# BTec National Diploma in Applied Science

# Summer Independent Learning

# Y12-13

## Part 1 – Compulsory Content (pages 2-19)

There are 3 sections to the compulsory content (Physics and Chemistry)

For each section.

1. Watch the videos and complete the notes – you may consider adding flashcards / condensed notes, so you can use them to test yourself (metacognition)
2. Complete the follow up application questions
3. Correct and improve the questions where available (mark scheme at the end of the document)

## Part 2 – Highly Recommended (pages 20-31)

There are 1 sections to the highly recommended content (Biology)

Solutions to some of the content (pages 32-36)

# Part 1 – Compulsory Content

## PHYSICS –

### NOTES (recall)

Watch the following videos and complete the notes on energy:

You don't need to include any derivations of formulae.

**Conservation of energy (link)**

State the law of conservation of energy

_____

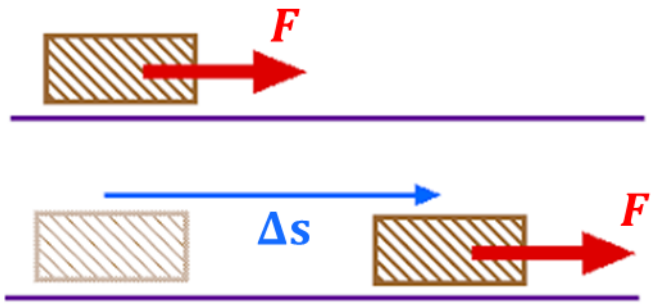
_____

_____

**Mechanical work & energy (link)**

1. State the unit of energy _____

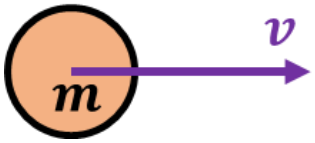
2. An object is pushed with a force, $F$, in the same direction as its displacement, $\Delta s$.
   State the equation for the work done:



**Kinetic energy (link)**

1. What do we associate **kinetic** energy with? _____

2. An object of mass, $m$, is moving at a velocity, $v$.
   State the equation for the kinetic energy of the object:

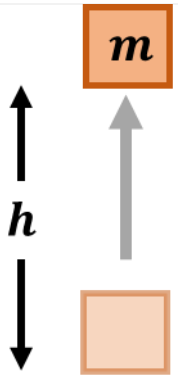



**Gravitational potential energy (link)**

1. How could you alter the gravitational potential energy of an object?

_____

2. An object of mass, $m$, is lifted a distance, $h$, in a uniform gravitational field, $g$.
   State the equation for the gravitational potential energy of the object:

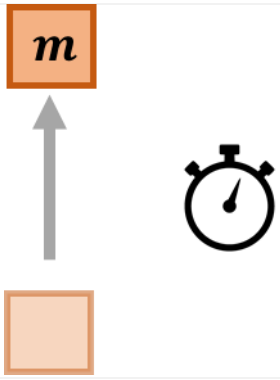



**Power (link)**

1. How could you be more powerful climbing a flight of stairs?

_____

2. Work, $W$, is done on an object moving shifting, $E$, between energy stores in a time, $t$.
   State the equation for the power transferred to the object:

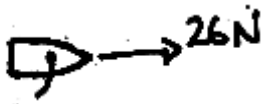



**Efficiency (link)**

1. State the equation for the efficiency of an object.

## APPLY - QUESTIONS (to be completed on separate paper)

**1.** A toy boat moves $4.00\ \text{m}$ in the direction of the applied force of $26\ \text{N}$ on the sails. Calculate the work done on the boat.




**2.** Calculate the gravitational potential energy stored raising a $60\ \text{kg}$ child to the top of a $2.0\ \text{m}$ slide.

**3.** A spring with a constant of $25\ \text{N/m}$ is extended by $50\ \text{cm}$. Calculate the stored elastic potential energy in the spring.

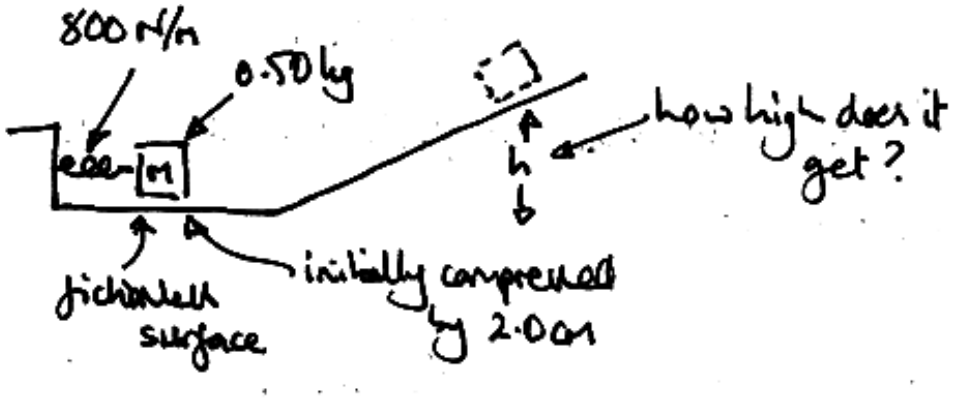
**4.** Calculate the kinetic energy of a $80\ \text{kg}$ student sprinting at $8.0\ \text{m/s}$.

**5.** A $4.0\ \text{kg}$ ball has $50\ \text{J}$ of kinetic energy. How fast is it moving?

**6.** The child in question 2 'loses' $10\ \%$ of their gravitational potential energy store to frictional forces going down the slide. Calculate the speed of the child at the bottom of the slide.

**7.** A $10\ \text{g}$ spring with a spring constant of $20\ \text{N/m}$ is extended by $10\ \text{cm}$ then released horizontally on a frictionless surface. Calculate the speed of the spring after release.

**8.** **(Challenge)** A $0.50\ \text{kg}$ mass is launched from a frictionless surface by a spring with a spring constant of $800\ \text{N/m}$ which is initially compressed by $2.0\ \text{cm}$. How high does the mass get up a slope as shown? Provide the vertical displacement.




**9.** A kettle transfers 1,500 J of energy, 1,200 J to a thermal energy store in the water and 300 J to the air as sound. How efficient is the kettle? **[2 marks]** [grade 3]

**10.** Playing on an Xbox 360 uses 102 J of electrical energy each second. 9 J of this energy is transferred to a thermal energy store. How efficient is the Xbox? **[3]** [grade 4]

**11.** A pendulum with a store of 100 J of gravitational potential energy transfers 99.5 J to a kinetic energy store on its first swing.

a. How much energy is being wasted due to friction by transfer to a thermal energy store? **[1]**

b. How efficient is the pendulum? **[2]** [grade 4]

**PTO**

## NOTES (preview)

Watch the following videos and complete the notes on materials:

You don't need to include any derivations of formulae.

