ALEXANDER ROAD HIGH SCHOOL

MARCH 2015 | 1 HOUR

PHYSICAL SCIENCE CONTROL TEST

KB, MH, CO | TOTAL = 60

GRADE 12

Instructions

- The question paper consists of 6 questions
- Answer all the questions
- Answer section A on the answer sheet provided
- Answer section B on the folio sheets and answer each question on a new side of a page.
- A non-programmable calculator may be used
- Number the answers correctly according to the numbering system
- All relevant data can be found at the end of the question paper
- Round off to two (2) decimal places where necessary

SECTION A

- Answer on the answer sheet -

QUESTION 1: Multiple choice

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A–D) next to the question number (1.1 – 1.6) on the attached ANSWER SHEET.

1.1 Power is defined as …

A the rate of change of velocity.

B the rate at which work is done.

C the rate of the change of momentum.

D the rate of change in displacement

1.2 Two cars (A and B) have the same mass and are travelling at the same speed. Car A strikes a wall and it takes 0,01s to come to rest. Car B also strikes a wall and take 0,05s to come to rest. How does the net force on car A compare to car B?

A the force is 5 times more than B

B the force is double that of B

C The force is 5 time less than B

D the force is half that of B

1.3 A sample of silver contains impurities of gold. During purification by electrolysis, the impure silver is used as an electrode. Which one of the following is the best choice of anode and cathode for this process?

	Cathode	**Anode**
A	Pure gold	Impure silver
B	Impure silver	Pure gold
C	Pure silver	Impure silver
D	Impure silver	Pure silver

1.4 A copper rod is placed in a zinc sulphate solution. Which of the following will be observed?

A The copper rod turns a silver colour

B The zinc solution turns blue

C The copper rod becomes eroded

D No observation is made

1.5 For the velocity and acceleration of a projectile that is thrown vertically down from a bridge and landing on the dry river bed below, the … (when air resistance is ignored):

A velocity is a maximum at the top and acceleration is maximum at the bottom

B velocity is zero at the top and acceleration is maximum at the bottom

C velocity is a minimum at the top and acceleration is downwards

D velocity is a maximum at the top and acceleration is constant

1.6 A form of projectile motion can be described as …

A free falling through space with no acceleration

B free falling through space with initial velocity = 0 $m.s^{-1}$ and g = 0 $m.s^{-2}$

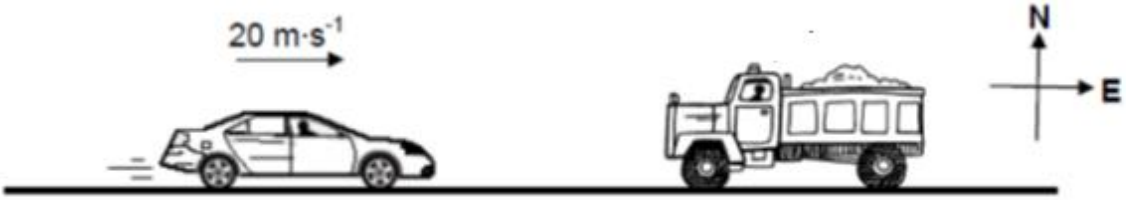
C free falling through space with upwards time = downwards time

D free falling through space with increasing acceleration

SECTION B

QUESTION 2

The diagram below shows a car of mass 750kg travelling at a velocity of 20 $m \cdot s^{-1}$ east on a straight level road and a stationary truck of mass 2000kg on the same road. Ignore the effects of friction.

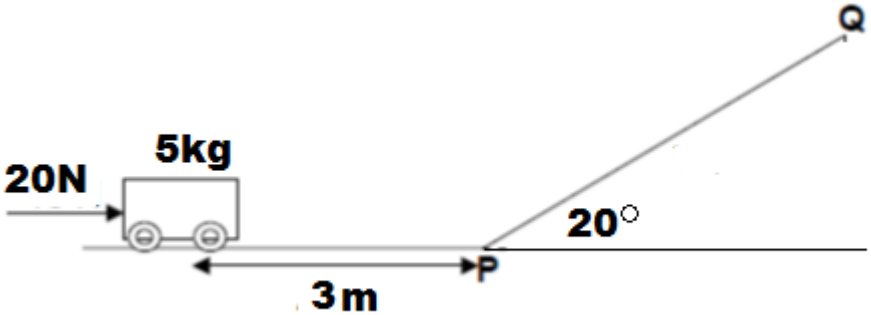


The vehicles collide head-on and stick together during the collision.

