PHYSICAL SCIENCES

Grade 10

TERM 4

RESOURCE PACK

Contents

WORKSHEETS

Topic 22: Energy

WORKSHEET

1. A boy of mass 48 kg climbs up a ladder until he is 3,4 m above the ground. How much gravitational potential energy has he gained? (4)

2. A man of mass 75 kg standing at the top of a tall building has 48 000 J of gravitational potential energy. How tall is the building? (4)

3. A girl drops a ball of mass 0,4 kg from a height of 2 m above the ground.

3.1 How much potential energy does the ball have before she drops it? (4)

3.2 How much potential energy relative to the ground does the ball have when it hits the ground? **Justify your answer**. (2)

3.3 Explain what happens to the gravitational potential energy while the ball falls to the ground. (4)

4. Usain Bolt reached a maximum speed of 12,2 $m \cdot s^{-1}$ when he broke the 100 m world record in 2009. His mass was 94 kg. Calculate his maximum kinetic energy in this race. (4)

5. The speed of a tennis ball is measured at 50 $m \cdot s^{-1}$ when its kinetic energy is 100 J. Determine the mass of the tennis ball. (4)

6. The current land speed record for a vehicle is held by the Thrust SSC. This car travels at supersonic speed. Its mass is 10 500 kg. At its top speed it has kinetic energy of 610 900 000 J. Calculate the top speed of the car. (5)

7. A car of mass 1 200 kg travels at 20 $m \cdot s^{-1}$.

7.1 Calculate its kinetic energy at this speed. (4)

7.2 Calculate its kinetic energy at double this speed. (3)

7.3 Without further calculation, determine by what factor its kinetic energy decreases when it travels at 10 $m \cdot s^{-1}$. (2)

8. A cyclist increases her speed from 10 $m \cdot s^{-1}$ to 14 $m \cdot s^{-1}$. She and her bicycle have a combined mass of 55 kg. What is the change in her kinetic energy? (4)

9. A pendulum bob of mass 250 g reaches a maximum height of 0,4 m above its rest position. (4)

9.1 Calculate the potential energy of the bob at its maximum height. (4)

9.2 State the principle of conservation of mechanical energy. (2)

9.3 Under what conditions can this principle be applied to the motion of the pendulum bob? (2)

9.4 Apply the principle of conservation of mechanical energy to find the maximum speed of the bob when it passes its rest position. (5)

10 A rollercoaster makes use of energy transfers from gravitational potential energy to kinetic energy, and vice versa. The mass of a rollercoaster coach with its passengers is 600 kg. Its maximum speed at the bottom of a hill is 12 $m \cdot s^{-1}$.

10.1 Determine the maximum height which this coach could reach above the bottom of the hill. (4)

10.2 Explain why the coach is unlikely to reach this maximum height by describing the energy transfers which take place when the coach is in motion. (3)

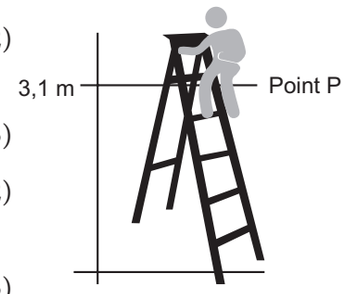
CONSOLIDATION QUESTIONS

TOTAL: 39 MARKS

FORMULAE: $E_K = \frac{1}{2} mv^2$ $E_P = mgh$ $E_M = E_K + E_P$ DATA: g = 9,8 m·s^{-2}

Assume that the effects of air resistance are negligible when solving these problems.

1. A man carries a briefcase of mass 5 kg while he climbs a ladder from the ground to point P which is 3,1 m above the ground. When he reaches point P, the man drops the briefcase. Refer to the diagram alongside.



1.1 Define "gravitational potential energy". (2)

1.2 Calculate how much gravitational potential energy the briefcase has gained when it reaches point P. (3)

1.3 State the law of conservation of mechanical energy. (2)

1.4 Determine the kinetic energy of the briefcase when it hits the floor. Justify your answer (3)

[10]

2. A cricket ball of mass 160 g travels at a speed of 20 m·s^{-1}.

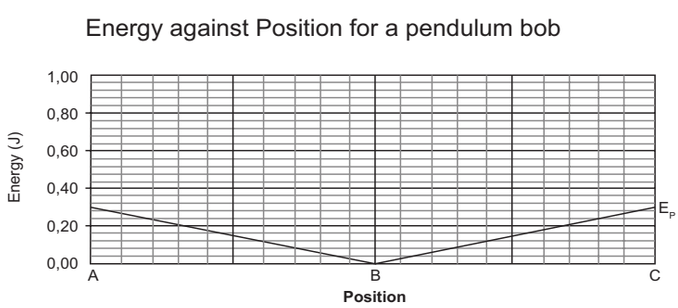
2.1 Define "kinetic energy". (2)

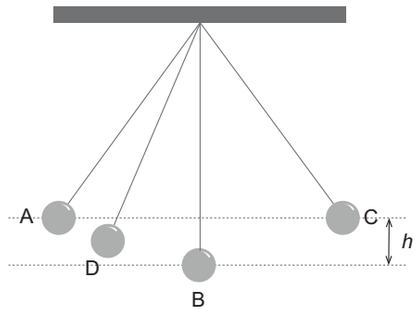
2.2 Calculate the kinetic energy of the ball. (4)

2.3 Determine the speed of the ball if it has TWICE this amount of kinetic energy (as calculated in **2.2**). (5)

[11]

3. The graph shows energy against position for a pendulum bob (mass 50 g) as it moves from A to B and to C. Air resistance is negligible.





