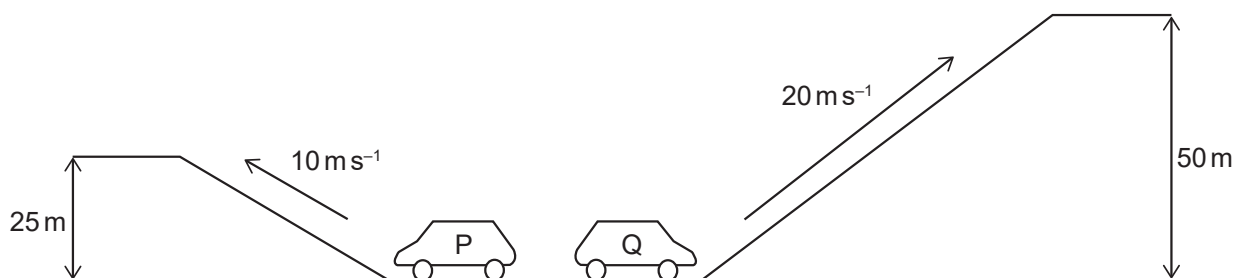


- 6 Inorganic substances are put into detergents to act as a buffer, i.e. to keep the pH close to 7. Sodium tripolyphosphate is one major one that is used. The equation for its formation is shown below:



What are the values of **a**, **b**, **c** and **d**, respectively?

- A** 3, 1, 1, 3
B 6, 2, 2, 7
C 2, 4, 2, 2
D 1, 2, 1, 2
E 2, 2, 1, 2
- 7 Two identical cars, P and Q, start at the same level. Car P moves at a constant speed of 10 m s^{-1} up a hill to a height of 25 m in a time of 20 s. In the same time, car Q moves at a constant speed of 20 m s^{-1} up a hill to a height of 50 m.



[diagram not to scale]

Which of the following statements are correct for the kinetic energies of the cars while they are travelling up the hills, and for their gravitational potential energies once they are at the top?

	<i>kinetic energy</i>	<i>gravitational potential energy</i>
A	car Q has twice as much as car P	car Q has twice as much as car P
B	car Q has twice as much as car P	car Q has four times as much as car P
C	car Q has four times as much as car P	car Q has twice as much as car P
D	car Q has four times as much as car P	car Q has four times as much as car P

8 Simplify:

$$\left(\frac{2x^{\frac{3}{2}}y^3}{\sqrt{z}} \right)^2$$

A $\frac{4x^6y^5}{z^2}$

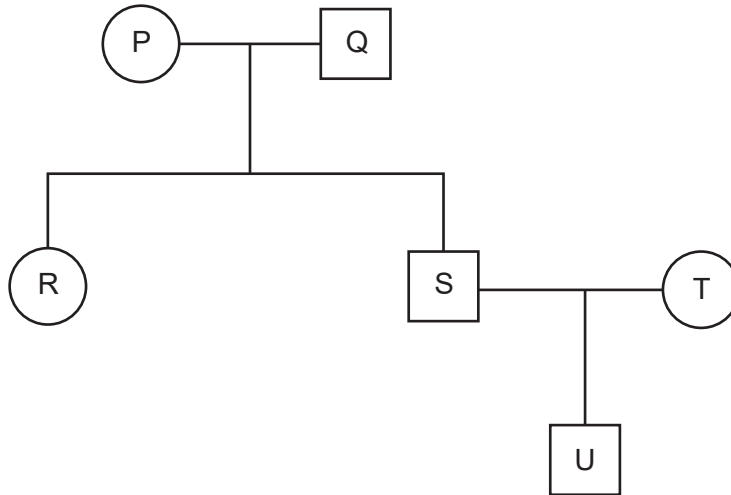
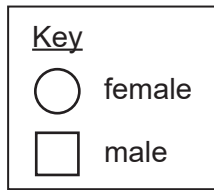
B $\frac{4x^3y^6}{z}$

C $\frac{4x^3y^5}{z}$

D $\frac{4x^{\frac{5}{2}}y^5}{z}$

E $\frac{4x^{\frac{5}{2}}y^5}{z^2}$

- 9 Individual P in the family pedigree below is homozygous dominant and individual Q is homozygous recessive for a particular feature.