2.1 Calculate the velocity of the truck-car system immediately after the collision. (4)

2.2 If the mass of the car increases, how will it affect the final velocity? Write only INCREASE, DECREASE or STAY THE SAME (1)

2.3 A 5 kg trolley is at rest on a horizontal frictionless surface. A constant horizontal force of 20 N is applied to the trolley over a distance of 3 m. When the force is removed at point P, the trolley moves a certain distance up the incline until it comes to rest at a maximum height at point Q. While the trolley moves up the incline, there is a constant frictional force acting on it.



2.3.1 Draw a labelled free-body diagram showing all the forces acting on the trolley as it moves along the horizontal surface. (3)

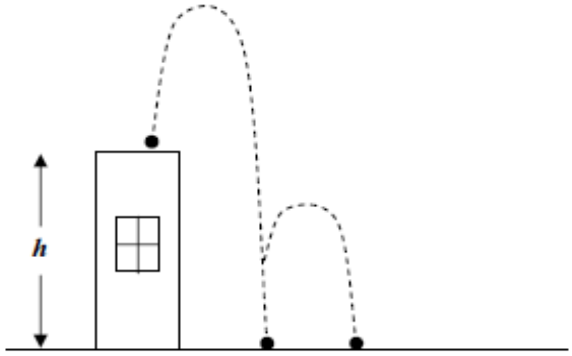
2.3.2 Use the work-energy theorem to calculate the speed of the trolley when it reaches point P. (4)

2.3.3 If the trolley comes to rest at point Q after travelling a distance of 5m, Calculate the Net Force (F_{net}) acting on the trolley as it slides up the slope. (4)

[16]

QUESTION 3

A rubber ball is shot vertically upwards from the top of a building of height *h*. The ball strikes the ground below after 1,77 s. It then immediately bounces to a height of ¼ h and lands on the ground 2,8 s after it was shot.



Ignore the effects of air friction. (Ignore the time of contact during the bounce).

3.1 Calculate the time taken for the ball to reach height ¼ h after it strikes the ground for the first time. (2)

3.2 Calculate the velocity with which the ball leaves the ground after the first bounce (3)

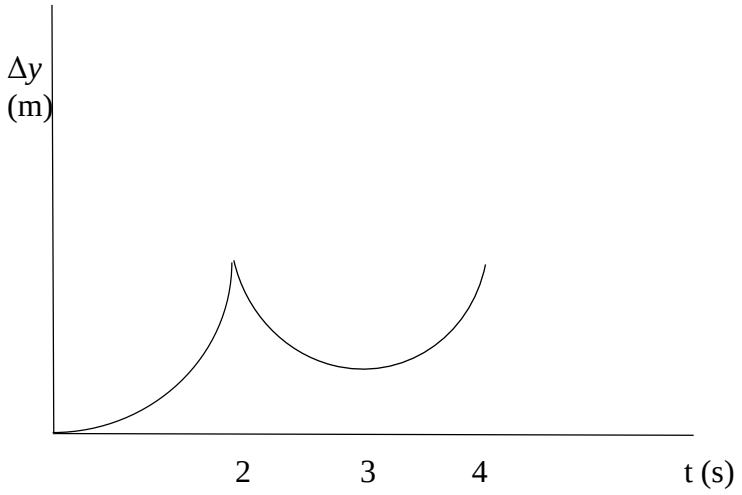
3.3 Calculate the height of the second bounce. (4)

3.4 Calculate *h*, the height of the building. (1)

[10]

QUESTION 4

The following displacement vs time graph (NOT TO SCALE) shows the motion of an object that spends most of its time in free fall.



4.1 Describe the motion for time intervals 0-2s and 2-4s. (2)

4.2 At which time(s) will this object have zero velocity? (1)

4.3 Draw a rough **velocity vs time** graph for this motion. You do not have to name the axes, just indicate the time intervals. Take the upwards direction as positive (use the same time intervals as above). (2)

4.4 Draw a rough **acceleration vs time** graph for this motion. You do not have to name the axes, just indicate the acceleration reading(s). (take upwards direction as positive) (1)

[6]

QUESTION 5

Boat B is anchored in the quiet, calm waters of the Indian Ocean of Algoa Bay while taking part in the Tuna Classic fishing competition. Boat A is moving at 12 $m.s^{-1}$ towards boat B and sounds a siren with a frequency 850 Hz. Accept that the speed of sound in air is 340 $m.s^{-1}$.