3.1 Determine the maximum potential energy of the bob. (2)

3.2 Calculate the maximum gain in height (h) of the bob. (4)

3.3 Calculate the maximum speed of the bob at position B. (4)

3.4 Determine the maximum speed of the bob when the bob is at D, at half its maximum height (½ h). (4)

3.5 Copy the graph and draw the following two graphs on your copy of the graph:

a) The graph of mechanical energy against position. (2)

b) The graph of kinetic energy against position. (2)

Label the graphs (a) and (b).

[18]

MARKING GUIDELINES

1. $E_P = mgh$✓ = 48 × 9,8✓ × 3,4✓ = 1599,36 J✓ (4)

2. $E_P = mgh$✓ 48 000✓ = 75 × 9,8✓ × h

h = 65,31 m✓ (4)

3.1 $E_P = mgh$✓ = 0,4 × 9,8✓ × 2✓ = 7,83 J✓ (4)

3.2 0 J ✓ by the principle of conservation of mechanical energy✓ (2)

3.3 (All) the E_P is transformed (transferred) to E_K ✓provided there is no air resistance. ✓ OR The E_P is transformed (transferred) to E_K ✓ and to the environment due to energy being dissipated due to air resistance. ✓ (4)

4. $E_K = ½\ mv^2$✓ = ½ × 94 ✓× $(12,2)^2$✓ = 6 995,48 J✓ (4)

5. $E_K = ½\ mv^2$✓ ½ × m × $(50)^2$✓ = 100 ✓

$m = \frac{100}{½ \times 50^2}$ = 0,08 kg✓ (4)

6 $E_K = ½\ mv^2$✓ ½ × 10 500 × v^2✓ = 610 900 000 ✓

v^2 = 116 361,9048

$v = \sqrt{116\,361,9048}$ ✓= 341,12 m·s^{-1} ✓ (5)

7.1 $E_K = ½\ mv^2$✓ = ½ × 1 200 ✓× $(20)^2$✓ = 240 000 J✓ (4)

7.2 $E_K = ½\ mv^2$✓ = ½ × 1 200 × $(40)^2$✓ = 960 000 J✓

OR When the speed doubles, the kinetic energy increases by (2)2✓ = 4 times

Therefore E_K = 4 × 240 000✓ = 960 000 J✓ (3)

7.3 When the speed is halved, the kinetic energy is decreased by (½)^2 ✓= ¼✓ (2)

8. Change in $E_K = ½\ mv_f^2 - ½\ mv_i^2$ ✓= ½ × 55 × $(14)^2$ ✓– ½ × 55 × $(10)^2$ ✓

= 5390 – 2750 = 2640 J✓ (4)

9.1 m = 0,25 kg✓

$E_P = mgh$✓ = 0,25 × 9,8 × 0,4✓ = 0,98 J ✓ (4)

9.2 In the absence of dissipative forces such as friction and air resistance✓ the total mechanical energy of a system remains constant. ✓ (2)

9.3 There are no frictional forces✓ or air resistance✓ in an isolated system. (2)

9.4 ($E_P + E_K$)at the top of its swing = ($E_P + E_K$)at the bottom of its swing ✓

0,98 + 0 = 0 + ½ mv^2 ✓ ½ mv^2 = 0,98 ½ × 0,25 v^2 ✓= 0,98

v^2 = 7,84

$v = \sqrt{7,84}$ ✓ = 2,8 m·s^{-1}✓ (5)

10.1 By the principle of conservation of mechanical energy

$(E_P + E_K)$at the top of the hill $= (E_P + E_K)$ at the bottom of the hill ✓

$0 + 600 \times 9{,}8 \times h$ ✓$= ½ \times 600 \times (12)^2 + 0$ ✓ $h = 7{,}35$ m ✓ (4)

10.2 The principle of conservation of mechanical energy does not apply to the roller-coaster ✓ because there is friction on the track, ✓ and there is air resistance as the coach moves. ✓ (Some E_P is transformed to heat, sound and internal energy of the system). (3)

CONSOLIDATION QUESTIONS

TOTAL: 39 MARKS

1.1 Gravitational potential energy is the energy an object possesses because of its position✓ in the gravitational field relative to some reference point.✓ (2)

1.2 $E_P = mgh$ ✓ $= 5 \times 9{,}8 \times 3{,}1$ ✓$= 151{,}9$ J ✓ (3)

1.3 In an isolated system✓ the total mechanical energy of a system remains constant. ✓ (2)

1.4 E_P at 3,1 m + E_K at 3,1 m = E_P at floor + E_K at floor ✓

$151{,}9 + 0 = 0 + E_K$ at floor ✓

$\therefore E_K$ at floor = 151,9 J ✓ (3)

2.1 Kinetic energy is the energy an object possesses as a result of its motion. ✓✓ (2)

2.2 $E_K = \frac{1}{2} mv^2$ ✓ $= \frac{1}{2}(0{,}16)$ ✓$(20)^2$✓ $= 32$ J✓ (4)

2.3 $E_K = 64$ J✓

$\frac{1}{2} mv^2 = \frac{1}{2}(0{,}16)v^2$ ✓$= 64$ ✓

$v = \sqrt{\frac{64}{\frac{1}{2} \times 0{,}16}}$ ✓ $= 20\sqrt{2} = 28{,}28$ m·s^{-1} ✓