What is the percentage probability that individual U is homozygous recessive if:

	<i>i) T is homozygous recessive</i>	<i>ii) T is heterozygous</i>
A	50%	0%
B	25%	50%
C	50%	25%
D	25%	0%
E	0%	25%

- 10 The reaction between nitrogen and hydrogen to form ammonia is exothermic.



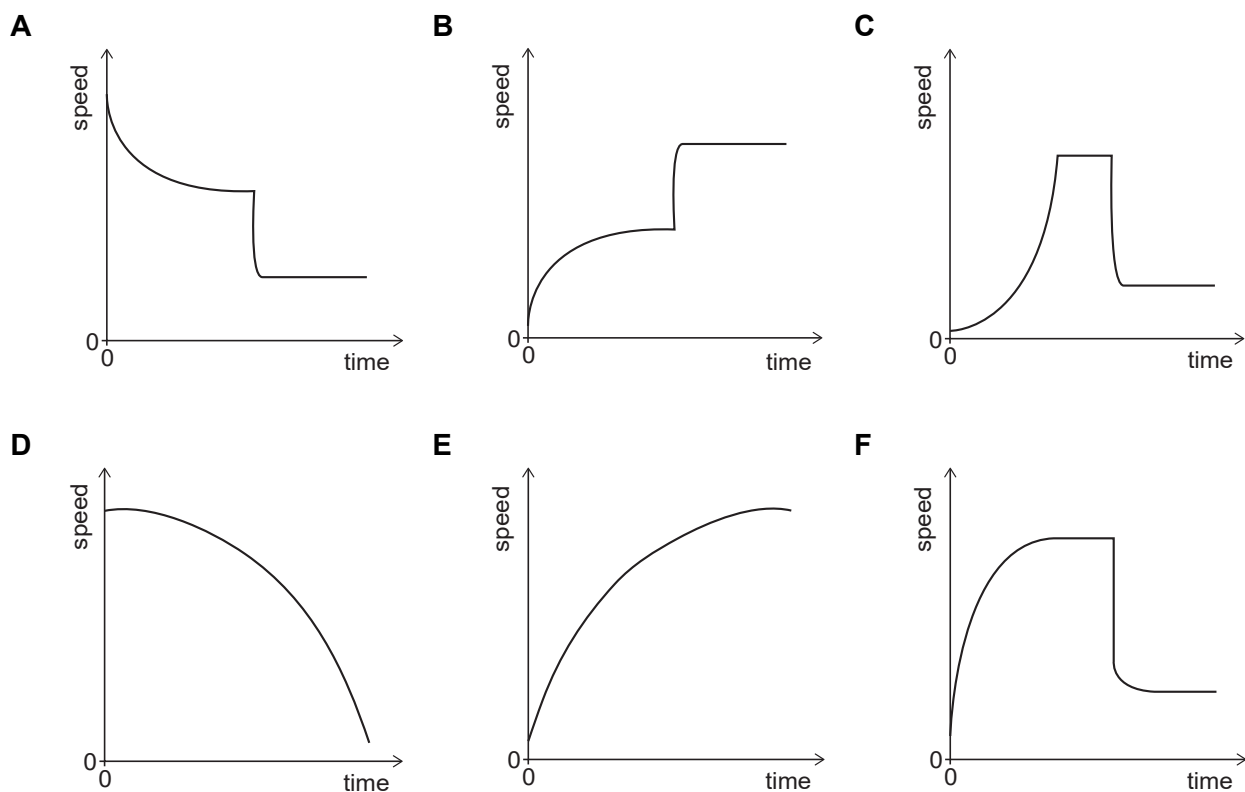
The bond energies in the three molecules are as shown.

