JENN

Training and Consultancy

The path to enlightened education

SUBJECT: SUBJECT NAME

GRADE 12

2025 WINTER CLASSES

TEACHER
ACTIVITY SOLUTIONS

Topic(s)

1. Work Energy and Power
2. Acid and Bases
3. Chemical Equilibrium

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ACTIVITY SOLUTIONS

Topic(s)

Work Energy and Power

WORK ENERGY AND POWER SOLUTIONS

ACTIVITY 1

1.1 A ✓✓

1.2 B ✓✓

1.3 D ✓✓

1.4 C ✓✓

1.5 B✓✓ **[10]**

ACTIVITY 2

2.1 Kinetic energy is the energy an object has as a result of the object's motion ✓✓ (2)

2.2 $E_K = \frac{1}{2}mv^2$

$E_K = \frac{1}{2}(60)(7,5)^2$ ✓✓

$\mathbf{E_K = 1\ 687,5\ J}$ ✓ (3)

2.3 At top: $E_p = mgh$

$E_p = (60)(9,8)(2,8)$ ✓✓

$E_p = \mathbf{1\ 646,4\ J}$ ✓ (3)

2.4 $W_{nc} = \Delta E_K + \Delta E_p$

Work done against friction = (-1687,5) + (1646, 4)✓= -41,1 J

∴**Work done against friction = 41, 1 J**✓ (2)

2.5 $\sin 25 = \frac{28}{\Delta x}$ ✓

$\Delta x = 6,63$ m

$W_{friction} = F_f \Delta x$ ✓

$41,1 = F_f(6,63)$ ✓

$\mathbf{F_f = 6,20\ N}$ ✓ (4)

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ACTIVITY 3

3.1.1 Frictional force is the force that opposes the motion of an object ✓✓ (2)

3.1.2 $E_K = \frac{1}{2}mv^2$

$E_K = \frac{1}{2}(2)(1{,}5)^2$ ✓✓

$E_K = 2{,}25\text{ J}$ ✓ (3)

3.1.3 W = $F\Delta x \text{Cos}\theta$ ✓

W = (26)(0,7)Cos 180^0 ✓

W = 18, 2 J ✓ (3)

3.1.4 The work done by a net force on an object is equal to the change in the kinetic energy of the object. ✓✓ (2)

3.1.5 $W_{net} = \Delta E_K$ ✓ OR F_{net} = ma for both equations

-18, 2 = 2, 25 - $\frac{1}{2}$ (2) $(1{,}5)^2$ ✓

v_i = 4, 52 $m.s^{-1}$ ✓

OR

-26 = 2a

a = -13 $m.s^{-1}$ ✓

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

$1,5^2 = v_i^2 + 2(-13)(0,7)$ ✓

v_i= 4,52 $m.s^{-1}$ ✓ (3)

3.2.1 In the absence of air resistance or any external forces, the mechanical energy of an object is constant.✓✓ (2)

3.2.2 crate: $\frac{1}{2}mv^2 + mgh = \frac{1}{2}mv^2 + mgh$ ✓

$\frac{1}{2}(1{,}2)v^2 + 0 = 0 + (1{,}2)(9{,}8)(0{,}65)$ ✓

v = 3, 57 $m.s^{-1}$ ✓ (3)

3.2.3 The total (linear) momentum of an isolated system remains constant (is conserved). ✓✓ (2)

3.2.4 $(P_{total})_{before} = (P_{total})_{after}$ ✓

0, 4v_b + 0= (0, 4)(-0, 36) + 1, 2 (3, 57)✓

V_b = 10, 35 $m.s^{-1}$ ✓ (3)

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ACTIVITY 4

4.1 contact force – dependant on the path taken ✓✓ (2)

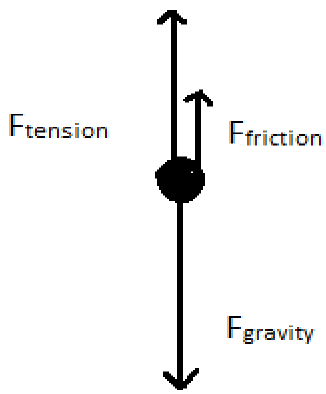
4.2 force of air friction ✓

Tension/ Force of rope ✓ (2)

4.3 weight/ gravitational force of earth on an object.