OR

Original $E_K = \frac{1}{2} mv_i^2$ ✓

New $E_K = 2(\frac{1}{2} mv_i^2)$ ✓ $= \frac{1}{2} mv^2$ where v is the new speed✓

$2(\frac{1}{2} mv^2) = \frac{1}{2} mv^2$ ✓

$2(v_i^2) = v^2$ Dividing through by ½ m on both sides

$v = \sqrt{2} \times v_i$ ✓$= \sqrt{2} \times 20 = 28{,}28$ m·s^{-1} ✓ (5)

3.1 $E_P = 0{,}30$✓ J ✓ Reading from the graph (2)

3.2 mass = 50 g = 0,05 kg ✓

$mgh = 0{,}30$✓

$0{,}05 \times 9{,}8 \times h$✓ $= 0{,}30$

$h = \frac{0{,}30}{0{,}05 \times 9{,}8} = 0{,}61$ m ✓ (4)

3.3 E_P at A + E_K at A = E_P at B + E_K at B ✓

(by the principle of conservation of mechanical energy)

$0{,}3 + 0 = 0 + \frac{1}{2} mv^2$ ✓

$\frac{1}{2} \times 0{,}05 \times v^2 = 0{,}3$ ✓

$v = \sqrt{\frac{0{,}3}{\frac{1}{2} \times 0{,}05}}$ ✓ $= 3{,}46$ m·s^{-1}✓ (3)

3.4 $E_{P\,at\,A} + E_{K\,at\,A} = E_{P\,at\,D} + E_{K\,at\,D} = 0{,}30$✓

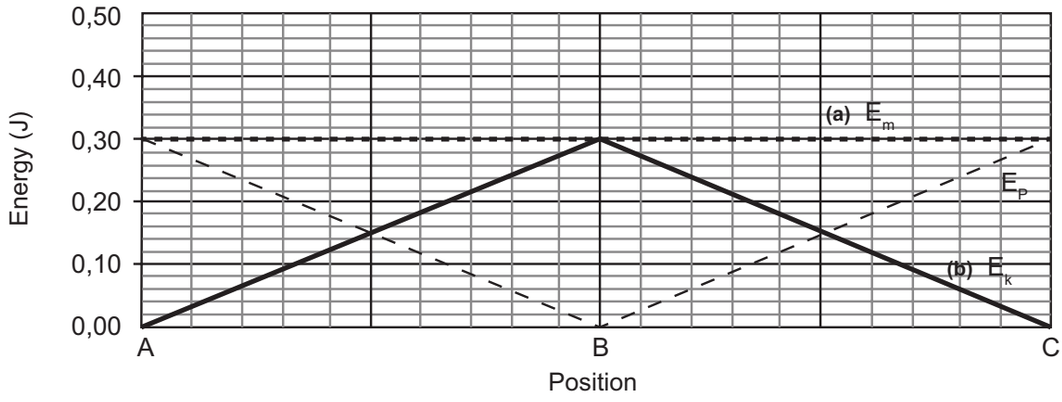
(by the principle of conservation of mechanical energy)

$0{,}30 + 0 = 0{,}15 + ½\ mv^2$ ✓

$½ \times 0{,}05 \times v^2 = 0{,}15$ ✓

$v = \sqrt{\frac{0{,}15}{\frac{1}{2} \times 0{,}05}}$ ✓ = 2,45 m·s^{-1}✓ (2)

3.5 Energy against Position for a pendulum bob



(4)

Topic 23: The Hydrosphere

WORKSHEET

MULTIPLE CHOICE

1. Water contains numerous substances that need to be removed because water ...

A can dissolve salts only.

B can dissolve all types of substances.

C only occurs in the liquid phase.

D can only dissolve molecular substances. (2)

2. The earth system that contains all the earth's water is called the ...

A lithosphere.

B biosphere.

C hydrosphere.

D atmosphere. (2)

3. Which one of the following is an INCORRECT criterion for quality water?

A It must be free of micro-organisms that cause disease.

B It must be at room temperature.

C It must be free of toxic chemicals.

D It must be odourless. (2)

4. Barium nitrate solution is added to each of the following solutions: potassium chloride, potassium bromide, sodium nitrite, calcium carbonate. Which one will form a white precipitate?

A Potassium chloride

B Potassium bromide

C Sodium nitrite

D Calcium carbonate (2)

LONG QUESTIONS

5. Tests are carried out on two sodium salts, A and Y, to determine which anions the salts contain.The following are the results of these tests:

- When a solution of barium nitrate is added to salt A, a white precipitate B is formed, which disappears when dilute nitric acid is added to B. A gas C is liberated during the process.
- When a solution of silver nitrate is added to salt Y, a white precipitate Z is formed which does not dissolve when dilute nitric acid is added to the solution.

5.1 What is meant by the term "anion"? (1)

5.2 Give the name of the white precipitate B. (2)

5.3 What gas, C, is released during the reaction? (1)

5.4 Write down the chemical formula for salt A. (2)

5.5 Write down the name of precipitate Z. (2)

5.6 Identify salt Y. (2)

6. During processes in which fossil fuels are burned (especially in power stations) the gas SO_2 is released into the atmosphere. This gas is soluble in water and dissolves in water droplets in the clouds to form sulfurous acid (H_2SO_3). This then falls back to earth as acid rain with rainfall.

