nm. (3)

4.2. Give the scientific term for the frequency that you calculated in question 4.1. above. (1)

4.3. Define, in words, work function. (2)

4.4. Calculate the frequency of the monochromatic light that must be used to emit photoelectrons with a velocity of 1,57 x 10^6 m.s^{-1} from the cathode of the above photocell. (5)

4.5. How will the answer in question 4.4. change if the largest wavelength of monochromatic light needed to eject photoelectron is reduced to 189 nm? Write down INCREASE, DECREASE or REMAINS THE SAME. Give a reason for your answer. (3)

Answers

Question 1

1.1. Using Work-Energy Theorem

$W_{net} = \Delta E_k$

$F_{g\parallel}\Delta x \cos\theta = E_{kf} - E_{ki}$

$(mg\sin\theta)\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(2{,}5)(9{,}8)(\sin 30°)(1)(\cos 0°) = \frac{1}{2}(2{,}5)v_f^2 - 0$

$12{,}25 = 1{,}25\ v_f^2$

$\therefore\ v_f^2 = 9{,}8$

$v_f = 3{,}13\ m.s^{-1}$

OR

Use law of conservation of mechanical energy

$\sin\theta = \frac{vertical\ height\ (h)}{lenght\ of\ plane}$

$\sin 30° = \frac{h}{1}$

$h = 0{,}5\ m$

$E_{mech} at\ top = E_{mech} at\ bottom$

$mgh + \frac{1}{2}mv_i^2 = mgh + \frac{1}{2}mv_f^2$

$(2{,}5)(9{,}8)(0{,}5) + 0 = 0 + \frac{1}{2}(2{,}5)v_f^2$

$12{,}25 = 1{,}25\ v_f^2$

$\therefore\ v_f^2 = 9{,}8$

$v_f = 3{,}13\ m.s^{-1}$

1.2.1. Total linear momentum is conserved in an isolated system

1.2.2. Total p before = Total p after

$m_A v_{iA} + m_B v_{iB} = (m_A + m_B)v_f$

$(2{,}5)(3{,}13) + 0 = (2{,}5 + 3{,}8)v_f$

$7{,}825 = 6{,}3\ v_f$

$v_f = 1{,}24\ m.s^{-1}$

1.3. Take to the right as positive

$F_{net} = ma$

-5 = (6,3)a

a = -0,79 $m.s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$

$0 = (1{,}24)^2 + 2(-0{,}79)\Delta x$

$\Delta x = 0{,}97\ m$

Question 2

2.1.

2.2. The net total work down on an object ✓ is equal to the change in kinetic energy of the object ✓

2.3. $F_{net} = F_T + F_f + F_{g||}$

= 300 + 50 – mg sin 30°

=300 + 50 - (50)(9,8)(sin 30°)✓

= 105 N

$F_{net}\Delta x \cos\theta = \Delta E_k$ ✓

(105)(Δx)(cos 0°) ✓ = 450✓

Δx = 4,29 m✓

2.4. $f_k = \mu_k N$

$f_k = \mu_k (mg \cos\theta)$

$50 = \mu_k(50)(9{,}8)(\cos 30^o)$

$\mu_k = 0{,}12$

Question 3

3.1.1. emf (ε) = IR_{ext} + Ir✓

When the current increases, Ir (lost volts) increases✓ /

IR_{ext} (terminal voltage/pd)(voltage of the load) decreases ✓

emf (ε) is the same /constant

3.1.2. Group 2 ✓

3.1.3. a) 12 V ✓

b)

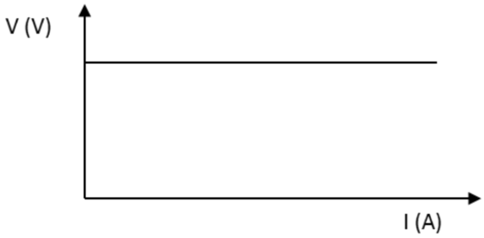
$gradient = \frac{\Delta y}{\Delta x}$

$= \frac{4-8}{4-2}$

$= -2\Omega\ or\ 2\Omega$

3.1.4. ✓ starts at (0 ; 12)

✓ line parallel to x-axis



3.2.1. The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature.✓✓

3.2.2. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$= \frac{1}{2} + \frac{1}{4}$ ✓

$= \frac{3}{4}$

$R_p = 1{,}33\ \Omega$

$R_{ext} = \frac{V}{I}$ ✓

$= \frac{8}{1}$ ✓

$= 8\ \Omega$

$R_{ext} = R_x + R_p$

8 ✓= R_x + 1,33✓

R_x = 6,67 Ω ✓

3.2.3. Emf = I(R+r) ✓

10 = (1)(8 +r) ✓

r = 2Ω ✓

3.2.4. Energy – W = $I^2R\Delta t$ ✓

For the same time interval ✓ $I^2R\Delta t$ will be greater for the 2 Ω resistor than for the 4 Ω resistor✓

Question 4

4.1. c = f λ ✓

$3 \times 10^8 = f(229 \times 10^{-9})$ ✓

$f = 1{,}31 \times 10^{15}$ Hz ✓

4.2. Threshold frequency ✓

4.3. Work function is the minimum energy ✓ required to eject an electron from a metal ✓

4.4. $E = W_o + E_K$ ✓

$hf = \frac{hc}{\lambda} + \frac{1}{2}mv^2$

$(6{,}63 \times 10^{-34})f$ ✓ $= \frac{(6{,}63 \times 10^{-34})(3 \times 10^{8})}{229 \times 10^{-9}}$ ✓ $+ \frac{1}{2}(9{,}11 \times 10^{-31})(1{,}57 \times 10^{6})^2$ ✓

$f = 3{,}00 \times 10^{15} Hz$ ✓

4.5. Increases ✓

If the threshold frequency increases then a greater frequency ✓of light will be needed to eject the electrons with the same speed. ✓