**Hooke's law (link)**

1. Define tension

_____

2. What happens to objects under tension?

_____

3. Define compression

_____

4. What happens to objects under compression?

_____

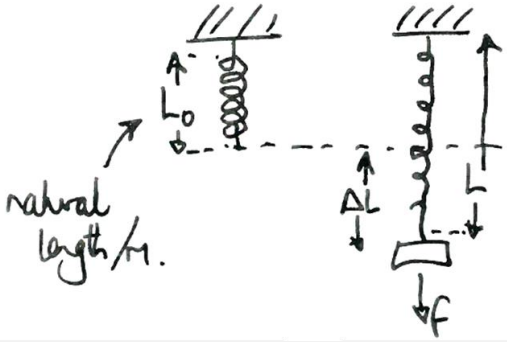
5. What is the additional length, $\Delta L$, ($x$ in the video) called when a spring is stretched past its original (natural length?)

_____

6. What does the spring constant aka the stiffness, $k$, tell us?

_____

7. State the equation for Hooke's law:



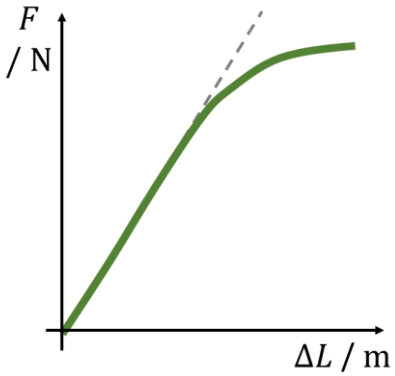

8. What does the gradient of the linear part of the curve represent?

_____

_____

9. Name the point at which the graph is no longer linear.

_____



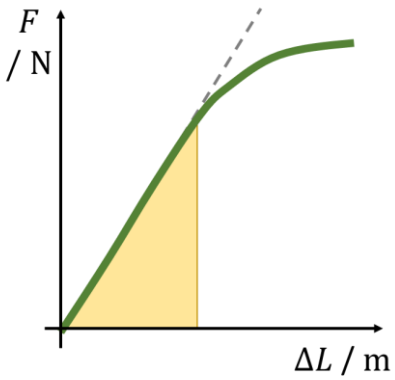
**Hooke's law energy (link)**

1. What does the area under the linear part of the curve represent?

_____

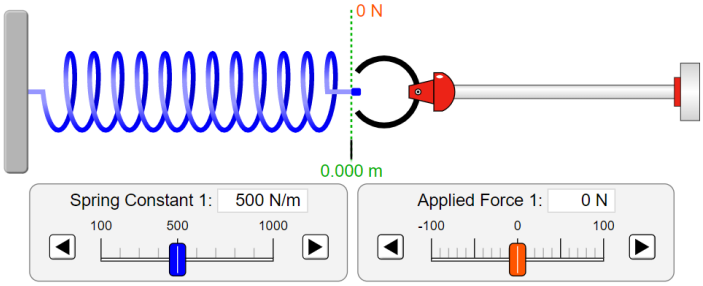
_____

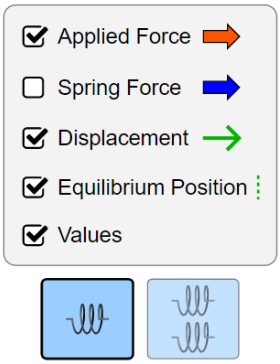
2. State the equation(s) that there area represents.




**Hooke's law simulation (link)**

Set up the simulation as shown in the images provided




**SIMULATION**

1. With the spring constant set at 500 N/m apply a tension force of 50 N. Record your extension.

_____

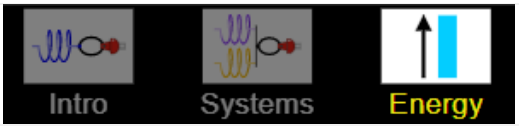
2. Use Hooke's law to predict the extension when 100 N are applied.

_____

3. Apply a force of 100 N in the simulation. Record the extension.

_____

Stretch. Try adjusting the parameters of the simulation including viewing the elastic potential energy stored on the 3rd tab. Describe your findings:




_____

_____

_____

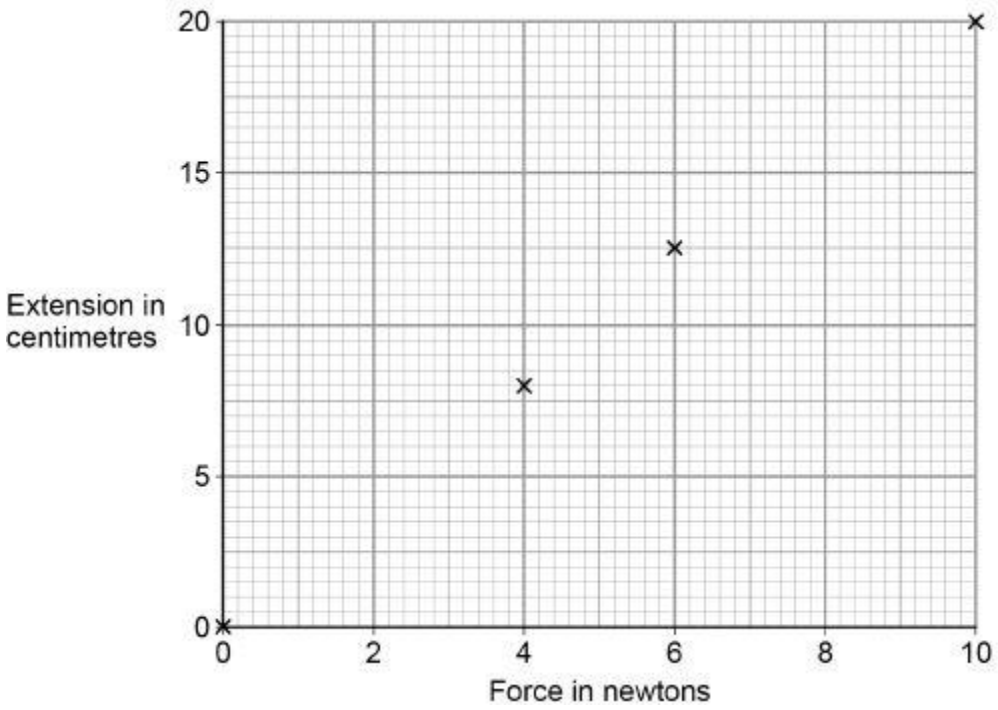
## APPLY - QUESTIONS (to be completed on separate paper)

**Q1.** A student carried out an investigation to determine the spring constant of a spring.

The table below gives the data obtained by the student.

| Force in N | Extension in cm |
|---|---|
| 0 | 0.0 |
| 2 | 3.5 |
| 4 | 8.0 |
| 6 | 12.5 |
| 8 | 16.0 |
| 10 | 20.0 |

The diagram below shows some of the data obtained by the student.




(c) Complete the diagram above by plotting the missing data from the table above.

Draw the line of best fit.

The table above is repeated here to help you answer this question.

**(2)**

(d) Write down the equation that links extension, force and spring constant.