6.1 How do clouds form in the atmosphere? (2)

6.2 List three possible effects of acid rain. (3)

6.3 What change of phase occurs during the process of the formation of water droplets in the clouds? (2)

CONSOLIDATION QUESTIONS

TOTAL: 33 MARKS

LONG QUESTIONS

1. The water cycle is a closed system, which means that the total amount of water on earth remains constant. Give three possible reasons why so many countries in the world today, including South Africa, are facing shortages of water. (6)

2. When rivers are dammed, there are both advantages and disadvantages involved in the process of building a dam. Discuss the building of dams, considering both sides of the argument. (9)

3. Explain what happens at the molecular level when each phase change of the water cycle takes place. (6)

MULTIPLE CHOICE

4. Which one of the following substances is responsible for acid rain?

A H_2SO_3

B $BaCO_3$

C $HC\ell$

D NH_3 (2)

5. Which one of the following substances is NOT used in the purification of water?

A H_2SO_3

B $C\ell_2$

C $A\ell_2(SO_4)_3$ (2)

6. Which one of the following is removed from river water by boiling it?

A Chemical pollutants

B Soil

C Harmful bacteria

D Twigs and leaves (2)

7. What observation is made when silver nitrate solution is added to a solution of sodium chloride in water?

A A dark yellow precipitate is formed.

B Bubbles of gas are given off.

C A light yellow precipitate is formed.

D A white precipitate is formed. (2)

8. Water as part of hydrated crystals is found in the ...

A atmosphere.

B lithosphere.

C biosphere.

D hydrosphere. (2)

9. Which one of the following processes involves a release of energy?

A Evaporation

B Boiling

C Condensation

D Sublimation (2)

MARKING GUIDELINES

MULTIPLE CHOICE

1. B Water is a universal solvent and can dissolve many different types of substances. It can dissolve ionic compounds but also molecular compounds. It is for this reason that there are so many substances found in water, most of which have to be removed before water is safe for drinking. (2)

2. C The hydrosphere contains all the earth's water, both fresh water and salt water. By far the largest amount of water is found in the oceans. The rest is in rivers and lakes, the polar ice caps, glaciers and in permafrost. (2)

3. B Remember that the answer here is the statement which is not correct. The temperature at which water is provided does not affect its quality. Water can be of excellent quality whether it is warm or cold. (2)

4. D When barium nitrate is put into a solution containing a carbonate salt, it forms barium carbonate, which is insoluble in water. This is why a white precipitate forms. When barium nitrate is added to chlorides or bromides, the salts formed are barium chloride and barium bromide, both of which are soluble in water and so do not form precipitates. Barium nitrite forms in the sodium nitrite solution. This salt is also soluble in water. (2)

LONG QUESTIONS

5.1 An anion is a negative ion✓ (1)

5.2 Barium carbonate ✓✓
A white precipitate, which is soluble in dilute nitric acid forms when barium ions from barium nitrate react with a solution that contains a carbonate. (2)

5.3 Carbon dioxide ✓
When carbonate ions react with an acid, they form carbon dioxide and water. (1)

5.4 Na_2CO_3✓✓ (2)

5.5 Silver chloride✓✓
Silver nitrate in solution contains Ag^+ and NO_3^- ions. The solution of salt Y must contain $C\ell^-$ ions which combine with Ag^+ ions to form $AgC\ell$, which is not soluble in water and forms a white precipitate. This precipitate does not dissolve when nitric acid is added. (2)

5.6 Salt Y is sodium chloride/$NaC\ell$. ✓✓ (2)

6.1 Water from the earth's surface evaporates into the atmosphere as water vapour.✓
When the water vapour reaches the upper layers of the atmosphere, the temperature drops and the water vapour condenses to form clouds.✓ (2)

6.2 Acid rain is responsible for:

- Destroying forests ✓
- Making it impossible for any form of life to exist in lakes which have had excessive acid rain. ✓
- Corroding metal structures, buildings and statues. ✓

SO_2 dissolves in water according to the chemical equation:

$SO_2 + H_2O \rightarrow H_2SO_3$ (sulphurous acid)

The sulphurous acid falls back to earth with rainwater. (3)

6.3 Gas phase to liquid phase ✓✓ (2)

CONSOLIDATION QUESTIONS

TOTAL: 30 MARKS

LONG QUESTIONS

1. Possible reasons are:

- The populations of countries have grown at a rate which has outstripped the existing water supplies. ✓✓
- Many countries have seen a rapid increase in industrialisation which requires large quantities of water. ✓✓
- Weather patterns have changed and many countries have experienced droughts, which in many instances are prolonged and so available water supplies have dwindled. ✓✓ (6)

2. Dams are generally built to provide a steadier or larger supply of water to cities, industry and or agriculture.

Advantages:

- These (the reasons stated above) are the stated advantages and the rationale for building the dam. ✓
- There are other possible advantages such as being able to build a hydroelectric scheme attached to the dam, which can provide more electricity to expand the national grid. ✓
- The lake which the dam forms can also create recreational facilities for the local community and possibly attract tourists. ✓

There are also many negative aspects to the building of dams, which need to be considered.