Criteria	Mark
$F_{tension}$ of cable on body	✓
$F_{friction}$ of air on body	✓
$F_{gravity}$ force of earth on body	✓

(3)



4.5 $W_{net} = \Delta E_k$ ✓

4.6 $W_{net} = \Delta E_k$

$F_{net} \Delta x \cos Ø = ½mv_f^2 - ½mv_i^2$

$F_{net}(10)\cos 180^0 = ½(2)(0^2) - ½(2)(1.5^2)$ ✓

$F_{net}(-10) = -2{,}25N$

$F_{net} = ma$ ✓ $= +0{,}225$

(2) a = 0,225

a ✓ = 0,11 25$m \cdot s^{-2}$ ✓

OR

$W_{net} = \Delta E_k$

$f_{net}\ \Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$f_{net}(10)\cos 180^0$✓ $= \frac{1}{2}(2)(0^2) - \frac{1}{2}(2)(1.5)^2$✓

$f_{net}(-10) = -2.25$

$f_{net} = ma$ ✓$= 0.\ 225$

$(2)a = 0.225$

$\therefore a = 0.1125 m.s^{-2}$✓ (4)

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ACTIVITY 5

5.1.1 **OPTION 1**

$W = F\Delta x\cos\theta$✓

$W_{gravity} = mg\Delta y\cos\theta$

$= \underline{(1\ 100)(9,8)(60)\cos180^o}$✓

$= -\ 646\ 800$ J ($6,47\times10^5$ J)✓

OPTION 2

$W = -\ \Delta E_p$✓

$= -(1\ 100)(9,8)(60 - 0)$ ✓

$= -646800$ J✓

-1 if either negative is omitted or Ep = mgh is used instead of W (3)

5.1.2 $W_{counterweight} = mg\Delta y\cos\theta$

$= \underline{(870)(9,8)(60)\cos0^o}$✓

$= 511\ 560$ J ($5,11\times10^5$ J)✓ (2)

5.2 **OPTION 1**

POSITIVE MARKING FROM QUESTIONS 5.2.1 AND

$W_{net} = \Delta E_K$

$W_{gravity} + W_{countweight} + W_{motor} = 0$

$W_{motor} = -\ (W_{gravity} + W_{countweight})$

$W_{nc} = \Delta E_K + \Delta E_p$

} ✓ 1 mark for any one

NOTE: Substituting into any of the above equations will lead to:

$-646800✓ + 511560$ ✓ $+ W_{motor} = 0$

$\therefore W_{motor} = 135240$ J

$P_{ave\ motor} = \frac{W}{\Delta t}$ ✓

$= \frac{135240}{180}$ ✓

$= 751,33$ W✓ (5)

OPTION 2

$F_{net} = 0$ ✓1 mark for any one

$F_{gcage} + F_{gcount} + F_{motor} = F_{net}$

$-10780 + 8526$✓ $+ F_{motor} = 0$

$F_{motor} = 2254$ N

$P_{ave} = Fv_{ave}$✓

$= 2254$✓ $\frac{5560}{180}$

$= 751,33$ W ✓ (5)

OPTION 3

Pave = Fvave✓✓

$= [1\ 100\ (9,8) – 870(9,8)]$ ✓ $\frac{60}{180}$ ✓

$= 757,33$ W✓ (5)

[**10]**

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ACTIVITY SOLUTIONS

Topic(s)