_____

**(1)**

(e) Calculate the spring constant of the spring that the student used.

Give your answer in newtons per metre.

_____

_____

_____

_____

Spring constant = _____ N/m

**(4)**

(f) Hooke's Law states that:
'The extension of an elastic object is directly proportional to the force applied, provided the limit of proportionality is not exceeded.'

The student concluded that over the range of force used, the spring obeyed Hooke's Law.

Explain how the data supports the student's conclusion.

_____

_____

_____

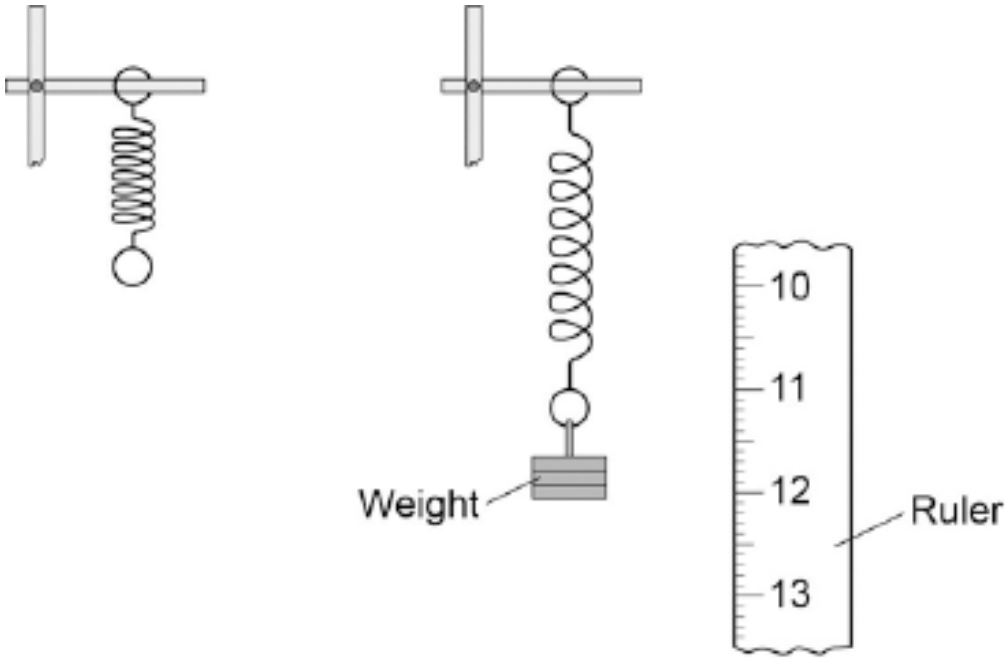
_____

**(2)**
**(Total 9 marks)**

**Q2.** A student suspended a spring from a laboratory stand and then hung a weight from the spring.

**Figure 1** shows the spring before and after the weight is added.

**Figure 1**



(a) Measure the extension of the spring shown in **Figure 1**.

Extension = _____ mm

**(1)**

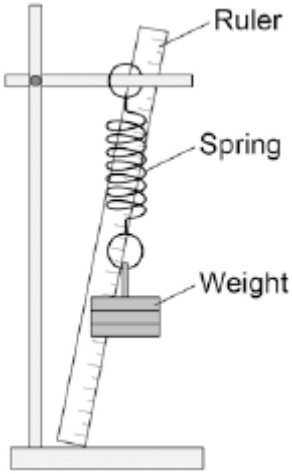
(b) The student used the spring, a set of weights and a ruler to investigate how the extension of the spring depended on the weight hanging from the spring.

Before starting the investigation the student wrote the following prediction:

The extension of the spring will be directly proportional to the weight hanging from the spring.

**Figure 2** shows how the student arranged the apparatus.

**Figure 2**




Before taking any measurements, the student adjusted the ruler to make it vertical.

Explain why adjusting the ruler was important.

_____

_____

_____

_____

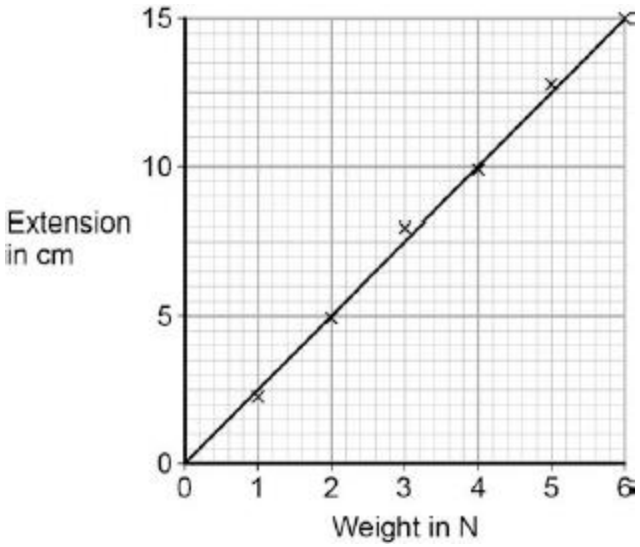
**(2)**

**PTO**

(c) The student measured the extension of the spring using a range of weights.

The student's data is shown plotted as a graph in **Figure 3**.

**Figure 3**




What range of weight did the student use?

_____

**(1)**

(d) Why does the data plotted in **Figure 3** support the student's prediction?

_____

_____

**(1)**

(e) Describe **one** technique that you could have used to improve the accuracy of the measurements taken by the student.

_____

_____

_____

_____

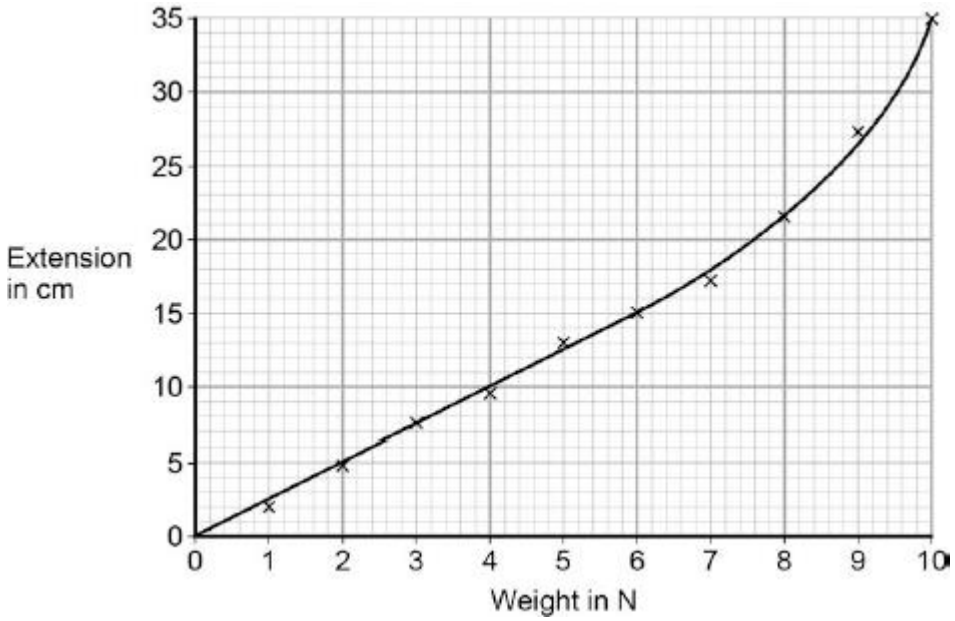
**(2)**

**PTO**

(f) The student continued the investigation by increasing the range of weights added to the spring.