Disadvantages:

- Communities who live and possibly farm in the area to be flooded have to be moved to new homes. This may deprive people of their livelihood.✓
- Wildlife that inhabits the area will be drowned unless moved beforehand.✓
- There is a high degree of evaporation from the surface of a dam, especially if is very large and relatively shallow (as is the case with most dams in South Africa).✓
- After the passage of time, the bottom of a dam will silt up and reduce the space available for water and the water resource will thus diminish.✓
- Communities living downstream of the dam will be affected in that the flow of the river will be slowed, which in turn will affect the number of fish in the region.✓
- Farmers in lower reaches will also be affected, in that the dam will decrease the flow of nutrients downstream. ✓

This question is an example of an issue where both sides of the picture need to be considered and discussed. Where learners are asked to draw a conclusion it must be stressed that there is no correct answer. The learners may answer either in the positive or negative, as long as they support their conclusion with facts. (9)

3. In the process of evaporation, some of the molecules of water at the surface are vibrating with sufficient energy to break the forces✓ holding them to the other water molecules and to enter the atmosphere. ✓

It is common for learners to think that molecules only evaporate when a liquid is heated, but evaporation occurs at any temperature as described. It is only when some molecules have escaped that the temperature of the liquid drops and energy is then taken in from the surroundings to return the liquid to the temperature it was at before.

When the water condenses it is because at the lower temperatures that prevail in the upper atmosphere, the water molecules transfer energy to the surroundings.✓ The molecules vibrate less and the forces between molecules can be re-established to form the liquid.✓

If the temperature is sufficiently low in the atmosphere, the water molecules transfer enough energy for the liquid to become a solid✓ as there is even less vibration occurring at these lower temperatures. ✓ (6)

MULTIPLE CHOICE

4. A The burning of fossil fuels releases SO_2 gas into the atmosphere. This gas is soluble in water and dissolves in the moisture in the clouds. It then returns to the surface of the earth with rainfall as sulfurous acid (H_2SO_3), which makes the rainfall acidic. (2)

5. A Sulfurous acid would make the water acidic and is thus a pollutant rather than a substance which purifies water. (2)

6. C Boiling water for a period of time produces a temperature that is high enough to destroy any bacteria that may be present in the water. (2)

7. D Adding silver nitrate to a solution of sodium chloride forms silver chloride, which is insoluble in water and produces a white precipitate. A light yellow precipitate is formed by bromide ions and a dark yellow precipitate is formed by iodide ions. No gas is released from sodium chloride solution in this case. (2)

8. B Water is found in crystals as water of crystallisation, which is an integral part of the crystal lattice. These crystals are found in the ground as part of the lithosphere. (2)

9. C All the other processes require the supply of energy in order to occur because intermolecular forces are weakened or broken in these processes. (2)

ASSESSMENTS

Topic 22: Energy

QUESTIONS

MULTIPLE CHOICE

1.1 The kinetic energy of a moving body will increase the most if its …

A mass is doubled.
B velocity is doubled.
C mass is halved.
D velocity is halved. (2)

1.2 The mechanical energy gained by a 10 kg object that is lifted to a height of 10 m above the ground and held at rest in this position is approximately equal to …

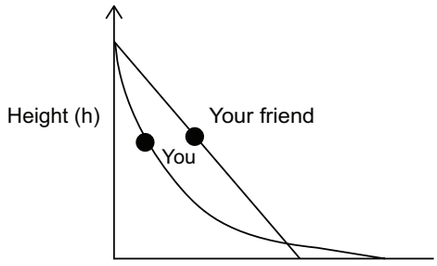
A 10 000 J
B 1 000 J
C 100 J
D 1 000 kJ (2)

1.3 Which of the following factors affects the gravitational potential energy gained by an object when it is lifted from the floor onto a table?

I Whether you lift the object quickly or slowly.
II The height of the table above the floor.
III Whether the object is lifted directly up to the table or along a longer path.

A I only
B II only
C III only
D II and III only (2)

1.4 Two frictionless slides are shaped differently but they start at the same height (h) and end at the same level as shown in the diagram. You and your friend, who has the same mass as you, slide down from the top of different slides starting from rest.



Which one of the following statements best describes who has the larger speed at the bottom of the slide?

A You, because you slide down a steeper slope at the beginning so you have a greater acceleration overall.
B You, because you travel a longer distance so there is more opportunity for accelerating.
C Your friend, because her slide has a constant slope so she has more opportunity for accelerating.
D Both of you have the same speed. (2)

1.5 When a car of mass m travels at velocity v, its kinetic energy is K. What is its kinetic energy, in terms of K, when it travels at twice the velocity (that is, as a velocity of $2v$)?

A $\frac{1}{4}K$

B $\frac{1}{2}K$

C $2K$

D $4K$ (2)

1.6 An object falls from rest from a height of X metres, where it has a potential energy of E joules. When it has fallen $\frac{1}{4}$X metres, its mechanical energy, in joules, is ...

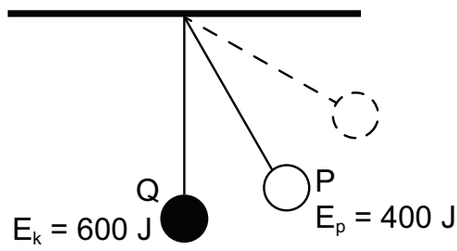
A $\frac{1}{4}$E

B $\frac{1}{2}$E

C $\frac{3}{4}$E

D E (2)

1.7 A spherical steel ball is suspended from the ceiling by a light inextensible string. At a certain height the ball is released. At a certain point P of its swing, the ball has a gravitational potential energy of 400 J with respect to its lowest point at Q. At point Q the ball has a kinetic energy of 600 J.