ACID AND BASES

ACID AND BASES SOLUTIONS

ACTIVITY 1

1.1 B√√
1.2 A√√
1.3 B√√
1.4 C√√
1.5 C√√
1.6 D√√
1.7 D√√
1.8 B√√
1.9 B√√
1.10 B√√

[20]

ACTIVITY

2.1.1 A base that dissociates /ionizes slightly / partially/ incompletely when dissolved in water (solution).✓✓ (2)

2.1.2 It is a proton acceptor✓✓ (2)

2.1.3 NH_4^+✓ (1)

2.1.4 $NH_4^+ (aq) + H_2O (\ell) \leftrightharpoons NH_3 (g) + H_30^+(aq)$ **✓R, ✓P and Balancing✓** (3)

2.2.1 H_3O^+✓ (1)

2.2.2 $pH = -log[H_3O^+]$✓
$3, 5=- log[H_3O^+]$
$[H_3O^+]=10^{-3, 5}$✓
$=0,0003 mol.dm^{-3}$ or $3 \times 10^{-4} mol.dm^{-3}$✓ (3)

2.2.3 The reaction of an acid and a base to form salt and water✓✓ (2)

2.2.4 n $(HC\ell)$: $\frac{1}{2}$ $n(Na_2CO_3)$ ✓
n $(HC\ell)$ = cV = 0,0003 mol✓
$n(Na_2CO_3) = \frac{0,0003}{2}$ =0,00015mol✓
m (Na_2CO_3) = nM✓
= (0, 00015) (106)✓
= 0, 0159 g✓

Marking guideline

- Mole ratio
- $n(HC\ell)$
- $n(Na_2CO_3)$
- m = nM
- $M(Na_2CO_3)$
- Answer with units

OR

From the balanced equation
2 moles of HCℓ = 1 mole of Na_2CO_3✓
n (HCℓ) = cV = 0, 0003 mol✓

$n(Na_2CO_3) = \frac{0,0003}{2}$ =0,00015mol✓

$m(Na_2CO_3) = nM$✓
= (0, 00015)(106)✓
= 0, 0159 g✓ (6)

2.2.5 The water tasted salty due to the formation of NaCℓ✓✓ (2)

2.3.1 CO_3^{2-} ✓ (1)
2.3.2 BASIC✓ (1)
2.3.3 The carbonate ion (CO_3^{2-}) hydrolysis to produce hydroxyl ion (OH^-) in solution✓✓ (2)

[26]

ACTIVITY 3

3.1 Hydrochloric Acid✓ (1)

3.2.1 Increases✓ (1)
3.2.2 Increases ✓ (1)
3.2.3 Decreases ✓ (1)

3.3 $K_w = [H^+][OH^-] = 1 \times 10^{-14}$ ✓
$= [H^+](10^{-6}) = 1 \times 10^{-14}$✓
$\therefore [H^+] = 10^{-8}$✓

$pH = -\log [H^+] = -\log (10^{-8})$✓
$\therefore$ **pH = 8** ✓ (5)

3.4
3.4.1 The point during a titration where an exact number of moles of acid will neutralize an exact number of moles of base.✓✓ (2)

3.4.2 For NaOH:
$(c \times V)_{dilute} = (c \times V)_{conc}$✓ $C_{dilute} = \frac{c \times V_{conc}}{V_{dilute}}$ =0, 08 mol.dm^3✓

OR

Solution is diluted 20 times (i.e. 50 cm^3 in 1 dm^3) ∴ Concentration must decrease 20 times

n_{NaOH} = cV
= 0, 08 x 0, 04
= 3, 2 x 10^{-3} mol✓
$2n_{NaOH} = n_{C_2H_2O_4}$ ✓
∴ n = 1, 6 x 10^{-3} mol✓
$m_{C_2H_2O_4}$ = nxM
= 1, 6 x 10^{-3} x90
= 0, 144g✓

∴ % purity = $\frac{0{,}144}{0{,}25}$ ✓x 100 = 57, 6%✓ (9)

[20]