All of the data is shown plotted as a graph in **Figure 4**.

**Figure 4**




At the end of the investigation, all of the weights were removed from the spring.

What can you conclude from **Figure 4** about the deformation of the spring?

_____

_____

Give the reason for your conclusion.

_____

_____

**(2)**

**(Total 9 marks)**

# CHEMISTRY

## Electrolysis

**Use the following resources to help you with this section:**

**Give the definition of the following terms:**

i. **Electrolysis**

_____

_____

ii. **Electrolyte**

_____

_____

iii. **Electrode**

_____

_____

iv. **Reduction**

_____

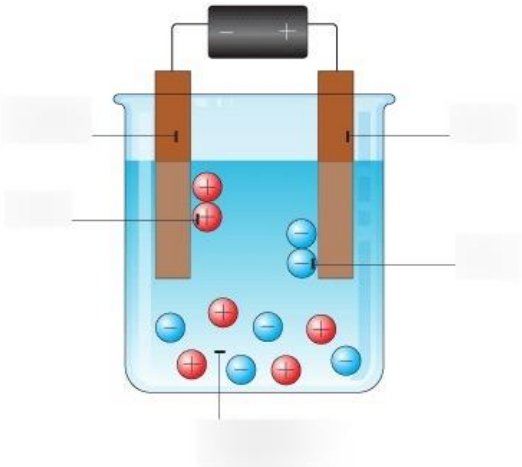
_____

v. **Oxidation**

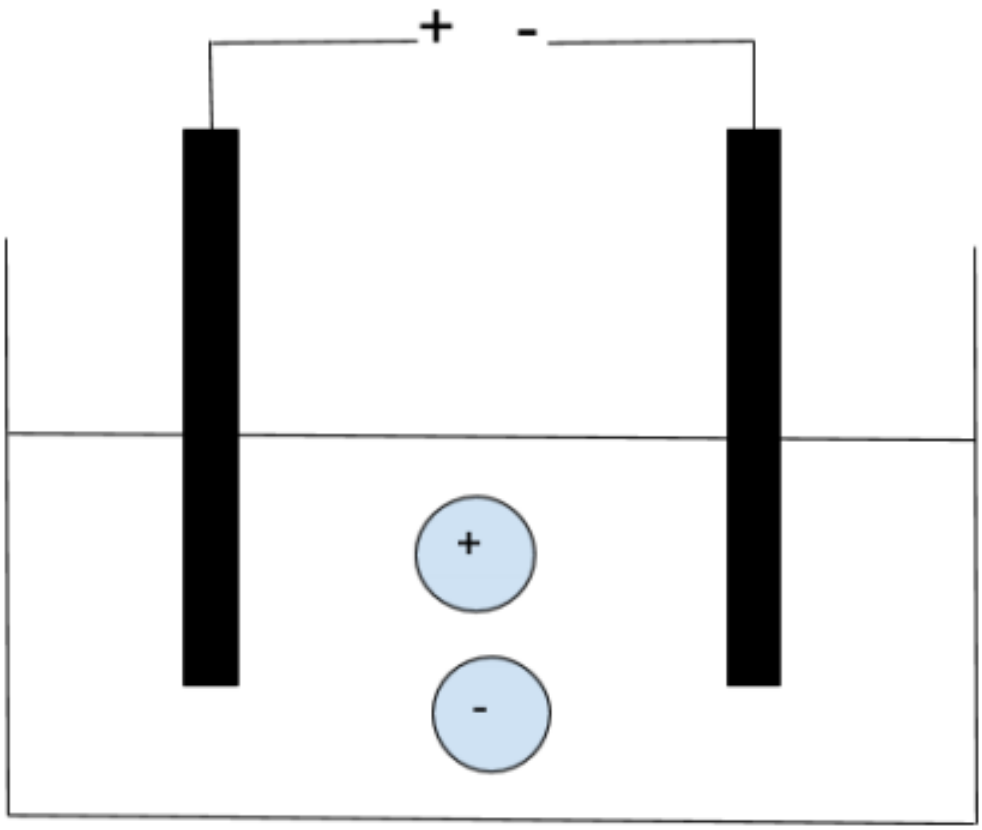
_____

_____

**Label the diagram**



1. Complete the diagram with the following labels: anode, cathode, electrode, electrolyte, anion and cation




2. Describe an ionic bond.

.....

.....

3. Why can't a solid ionic substance conduct electricity?

.....

.....

4. Why can molten and solutions of ionic substances conduct electricity?

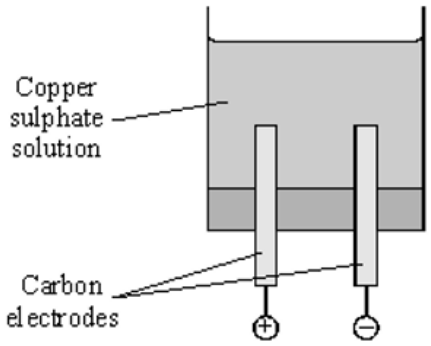
.....

.....

Complete the table

| Substance electrolysed | What is formed at the cathode | What is formed at the anode |
|---|---|---|
| molten lead iodide | | |
| | Sodium | chlorine |
| Copper sulfate solution | | |
| calcium bromide solution | | |
| molten aluminium oxide | | |

**Q1.** An investigation into the *electrolyte* copper sulphate solution was carried out as shown.




(a) What does *electrolyte* mean?

.....

.....

.....

**(2)**

(b) These were the observations.

| | |
|---|---|
| Negative electrode | solid formed |
| Positive electrode | gas given off |

(i) Name the solid formed.

.....

**(1)**

(ii) Name the gas given off.

.....

**(1)**

(c) How could a sample of gas be collected at the positive electrode?

.....

.....

**(2)**

(d) Suggest why the blue colour of copper sulphate becomes paler during the investigation.

.....

.....

**(2)**

**(Total 8 marks)**

## ***Ionic half equations***

***A half-equation shows you what happens at one of the electrodes during electrolysis. Electrons are shown as e-. A half-equation is balanced by adding, or taking away, a number of electrons equal to the total number of charges on the ions in the equation.***

***When positive metal ions (cations) arrive at the negative electrode (the cathode), they gain electrons to form neutral metal atoms. This is called reduction. For example:***

***$Pb^{2+} + 2e^- \rightarrow Pb$***

## Q1.

A student makes a hypothesis:

'When different salt solutions are electrolysed with inert electrodes, the product at the negative electrode is always a metal'.