The total mechanical energy of the system is ...

A 1 000 J

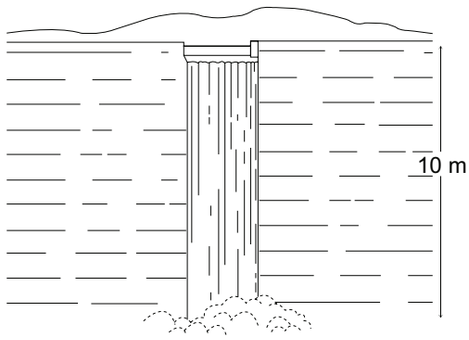
B 600 J

C 400 J

D 200 J (2)

LONG QUESTIONS

1. The diagram below shows water falling over a dam wall. The water falls a vertical distance of 10 m.

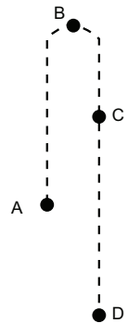


1.1 Calculate the potential energy of 1 kg of water at the top pf the waterfall. (3)
1.2 State the law of conservation of mechanical energy. (2)
1.3 Assume that no frictional forces act on the falling water. What will be the kinetic energy of 1 kg of water at the bottom of the waterfall? (1)
1.4 Determine the speed of the water at the bottom of the waterfall. (4)

2. A 20 kg rock falls vertically from rest from a cliff into the sea. The cliff is 12 m high. Ignore any effects of air resistance.
2.1 Define "gravitational potential energy". (2)
2.2 Calculate the gravitational potential energy of the rock relative to sea level. (3)
2.3 Calculate the speed of the rock when it hits the sea. (4)

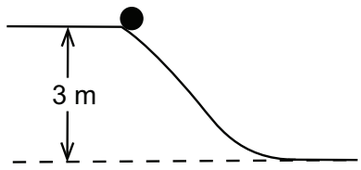
3. A 180 g ball is thrown up into the air with a velocity of 4 $m \cdot s^{-1}$. Ignore air resistance.
3.1 Calculate the initial kinetic energy of the ball as it is thrown upwards. (3)
3.2 Calculate the maximum height that the ball reaches. (4)
3.3 Calculate the gravitational potential energy of the ball when it is 0,5 m above its initial position. (3)
3.4 Calculate the speed of the ball at 0,5 m above its initial position. (4)

4. A toy missile (mass 500 g) is launched with a speed of 12 $m \cdot s^{-1}$ from a platform (at position A) which is 3 m above the ground. It reaches a maximum height at position B, then falls back down to the ground passing position A and landing at position D. [The diagram is not drawn to scale.] Ignore the effects of air resistance.



4.1 Define *kinetic energy.* (2)
4.2 Calculate the initial kinetic energy of the missile. (4)
4.3 Define *mechanical energy.* (2)
4.4 Calculate the initial mechanical energy of the missile. (4)
4.5 State the law of conservation of mechanical energy. (2)
4.6 Calculate the maximum height that the missile reaches **above the ground.** (4)
4.7 Determine the speed of the missile just before it hits the ground at position D. (4)

5. A ball of mass 600 g rolls from rest down a slope as shown in the diagram below.



The speed of the ball when it reaches the lower level is 6 $m \cdot s^{-1}$.

5.1 Calculate the potential energy of the ball on the upper level. (3)
5.2 Calculate the kinetic energy of the ball on the lower level. (3)
5.3 Calculate the energy loss experienced by the ball. (2)
5.4 What happens to this "lost" energy? (1)

MARKING GUIDELINES

MULTIPLE CHOICE

1.1 B✓ ✓ $E_k = \frac{1}{2}mv^2$ If v doubles $E_k = \frac{1}{2}m(2v)^2 = 4 \times \frac{1}{2}mv^2$. It becomes four times larger. [CL3] (2)

1.2 B✓ ✓ $E_{mechanical} = mgh + \frac{1}{2}mv^2 = mgh$ since v = 0 (The object is at rest).

$= 10 \times 9,8 \times 10$

$= 980\,J$

Almost $1000\,J$ [CL2] (2)

1.3 B✓ ✓ $E_p = mgh$ where h is the vertical height through which the object is lifted. Therefore III is does not affect E_p, nor does I. [CL2] (2)

1.4 D✓ ✓ Both you and the friend have the same initial gravitational potential energy, and the same mechanical energy. You both fall through the same vertical height. All your gravitational potential energy is transferred to kinetic energy. There are no frictional forces. Therefore, you both have the same kinetic energy at the bottom. Therefore, you have the same speed. [CL4] (2)

1.5 D✓ ✓ $K = \frac{1}{2}mv^2$

If v doubles, $E_k = \frac{1}{2}m(2v)^2$

$= 4 \times \frac{1}{2}mv^2$

$= 4K$ [CL3] (2)

1.6 D✓ ✓ There is no air resistance, therefore the law of conservation of mechanical energy applies to this situation.
If the initial mechanical energy $= E$,
then the final mechanical energy $= E$. [CL4] (2)

1.7 B✓ ✓ According to the law of conservation of mechanical energy, all the potential energy has been transferred to kinetic energy at position Q.
Therefore, the total mechanical energy of the system is 600 J [CL2] (2)