$\text{N} \equiv \text{N}$	$x \text{ kJ mol}^{-1}$
$\text{H} - \text{H}$	$y \text{ kJ mol}^{-1}$
$\text{N} - \text{H}$	$z \text{ kJ mol}^{-1}$

Which statement can be deduced from this information?

- A $z > x + y$
- B $2z > x + y$
- C $2z > x + 3y$
- D $6z > x + 3y$
- 11 Following a natural disaster, a container of emergency supplies is dropped from a hovering (stationary) helicopter to people on the ground. The container drops vertically until it reaches its terminal speed. A parachute attached to the container then opens and the container quickly reaches a new terminal speed.

Which graph represents how the speed of the container changes with time from when it is released from the helicopter to just before it hits the ground?



- 12** A bag contains x red balls, y blue balls and z yellow balls. One ball at random is taken out and put back. A second ball at random is taken out and put back.

If the balls are identical in all respects except colour and are well mixed, what is the probability that the first ball was red and the second blue?

A $\frac{(x+y)}{(x+y+z)}$

B $\frac{(x+y)}{(x+y+z)^2}$

C $\frac{xy}{(y+z)(x+z)}$

D $\frac{xy}{(x+y+z)(x+z)}$

E $\frac{xy}{(x+y+z)^2}$

- 13** Signals travelling along a reflex arc pass from one neuron to the next neuron by the release of transmitter molecules. The statements below are about this process.

- 1** The signal is transmitted across the synapse by osmosis.
- 2** Transmitter molecules are released once the signal has been transmitted across the synapse.
- 3** The release of transmitter molecules is triggered by the signal.
- 4** The signal is transmitted across the synapse by diffusion.

Which of the above statements are correct?

- A** 1 and 2 only
- B** 1 and 3 only
- C** 1 and 4 only
- D** 2 and 4 only
- E** 3 and 4 only

- 14 Hydrogen, magnesium and phosphate can exist as the following ions: H^+ , Mg^{2+} , PO_4^{3-} .

Different salts can be formed from these ions.

Which formula below is a formula for one of these salts?

- A $\text{Mg}(\text{HPO}_4)_2$
- B $\text{Mg}(\text{H}_2\text{PO}_4)_2$
- C MgH_3PO_4
- D $\text{Mg}(\text{H}_3\text{PO}_4)_2$
- E Mg_2HPO_4
- F $\text{Mg}_2\text{H}_2\text{PO}_4$
- 15 A radioactive isotope X, which is used in hospitals, has a half-life of 6.0 hours. It decays to form an isotope Y of a different element which is not radioactive.

A pure sample of X is produced in a nuclear reactor. Twelve hours later, when the sample arrives at a hospital, the number of atoms of X in the sample is 1.6×10^{23} .

How many atoms of X were in the original pure sample, and how many atoms of Y will the sample contain exactly 24 hours after it arrives at the hospital?

	<i>original number of atoms of X</i>	<i>number of atoms of Y after 24 hours</i>
A	3.2×10^{23}	1.0×10^{22}
B	3.2×10^{23}	2.0×10^{22}
C	3.2×10^{23}	3.0×10^{23}
D	3.2×10^{23}	3.1×10^{23}
E	6.4×10^{23}	1.0×10^{22}
F	6.4×10^{23}	2.0×10^{22}
G	6.4×10^{23}	6.2×10^{23}
H	6.4×10^{23}	6.3×10^{23}

- 16 In statistics, Spearman's rank correlation coefficient is given by the formula:

$$r = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$

Rearrange the formula to make $\sum d^2$ the subject.