5.1 Calculate the frequency of the siren's sound (of Boat A) that is heard by the captain of boat B. (5)

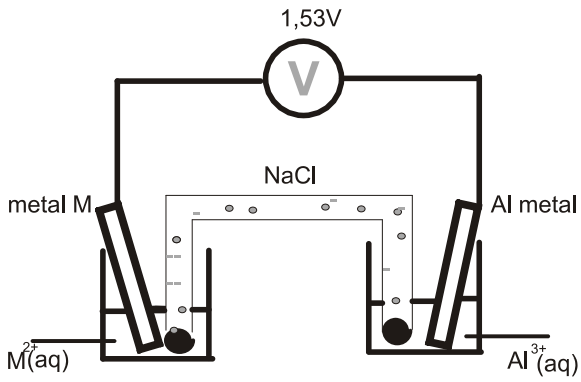
5.2 Boat A moves ahead of the stationery boat B. Boat A sounds the siren again. How will the frequency of the sound of the siren heard by the captain of boat B compare to the frequency at which the sound was emitted by boat A.
(Choose one of the following: HIGHER, LOWER or the SAME). (1)

[6]

QUESTION 6

A group of learners constructs a certain galvanic cell as follows:

A strip of aluminium metal in contact with a solution of $A\ell^{3+}$ ions; a strip of an unknown metal M in contact with M^{2+} ions in solution; a voltmeter and a NaCℓ-salt bridge. The reading on the voltmeter is 1,53 V under standard conditions. The $A\ell^{3+}/A\ell$ redox pair acts as the ANODE of the cell.



6.1 Show by calculation that the unknown redox pair is Pb^{2+}/Pb. (5)

6.2 Give the symbolic representation of the cell according to the standard cell convention. (3)

6.3 State TWO functions of the salt bridge in the operation of the cell. (2)

[10]

PHYSICAL CONSTANTS

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}\ m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}\ J \cdot s$
Gravitational constant *Swaartekragkonstante*	G	$6,67 \times 10^{-11}\ N \cdot m^{2} \cdot kg^{-2}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}\ N \cdot m^{2} \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}\ C$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}\ kg$
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}\ F \cdot m^{-1}$
Permeability of free space *Permeabiliteit van vry ruimte*	μ_0	$4\pi \times 10^{-7}\ T \cdot m \cdot A^{-1}$

WAVES, LIGHT AND SOUND

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\lambda = \frac{h}{mv}$	$\sin\theta = \frac{m\lambda}{a}$
$hf = W_0 + \frac{1}{2}mv^2$	

Electrochemical

NAME	SYMBOL	VALUE
Standard pressure	p^{θ}	$1,013 \times 10^{5}\ Pa$
Molar gas volume at STP	V_m	$22,4\ dm^{3} \cdot mol^{-1}$
Standard temperature	T^{θ}	273 K
Charge on electron	e	$-1,6 \times 10^{-19}\ C$

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$	

MOTION/*BEWEGING*

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/*of* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F\Delta t = \Delta p = mv_f - mv_i$	$F_g = mg$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = E_P = mgh$
$K = E_k = \frac{1}{2}mv^2$	$W = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↓

Increasing reducing ability ↑

Half-reactions			$E^{\ominus}$ (V)
$Li^+ + e^-$	⇌	Li	– 3,05
$K^+ + e^-$	⇌	K	– 2,93
$Cs^+ + e^-$	⇌	Cs	– 2,92
$Ba^{2+} + 2e^-$	⇌	Ba	– 2,90
$Sr^{2+} + 2e^-$	⇌	Sr	– 2,89
$Ca^{2+} + 2e^-$	⇌	Ca	– 2,87
$Na^+ + e^-$	⇌	Na	– 2,71
$Mg^{2+} + 2e^-$	⇌	Mg	– 2,36
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	⇌	Mn	– 1,18
$Cr^{2+} + 2e^-$	⇌	Cr	– 0,91
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	⇌	Zn	– 0,76
$Cr^{3+} + 3e^-$	⇌	Cr	– 0,74
$Fe^{2+} + 2e^-$	⇌	Fe	– 0,44
$Cr^{3+} + e^-$	⇌	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	⇌	Cd	– 0,40
$Co^{2+} + 2e^-$	⇌	Co	– 0,28
$Ni^{2+} + 2e^-$	⇌	Ni	– 0,27
$Sn^{2+} + 2e^-$	⇌	Sn	– 0,14
$Pb^{2+} + 2e^-$	⇌	Pb	– 0,13
$Fe^{3+} + 3e^-$	⇌	Fe	– 0,06
$2H^+ + 2e^-$	⇌	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87