ACTIVITY 4

4.1 An acid is a substance that produces hydrogen ions (H+) hydronium ions (H_3O^+) when it dissolves in water. ✓✓ (2)

4.2 4.2.1 **P✓** (1)

4.2.2 (a) NH_4^+ ✓+ H_2O✓ ⇌ NH_3 +H_30^+✓ bal (3)

(b) Acidic ✓ Hydronium ions (H_3O^+) are formed in the solution✓(2)

4.3 4.3.1 c = $\frac{m}{MV}$ ✓

= $\frac{4}{(40)(0{,}5)}$ ✓

= 0,2 mol.dm^{-3} ✓ OR n = $\frac{m}{M}$

= $\frac{4}{40}$

= 0, 1 mol ✓

c = $\frac{n}{V}$

= $\frac{0{,}1}{0{,}5}$✓

= **0, 2 mol.dm^{-3}**✓ (3)

4.3.2 $\frac{C_a V_a}{C_b V_b} = \frac{n_a}{n_b}$ ✓ OR $C_b V_b = n_b$

✓ $\frac{C_a(25)}{(0,2)(12,5)} = \frac{1}{2}$ ✓

c_a = 0, 05 mol.dm^{-3}

OR:

(0,2)(12,5 x 10^{-3}) ✓ = n_b

n_b = 2,5 x 10^{-3} mol

n_a = ½(2,5 x 10^{-3})

$c_a = \frac{n_a}{V_a}$

$= \frac{1,25 \ x \ 10^{-3}}{25 \ x \ 10^{-3}}$ ✓ ✓

= 0,05 mol.dm^{-3}

c_a = 0, 05 mol.dm^{-3}

[$H3O^+$] = 2(0,05) ✓

pH = -log[$H3O^+$]✓

pH = -log(0,1) ✓

pH = 1✓ (7)

[18]

<u>ACTIVITY 5</u>

5.1 **An acid** is a proton (H^+ ion) donor.✓✓ (2)

5.2 5.2.1 CO_3^{2-} ✓ (1)

5.2.2 HCO_3^- ✓ (1)

5.3 5.3.1 A strong acid is one that **ionises** (almost) completely (in an aqueous solution). ✓✓ (2)

5.3.2 **HI** ✓
It has a higher Ka, which indicates that it ionises more than HF does ✓
OR
it indicates that it has a higher concentration of H_3O^+ ions. ✓ (2)

5.3.3 **HI** ✓since it would have a higher concentration of (free) ions (as it ionises more). ✓ (2)

5.3.4 (a) K_w = [H_3O^+].[OH^{-1}] = 1 x 10^{-14}✓

[OH^-] $\frac{1 \text{ x } 10^{-14}}{0,02}$✓

[OH^-] = 5 x 10^{-13} mol.dm^{-3}✓ (3)

(b) Ka = $\frac{[H_3O^+].[F^-]}{[HF]}$ ✓✓Round brackets (-1) (2)

(c) 6, 6 x 10^{-4} = $\frac{0,02\ x\ 0,02}{[HF]}$ ✓✓

[HF] = 0,61 mil.dm^{-3} ✓ (3)

5.4 $NH_4NO_3(s) \rightleftharpoons NH_4^+(aq) + NO_3^-(aq)$

$H_2O(\ell) \rightleftharpoons OH^-(aq) + H^+(aq)$

Consider the pairs of ions formed:

• NH_4^+ and OH^- ions would form a **weak base (NH_4OH)** which is **not completely dissociated**. ✓
• H^+ and NO_3^- ions would form a **strong acid (HNO_3)** which remains **completely ionised**. ✓
• Thus, **OH^- ions are removed from solution**, upsetting the equilibrium of water (favouring the forward reaction) and leaving an **excess of H^+ (or H_3O^+) ions**, hence a weakly acidic solution. ✓✓ (4)

5.5 5.5.1 n = cV ✓
C=n/V)
= 0,8 × 0,05 ✓
= 0,04 mol of HCℓ ✓ (3)