- A $\sum d^2 = 1 - \frac{r(n^3 - n)}{6}$
- B $\sum d^2 = \left(\frac{(1-r)(n^3 - n)}{6} \right)^2$
- C $\sum d^2 = \frac{(1-r)(n^3 - 1)}{6}$
- D $\sum d^2 = \frac{(1+r)(n^3 - n)}{6}$
- E $\sum d^2 = \frac{(1-r)(n^3 - n)}{6}$

- 17 The three statements below are about breathing out.

- 1 The ribs swing down and inwards when breathing out.
- 2 The diaphragm muscles contract when breathing out.
- 3 The pressure in the lungs increases when breathing out.

Which of these statements is/are correct?

- A 1 only
- B 2 only
- C 3 only
- D 1 and 2 only
- E 1 and 3 only
- F 2 and 3 only

18 An ore of lead contains lead only in the form of lead(II) sulfide, PbS.

By mass, 75% of this ore is PbS.

Calculate the maximum mass of lead that can be extracted from 480 kg of the ore.

[A_r : Pb = 207; S = 32]

A 48.20 kg

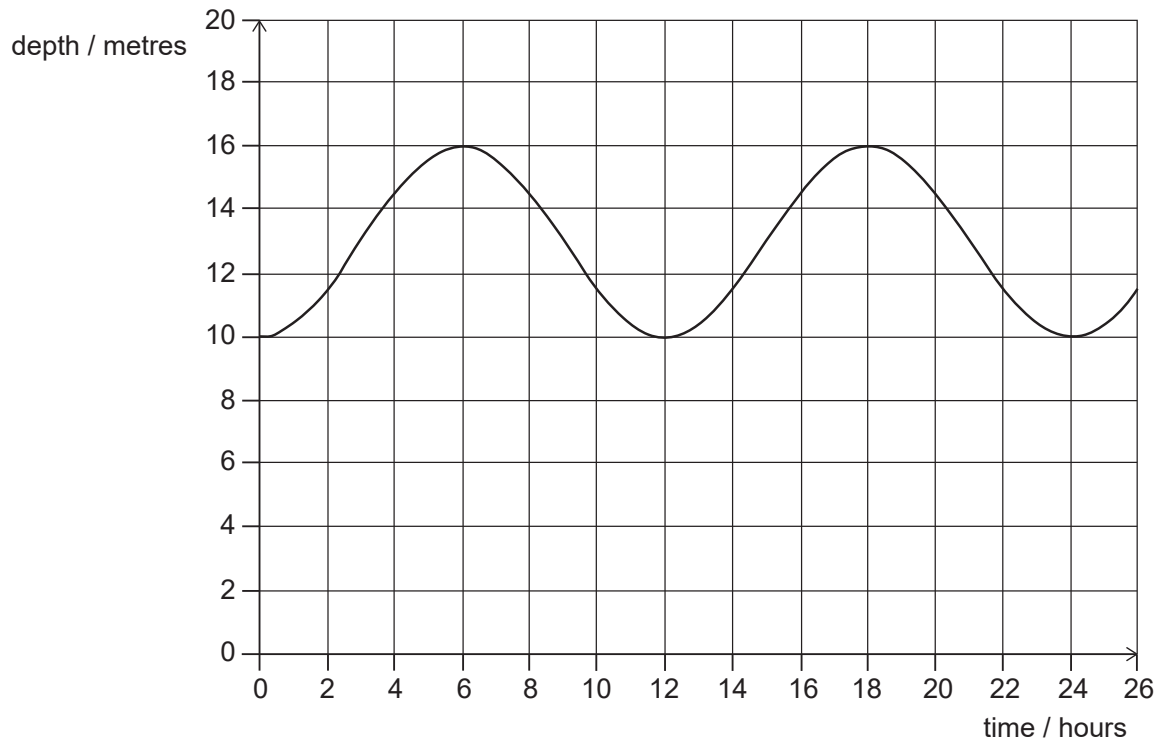
B 103.9 kg

C 180.0 kg

D 311.8 kg

E 415.7 kg

19 The depth of water in a particular tidal harbour varies with time as shown in the graph:



If the variation in depth caused by the effect of the tide is considered as a wave, what are the amplitude and frequency of this wave?