(a) Describe how you would test this hypothesis in the laboratory.

You should:

- draw a labelled diagram of the apparatus
- give the independent variable
- describe what you would see at the negative electrode if the hypothesis is true.

Diagram

Independent variable _____

_____

Observation _____

_____

**(5)**

(b) The student's hypothesis is only partially correct.

Explain why the product at the negative electrode is not always a metal.

_____

_____

_____

_____

**(2)**

(c) Predict the product at the positive electrode in the electrolysis of:

- sodium chloride solution
- copper sulfate solution.

Sodium chloride solution _____

Copper sulfate solution _____

**(2)**

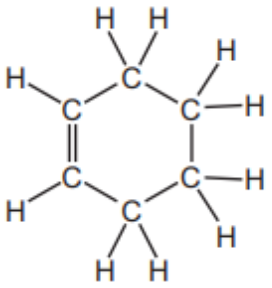
# Organic chemistry

**Use the following resources to help you with this section:**

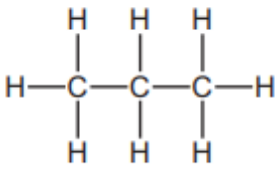
| Name | Molecular Formula | Structure |
|---|---|---|
| Methane | | |
| Ethane | | |
| Propene | | |
| Butane | | |
| Pentene | | |
| Hexane | | |

**4** The structures of some organic compounds are shown.

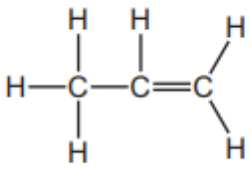
**P**



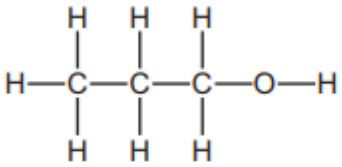
**Q**



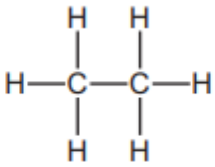
**R**



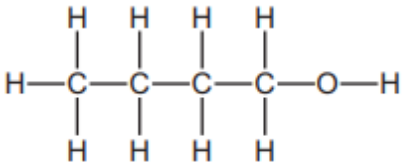
**S**



**T**



**U**



**(a)** **(i)** Which **two** of these compounds are alcohols?

Explain your answer.

.....

..... [2]

**(b)** Methanol and ethanol are alcohols in the same homologous series.

Complete the following sentence about a homologous series using words from the list.

| | | | |
|---|---|---|---|
| **alcohols** | **chemical** | **compounds** | **elements** |
| **functional** | **mixtures** | **physical** | |

A homologous series is a family of similar ..... with similar

..... properties due to the same ..... group. [3]

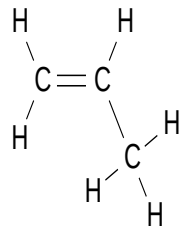
# Nomenclature

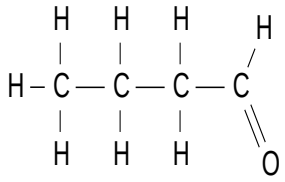
**Use the following resources to help you with this section:**

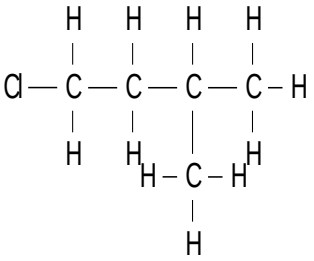
For each of the molecules below:

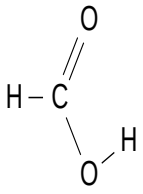
a) state the name of the molecule

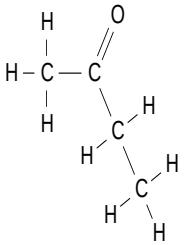
b) state the functional group(s) present

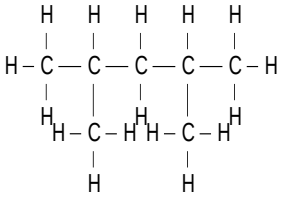


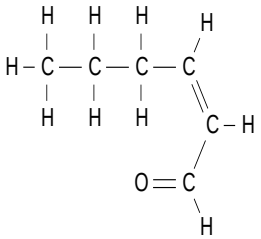


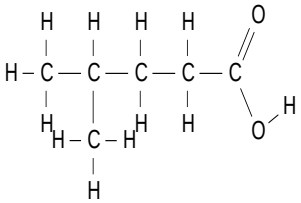












# Part 2 – Highly Recommended

## BIOLOGY

## Organs and Systems

### Cardiovascular System

***Q1. Describe the structure and function of the different types of blood vessels***

| Vessel | Structure | Function |
|---|---|---|
| Arteries | | |
| Capillaries | | |
| Veins | | |

**REVIEW**

**Cardiovascular System**

**Use the resources below to support you with the questions**

https://www.youtube.com/watch?v=3ZYh00GJZSI

https://www.savemyexams.co.uk/notes/gcse-biology-aqa-new/organisation/organisation-the-cardiovascular-respiratory-system/the-heart/

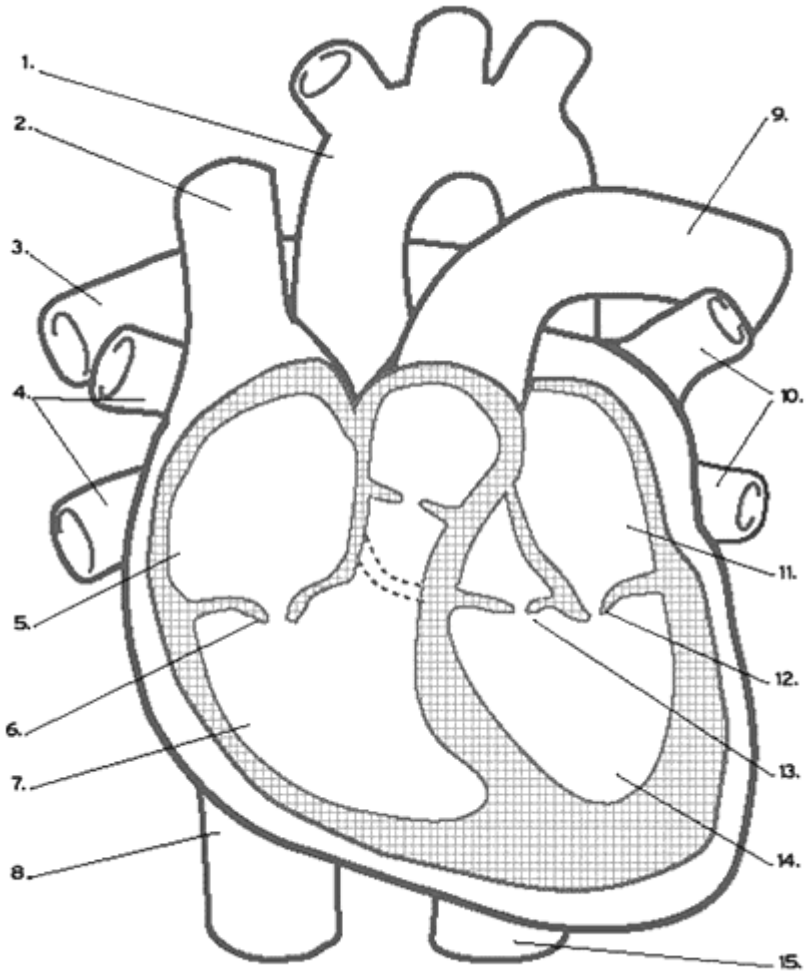
***Q2. Complete the table below on the ABO blood type system***

| | Group A | Group B | Group AB | Group O |
|---|---|---|---|---|
| Red Blood Cell Type | | | | |
| Antibodies in Plasma | | | | |
| Antigens on red blood cell | | | | |