LONG QUESTIONS

1. 1.1 $E_p = mgh$ ✓ (method)

$= 1 \times 9,8 \times 10$ ✓ (substitutions)

$= 98$ J ✓ (accuracy; SI units) [CL2] (3)

1.2 In an isolated system✓ the total mechanical energy of a system remains constant.✓ [CL1] (2)

1.3 98 J ✓ [CL3] (1)

1.4 $E_k = \frac{1}{2}mv^2$ ✓ (method)

$98 = \frac{1}{2}(1)v^2$ ✓ (substitutions)

$v^2 = 196$ ✓ (changing the subject of the formula)

$v = \sqrt{196}$

$= 14\ m{\cdot}s^{-1}$ ✓ (accuracy; SI units) [CL3] (4)

2. 2.1 Gravitational potential energy is the energy an object possesses because of its position ✓ in the gravitational field relative to some reference point. ✓ [CL1] (2)

2.2 $E_p = mgh$ ✓ (method)

$= 20 \times 9,8 \times 12$ ✓ (substitutions)

$= 2\ 352$ J ✓ (accuracy; SI units) [CL2] (3)

2.3 $(E_p + E_k)_{initial} = (E_p + E_k)_{final}$ ✓ (using the law of conservation of mech. energy)

$2\ 352 + 0 = 0 + \frac{1}{2}mv^2$

$2\ 352 = \frac{1}{2}(20)v^2$ ✓ (substitutions)

$v^2 = 235,2$ ✓ (changing the subject of the formula)

$v = 15,34\ m{\cdot}s^{-1}$ ✓ (accuracy; SI units) [CL3] (4)

3. 3.1 $E_k = \frac{1}{2}mv^2$ ✓ (method)

$= \frac{1}{2} \times 0,18 \times (4)^2$ ✓ (substitutions)

$= 1,44$ J ✓ (accuracy; SI units) [CL2] (3)

3.2 $(E_p + E_k)_{initial} = (E_p + E_k)_{final}$ ✓ (method)

$0 + 1,44 = mgh + 0$ ✓ (substitutions)

$h = \frac{1,44}{0,18 \times 9,8}$ ✓ (changing the subject of the formula)

$= 0,82$ m ✓ (accuracy; Si units) [CL3] (4)

3.3 $E_p = mgh$ ✓ (method)

$= 0,18 \times 9,8 \times 0,5$ ✓ (substitutions)

$= 0,88$ J ✓ (accuracy; SI units) [CL2] (3)

3.4 $E_k = E_{mech} - E_p$

$= 1,44 - 0,88$ ✓ (method)

$= 0,56$ J

$\frac{1}{2}mv^2 = 0,56$ ✓ (substitution)

$v^2 = \frac{2 \times 0,56}{0,18}$ ✓ (changing the subject of the formula)

$v = 2,49\ m{\cdot}s^{-1}$ ✓ (accuracy; SI units) [CL4] (4)

ASSESSMENTS

4. 4.1 Kinetic energy is the energy an object possesses as a result of its motion. ✓ ✓ [CL1] (2)

4.2 $E_k = \frac{1}{2}mv^2$ ✓ (method)

$= \frac{1}{2} \times 0,5\checkmark \times (12)^2$ ✓ (conversion of g to kg) (substitutions)

$= 36$ J ✓ (accuracy; SI units) [CL2] (4)

4.3 Mechanical energy is the sum of the kinetic and gravitational potential energy of an object. ✓ ✓ [CL1] (2)

4.4 $E_{mechanical\ initial} = E_{p\ initial} + E_{k\ initial}$

$= mgh + \frac{1}{2}mv^2$

✓ ✓ ✓

$= 0,5 \times 9,8 \times 3 + 36$

$= 50,7$ J ✓ [CL2] (4)

4.5 In an isolated system, ✓ the total mechanical energy of a system remains constant. ✓ [CL1] (2)

4.6 $E_{mech\ initial} = E_{mech\ final}$ (at maximum height) ✓ (method)

$50,7 = mgh + 0$

$= 0,5 \times 9,8 \times h$ ✓ (substitutions)

$= \frac{50,7}{0,5 \times 9,8}$ ✓ (changing the subject of formula)

$= 10,35$ m ✓ (accuracy; SI units) [CL3] (4)

4.7 $E_{mech\ initial} = E_{mech\ final}$ (at position D) ✓ (method)

$50,7 = 0 + \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0,5 \times v^2$ ✓ (substitutions)

$v^2 = \frac{2 \times 50,7}{0,5}$ ✓ (changing the subject of the formula)

$v = 14,24\ m \cdot s^{-1}$ ✓ (accuracy; SI units) [CL3] (4)

5. 5.1 $E_p = mgh$ ✓ (method)

$= 0,6 \times 9,8 \times 3$ ✓ (substitutions)

$= 17,84$ J ✓ (accuracy; SI units) [CL2] (3)

5.2 $E_k = \frac{1}{2}mv^2$ ✓ (method)

$= \frac{1}{2} \times 0,6 \times (6)^2$ ✓ (substitutions)

$= 10,8$ J ✓ (accuracy; SI units) [CL2] (3)

5.3 Energy loss $= 10,8 - 17,84$ ✓ (method)

$= -7,04$ J ✓ (accuracy; SI units)

NB: Learners may calculate $17,84 - 10,8 = 7,04$J. Accept this as correct because they are only asked to find the quantity of energy "lost". [CL3] (2)

5.4 It is transferred ✓ (to internal energy of the system e.g. heat due to the work done against friction). [CL3] (1)

TOPIC 23: THE HYDROSPHERE

QUESTIONS

MULTIPLE CHOICE

1.1 Some silver nitrate solution is added to a solution containing an unknown anion. A white precipitate is observed, which is insoluble in dilute nitric acid. The unknown anion could be the ...