5.5.2 n = c.V
= 0,5 × 0,02 ✓
= 0,01 mol of NaOH ✓

Therefore 0,01 mol of HCℓ neutralised (excess).
Mols of HCℓ that reacted with MgO = (0,04 – 0,01) (c.o.e from 8.5.1)
= 0,03 mol of HCℓ
Mol ratio: MgO : HCℓ
1 : 2
0,015 : 0,03 ✓

Mass of MgO: m = n × M
= 0,015 × 40,3 ✓
= 0,6045 g of MgO ✓

% of MgO in tablet = 0,6045/0,96 × 100 ✓
= 62,97% ✓

OR

Assume 100% purity

n = m/M

= 0,96/40,3

= 0,02382134 mol of MgO

But only 0,015 mol of MgO in tablet

% of MgO in tablet = 0,015/0,02382134 × 100

= 62,97% (7)

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ACTIVITY SOLUTIONS

CHEMICAL EQUILIBRIUM

CHEMICAL EQUILIBRIUM
ACTIVITY 1

1.1 D✓✓ (2)

1.2 A✓✓ (2)

1.3 B✓✓ (2)

1.4 D √√ (2)

1.5 C√√ (2)

ACTIVITY 2

2. 2.1 The reaction continues (forward and reverse) ✓✓although the concentrations remain constant. (2)

2.2 Equilibrium has been established. ✓ (1)

2.3 The concentrations of H_2 and N_2 are the same at the beginning ✓✓ whereas the concentration of NH_3 at the beginning is zero. (2)

2.4
2.4.1 Increases✓
2.4.2 Decreases✓
2.4.3 Increases✓ (3)

[8]

ACTIVITY 3

3.1

	AB_3	AB_2	B_2	
Initial quantity (mol)	4	6	3✓	
Change (mol)	+4,4	-4,4	-2,2 ✓	ratio✓
Quantity at equilibrium (mol)	8,4	1,6	0,8 ✓	
Equilibrium concentration ($mol.dm^{-3}$)	4,2	0,8	0,4	Divide by 2✓

$$K_c = \frac{[AB_2]^2[B_2]}{[AB_3]^2} \checkmark$$

$$= \frac{(0{,}8^2)(0{,}4)}{4{,}2^2} \checkmark$$

$$= 0{,}015 \checkmark$$

Marking guidelines

Reading of number of initial number of moles correctly from the graph✓
Using the correct ratio to calculate the change✓
Correct calculation of the change✓
Subtracting the change from the initial number of moles to get values at equilibrium✓
Dividing by 2 to get concentration at equilibrium✓
Correct Kc expression(<u>formulae in square brackets</u>)✓
Substitution of concentrations into Kc expression✓
Correct answer: 0,015✓

(8)

3.2 Temperature ✓✓ (2)

3.3 Increased ✓ (1)

3.4 According to Le Chatelier's Principle an increase in temperature favours the endothermic reaction.✓

In this case the reverse reaction✓
Number of mol of AB_3 increased. ✓ (3)