***Q3. What is the Rhesus system?***

_____
_____
_____
_____
_____
_____
_____
_____
_____

***Q4. Label the diagram of the heart below. Shade in RED the areas where there is flow of oxygenated blood. Shade in BLUE the areas where there is flow of deoxygenated blood***



## Apply

Explain how the structure of an artery is related to its functions.

(3)

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Describe two differences between the structure of a capillary and the structure of a vein

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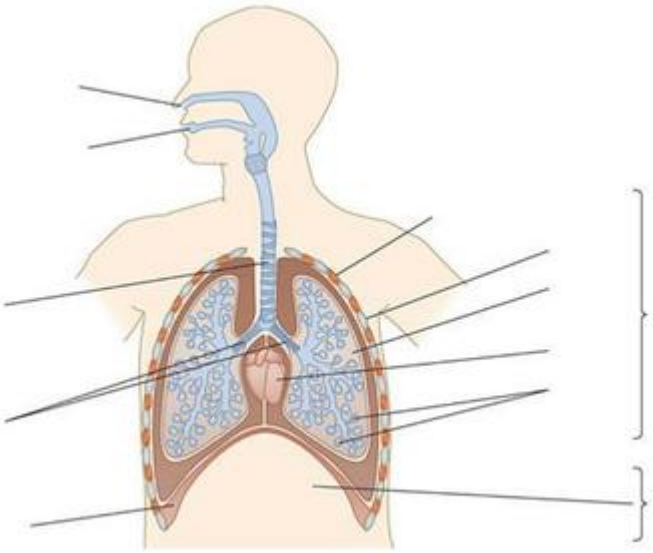
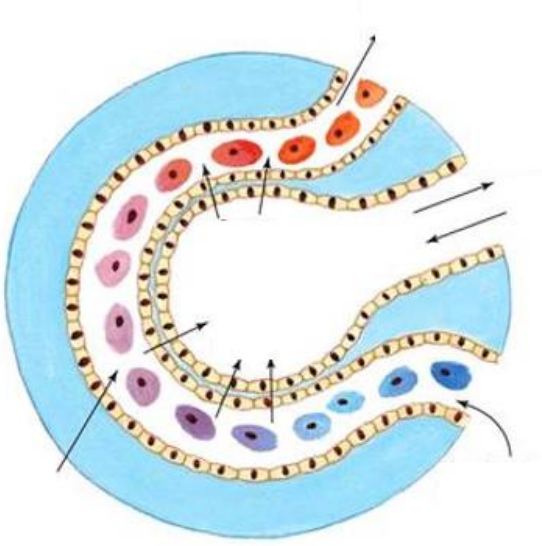
# Lungs and Ventilation

***Q1. Label the diagram below of the lungs and ventilation system***



***Q2. Label the diagram of the alveolus and indicate the direction of the flow of gases.***



Labels

| | | |
|---|---|---|
| Capillary | Oxygenated blood | Deoxygenated blood |
| Alveolus (air sac) | Oxygen | Carbon dioxide |
| Oxygen in | Carbon dioxide out | Short diffusion distance |
| From pulmonary artery | To pulmonary vein | One cell thick |

**REVIEW**

**Lungs and Ventilation**

**Use the resources below to support you with the questions**

https://www.youtube.com/watch?v=Y8R_fgJS9jA

https://www.savemyexams.co.uk/notes/gcse-biology-aqa-new/organisation/organisation-the-cardiovascular-respiratory-system/the-lungs/

***Q3. What are the three main features of the gas exchange system?***

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

***Q4. Complete the flowchart showing inspiration and expiration***

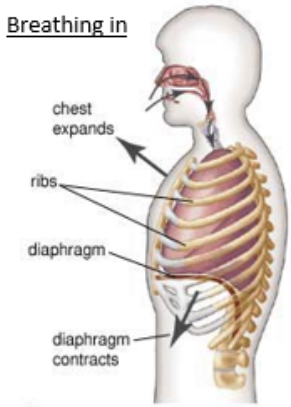
Breathing in (inhalation)

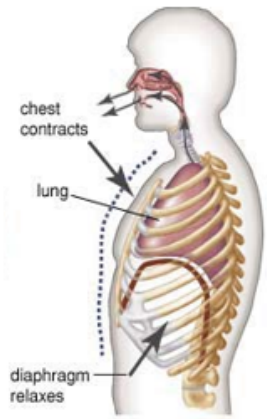
_____ contracts and moves downwards

_____ move upwards and outwards

Air pressure in the lungs _____

Air automatically rushes into the _____




Breathing out (exhalation)

_____ relaxes and moves upwards

_____ move downwards and in

Air pressure in the lungs _____

Air automatically rushes out of the _____

| |
|---|
| lungs |
| decreases |
| ribs |
| diaphragm |

| |
|---|
| lungs |
| increases |
| ribs |
| diaphragm |

## Apply

Describe and explain how the lungs of a mammal are adapted for rapid gas exchange.

**(5)**

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The lungs in a mammal are adapted for efficient gas exchange.

(a) The diagram below illustrates a small part of the lung responsible for gas exchange.

(i) On the diagram, add a line labelled P to a branch of the pulmonary vein.

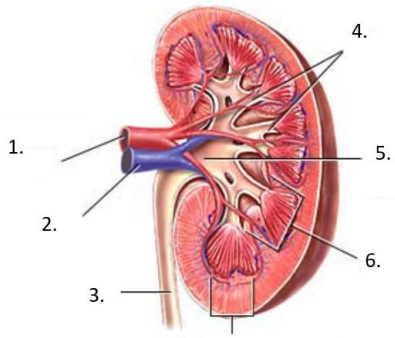
**(1)**

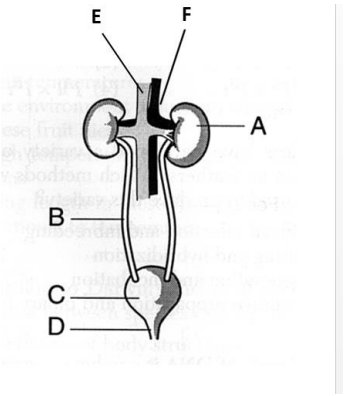
(ii) Give **one** difference between the structure of a capillary and the structure of a vein.