A iodide ion.
B chloride ion.
C bromide ion.
D nitrate ion. (2)

1.2 A small amount of ether is placed in a container and compressed air is blown over it to make it evaporate very quickly. The container soon becomes ice cold. This is because ...

A ether is a cold substance.
B the air blown over it is cold.
C the process of evaporation absorbs energy.
D the process of evaporation releases energy. (2)

1.3 One word that is used to describe all the earth's oceans, rivers, lakes, ground water and ice caps is the ...

A hydrosphere.
B atmosphere.
C lithosphere.
D biosphere. (2)

1.4 A clear solution contains a certain anion. To test for the anion, a small amount of barium chloride solution is added to the solution and a white precipitate forms. A few drops of dilute nitric acid are then added and the white precipitate dissolves. The anion present is the ...

A nitrate ion.
B sulfate ion.
C chloride ion.
D carbonate ion. (2)

1.5 Which one of the following processes is NOT part of the water cycle?

A Evaporation
B Condensation
C Acidification
D Precipitation (2)

1.6 Why is it necessary to disinfect water at the end of the water treatment process? To remove ...

A toxic pollutants.
B harmful bacteria.
C undesirable solids.
D sand from the water. (2)

LONG QUESTIONS

1. Water occurs on the earth in all three phases: solid, liquid and gas.
   a. Where is by far the greatest amount of water found on earth? (2)
   b. Describe where on earth water is found in each of the three phases. (6)

2. All water from rivers and dams contains contaminants and pollutants. Name **three** of these and describe how they are removed in the water purification process. (6)

3. Describe the path of water through the water cycle. State the changes of phase that occur and the energy changes involved at each of these changes. (9)

4. You are told that a sample of water contains the following anions: iodide, chloride, carbonate and bromide ions. Describe a test that you could use to determine the presence of each ion. (8)

5. A solution contains sulfate ions. Describe one possible way of removing the ions from the solution. Write down a balanced chemical equation for what happens. (4)

6. List three disadvantages of damming a river in order to make a large reservoir of water. (6)

MARKING GUIDELINES

MULTIPLE CHOICE

1.1 B✓ ✓ The iodide ion forms a dark yellow precipitate and the bromide ion forms a light-yellow precipitate. The nitrate ion does not react under these circumstances. [CL3] (2)

1.2 C✓ ✓ The process of evaporation occurs by the liquid absorbing energy from its surroundings. When a liquid evaporates quickly, a lot of energy is absorbed from its surroundings, making them much cooler. [CL3] (2)

1.3 A✓ ✓ [CL1] (2)

1.4 D✓ ✓ The solution becomes clear again, because when barium chloride is added, barium carbonate forms. This is the white precipitate. It reacts with the acid to release carbon dioxide gas, leaving behind barium nitrate, which is soluble. [CL3] (2)

1.5 C✓ ✓ The other three processes are all part of the water cycle. [CL2] (2)

1.6 B✓ ✓ The other substances mentioned are all in water, but they are removed by methods other than disinfection. [CL2] (2)

LONG QUESTIONS

1. a. In the oceans. ✓ ✓ [CL 1] (2)

   b. Solid - ice caps, frozen ground ✓ ✓
   Liquid – oceans, lakes, rivers ✓ ✓
   Vapour – atmosphere ✓ ✓ [CL 2] (6)

2. Chemical pollutants – by chemical reactions ✓ ✓

   Solid pollutants – by filtration, sedimentation ✓ ✓

   Bacteria – by chemical means ✓ ✓ [CL 2] (6)

3. Evaporation from water sources and the ground ✓ liquid to vapour ✓ energy is absorbed.✓

   Condensation in the atmosphere ✓ vapour to liquid ✓ energy is released. ✓

   Solidification in the clouds ✓ (hail and snow) liquid to solid ✓ energy is released.✓
   [CL 3] (9)

4. Iodide – add silver nitrate solution ✓ a dark yellow precipitate forms which is insoluble in dilute nitric acid. ✓

   Chloride – add silver nitrate solution ✓ a white precipitate forms which is insoluble in dilute nitric acid. ✓

   Carbonate – add a solution of barium chloride ✓ a white precipitate forms which dissolves in dilute nitric acid. ✓

   Bromide – add silver nitrate solution ✓ a light yellow precipitate forms which is insoluble in dilute nitric acid. ✓ [CL 2] (8)

5. Add some dilute barium chloride solution. ✓ The sulfate ions will precipitate out as barium sulfate. ✓

   $BaCl_2(aq) + SO_4^{2-}(aq)$ ✓ $\longrightarrow BaSO_4(s) + 2Cl^-(aq)$ ✓ [CL 4] (4)

6. People and animals are displaced and homes submerged. ✓ ✓

   The ecosystem below the dam is affected. ✓ ✓

   Farmers and fishermen below the dam have their lives disrupted. ✓ ✓

   Silt builds up against the dam wall. ✓ ✓ ANY THREE [CL 2] (6)