3.5 Smaller than ✓ (1)

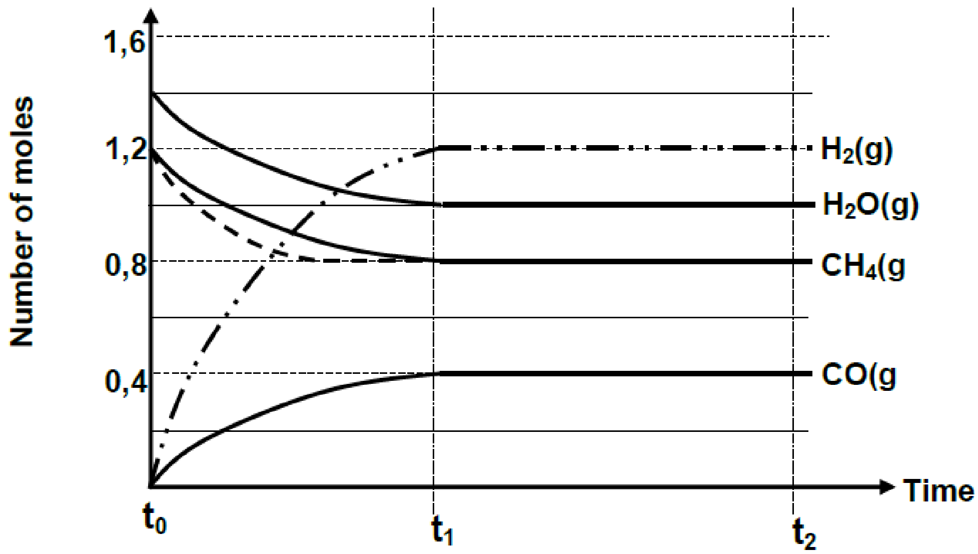
3.6 No change ✓ (1)

[16]

<u>ACTIVITY 4</u>

4.1 The reaction is in (dynamic chemical) equilibrium or the **rates** of the forward and reverse reactions are equal or the **rate** of formation of products is equal to the **rate** of formation of reactants. (2)

4.2



4.2.1 Graph levels out at t_1 at 1,2 moles ✓
Between t_0 and t_1 line must be curved (decreasing gradient) as shown. ✓ (-1 if H_2 not started at zero) (2)

4.2.2 Graph levels out BEFORE t_1 at 0,8 moles
Between t_0 and t_1 line must be curved (decreasing gradient) as shown (–1) if not. (Allow c.o.e. from 5.2.1.) (-1 if not started at 1,2 mol) (2)

4.3

$$K_c = \frac{[CO]\times[H_2]^3}{[CH_4]\times[H_2O]}$$

$$K_c = \frac{(0{,}4/2)\times(1{,}2/2)^3}{(0{,}8/2)\times(1/2)}$$

$= \mathbf{0{,}22}$

(–1 for use of round brackets)

- Correct moles for reactants ✓
- Correct moles for products (c.o.e. from 7.2.1 if incorrect number of moles used for H_2✓✓
- Divide by volume ✓

(6)

4.4 **Low yield of products** (c.o.e. from 7.3) (Answer MUST link to 7.3) ✓ (1)

4.5 When an external stress is applied to a system in **chemical equilibrium**, the equilibrium point will change in such a way as to **counteract the stress**(2)

4.6 Explanation using Le Chatelier's Principle
Decrease or low yield of hydrogen. ✓
High pressures **favours the reverse reaction**✓ which produces **less moles of gas and relieves the stress of high pressure** or reduces the pressure). ✓
OR
Explanation using rates
Decrease or low yield of hydrogen. ✓

A high pressure increases the rates of both the forward and reverse reactions but the reverse rate increases more ✓as it **involves more gas particles**, therefore **favours the reverse reaction**✓. (3)

4.7 No change ✓ (1)

4.8 **Faster** reaction **rate**. ✓ (Products produced faster.)

Higher yield of products. ✓ (2)

[21]

<u>ACTIVITY 5</u>

5.1 5 minutes✓ (1)

5.2 $2SO_3$ ✓→ $2SO_2 + O_2$✓ (2)

5.3 When an external stress (change in pressure, temperature or concentration) is applied to a system in chemical equilibrium, ✓the equilibrium point will change in such a way as to counteract the stress. ✓ (2)

5.4

- Stress: increase in concentration of O_2 ✓
- Le Châtelier's principle predicts the system will respond in order to decrease the concentration of O_2 ✓
- Therefore, the forward reaction is (initially) favoured as it consumes O_2
- Decreasing the amount of SO_2 ✓ (3)

5.5 7.5.1 Forward✓ (1)

7.5.2 Exothermic ✓ (2)

[10]