**(1)**

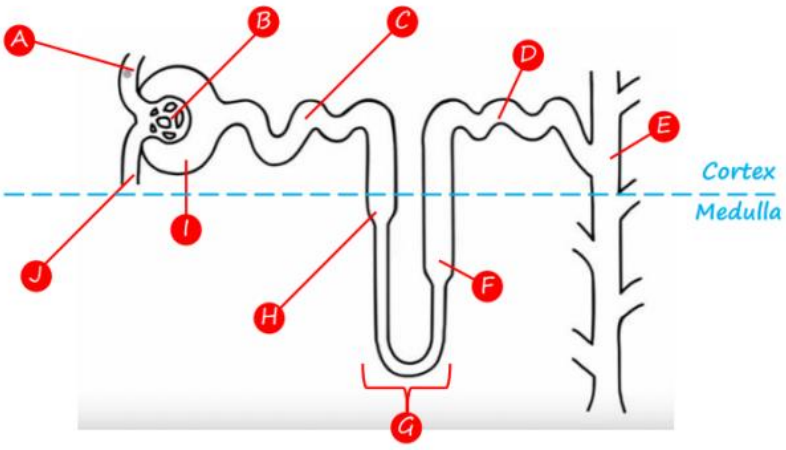
# Urinary System

***Q1. Label the structures and diagrams below***




***Q2. Label the diagram of the nephron***




**REVIEW**

**Urinary System**

**Use the resources below to support you with the questions**

https://www.youtube.com/watch?v=tx9hYFeEd1E

https://www.savemyexams.co.uk/notes/igcse-biology-cie-new/13-excretion-in-humans/13-3-the-kidney/

## Apply

(a) Explain what is meant by the term *homeostasis*.

[2]

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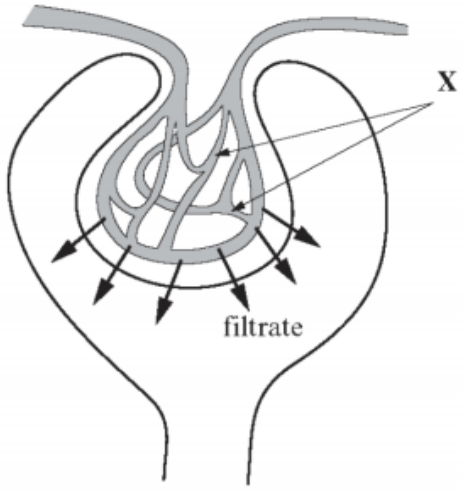
.....

The diagram shows part of a kidney tubule or nephron.




*(a)* (i) Name the network of capillaries labelled **X**. [1]

.....

(ii) Apart from water and glucose, name **two** substances which will be present in the filtrate. [1]

.....

(iii) Name the process that separates these molecules from the blood plasma. [1]

.....

# Cell Transport

**REVIEW**

**Cell Transport**

**Use the resources below to support you with the questions**

https://www.youtube.com/watch?v=J5pWH1r3pgU

https://www.savemyexams.co.uk/notes/as-biology-cie/4-cell-membranes-transport-as/4-1-fluid-mosaic-membranes-as/4-1-3-the-cell-surface-membrane-as/

## Surface Area to Volume Ratio

***Q1. Complete the table below***

| Length of each side of cube (L) cm | Area of each face of cube ($L^2$) $cm^2$ | Surface area of the whole cube ($L^2$) × 6 $cm^2$ | Volume of the cube ($L^3$) $cm^3$ | Surface area to volume ratio $\frac{\text{surface area } cm^2}{\text{volume } cm^3}$ |
|---|---|---|---|---|
| *2* | | | | |
| *4* | | | | |

***Q2. Now work out what the surface area to volume ratio of a 10 cm × 10 cm cube is.***

| Length of each side of cube (L) cm | Area of each face of cube ($L^2$) $cm^2$ | Surface area of the whole cube ($L^2$) × 6 $cm^2$ | Volume of the cube ($L^3$) $cm^3$ | Surface area to volume ratio $\frac{\text{surface area } cm^2}{\text{volume } cm^3}$ |
|---|---|---|---|---|
| *10* | | | | |

***Q3. Complete the following sentences.***

The …… the animal, the …… the surface area : volume (SA/V) ratio.

Animals often have …… surface areas in hot climates, and …… surface areas in cold climates.

***Q4. Draw a diagram of the cell surface membrane, including phospholipid bilayer and channel proteins***

***Q5. Describe the different types of Passive Transport***

| | |
|---|---|
| Diffusion | |
| Facilitated Diffusion | |
| Osmosis | |

***Q6. Describe the process of Active Transport with the aid of a diagram***

_____
_____
_____
_____
_____
_____
____

***Q7. Describe the process of endocytosis and exocytosis***

## Apply

The fluid mosaic model has been developed from the knowledge of the structure and properties of cell membranes. It can explain how molecules can enter and leave a cell.

(a) Describe the structure of a cell membrane. (You may use a labelled diagram to support your answer).

**(5)**

(b) Suggest **two** properties of molecules that enable them to enter a cell by diffusion.

**(2)**

1 .....

2 .....

(c) Facilitated diffusion and active transport are two ways in which molecules are transported across cell membranes.

Describe **one** similarity and **one** difference between facilitated diffusion and active transport.

(i) Similarity

**(1)**

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.....

.....

.....

(ii) Difference

**(1)**

.....

.....

.....

.....

# SOLUTIONS

## BIOLOGY SOLUTIONS

Q1

| Question | | Marking details | Marks Available |
|---|---|---|---|
| *(a)* | (i) | *atrio-ventricular node (max 2)*<br>{collects/ receives} {wave of excitation/ impulses} from SAN;<br>NOT signal<br>passes on to{Purkyne fibres/Eundle of His};<br>allows delay before wave passed to ventricles/ stops atria and ventricles contracting at the same time; | 2<br><br>2 |
| | (iii) | *Bundle of His and Purkyne fibres*<br>conducts wave to {base/ apex} of ventricles/ heart;<br>ensures contraction (from base) upwards; | |
| *(b)* | (i) | 11; | 1 |
| | (ii) | 7; | 1 |
| | (iii) | 1; | 1 |
| | (iv) | 6; | 1 |
| | (v) | 4; | 1 |
| | (vi) | 2; | 1 |
| | (vii) | 12; | 1 |
| | (viii) | 10; | 1 |
| | | **Question 5 Total** | **[12]** |

Q2

| | | | |
|---|---|---|---|
| **1** | **ultrafiltration** ; | | |
| **2** | **afferent** arteriole is wider than **efferent** arteriole ; | | |
| **3** | high **blood pressure** in glomerulus / high(er) **hydrostatic pressure** in glomerulus (than in Bowman's capsule) ; | | |
| **4** | *idea that* **endothelium** / wall of capillary , has gaps to , allow / prevent , passage (of substances / cells) ; | | ***4*** e.g. fenestrations in capillary wall don't allow red blood cells to leave<br>**DO NOT CREDIT** cell walls of capillaries |
| **5** | *idea that* **basement membrane** stops removal of , large molecules / cells ; | | ***5*** e.g. basement membrane (only) allows small molecules to pass through |
| **6** | **podocytes** / **epithelial** cells of Bowman's capsule , have (finger-like) projections / processes ; | | |
| **7** | (projections) ensure gaps to allow passage (of substances) ; | | |
| | | **3 max** | |

Q3.