	<i>amplitude / m</i>	<i>frequency / Hz</i>
A	3	$\frac{1}{12 \times 3600}$
B	3	$\frac{3600}{12}$
C	6	$\frac{1}{24 \times 3600}$
D	6	$\frac{3600}{24}$
E	8	$\frac{1}{12 \times 3600}$
F	8	$\frac{3600}{12}$
G	16	$\frac{1}{24 \times 3600}$
H	16	$\frac{3600}{24}$

20 The graphs of the following equations are drawn:

1 $y = 3x - 2$

2 $y = x^2$

3 $y = 1 - x^2$

4 $y = x + 6$

Which pair of graphs do **not** intersect?

A 1 and 2

B 1 and 3

C 2 and 3

D 2 and 4

E 3 and 4

21 The table shows the concentrations, in arbitrary units, of four substances. These substances are present in each of two animal cells, 1 and 2, whose cell membranes are in contact.

<i>substance</i>	<i>concentration in arbitrary units</i>	
	<i>cell 1</i>	<i>cell 2</i>
P	9	15
Q	12	15
R	7	4
S	6	3

Which overall movement of a substance between the two cells requires oxygen?

A P: cell 2 → cell 1

B Q: cell 1 → cell 2

C R: cell 2 → cell 1

D S: cell 1 → cell 2

- 22 Assume that element Y forms a naturally-occurring ion Y^{3-} with the electronic configuration 2,8,8.

Using this information, determine to which Group and Period of the IUPAC Periodic Table Y would belong.

	<i>Group</i>	<i>Period</i>
A	13	3
B	13	4
C	15	3
D	15	4
E	18	3
F	18	4

- 23 A 100% efficient transformer has 1500 turns in its primary coil. The input to the transformer is 250 V alternating current (ac). The output is connected to a resistor. The output current is 10 A and the output power is 0.50 kW.

What is the number of turns in the secondary coil?

- A 75
- B 300
- C 750
- D 7500
- E 30 000

- 24** A solid sphere of radius r fits inside a hollow cylinder. The cylinder has the same internal diameter and length as the diameter of the sphere.

The volume of a sphere is $\frac{4}{3}\pi r^3$, where r is the radius of the sphere.

What fraction of the space inside the cylinder is taken up by the sphere?

A $\frac{1}{4}$

B $\frac{1}{3}$

C $\frac{1}{2}$

D $\frac{2}{3}$

E $\frac{3}{4}$

- 25** Which one of the following is **not** needed in order to genetically engineer bacterial cells to produce a fluorescent protein from a jellyfish?

A a plasmid or viral vector

B enzymes to cut DNA molecules

C fluorescent protein from a jellyfish

D ligase enzyme

- 26 A compound of iodine and oxygen contains 63.5 g of iodine and 20.0 g of oxygen.

Which one of the following is its empirical formula?

(A_r : I = 127; O = 16)

- A IO
- B IO₂
- C I₂O
- D I₂O₃
- E I₂O₅
- F I₅O₂

- 27 The microwaves generated in a microwave oven travel through air at a speed of $3.0 \times 10^8 \text{ ms}^{-1}$, with a wavelength of 12 cm. They pass through plastic food containers, but at a reduced speed of $2.0 \times 10^8 \text{ ms}^{-1}$.

What are the wavelength and frequency of these microwaves as they pass through a plastic food container?

	wavelength / cm	frequency / Hz
A	8.0	1.7×10^9
B	8.0	2.5×10^9
C	8.0	3.8×10^9
D	12	1.7×10^9
E	12	3.8×10^9
F	18	1.7×10^9
G	18	2.5×10^9
H	18	3.8×10^9

END OF TEST

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