(a) Diaphragm/intercostal muscles contract;
Increases volume of thorax/chest/lungs;
Negative/lower pressure in lungs; 3
[*Ignore: references to internal and external intercostal muscles*]

(b) (i) Allows stabilisation/becomes steady/adapts; 1

(ii) 41.7 ($dm^3$/litres); 1

(iii) Tidal volume increases steadily then levels out;
Breathing rate changes little until highest exercise rate/180 reached then increases; 2
[*Note: Consider giving credit to answers where a specific part of the range is defined and described accurately*]

**[7]**

## PHYSICS RECALL PRACTICE QUESTIONS SOLUTIONS

**1.** A toy boat moves $4.00\ \text{m}$ in the direction of the applied force of $26\ \text{N}$ on the sails. Calculate the work done on the boat.

$W = Fd = 26 \times 4 = 100\ \text{J}$

**2.** Calculate the gravitational potential energy stored raising a $60\ \text{kg}$ child to the top of a $2.0\ \text{m}$ slide.

$E_p = mgh = 60 \times 9.81 \times 2 = 1177\ \text{J}.$

$= 1200\ \text{J} = 1.2\ \text{kJ}$

**3.** A spring with a constant of $25\ \text{N/m}$ is extended by $50\ \text{cm}$. Calculate the stored elastic potential energy in the spring.

$E_e = \frac{1}{2}kx^2 = \frac{1}{2} \times 25 \times 0.5^2 = 3.125 = 3.1\ \text{J}.$

**4.** Calculate the kinetic energy of a $80\ \text{kg}$ student sprinting at $8.0\ \text{m/s}$.

$E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 80 \times 8^2 = 2560 = 2.5\ \text{kJ}$

**5.** A $4.0\ \text{kg}$ ball has $50\ \text{J}$ of kinetic energy. How fast is it moving?

$E_k = \frac{1}{2}mv^2, \quad v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2 \times 50}{4}} = 5.0\ \text{m/s}$

**6.** The child in question 2 'loses' $10\ \%$ of their gravitational potential energy store to frictional forces going down the slide. Calculate the speed of the child at the bottom of the slide.

$E_k = 0.9 \times E_p = 0.9 \times 1177 = 1059.3\ \text{J}.$

$\therefore E_k = \frac{1}{2}mv^2, \quad v = \sqrt{\frac{2E_k}{m}} = \sqrt{\frac{2 \times 1059.3}{60}} = 5.942$

$= 5.9\ \text{m/s}$

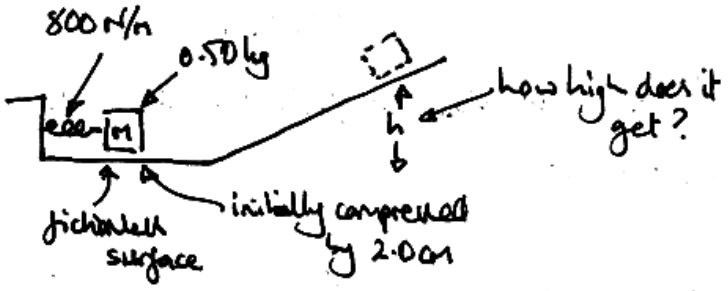
**7.** A $10\ \text{g}$ spring with a spring constant of $20\ \text{N/m}$ is extended by $10\ \text{cm}$ then released horizontally on a frictionless surface. Calculate the speed of the spring after release.

$E_e = E_k \qquad \frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$v = \sqrt{\frac{kx^2}{m}} = \sqrt{\frac{20 \times 0.1^2}{0.01}} = 4.472$

$= 4.5\ \text{m/s}.$

**8.** A $0.50\ \text{kg}$ mass is launched from a frictionless surface by a spring with a spring constant of $800\ \text{N/m}$ which is initially compressed by $2.0\ \text{cm}$. How high does the mass get up a slope as shown? Provide the vertical displacement.




$E_e = E_p.$

$\frac{1}{2}kx^2 = mgh.$

$h = \frac{kx^2}{2mg} = \frac{800 \times 0.02^2}{2 \times 0.5 \times 9.81}$

$= 0.0326$

$= 3.3\ \text{cm}$

| Q | Marking guidance | Mark |
|---|---|---|
| **9** | Eff = 1200 / 1500<br>Eff = 0.8 or 80% | 1<br>1 |
| **10** | Useful energy transfer = 102 – 9 = 93 J<br>Eff = 93 / 102<br>Eff = 0.91 or 91 % (to 2sf) | 1<br>1<br>1 |
| **11** | a) Wasted energy transfer = 100 – 99.5 = 0.5 J<br>b) Eff = 99.5 / 100<br>Eff = 0.995 or 99.5 % | 1<br>1<br>1 |

## HOOKE'S LAW

**Q1.**(c) both points plotted correctly

**1**

correct line of best fit drawn
*to pass through (0,0) and (10,20)*

**1**

(d) force = spring constant × extension
*allow F = ke*

**1**

(e) extension = 0.2
*allow 0.035 / 0.08 / 0.125 / 0.16*

**1**

10 = k × 0.2
*force value must match extension*
*this mark may be awarded if e is in cm*

**1**

$$k = \frac{10}{0.2}$$

*allow correct transformation of their chosen values*
*this mark may be awarded if e is in cm*

**1**

k = 50
*an answer 0.5 scores **3** marks*

**1**

*an answer of 50 scores **4** marks*

(f) the line is straight
*allow the line does not curve*

**1**

and passes through the origin
*this mark is dependent on scoring the first mark*
*llow a correct description of direct proportionality for **2** marks*
*ignore the line shows they are directly proportional*

**1**

**[9]**

**Q2.** (a) accept any value between 12 (mm) and 13 (mm) inclusive

**1**

(b) to reduce the error in measuring the extension of the spring

*accept length for extension throughout*

**1**

as the ruler at an angle would make the measured extensions shorter

**1**

(c) 1 (N) to 6 (N)

*accept from 0 (N) to 6 (N)*

**1**

(d) gives a straight line through the origin

**1**

(e) any practical technique that would improve the accuracy of length measurement eg use a set square

**1**

to line up the bottom of the spring with the ruler scale
**or**
attach a horizontal pointer to the bottom of the spring (1)
so that the pointer goes across the ruler scale (1)

**1**

(f) the spring has been inelastically deformed

**1**

because it went past its limit of proportionality

*accept elastic limit for limit of proportionality*

**1**

*accept it does not go back to its original length when the weights are removed*

**[9]**